

# Exploration on the Teaching Reform of the Course "Principles of Automatic Control" Based on the Concept of Scientific Research

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## ABSTRACT

This article is aimed at undergraduate teaching work in comprehensive universities. It takes the course of "Automatic Control Principles" as the teaching and research object, based on the concept of scientific research back-feeding teaching, combined with the scientific research results of the teaching and research team itself, focusing on the academic frontiers in the field of automatic control, and using national major scientific research project support technology Reforming the teaching links of undergraduate courses, enriching teaching cases, enriching teaching content, improving teaching methods, effectively improving students' mastery of course content, while further expanding students' academic vision, and greatly enhancing students' innovation spirit. The results of the practical activities of the curriculum teaching reform show that the curriculum teaching reform based on the concept of scientific research back-feeding teaching is effective, which is not only conducive to the cultivation of innovative talents in comprehensive colleges and universities, but also provides useful explorations for related curriculum teaching reforms.

**Keywords:** scientific research feedback, automatic control principle, teaching reform, maglev train

## 1. INTRODUCTION

### 1.1. Basic course introduction

"Principles of Automatic Control" is a technical basic course with strong theoretical and engineering application for the undergraduate major of automation. It is set up for cultivating engineering and technical personnel engaged in professional fields such as automatic control and automatic detection. This course is the theoretical foundation of related professional courses in the field of control, such as motion control and process control.

The course "Principles of Automatic Control" systematically explained the basic concepts and theories of automatic control, as well as the analysis and design methods of linear time-invariant systems, nonlinear systems, and various control systems. Through the teaching of this course, students can master the basic concepts of automatic control more proficiently; the mathematical model of the control system and the representation method of the structure diagram and signal flow diagram; the time domain analysis method, root locus method and frequency domain of linear control system Analytical method, basic method of control system calibration; analysis method of system stability, steady-state error, and dynamic performance. This course not only has a strong basic theory, but also has a strong practicality. It focuses on the close combination of theory and practice,

cultivates students' dialectical thinking ability, establishes scientific viewpoints that integrate theory with practice, and improves the ability of comprehensive analysis of problems.

### 1.2. Introduction to Scientific Research Work of Teaching and Research Section

The National University of Defense Technology's Maglev Technology Engineering Research Center is the earliest unit engaged in the research and development of maglev train technology in my country. Since 1980, it has successively carried out research on the levitation control of medium and low speed maglev transportation and high-speed maglev transportation, vehicle running mechanism design, system dynamics, line and track design, etc., and successively undertook the "Eighth Five-Year" to "Thirteenth" of the Ministry of Science and Technology. Five "maglev train technology research and technology support project. The main research directions are as follows:

(1) In terms of low- and medium-speed maglev transportation: Since the 1980s, the team has taken advantage of the automatic control discipline and military control technology, and carried out long-term independent innovation around the core and key technologies of maglev transportation, breaking through the suspension-oriented control and steering. Core technologies such as maglev principle prototypes and full-scale single bogie

manned test operation systems have been successfully developed.

Since 2012, the team has been supported by the National Twelfth Five-Year Science and Technology Support Program Project "Mid-low Speed Maglev Transportation Application Development and Integration Demonstration Research". The project supported the construction of Beijing S1 line, as shown in Figure 1, the current research results Beijing Maglev S1 line has been put into commercial operation at the end of 2017. In 2015, the team also undertook the development of a levitation guidance control system for a maglev car on the Changsha Airport Express Railroad. The train has advantages in terms of stability and smoothness.



**Figure 1.** Changsha Maglev Express Line and Beijing Maglev S1 Line Maglev Train

(2) High-speed maglev: successively undertook the national 863 high-speed maglev major project, the 11th Five-Year Science and Technology Support Program, the 12th Five-Year Science and Technology Support Program, the suspension control technology, suspension frame and vehicle dynamics, and speed measurement of high-speed maglev trains Systematic in-depth research has been carried out on positioning technology. At present, the maglev team of the National University of Defense Technology has undertaken the task of developing the levitation guidance control system for the two programs of the Ministry of Science and Technology in the 13th Five-Year Plan of the high-speed maglev levitation control and the medium-speed maglev.

Therefore, this article is based on the course of "Automatic Control Principles", combined with the actual scientific research work undertaken by the teaching and research section, starting from the concept of scientific research back-feeding teaching, selecting the latest engineering examples, enriching the content of teaching courses, improving teaching models, and exploring and practicing the current teaching models. Enhance students' learning and mastery of course content, broaden students' academic vision, and strengthen students' ability to transform knowledge and skills.

## **2. THE INTERNAL LOGIC OF SCIENTIFIC RESEARCH FEEDING BACK TEACHING**

Talent training, scientific research, service to society, and cultural inheritance are the four major functional elements of institutions of higher learning[1]. Teaching work runs through the entire process of talent training, while scientific research runs through the entire process of

university teachers' self-development. Scientific research should be mutually unified and mutually promoted. The main responsibility of teaching is to impart knowledge. Therefore, teaching is the foundation for universities and scientific research to undertake knowledge innovation. For this reason, scientific research is the source of university development. The stronger the foundation of teaching, the more scientific research can be achieved. Long-term development. Conversely, scientific research promotes teaching work more significantly. Scientific research feeds back teaching, applies the knowledge innovation results brought by the latest scientific research progress to teaching work, feeds back to teaching, resolves the opposition and differentiation between the two, and realizes the commonality of both Development and progress are issues that universities and university teachers need to think deeply about.

At present, regardless of whether it is a comprehensive college or a science and engineering college, under the guidance and constraints of various policies and systems, some teachers have a situation of focusing on scientific research and neglecting teaching, which directly affects the quality of teaching, which is the so-called teaching. Scientific research has two layers; in addition, some engineering teachers lack practical experience in scientific research and engineering, and the teaching of some engineering professional courses is empty and boring. They have not been able to fully mobilize and improve students' learning passion and cannot achieve the desired teaching effect. In response to this phenomenon, domestic teaching experts proposed the initiative of scientific research to feed back teaching. Through this concept, teachers who have a good scientific research foundation and are closely integrated with teaching can integrate scientific research activities into the student training system to promote the interaction between scientific research and teaching. Transform scientific research results into teaching content in time to form a high-quality training model.

The above-mentioned problems still exist in the personnel training of control science and engineering in our school. For this reason, it is necessary to further carry out practical research based on the concept of scientific research back-feeding teaching, and explore and innovate a kind of scientific research and teaching suitable for control science and engineering[2]. It is a new teaching mode that can improve students' sense of engineering practice and engineering enthusiasm during school.

## **3. AN EXPLORATORY MODEL OF SCIENTIFIC RESEARCH BACK-FEEDING TEACHING**

The mutual integration and promotion of teaching and scientific research is the basic prerequisite for the coordinated development of colleges and universities. In view of the current relationship between teaching and scientific research, and the relatively independent development between the two, the purpose of this teaching

exploration practice is to pursue a win-win result for both. Explore the mutual support between teaching and scientific research to form a virtuous cycle of development. This teaching practice takes the professional course "Automatic Control Principles" for the major of control science and engineering as the entry point. The course development idea is student-centred, and the students' mastery of the course knowledge is the core to construct a closed-loop negative feedback control system. In order to expect students to master the level of knowledge, the output is the actual situation of students' mastery of knowledge. When designing the teaching plan, choose appropriate cases from scientific research topics and combine the content of professional courses to enrich classroom teaching. You can also try to introduce scientific research projects into the classroom in the form of lectures to fully mobilize students' learning enthusiasm; correspondingly, you can use scientific research projects Select sub-tasks of moderate difficulty and select some students to participate in actual scientific research tasks, so that students can use the knowledge learned in professional courses to practice when performing project research, and the instructor will address the problems that students use professional knowledge to participate in the process of subject research Carry out analysis and discussion, feedback the problems existing in students' participation in practice to the input of teaching control, compare with the expected learning effect of students, and improve teaching methods and content design in time according to actual deviations, and explore how to apply what they have learned[3]. The specific methods of student assistance are applied in classroom teaching and practical teaching, so that the quality of students' training will eventually meet the expected goals and requirements.

#### **4. EXPLORATION ON THE PRACTICE OF SCIENTIFIC RESEARCH BACK FEEDING TEACHING**

In response to the exploration model proposed in the previous section, the core professional courses of control science and engineering, "Principles of Automatic Control", "Integrated Practice of Control Systems", "Power Electronics Technology" and "Computer Control Technology" and other related automation professional courses are as follows: The carrier is based on the undergraduates of the 18th and 19th grades of the automation major of our school's control science discipline as the research object, and is supported by the excellent teaching team of the college's automation department-the professional faculty of the Maglev Teaching and Research Section. Focus on infiltrating the scientific research results of the teaching and research section in the undergraduate teaching of the professional course "Principles of Automatic Control", mobilize students' enthusiasm for learning, fully tap the students' learning potential, and improve students' innovative thinking and innovative ability, so as to improve teaching methods and enhance

classroom teaching The purpose of quality. The teachers of the scientific research team mainly did practical teaching from the following aspects[4].

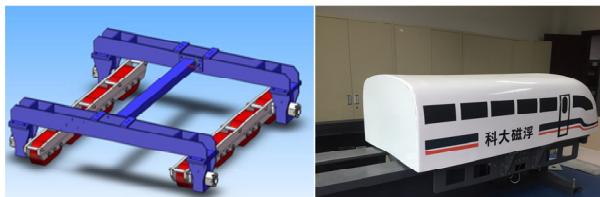
(1) Before the course starts, first push the scientific research lectures into the teaching classroom. Facing college students in the new century, they often question what practical problems their theoretical knowledge can solve[4]. For this common problem, our teachers use the team's actual scientific research advantages to choose scientific research topics that are highly relevant to professional courses. , Introduce the classroom in the form of lecture content in advance, invite students to have divergent thinking discussions, the teacher combines the students' focused attention with the course teaching content, conduct in-depth analysis and integration, and frequently adjust the teaching content design. In addition, in order to stimulate a small number of students with strong interest, some more representative literature materials or scientific research results reports are used as after-school learning materials, which are reserved for students to read for reference, continuously stimulate students to think about problems, and improve students' learning of the professional course Interest, but also cultivate students' ability to discover, analyse and solve problems.

(2) Actively participate in the research work of the subject project, and continue to summarize and refine during the research process, and dig out materials matching classroom teaching from the scientific research process[5].

For example, in the scientific research work of our professional course teacher team, by studying the latest professional research documents at home and abroad, in the process of promoting scientific research projects, we always pay attention to the latest developments in the subject field, and propose, solve, technical routes, and solve scientific research problems. The measures and actual effects can be mastered personally, and at the same time, I have a deep experience in solving the technical difficulties in the subject. In response to these actual scientific research situations, the collection and induction of the problems and the summary and refinement of the experience will continue to enrich the teaching materials and content of the professional courses. In this way, in the actual teaching process, all kinds of scientific research examples can be understood, and the teaching of professional curriculum knowledge can be easily grasped and handy.

(3) Enrich classroom teaching content with specific scientific research examples. First, the teaching team summarizes and refines the new knowledge and new results obtained in the practice of the subject research work, and regularly incorporates it into the teaching content system during the teaching implementation process. Secondly, by interspersing scientific research examples related to the teaching content in the classroom, it not only stimulated the students' enthusiasm for learning, but also allowed them to experience the fun of applying book knowledge to the actual engineering background. In addition, the use of wonderful cases from scientific research practice for teaching makes the originally boring mechanical mechanism design and control principle analysis lively and interesting, and is connected with the

actual scientific research work, so that students can listen to the classroom with relish and master knowledge. I am deeply impressed, and I can truly learn professional knowledge and remember the practical operation. Enriching classroom teaching through scientific research work makes the content of the classroom close to the actual scientific research, not only the classroom is lively and vivid, but also the learning knowledge can be deepened to a higher level, and the teaching effect achieved by this is also self-evident.



**Figure 2.** Laboratory equipment of automation control engineering practice laboratory

(4) Use the scientific research platform of the teaching and research section to provide scientific research equipment, key supporting technologies, and teaching teacher services for the "college student innovation and entrepreneurship training program". The current cultivation of innovative talents is an important goal of teaching and educating people in colleges and universities, and it is also an urgent need for social progress and development. In order to enable students to better participate in the project, combined with the scientific research practice of the research group, we opened the automation control engineering practice laboratory to provide instrument and technical support for innovative and entrepreneurial experimental projects. The equipment in the laboratory is based on scientific research practice——The scaled-down model of the maglev train is shown in Figure 3. The maglev trolley demonstration platform has all the elements of the medium and low speed maglev train, which is composed of the car body, track bracket, linear motor, sensor, electromagnet and its control system. It can realize the functions of levitation of the trolley and towing back and forth in straight sections. This demonstration platform has a rich structure and a wide range of applications, which provides high-quality practical resources for the automatic practice course. At the same time, through the assistance of experimental teaching assistant technical personnel and the whole mentor team to provide teacher support for the "college students' innovation and entrepreneurship plan project", it provides students with a good learning and practice environment that can give full play to their independence and innovation. In addition, the entire mentor team regularly organizes college students to report and summarize and discuss the research progress of innovation and entrepreneurship projects, and provide timely follow-up guidance for the discovered weaknesses of students' knowledge to further improve the quality of college students' training.

## 5. CONCLUSION

Taking the core professional courses of control science and engineering as the starting point, supported by our excellent teaching and research team, and using the supporting technology of major national scientific research projects to reform the teaching link of undergraduate courses, enrich teaching cases, enrich teaching content, and improve teaching methods , Effectively improve the students' mastery of the course content, at the same time further expand the students' academic vision, and to a large extent enhance the students' innovative spirit. Utilizing the concept of scientific research back-feeding teaching, taking the student-centred thinking, and building a closed-loop negative feedback control system as the core of knowledge mastery, the results of practical activities show that the curriculum teaching reform based on the concept of scientific research back-feeding teaching is effective and beneficial to integration The cultivation of innovative talents in colleges and universities can provide useful explorations for the teaching reform of related courses, and ultimately enable the cultivation of students to achieve our goals.

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