

# Study on Research-Based Teaching for Mechanical Engineering Control Basis

Hongjun Yang

School of Mechanical Engineering  
Wuhan Polytechnic University  
Wuhan, China  
Hongjun\_yang@163.com

**Abstract**—Because of the strong abstract and theoretical characteristic of the course of mechanical engineering control basis, a research-based teaching idea is put forward to improve the quality of the teaching. After reviewing and summarizing the development of the idea, this paper analyzes its connotation from two aspects: the teaching and learning. In order to meet the need of the idea, four specific measures are proposed, including problem-based teaching, discussion teaching, case teaching and engineering practice teaching. Moreover, the evaluation methods of the teaching are presented and an example is given. The result shows that the teaching idea can effectively improve the students' abilities of independent learning and creativity.

**Keywords**—mechanical engineering control basis; research-based teaching; connotation; evaluation methods

## I. INTRODUCTION

Mechanical engineering control basis is a course which combines control theory with mechanical engineering, and it is also a major professional foundation course for electromechanical undergraduate majors. This course plays an important role in promoting the development of mechanical engineering and cultivating mechanical engineering talents, especially with regard to mechatronics talents. However, the course involves many courses, including the mechanical principle, electrotechnics, hydraulic transmission, theoretical mechanics, higher mathematics, complex variable function, integral transform, etc, and its contents are abstract and focus on theoretical analysis, so many students feel boring and hard to understand in learning this course. In the purpose of developing the undergraduates' innovative and research ability, the creation and application of research-based teaching has met the requirements of development of high education and engineering technology.

Research-based teaching is a new teaching method which has a rapid development in the field of higher education in recent years. Aiming at cultivating students' research consciousness, research ability and innovation ability, the teachers guide students to carry on the investigative study using researching-based teaching which can motivate students, widen their knowledge and make the students get a deeper understanding of the theory.

On the other hand, the course of mechanical engineering control basis is about the basic knowledge of automatic control theory, which is closely related to scientific research and

engineering practice and it is one of the specific applications of information science in mechanical engineering. So it will be boring and hard to understand when teaching the course when it is separated from scientific research and engineering practice. Using research-based teaching can greatly stimulate students' interest in learning, increase the students' perceptual knowledge, and cultivate the students' research ability and innovation ability. In order to achieve the purpose of improving the teaching effect, teachers should help students improve learning initiative.

## II. DEVELOPMENT AND CONNOTATION

### A. The Origin and Development of Research-based Teaching

The thought of research-based teaching goes back on the ancient times, and many educators and thinkers have done a lot of research and exploration. At the beginning of the 20th century, due to traditional American education present situation which stayed away from the students' real life and force-fed pure knowledge, the famous educator, John Dewey [1], put forward the teaching concept of problem-based teaching which actually contains the basic thought of research-oriented teaching. In the middle of the 20th century, the famous educationist Schwab [2] put forward the methods of inquiry and further promoted the formation of research-based teaching thought. In 1998 and 2001, the research-based undergraduate education committee of the United States Boyer[3]-[4] continuously published two important reports, which put forward the teaching should be combined with research and student's study should be based on the research. At last, it concluded that the research-based teaching mode should be established rapidly. Additionally, France, Britain, Japan and other countries have attached great importance to the development of research-based teaching and both theory and practice has obtained certain achievement. In 1996, France started to carry out the moderate students creativity courses in college preparatory class and emphasized students' the ability to analyze and solve problems independently. In Japan, the course of comprehensive study was established aiming to cultivate the quality and ability of students to adapt to social change and guided the student to master the scientific learning method and thinking method [5]. In China, since the 1990s, some key university has already started to introduce the scientific research teaching process. For example, in 1995, Qinghua University started to implement college student

research training program at the undergraduate stage. In 1999, the Chinese university of science and technology stipulated that excellent undergraduate students could apply for a research project which has been set up by the campus key research institutions. In 2002, Beijing University started to adopt measures and funded undergraduate scientific research activities [6]. At present, the China's education ministry and other education organizations have organized a variety of disciplines races, including the national college students' mathematical contest in modeling, electronic design competition and mechanical innovation design contest, etc. In fact, these races have embodied the application of the research-based teaching.

#### B. The Connotation of Research-based Teaching

At present, research-based teaching theory research is still at the stage of development and there are different descriptions of the connotation about the teaching thought. The author thinks that the research-based teaching aims at cultivating students' research consciousness and innovative ability, and with the design of small project or a project as the breakthrough point, the teachers introduce research problem in the teaching process, and teachers should create a kind of research-based environment at the same time and guide students to think and explore problems independently. On the other hand, the student should solved the problems thought research-based learning and improve their ability. This definition includes two meanings at least, as follows.

First of all, for the teaching, the teachers should not only impart knowledge, but also cultivate the students' research consciousness and ability. Which means it is more important to teach a person to fish than to give a man a fish. So it is necessary that the teachers should provide or to create an atmosphere which can let the student carry on the investigative study.

Secondly, for the students, it is not a passive way to accept the knowledge in the research-based teaching process. On the contrary, they should be initiative to explore, practice, study and research under the guidance of teachers, so as to obtain a new knowledge, and cultivate their research ability and innovation ability.

### III. SPECIFIC MEASURES OF RESEARCH-BASED TEACHING

In view of the strong theory and abstract, the course of mechanical engineering control basic is suited for research-based teaching, and the main implements are as follows.

#### A. Problem-based Teaching Method.

Research-based teaching is to cultivate students' innovation ability as the main target, which determines it is very different from traditional teaching. The research-based teaching classroom should be on-limits, and the content should not be limited to the textbook. This way of teaching should guide the students to think in class, and extend the textbook content, thus causes the student to obtain a deeper knowledge. This requires that the teacher can't only teach complete knowledge from textbooks, but also should be to expand the basic theory of mechanical engineering control, namely the problem-based teaching. In other words, the teacher should first create a

problem-based scenario, and put forward the question which will be solved, then guides the student to analyze and think about this question, collect and summarize the related data, seek solutions to the problem, draw a scientific conclusion and obtain new knowledge.

#### B. Seminar Teaching Method

In order to stimulate the learning enthusiasm of students and develop students' spirit of cooperation, it is a good method to change the classroom atmosphere and take the seminar teaching. This method requires teachers to make reasonable arrangements for teaching contents, design some appropriate subjects for some important and difficult knowledge after completing every major section, then divide the students into several groups by dormitory units or student ID. Each group analysis and discussion on this issue in a collaborative manner, and explore the solutions. In the end, in order to check the results, teachers can make use of curricular or extra-curricular time to organize a report meeting where every group representative report the solution of the problem and answer the teacher' and other group students' questions through the discussion and analysis of the group members. The method can activate the students' thinking, extend their knowledge and enhance their understand ability.

#### C. Case Teaching Method

Case teaching method is also an important research-based teaching, which is adopted by many educationists. For this method, the teacher should prepare some appropriate engineering application cases for some important knowledge contents in curriculum, then analyze and review the cases in class. Because the course of mechanical engineering control basic is closely related to information science principle, and its theories have some important applications in mechatronics engineering field has important applications currently, so there're a lot of successful engineering cases which are proper to be adopted to the class teaching. The teachers should first filtrate the engineering cases, and select those who meet the student's understanding ability and teaching hours as an teaching examples. When explaining the case, the teacher should take the progressive teaching method, simultaneously, guide the student and ask questions, and gives the final solution to the engineering problems in the end, which deepen the students' knowledge about the critical theory and let them know the basic steps of engineering design.

#### D. Engineering Practice Teaching Method

The course of mechanical engineering control basis is a very practical course, so it makes the students feel like castles in the air and hard to understand the knowledge when teaching without practical training. Engineering practice teaching method, which allow students to participate directly in practice, develop their practice ability and innovation ability, and deepen students' understanding and awareness of the discipline. There are several approaches for engineering practice teaching. The first way is experimental teaching, which provides corresponding experiments for the important content. This approach requires teachers to design good experimental content, and guide the students to complete the experiment independently, and give some significative questions to the students after class. The second method requires students to

participate in a variety of extracurricular production or competition, which purpose is to develop their interest in learning and motivation. Such practices include mechanical innovation contest and electronic design match which are organized by state or local authorities. In addition, there are all kinds of college students' innovation fund projects organized by school and so on. The third way is to let students directly involve in teacher's scientific research subject, which is currently the most effective and the best kind of method. This method can develop students' practical ability and scientific research ability, and broaden their knowledge, so that students can deeply understand subject content.

#### IV. THE EVALUATION OF RESEARCH-BASED TEACHING

##### A. Student's Academic Evaluation

Because of the Research-based teaching is characterized by openness and diversity, the teacher can not take a traditional test to decide the student's achievement. On the contrary, the teacher should adopt multi-style and multi-level assessment methods including autonomous learning, classroom teaching, discussion, engineering practice training, extracurricular scientific and technology work and other aspects. The students can submit oral report, scientific essay, practical subject design, and other scientific works to acquire credits.

##### B. Evaluation of Teachers

For the teachers, in order to develop an impartial and objective indicator about their teaching lever, these indicators should include the atmosphere of classroom, students' assessment and the research capabilities of student.

#### V. THE EXAMPLE OF RESEARCH-BASED TEACHING

The structure of the key knowledge points of the course of the mechanical engineering control basis are give in fig.1. There are three lays structure including basic knowledge, basic theory and application. The difficult methods about researched should be designed for the three different lays.

The system structure are shown as Fig.2, which is designed according to the ideas of the teacher, XiuyiYan[7]. The process of the teaching shows that the methods mainly focus problem-based teaching and designing proper research subjects for students. Through discussion and analysis, the student should report the research results in papers or other works, the teacher will organize the subject defends for the students.

#### VI. CONCLUSION

Compared to other teaching methods, the research-based

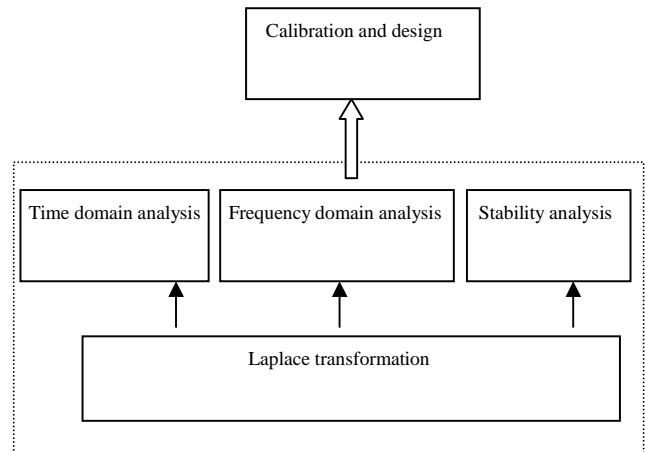


FIGURE I. THE STRUCTURE OF THE KNOWLEDGE

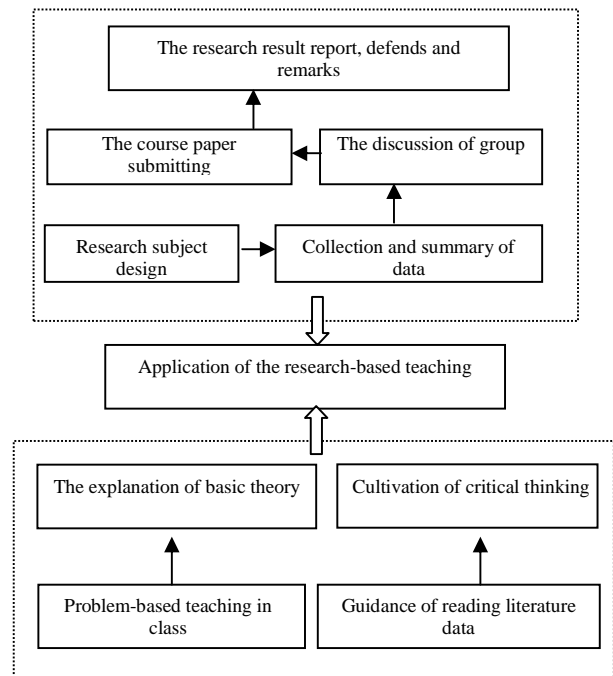


FIGURE II. THE SYSTEM FOR RESEARCH-BASED TEACHING

teaching has incomparable advantages. For the research-based teaching, the role of the teacher changes from simply throwing knowledge to teaching research methods and skills. On the other hand, the research-based teaching changes the student from a passive recipient to an active participant and positive responder. The research-based teaching cultivates the students' scientific learning method, research method and the innovation ability. The goal of the teaching method meets the need of the innovative talents of the 21st century, especially in mechatronic engineering area.

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