

# Study of research-based teaching mode in the course of “Geometric optics and optical instruments”

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**Abstract:** Modern teaching opinions require research-based teaching mode in research universities. It is an advanced teaching mode enabling students to explore science and technology autonomously. It has a lot of advantages comparing with the conventional knowledge-oriented teaching mode. In this paper, we show some understanding of research-based teaching mode. And based on the course features of *Geometric optics and optical instruments* and characteristics of students, we explore the research-based teaching mode in the part of Practical Optical Systems.

**Keywords:** teaching method; research-based teaching; knowledge-oriented teaching; Research University

## 1. INTRODUCTION

Modern teaching concept claims that students should be the main body in teaching. The function of teachers is to inspire and guide students to learn independently and do some research. The principal task of teaching is to cultivate students' innovative thinking and research abilities<sup>[1-3]</sup>. The traditional teaching method, which is knowledge-oriented by the mode of "teachers talking, students listening", should be rejected.

During the past several years, degradation of the quality of students, lack in staff and facility resources caused by the expansion of university enrollment, have made teaching reform urgent and have got close attention of advanced education workers in our country<sup>[1]</sup>. In 2005, the National Ministry of Education's "Some suggestions on further strengthen undergraduate teaching work in universities" emphasized that "research-based education should be prompted positively, and the innovative abilities of undergraduates should be enhanced". Then, many universities took all kinds of measures to quicken the process of teaching reform, of which research-based teaching is a main research topic.

In this paper, based on the practices of research-based teaching in *Geometric optics and optical instruments*, which is a fundamental course for students major in optoelectronics, some understanding and experience of research-based teaching method are given, which is useful for the coming implementation of research-based teaching in other courses.

## 2. MEANING OF RESEARCH-BASED TEACHING

What is research-based teaching? There is no uniform definition. From our perspective, the means of search-based teaching mode is variational, and shouldn't be defined fixedly. It has different connotations due to different teachers, different students, different courses and different phases.

Comparing with traditional teaching modes, the most obvious feature of research-based teaching mode is the "key role" of students in the teaching and learning activities<sup>[1]</sup>. Teachers play the role of "director" in teaching, and guide students to study autonomously, to think independently, and to research creatively. The key is to transform from providing students with fishes to teaching them to fish by themselves.

Although research-based teaching has different connotations in practice due to different teachers, students, courses, and phases, the fundamental purpose is to achieve the best teaching results, and to improve students' comprehensive qualities, including the ability to learn and think independently, to analyze and solve problems, to retrieve and read literatures, to write scientific thesis, to research and innovate, to cooperate, and so on. In a sense, the research-based teaching mode

offers a platform for the students to show themselves and to uplift their own comprehensive qualities incessantly in the process of practicing.

In our opinion, research-based teaching has two aspects of meaning for teachers in research universities. One is to teach "research", the other is to research on "teaching". Teaching "research" means the tutors should consider the requirements of cultivation of scientific talents and try to include all kinds of factors such as scientific spirits, knowledge level, thinking patterns and virtue, insights, critical thinking, cooperation spirit, dedication and discretion in teaching. Research on "teaching" means doing some research on teaching methods and teaching contents. The research on teaching methods refers to learning the modern teaching concepts thoroughly; designing courses centered on students, exercising all teaching methods such as heuristic teaching, teaching by discussion and cases, and fully motivate students' learning and researching interest and enthusiasm to get the most desirable teaching results.

### 3. PRACTICES OF RESEARCH-BASED TEACHING

Aiming at the curriculum features of *Geometric optics and optical instruments* and the deficiencies in current teaching contents and methods, combining the characteristics of the students majoring in optoelectronics in our universities, we preliminarily explored the research-based teaching mode in the part of "Practical Optical Systems".

#### 3.1 Bringing the frontiers into classroom teaching

The contents of research-based teaching in research universities should change with the development of modern science and technology. Therefore, when designing the whole course, we try our best to introduce the frontier of scientific research into the course teaching of *Geometric optics and optical instruments* according to the teaching contents based on the previous experiences<sup>[4-6]</sup>. Our group mainly researches on laser technology and the properties and applications of photonic crystal fibers. In recent years, our group has achieved good research results in solid laser design, fiber laser technology, coherent synthesizing, super-continuum light source, photonic crystal fiber and fiber sensing etc. During the process of course teaching, we made full use of the scientific research advantages of our group, combining the teaching contents with our up-to-date research and introducing to students some frontier of relevant fields.

#### 3.2 Applying various teaching methods

Research-based teaching in research universities requires teachers to use various methods in teaching activities according to different teaching contents. Among all the teaching methods, the heuristic teaching is one of the most important methods in research-based teaching<sup>[7,8]</sup>. Its main aim is to guide students to think and research independently. We try our best to run the heuristic teaching method through the whole teaching process, from the elicitation and analysis of questions to finding a solution. Students are guided to think and discuss positively and trained to analyze and solve problems independently. According to the features of the contents, we adopted improvisational discussion and topic seminars approach flexibly aiming at some important parts<sup>[5,6]</sup>, which received warm welcome among students. We also adopted case-based teaching method. Some cases relevant to our investigations were introduced into course teaching. In addition, according to teaching contents, we demonstrate lots of experiments in classroom, including *water column transmitting light*, *three-ring effect of optical fiber panel*, *lens and disc dispersion*, *crystal birefringence*, *polarization detection* and *super-continuum light source* etc. These demonstration experiments greatly motivated students' enthusiasm to think and research autonomously.

#### 3.3 Designing leading questions for students

Question designing is one indispensable part in research-based teaching. Good questions can guide students to think about teaching contents actively. The research-based teaching not only manifests itself during class, but also lies more in guiding students to do extracurricular study and research independently, which should be carried along the whole learning process. Aiming at these, we designed pre-class, during class and post-class questions carefully. Among them, the pre-class questions were used to guide students to learn some relevant knowledge by themselves before class, benefiting the instruction of basic physics conception and the active discussion on related contents during class. Questions during class mainly aimed at keystones and difficult points of teaching contents by discussion and calculation. Post-class questions emphasized on practical applications, leading students to further learn and research on related teaching contents and apply the acquired knowledge to solving practical problems.

### 3.4 Combining interests and knowledge deliveries

Most of the teaching contents of *Geometric optics and optical instruments* are relatively short of interests. So in order to motivate enthusiasm among students, we generally begin a lesson with interesting historical stories of scientists, blending knowledge delivery and interests. For example, we introduced the story of Doc. Gao Kun and fibers in the chapter of fiber optical systems, the story of Newton and dispersion in the chapter of dispersive optical systems, the story of Huygens and birefringence, Malus and polarization in the chapter of polarized optical systems, the story of Planck and quantum hypothesis, Einstein and laser in the chapter of laser optical systems etc. In this way, teaching and learning become more interesting, at the same time, students learned the thinking patterns of the way scientists analyzed and solved problems from the scientists, which was very important for students to study and research.

### 3.5 Building course network

Course network is also one indispensable part in research-based teaching. Good course network can provide students with abundant study resource and useful information. Therefore, we build a specialized *Geometric optics and optical instruments* course website on campus net, which is open to all students and teachers. We have uploaded teaching courseware, electronic teaching plan, course standard, teaching plan, staff information, excellent electronic textbooks and videos from both home and abroad, references in both Chinese and English, praxis library and previous examination paper, teaching and demonstration videos, some relevant materials about teaching cases, biography of scientists etc.. The resources are updated in time. In the meantime, the course website has the functions to answering questions online, setting and solving homework, submitting and correcting homework and testing online. Moreover, we recommend some advanced learning websites to students such as *Wangyi public courses* column, where videos of public class given by some famous professors in top universities in the U.S. are accumulated.

## 4. CONCLUSIONS

Modern teaching opinions require research-based teaching mode in research universities. It is a advanced teaching mode enabling students to explore science and technology autonomously. It has a lot of advantages comparing with the conventional knowledge-oriented teaching mode. In this paper, we show some understanding of research-based teaching mode. And based on the course features of *Geometric optics and optical instruments* and characteristics of students, we explore the research-based teaching mode in the part of Practical Optical Systems. During the teaching process, we make best use of all kind of teaching methods and techniques such as heuristic teaching, teaching by discussing, case-based teaching, demonstration teaching etc. We also design questions deliberately, blend interesting stories of scientists and teaching contents, and recommend some advanced study resources to students, which motivates huge enthusiasm among students. These not only strengthen the students' understanding and grasping of some basic principles in *Geometric optics and optical instruments* and performance of some typical optical systems, but also let students know the frontier of modern science and technology. What's more important is the training of innovative thinking and abilities among students which accords with the cultivation objective of innovative talents.

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