Study and Practice of Research-oriented Teaching Mode in Postgraduate Special Courses—Taking the Course of Fiber Optics as an Example

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Abstract. Postgraduate courses are important and bridge the gap between graduate study and thesis research. How to improve postgraduate courses teaching qualities is an urgent task of research universities in the present China. Considering the properties of the special course of fiber optics, the problems existing in current teaching processes, and the characteristics of students, in this paper, we research and practice the research-oriented teaching mode in this course, which can provide some useful reference for the reform of postgraduate course teaching.

Introduction

Modern teaching philosophy advocates that teaching activities should be student-centered, aiming at cultivating students' innovative thinking and scientific research capabilities, and breaking through the traditional teaching mode mainly based on knowledge transfer [1]. This is especially important for postgraduate training. The main function of teachers is to inspire and guide students to study independently and to explore and research. Under the influence of this teaching philosophy, developed countries such as the United States, Germany, France, Britain, Japan and other countries all advocated research-oriented teaching mode in research universities since the 1990s. In 1998, the well-known research report published by the U.S. Boyer Commission, "Reinventing Undergraduate Education: A Blueprint for America’s Research Universities," clearly pointed out that research-oriented teaching should be regarded as the basic requirement for undergraduate teaching. The reform of domestic universities in this area is relatively lagging behind. In recent years, with the expansion enrollment, there are some problems such as declining students quality, shortage of teachers and lack of teaching resources. Teaching reforms have become extremely urgent and have been highly valued by the higher education sector in China. In 2005, the National Ministry of Education's "Several Opinions on Further Strengthening Undergraduate Teaching in Colleges and Universities" emphasized that "we must actively promote research-oriented teaching and improve the innovative abilities of college students", and clearly put forward the requirements for the development of research-oriented teaching. For this reason, many universities have successively introduced various measures to accelerate the pace of teaching reforms, of which research-oriented teaching is one of the main research contents of education reform. As the highest educational institution of military technology, National University of Defense Technology (NUDT) shoulders the historic mission of cultivating large numbers of research-type military personnel. School leaders attach great importance to teaching reform. In recent years, many education reform measures have been introduced in succession, among which the vigorous promotion of research-oriented teaching mode in undergraduate teaching is a very effective measure.

Fiber optics is an important part of the field of modern optics. It is the science of studying the propagation characteristics of light waves in optical fibers. Since optical fibers have been widely used in modern optics such as communication, sensing, fiber lasers, and information processing,
Fiber optics has become a basic theory in related fields. *Fiber Optics* is an important specialized basic course for postgraduates of optical engineering major in NUDT. Through this course, students will understand and master the basic theories of light wave transmission in optical fibers, fiber characteristics, fiber optic devices and other basic knowledge, and lay the foundation for relevant research. Based on the characteristics of the course and the deficiencies in current teaching activities, considering the characteristics and training objectives of the military school students, the research-oriented mode was studied and practices in *Fiber Optics*.

**Understanding of Research-oriented Teaching**

There is no uniform definition of research-oriented teaching in the field of education so far. For different teachers, different students, different curriculums, and different periods, research-oriented teaching will have different meanings [2-4]. Here, based on practice experiences, the authors have the following four aspects of understanding.

**Research-oriented Teaching Should be Student-centered**

In traditional teaching mode, students are usually in a state of passive acceptance, and teachers are often the main body of teaching activities. However, the greatest feature of research-oriented teaching mode is that students should become the “protagonists” of teaching activities, meanwhile teachers play more roles of "director" and guide students to learn by themselves, think independently and do research innovatively. The key point is that teachers should try their best to complete the change of teaching from "giving a man a fish" to "teaching a man to fish".

**The Fundamental Purpose of Research-oriented Teaching is to Improve the Overall Quality of Students**

The meaning of research-oriented teaching mode should be evolving, however we think that the fundamental purpose is to achieve the best teaching effects, improve the overall quality of students, including self-learning ability, independent thinking ability, problem-solving ability, document retrieval and reading ability, scientific papers writing ability, research and innovation ability, oral expression ability, cooperation ability, organization and management ability, and so on. So the research-oriented teaching mode is to create a platform for students to show themselves, and improve their overall quality through practice.

**For Teachers, Research-oriented Teaching Has Two Meanings: “Teaching ‘Research’” and “Researching ‘Teaching’”**

“Teaching ‘research’” means that teachers should give full consideration to the training of scientific talents in the process of teaching and try their best to integrate the various elements of scientific research, such as scientific spirit, knowledge, scientific literacy, scientific thinking, insight, scientific ethics, critical spirit, cooperation spirit, professionalism, rigorous style, etc., into all aspects of teaching activities. “Researching ‘teaching’” includes research on “teaching contents” and “teaching methods”. The study of “teaching contents” means that teachers should systematically and deeply study the contents of lectures and keep up with the international frontier development. It is best to become an expert in this field. The study of “teaching methods” refers to conscientious study of modern teaching philosophy, student-centered curriculum design, and flexible use of heuristic, discussing, case-based teaching methods to fully mobilize students’ interest in learning and research, which can bring the best teaching effects.

**For Students, Research-oriented Teaching also Has Two Meanings: “Studying ‘Research’” and “Researching ‘Study’”**

“Studying ‘research’” means that in the process of teaching students should not only learn scientific knowledge and basic skills, but also acquire scientific research methods so as to “dig wells and get water” by themselves. “Researching ‘study’” includes research on “scientific knowledge” and “learning methods”. The research on “scientific knowledge” refers to active and deep study of the
knowledge instead of being satisfied with the mastery of classroom teaching content, and extensive research on the international frontiers of related fields. Students should think actively and be able to use the knowledge to analyze and solve the related practical problems. The research on “learning methods” refers to that in the process of learning, students should actively explore their own scientific learning methods to achieve the best study effects.

**Exploration and Practice of Research-oriented Teaching Mode**

Based on the properties of the course of *Fiber Optics*, the problems of current teaching mode, and the characteristics of students of military universities, we introduce research-oriented teaching mode into this course and practice it.

**Strengthening Military Applications**

According to the characteristics of cadets and training objectives of optical engineering, as well as the demands of students’ work in the future, the entire curriculum design is well combined with military applications. All the cases cited in the process of teaching have a clear military application background, such as submarine detection technology based on fiber hydrophone, underwater military target detection and recognition system based on polarization detection, high power fiber laser system, high power supercontinuum fiber source and so on. The purpose of study is more clear through the combination of learned knowledge and military application.

**Closely Combining Academic Frontiers with Scientific Research**

We try our best to make sure the entire curriculum design is closely combined with academic frontier and scientific research [5]. Our college is mainly engaged in laser technology and basic research of new optical fiber, and achieved good results in laser design, fiber lasers, coherent synthesis, supercontinuum source, photonic crystal fiber, fiber components, optical fiber sensing. In the process of teaching, through making full use of the scientific research advantages of our college and adequately arranging the teaching content, we introduced to students the forefront developments in relevant fields at home and abroad, and timely introduced our latest research such as fiber laser coherent synthesis system, supercontinuum fiber source system, photonic crystal fiber post-processing system. In this way, on the one hand, students’ understanding of what they have learned can be deepened, and on the other hand, students’ interest in learning is greatly stimulated.

**Focusing on Heuristic, Discussing, Case-based Teaching and Demonstration**

We try our best to practice heuristic teaching throughout the entire teaching activities, and inspire students to think and discuss actively, so as to develop their ability to find, analyze and solve problems on their own. The teaching mode of class discussion and seminar, flexibly adopted according to the characteristics of teaching contents, is widely welcomed by students [6]. We also pay attention to case-based teaching. Combined with teaching contents, some examples are selected with particular emphasis on military applications. In addition, we also do a lot of demonstration experiments in the classroom, such as water-column light transmission, fiber modes, prism dispersion, laser frequency doubling, crystal birefringence, polarization detection, supercontinuum laser and so on, which stimulates students’ interest in learning and prompt them to think and research actively.

**Carefully Designing Pre-class, Classroom and After-class Thinking Questions**

Research-oriented teaching is not only in classroom, but also in guiding students in independent learning and research outside classroom. It should run through the entire process of students’ learning activities. For this, in addition to classroom thinking questions, we also carefully design pre-class, and after-class thinking questions. The purpose of the “pre-class thinking questions” is mainly to guide students to learn knowledge by themselves before class, which is helpful for students to understand the basic physical concepts taught by teachers in classroom and to discuss on key issues. “Classroom thinking questions” focus on the difficult but key knowledge needing to be
grasped, discussed and calculated by students, which could strengthen students’ understandings of the basic concepts. “After-class thinking questions” highlight military applications, and guide students to deeply study and research relevant teaching contents, and apply the learned knowledge to solving practical problems.

Adding Fun into the Process of Knowledge Imparting

Most of the teaching contents of Fiber Optics are usually boring. In order to greatly arouse students' interest, we always insist on introducing the topic with related scientists' story in the whole teaching process and integrating the knowledge into historical stories. For example, in the part of “introduction”, we introduce the story of Dr. Kuen Kao, who is one of 2009 Nobel Prize winners in physics; in the part of “fiber's dispersion”, we introduce dispersion-studying stories of Descartes and Newton; in the part of “fiber's polarization”, we introduce the story of Huygens with birefringence and the story of Marius with polarization. In this way, students' interests of study are greatly inspired, meanwhile students have experienced scientists’ way of thinking, analyzing and solving problems.

Paying Attention to Course Website Construction

Course websites are very important, providing a good communication platform for teachers and students. We have set up a dedicated Fiber Optics course website on the campus web, opening to all students and faculty members. We offer courseware, electronic lesson plans, curriculum standards, teaching schedule, teacher information, excellent electronic studying materials, Chinese and English references, exercise database and previous examination papers, teaching videos, demo experiments videos, relevant information on teaching cases, biographies of related scientists, etc., which are placed on the course website for students, and timely update relevant resources. At the same time, the course website also has online answering and test functions. In addition, we also recommend advanced learning websites to students, such as the “Netease Open Course” column, which brings together the open classroom videos of world-renowned professors from top-tier universities. It is a very good learning resource.

Conclusions

Taking into account the properties of the course of Fiber Optics and the characteristics of students, in this paper, research-oriented teaching mode is explored and practiced. Research-oriented teaching takes students as the center of teaching activities and aims at enhancing the overall quality of students. In practice, we highlight military applications, flexible use of various teaching modes, including heuristics, interrogatives, discussion styles, case styles, classroom experiments demonstrations, and so on. We also carefully design thinking questions, focus on teaching funs, and actively recommend advanced learning resources to students, which has greatly stimulated students' interest in learning and invigorated the classroom atmosphere. Researched-oriented teaching not only enhances students’ understanding of the basic principles, but also enables students to learn about international frontiers. More importantly, students get training in innovative thinking and innovative ability, agreeing with the training objectives of innovative military personnel.

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References


