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Practice and exploration of higher physics teaching reform

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ABSTRACT

Higher physics education can cultivate students' science literacy, experimental ability and creative ability. According to the current situation of students and our university, we have paid more attention to the absorption of current advanced education ideas and implement into teaching behaviors. We carried out some reform measures to improve the quality of higher physics education. By teaching reform, we have effectively improved the quality of advanced physics education.

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Introduction

In china, advanced physics education undertakes the task of cultivating talents in physics and other related professions. It plays an important role in helping students acquire necessary physics knowledge, enhance their ability to analyze and solve problems, and cultivate students' exploring spirit and innovation consciousness and ability [1]. With the deepening of the higher education curriculum reform, domestic traditional higher education model has experienced significant change and the teaching reform of advanced physics education has also achieved remarkable results in aspects of teaching contents, teaching material construction, teaching staff construction and teaching technology. In recent years, in the teaching process of advanced physics education, we have paid more attention to the absorption of current advanced education ideas and implement into teaching behaviors. We have also explored and summarized some effective teaching reform measures.

Implementation strategy of advanced physics teaching reform

Guide the teaching of advanced physics education with an open educational concept

In the information society, advanced physics education must actively adapt to the trend of technological and social development. The specific performances of guiding physics teaching with an open educational concept are as follows: the teaching activity is students centered and students' development oriented. Physics knowledge teaching no longer simply emphasizes on the learning of static and declarative knowledge, but pays more attention to the learning of dynamic physical knowledge (including procedural knowledge and strategic knowledge). It also lays emphasis on the association between physics and STS (science, technique and society), as well as the construction of an open and solid physics education system [2].

First of all, we have adjusted and enriched the original teaching program of professional curriculum. Based on the revision of professional curriculum teaching program, we select excellent teaching materials, carry out proper adjustment, enrichment and renovation on the content selection and chapter sequence of teaching materials with the combination of the reality, and set up a "window" and "interface" introducing cutting-edge physical knowledge in the teaching contents, striving to achieve the modernization of basic physics teaching as well as the foundation of modern physics teaching, thus making physics have a strong sense of modernity and changing the dull and boring traditional teaching mode. On this basis, we establish a resource library of advanced physics curriculum, which reserves a large number of physical resources. Secondly, in the teaching process, we have strived to achieve the dynamic association between advanced physics and modern society, so as to help students to recognize the real society in accordance with the physical knowledge they have learned (such as the practical application of physical science) and understand physical science according to the perception of social reality, thus master physical knowledge more comprehensively. For example, when teaching thermotics, we can introduce the knowledge of entropy of information, superfluity phenomena of liquid helium, fractal, theory of dissipative structure and photon gas with the combination of teaching contents (such as the examples and exercises). Thirdly, we have extended the advanced physics education teaching from in-class to outside-class and outside-school, enhanced the association with the scientific research institutes, factories and mining companies, and carried out activities such as scientific and technological paper writing, lectures on special topics and scientific production, providing students opportunities to apply what they have learnt into practice and training their abilities of autonomous learning, scientific practice, scientific inquiry and scientific research. Finally, in the teaching process, we have strengthened the teaching of interdisciplinary contents, so as to widen students' knowledge and enrich their knowledge structure. Based on continuous differentiation and high integration of the physical science, the physics discipline and other disciplines (such as chemistry, geography, biology and so on) are inter-penetrating, forming many new inter-disciplines, such as the photo-biology, molecular biology and quantum chemistry. Penetrating and reflecting the teaching contents of advanced physics and inter-disciplines in physics teaching is beneficial for students to understand the development trend of physics, expand horizons and stimulate learning interest.

Strengthen the methodology education and promote the development of students' scientific literacy

The core objective of advanced physics education is to develop students' scientific literacy. Scientific knowledge is the main component of scientific literacy while the scientific

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method is also an important part of scientific literacy. The physics method is the important idea and a method of studying and handling general problems. Understanding and mastering scientific methods can not only help students understand and grasp the knowledge, but also is beneficial to the development of their own learning ability. Advanced physics education should pay attention to the organic combination of knowledge teaching and method teaching, enabling students to understand, grasp and master physics method in the process of mastering knowledge, thus establishing a clear physical image as well as understanding and mastering the essence of physics [3].

First of all, penetrate method teaching into the teaching process of professional curriculum (such as mechanics and electromagnetic). In the process of teaching and learning, show the methods of studying physical problems to students with the combination of specific physical problems, so that students can gradually learn and master basic physics methods through the explicit treatment of the scientific methods, such as the symmetry principle, conservation idea, dimensional analysis, order of magnitude estimation, simplified model, Ideological experiment, micro-element idea, scientific reasoning, scientific beauty, etc.. For example, the ideal model such as particle and point charge; the symmetry and scientific beauty of the Maxwell electromagnetic field equation set, and the symmetry method of the positive electron application predicted by Dirac. Through learning and imitating the research method, idea or process of scientists (such as the creative method of solving problems and ingenious experiment design plan), students can better understand the dynamics of physical development and the relativity of knowledge, thus avoiding the rigescent and absolute understanding of knowledge and promoting the development of students' knowledge migration ability.

Secondly, systematically introduce scientific methodology to students through setting up a specialized course of scientific methodology or physical methodology. Through some scientific methods such as scientific observation and experiment, analogy, analysis, synthesis, induction, deduction, abstraction, generalization, comparison and mathematical methods, some conventional methods such as control theory, information theory, system theory, coordination theory, dissipative structure theory and some non conventional methods, such as intuition, inspiration, insight and scientific beauty are all reflected in the whole process of physics development. Through learning the course of methodology, students can get a relatively comprehensive and systematic understanding of the research methods commonly used in physics as well as their role in the development of physics, master specific physics method and carry out necessary training of scientific thinking (including strict logical thinking training, non-rational and non-logical creative thinking training), thus cultivating students' ability to solve physical problems with scientific methods as well as their creative problem solving skills.

Play the function of humanistic education of physics and develop students' humanistic quality

Science education emphasizes on the development of scientific literacy while humanistic education focuses on the cultivation of humanistic quality. Humanistic education refers to a variety of theories and teachings about social life. It is an important way for students to indirectly understand the society and reform themselves to improve their own socialization degree, as well as a necessary condition to promote the overall development of their qualities. Humanistic quality is embodied in several aspects, including human social consciousness, scientific spirit, ideology and morality, temperament, self-cultivation, value orientation, moral sentiments, psychological quality and so on, which constitute the individual spiritual outlook of students. The level of humanity's quality directly influences the scientific function. The coordinated development of scientific literacy and humanistic quality can cultivate excellent talents of science and technology.

In view that traditional science education over emphasizes the utilitarian of science, enhances humanistic education in advanced physics teaching, so as to help students establish a scientific and rational view of science, nature and the world. The history of physics has good function of humanistic education, so it is a good teaching material in humanistic education. The history of physics presents the dialogue between human and physical world. It is the complex of humanistic science, natural science, and thought science, which is full of the ideas of materialism and dialectics, as well as the examples and model of scientists in pursuit of truth and be dedicated to science. It reflects the physicists' truth-seeking, realistic, pioneering and innovative spirit, and reveals the ways and methods of solving problems. These are all good teaching bonding point and starting point of carrying out humanistic education. There are mainly two ways of carrying out humanistic education with historical materials of physics. One is to penetrate the historical materials of physics in the teaching process of various professional courses, so as to make physical learning more affinity. Penetrating the physical knowledge, the production of theories and development background in teaching and presenting the creation process of physicists to students can help students obtain the edification and cultivation of the scientific ideas, scientific spirit, scientific concepts and innovative spirit, thus avoiding their absolute and patterned understanding of physical concepts and rules. The other is to set up specialized series courses of "History of Physics", and carry out more comprehensive teaching of the development process of physics, so as to develop students' humanistic quality effectively and subliminally. In the history of physics, there are inspiring and sagacious biographical anecdotes of physicists and the winding process of scientific discovery; there are physicists' love to eh motherland and their contribution to the human progress, which is a good material for moral education and is beneficial to cultivating students' good scientific quality; there are typical examples of mutual promotion of physical science, technology and society; there are also some historical facts that cause disasters due to improper use. All these contents are conductive to helping students get an overall understanding of the double-edged sword role of science and technology, make comprehensive evaluations of science and technology, and establish correct scientific values.

Strengthen and improve the experiment teaching of advanced physics

Physics experiment is an important link of training students' experimental ability and research ability. The goal of advanced physics experiment teaching is as follows: enable students master the basic experimental principles, error theory basis and data processing methods; divide the experimental subjects into two categories: required and optional, and ensure the completion of required contents; open the laboratory and provide adequate experimental time and space for students; strengthen the intermediate physical experiment teaching to realize the modernization of physical experiment contents; further select classical experimental subjects and penetrate knowledge and methods of modern physics in the classical experiment teaching, expound the application of classical physics principles in modern science and technology and

penetrate modern scientific and technological achievements in classical physics experiment; pay attention to the integration and penetration of experimental operation and theoretical thinking [4].

In the process of advanced physics experimental teaching, after completing the basic experiments, some scientific small experiments and some comprehensive experimental subjects with strong practicability can be chosen by students according to the actual situation, such as the measurement of inductance and capacitance, research and application of intervention method, research on Hall elements and so on. These experiments can increase the amount of information and sense of the times of experimental teaching. Through their own experimental study and exploration, students can get the experimental results and experience the success and failure, joys and hardships in the process of the scientific research, so that they are glad to pursue in distress and good at winning in failure. At the same time, improve the experimental exam evaluation system. It can be carried out by reducing the usual performance, decreasing the systematic explanation of teachers, increasing students questions and doubts, and regard this as the important contents of experimental examination. The final exam adopts the combination of written examination and operation. The operation subject of experiment can strongly comprehend, so as to check the students' comprehensive ability. Through advanced physics experimental teaching, it can cultivate students' scientific attitude of being realistic and down-to-earth, rigorous and meticulous work style, as well as firm and indomitable willpower, which is beneficial for students to form correct scientific outlook and good scientific quality, comprehensively improve the scientific literacy, and develop their comprehensive ability.

Promote the integration of information technology and advanced physics teaching

The combination of information technology and physics teaching increases the openness of physics teaching and can provide a full range of technological support for physics teaching, including the diversified curriculum resources, intelligent teaching process, nonlinear teaching information organization, etc.. The integration of advanced physics teaching and information technology can not only increase the amount of information of in-class teaching, so that it is possible to introduce the physics related high-tech achievements; but also effectively drive the diversification of teaching methods (such as group discussion, personal inquiry, etc.), thus promoting the diversification of information exchange and cognitive styles in the process of teaching and learning, as well as the development of college students' information literacy.

We try to construct an advanced physics education model based on the network, so as to further enrich the teaching contents, methods and means of advanced physics. Firstly, we obtain rich physical curriculum resources (such as the cutting-edge issues of physics development, historical materials of physics, actual application of physical knowledge) through online search engine, and establish the resource library of physical curriculum to enrich the physical teaching contents, thus promoting the organic combination of physical science, technology and society. Secondly, according to the characteristics of the curriculum, make electronic teaching plans and carry out computer aided demonstration experiments with the use of software such as Authorware, Flash, Matlab and Maple, so as to demonstrate some classical physics experiments or carry out computer simulation experiments, thus overcoming the difficulties in the teaching. Thirdly, combining with the high-quality curriculum construction, we upload the contents such as the teaching outline, electronic notes, exercise answers, and problem analysis to the website for students to browse through establishing relevant curriculum websites with the use of campus networks. Also, we carry out interactions and exchanges with students through e-mail, BBS and online chat.

Implement innovative education and cultivate students' innovation ability and scientific research ability

First of all, in the teaching process, teachers should encourage students to ask questions and help them establish the spirit of scientific suspicion, which is an important factor pushing the development of physics. Throughout the history of physics, almost each stage progress starts from suspicion. For example, Galileo has questioned the theory of Aristotle with the fall paradox of the heavy ball and light ball. Teachers should encourage students to ask questions, remove their fear of mistakes and provide corresponding guidance and explanation, thus avoiding students' blind faith in authority. Teachers should encourage them to take the original problem as the starting point and reflect the problem solving ideas and methods of the predecessors. Instead of regarding any conclusion of the predecessors as unshakable truth, students are encouraged to throw doubt on any existing conclusion and carry out further research based on the questions, so as to develop their own innovative ability. Secondly, enable students to get a preliminary knowledge of the methods of looking up and retrieving professional literature. Through the learning of professional courses, students should understand and master some basic methods of looking up science and technology literature. Teachers can provide some research topics or reference books and guide students to look up and retrieve relevant information through the library or the Internet. Students should analyze and sort the collected information and select their needed information. Thirdly, train students' good qualities of engaging in scientific research. As an important part of professional education, advanced physics education mainly focuses on the cultivation of students' scientific quality (academic accomplishment). The cultivation of students' scientific quality should not be limited to the graduation thesis and graduation design, but should be integrated into all the links of daily physics education. Students' scientific quality can be cultivated subliminally in the process of in-class teaching, extracurricular tutoring and experiments.

Implement bilingual teaching and develop students' professional English learning ability

In the teaching process of advanced physics, bilingual teaching can be implemented with the combination of the curriculum characteristics of advanced physics and the learning characteristics of college students. Bilingual teaching of advanced physics can adopt a step-by-step teaching plan: (1) At the stage of primary teaching, mainly introduce some commonly used physical professional English words, and let students get familiar with and master these words. (2) After grasping a certain vocabulary of physical professional English words, considering the relatively good English grammar foundation of college students, gradually increase the proportion of English expression in blackboard-writing and teaching at the later stage, and gradually train students' professional English reading ability. (3) Properly compile some physics professional English exercises to students and let them complete, according to their own situation. Either Chinese or English can be used in solving the problems, so that students at different levels are capable of the tasks. (4) In teaching, try to train students' expression and exchange ability of physical professional English and add some

opportunities and contents of oral exchange correspondingly. As for top students, guide them to carry out professional English thesis writing. In a word, the implementation of bilingual teaching cab not only teach college students physical knowledge, but also effectively develop their English learning ability and improve their ability to understand the development trend of physical science through reading English literature, which is beneficial for them to build a scientific and reasonable complex knowledge structure.

Conclusion

Higher physics education plays an important role in cultivating talents in physics, helping students learn physics knowledge, enhance their ability to analyze and solve scientific problems, and cultivate students' science literacy. In the information society, advanced physics education must actively adapt to the trend of science and social development. For improve the quality of physics education, teachers should have advanced and open education concepts, strengthen the methodology and humanistic education, promote experiment teaching of advanced physics. The integration of advanced physics teaching and information technology can help teachers to introduce the physics related high-tech achievements, and effectively drive the diversification of teaching methods. By teaching reform, we have effectively improved the quality of advanced physics education.

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