A New Experimental Course Mode for Cultivating College Students' Ability of Innovation and Entrepreneurship

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Abstract. Since the traditional teaching mode ignores the cultivation of students' innovative and entrepreneurial ability, this paper proposes a new “full process, open and project driven course mode”. This new teaching model was piloted in the course of “Experiment of Optoelectronic Materials and Devices”. With the new course model, students will complete a project practice in group. Through this kind of practice, students have more solid knowledge of round management, and their interdisciplinary learning ability, application knowledge ability, team cooperation ability and pressure resistance ability can be cultivated. This course mode is conducive to the cultivation of university students with the ability of innovation and entrepreneurship.

The Necessity of Cultivating Innovation and Entrepreneurship Ability in University Education

With the development of science and technology innovation strategy, innovation has become the soul of a nation's progress and the power of a country's prosperity [1]. College students are the mainstay of innovation and entrepreneurship in the future. They must have broad basic knowledge, excellent entrepreneurial ability and extraordinary innovation spirit, so that they can seize the opportunities of the times and adapt to the challenges of the future, and contribute to the country's scientific, technological progress and economic development. Therefore, the cultivation of innovation and entrepreneurship ability has become the top priority of the comprehensive ability cultivation of college students. This puts forward new challenges to the education of the University. It is necessary for university educators to reform the teaching concepts, teaching modes, and teaching methods, and further break the boundaries between professional disciplines, theory and practice, and pay special attention to the cultivation of students' innovation and entrepreneurship ability [2, 3].

There are many elements involved in innovation and entrepreneurship ability:

The first is theoretical knowledge, which includes not only theoretical knowledge and humanistic knowledge, but also more professional knowledge and applied knowledge. Today's start-up is no longer simply a making old products or repeating the old business mode. In the era of knowledge economy, entrepreneurship must be closely linked to innovation, strong professional knowledge. These need pioneers with strong professional theoretical knowledge.

The second is the ability of acquire knowledge. The change of knowledge is changing with each passing day. The knowledge that college students have learned in the classroom obviously cannot meet the requirements of innovation and entrepreneurship. As the main body of innovation and entrepreneurship, college students must update old knowledge and acquire new knowledge in a timely manner, so the ability to acquire knowledge is especially important.

The third is the ability to use knowledge. Knowledge creates wealth, but transform knowledge into efficiency or efficiency must play the ability of people. This is the ability to use knowledge. How to enable college students to apply the knowledge they have learned is a key factor in the success of college students in the future innovation and entrepreneurship.

In addition, planning ability, project management ability, teamwork ability, pressure resistance ability and so on are all important parts of innovation and entrepreneurship.
The cultivation of these innovative and entrepreneurial abilities has been reflected in our previous course teaching mode, but there are shortcomings in our teaching, and there is room for improvement and reform in our teaching. In the past, our education paid more attention to theoretical knowledge. The ability of learning knowledge, applying knowledge and the cultivation of several other abilities are still lacking. We also need continuous reform in teaching mode teaching concepts, teaching mode, teaching methods [4].

The Necessity of Reforming the Mode of the College Experimental Course

Today is the information age. Optoelectronic technology is the foundation of modern information technology. The development level of optoelectronic technology is not only a manifestation of a country's scientific and technological strength, but also a manifestation of a country's comprehensive strength. Therefore, a large number of optoelectronics professionals with innovative and entrepreneurial capabilities are needed. Therefore, a series of optoelectronic theory courses, such as “The Basis of Optoelectronic Technology”, “Basis of Solar Cells Technology” and “Basis of Laser Materials Processing”, have been offered in the electronic science and technology major of our university. At the same time, in order to further strengthen the connection of related courses, consolidate and supplement the theoretical knowledge, and cultivate the ability of combining theory with practice, we specially set up the course of “Experiment of Optoelectronic Materials and Devices”.

“The Basis of Optoelectronic Technology” adopts the traditional course mode of experiment course, that is, the teacher sets the experiment content and the students only need to complete the experiment according to the setting content to obtain the predetermined experiment results. Under this course mode, the students just work through the procedures set by the teacher. At the end of this course, some students don't know what they have done, why these experiments are needed and what is the relationship between these experiments. There are also some cross-major students who take this course and don't know how to combine the content of the course with their own majors. Students also hope that the experimental course will have more interdisciplinary expansion and extension. Some students have a good understanding of the theoretical knowledge, but feel confused when it comes to practical application. Obviously, the traditional experimental course mode can only reproduce the theoretical knowledge, far from cultivating students’ innovation and entrepreneurship ability. How to reform the course mode of “Experiment of Optoelectronic Materials and Devices”, cultivate the ability of combining theory and practice, cultivate the comprehensive ability, and cultivate the innovation and entrepreneurship ability of college students has become an urgent problem to be solved.

The New Experimental Course Mode of “Experiment of Optoelectronic Materials and Devices”

Reform the course mode of “Experiment of Optoelectronic Materials and Devices”, and adopt a new “full process, open and project driven course mode”. This new course mode emphasizes interdisciplinary, interdisciplinary and practice will cultivate students’ innovation and entrepreneurship ability in many aspects. The specific course mode is as follows:

Course Object

Senior undergraduates in the department of electronic information materials (Electronic Science and technology, material physics, inorganic nonmetal, etc.) of the school of materials, who are interested in optoelectronic technology and are interested in studying for master's degree, working or starting their own businesses in related industries.

Full Process, Open and Project Driven Course Mode

In this course, the students form a project group of 3-5 in each group. Under the guidance of teachers, each project group completes the independent topic selection and carries out the
Experimental operation in the form of project management promotion. Each group needs to complete four stages of experiments, i.e. optoelectronic material preparation, material performance characterization, optoelectronic device preparation and device performance test, then finally submit the project report and the devices. The experimental course can be divided into three stages, as shown in Figure 1.

**Project Planning Stage.**

The teacher will design a number of basic experimental modules, which are divided into four categories: material preparation module, material characterization module, device preparation module and device test module. Each module contains several sub-modules. At this stage, the teacher will introduce students to the basics of optoelectronic technology, basic experimental modules, and related equipment. More importantly, the teacher will consciously guide students to explore the forefront of optoelectronics technology.

At this stage, students need to form a project group with cross-major students. Learn the basic experimental modules under the teacher guidance. Then, the project group will learn the research progress in the field of optoelectronics and obtain the most cutting-edge information of this field through literature research. Finally, each project group will consider the research interest, research frontier and actual experimental conditions to determine its own research project.

**Project Implementation Stage.**

At this stage, students develop detailed project implementation plans and implement them. The project implementation plan includes technical route, project schedule, experimental process, experimental materials, instruments and equipment. The most important part of the project implementation plan is to select the basic experimental module to build the technical route according to the project and design the new experimental module according to the needs. Complete the project experiment operation according to the technical route and project schedule. Get the data of experimental results, analyze and organize the data. If the experiment is failed or deviated from the expected results, the research group will analyze and find out the reasons for the experimental data, improve the technical route and optimize the experimental scheme under the guidance of the teacher.

At the same time, the role of teachers will be greatly weakened. Teachers are more likely to supervise the project progress and provide advice. For example, teachers guide students to discover problems, analyze problems and solve problems, and encourage students of different majors to use the knowledge they have learned to solve key technical problems.

At this stage, the autonomy of each project group will be greatly reflected. The professional expertise of each student will also be reflected. Students will ensure the smooth implementation of the project through the control of the progress of the project and the division of labor among the group members.

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**Figure 1. The three stages of experimental course and the main tasks of each stage under the new course mode.**

- **Project Planning**
  - Group Formation
  - Research
  - Literature research
  - Laboratory status survey
  - Experimental module research
  - Social needs research
  - Project establishment

- **Project Implementation**
  - Develop experimental plan
  - Experimental preparation
  - Experimental operation
  - Data analysis
  - Experimental adjustment

- **Project Conclusion**
  - Concluding report
  - Presentation
  - Product displays
  - Q & A
  - Mutual evaluation
**Project Conclusion Stage.**

The group members will analyze and arrange the experimental data, discuss the experimental results, and then complete concluding report of the project. A seminar will be hold, every project group need to give a presentation on the project and a product displays using multimedia, slideshows, videos etc. The teacher and all students will discuss the status and results of each group's projects.

**Evaluation**

The final score of each student will consist of the following parts:
A. Project report score: including project planning, project implementation and project conclusion.
B. Presentation & Product displays score.
C. Instructor score: the teacher will give a score based on the student's usual performance, including participation, practical ability, innovation ability, etc.
D. Group members score: members of the project group assess each other's scores according to the performance of each member during the project.
E. Group score: each group scores the performance of the other groups.

**Advantages of the Course Mode**

Based on the above new “full process, open and project driven course mode”, the “Experiment of Optoelectronic Materials and Devices” course has been offered for 2 academic years and 4 times. Through these teaching and studying practices, the new course mode has the following advantages:

This new course mode is based on the principle of “interest-driven, self-selected topics, independent experiments, and emphasis on the process”, which exerts students' subjective initiative in the experimental. This new course mode makes the experiment class no longer a traditional way for students to complete the predetermined experiment under the control of teachers, and present the predetermined experimental results. This new course mode is conducive to stimulate and encourage students to absorb knowledge, consolidate knowledge and apply knowledge, learn to find and solve problems, so as to improve students' comprehensive quality and cultivate students' creativity and innovation spirit in the process of cross major active exploration, active thinking and active practice.

This new course mode takes an experimental course as the starting point to cultivate students' interdisciplinary learning ability and innovation and entrepreneurship. The figure 2 shows the cultivation of various abilities of students at all stages of the course. Through this course mode, students have essentially completed a mini-project practice. In this practice, the accumulation of experience, the exercise of ability, the growth of knowledge, and the enhancement of self-confidence are valuable for student’ further study and employment innovation in the future.

![Figure 2. Cultivation of various abilities of students at all stages of the course under the new course mode.](image-url)
With this new course mode, all undergraduate students who take this experimental course can use all relevant equipment of the college, which means that undergraduate students can enjoy the same experimental conditions as graduate students. At the same time, undergraduate students also participate in scientific research, exploring a new way of combining teaching and research. A number of students who took the course won a number of innovation and entrepreneurship awards. At the same time, a number of students who have taken this course have been given the opportunity to go to famous universities in China and the world for further study.

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References

[1] M. Cheng, C. Li, X. Chen, et al, Research on College Students' Innovation and Entrepreneurship Education Based on the Tutorial System of Undergraduates, The Science Education Article Collects. 421 (2018) 28-30.

[2] X. Hong, Survey and Research on College Students’ innovation and Entrepreneurship Education: A Case Study of Central University of Finance and Economics, Innovation and Entrepreneurship. 20 (2019) 34-39.

[3] X. Xu, A comparison and enlightenment of the innovative entrepreneurship education between China and American, Journal of Liupanshui Normal University. 31 (2019) 103-108.

[4] H. Zhang, F. Yu, J. Tang, et al, Research on the Talent Training Mode of Application-type Undergraduate for Material Major Based on Innovation and Entrepreneurship Education, Education Modernization. 77 (2019) 48-51.