

# Construction and Exploration of Innovative Researching Course "Theory and Technology of Microforming"

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**Abstract:** Based on the scientific researching achievements by the team in the field of theory and technology of microforming for many years, the authors have built an innovative researching course - "Theory and technology of microforming". By optimizing the design of course teaching content, innovative teaching mode, assessment and evaluation system, the author have explored a course construction path to cultivate innovative talents relying on innovative researching courses. Through the construction and practice of this course, students' interest, enthusiasm and initiative in learning have been improved, and active exploration has been made for the cultivation of innovative talents.

**Keywords:** Innovative researching course, Cultivation of innovation ability, Course construction.

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## 1. Introduction

Innovation is the soul of a nation's progress and the inexhaustible driving force for a country's prosperity. Scientific and technological innovation increasingly determines the development process of a nation and a country, and is also the deepest national endowment of the Chinese nation. At the Summer Davos Forum in 2014, Premier Li Keqiang proposed to set off a new wave of "mass entrepreneurship" and "grassroots entrepreneurship" on a land of 9.6 million square kilometers, forming a new trend of "everyone innovating" and "everyone innovating"[1]. In the 2015 government work report, Premier Li Keqiang also proposed to promote mass entrepreneurship and innovation, pointing out that it can not only expand employment, increase residents' income, but also promote vertical social mobility and fairness and justice [2]. In May 2015, the "Implementation Opinions on Deepening the Reform of Innovation and Entrepreneurship Education in Colleges and Universities" (Guo Ban Fa [2015] No. 36) issued by the General Office of the State Council pointed out that, deepening the reform of innovation and entrepreneurship education in colleges and universities is an urgent need for the country to implement the innovation-driven development strategy and promote the upgrading of economic quality and efficiency [3]. Talent is the first resource to support innovation and development, and accelerating innovation-driven development is inseparable from a solid talent guarantee. Colleges and universities are an important platform for the cultivation of innovative talents. The cultivation of innovative talents in colleges and universities is inseparable from innovative educational concepts and educational models. The teaching of colleges and universities in our country often emphasizes the content of knowledge itself, and pays less attention to the process of mastering knowledge, emphasizing knowledge imparting and neglecting ability. Cultivation, resulting in insufficient practical ability of students, it is urgent to play the leading role of teachers and stimulate students' subject consciousness. Curriculum is the core element of talent cultivation, and the

quality of curriculum directly determines the quality of talent cultivation. The national outline for medium and long-term education reform and development (2010-2020) pointed out that efforts should be made to improve college students' innovative spirit of exploration and practical ability to solve problems. Innovative practical teaching effectively promotes the organic combination of knowledge acquisition and direct experience accumulation of college students, and plays an irreplaceable role in the cultivation of practical ability and innovation ability of college students, especially for science and engineering students [4]. Innovative practical teaching reflects the organic combination of teachers' research-based practical teaching and students' research-based learning, and plays an important role in improving students' practical ability and innovation ability [5]. At present, professional theoretical courses mainly focus on knowledge transfer, lack of ability training, and have not achieved the teaching effect of "thick foundation, flexible modules and strong practice". In 2006, Harbin Institute of Technology creatively established a new type of course - "Innovative researching course". The purpose is to solidify the latest scientific research results into teaching content in a timely manner, to implement the role of strong scientific research in researching universities in promoting teaching, and to provide practical new measures for the cultivation of innovative talents. The establishment of "Innovative researching course" aims to explore an innovative teaching mode based on scientific exploration to acquire knowledge to achieve learning transfer. "Innovative researching course" emphasize that students are the main body of learning, adhere to the combination of teacher-led and students' main body, adhere to the unity of imparting knowledge and development ability, highlight practicality, create real situations, and let students learn in practice. In the process of teaching interaction, learn how to learn, master methods and improve ability [6]. Innovative practical teaching is a "problem-centered" teaching mode that independently explores and completes independently or cooperatively under the guidance of teachers, and applies the theoretical knowledge learned to practice [7-10]. Since 2019, the authors have started an innovative training course "Theory

and technology of microforming" for mechanical undergraduates at Harbin Institute of Technology at Weihai. Microforming technology is a low-cost mass-manufacturing process for micro-nano components (feature sizes in the sub-millimeter order) using metal plastic deformation. It is an important part of micro-nano manufacturing technology, inheriting the advantages of traditional plastic forming technology, and has broad application prospects in aerospace, automobile, medical, environment, energy and other fields. This technology is not only one of the research hotspots in the field of plastic processing, but also one of the frontier technologies in the field of international manufacturing science [11]. This paper introduces the construction and practical exploration of the innovative training course "Theory and technology of microforming" in the School of Materials Science and Engineering, Harbin Institute of Technology at Weihai. Relying on this innovative training course to break through the barriers between theoretical teaching and practical teaching, to mobilize students' enthusiasm and initiative in learning. Focusing on improving students' comprehensive ability, innovating teaching methods, improving learning effectiveness, cultivating students' innovative awareness, improving students' ability to discover, analyze, solve and think independently, and provide a strong curriculum teaching foundation for the cultivation of first-class undergraduate talents .

## 2. Ideas for Construction of Teaching Content and Teaching Mode

This course combines the scientific research experience and achievements of the author and his team in the field of theory and technology of microforming, and considers the systematic and completeness of the field of theory and technology of microforming, and sets the main teaching content of this course. In order to better rely on scientific research to promote teaching, cultivate students' basic scientific research thinking and improve students' scientific research innovation ability, this course has been designed the teaching content and teaching mode of this course based on the education and teaching concept of "student-centered, learning effect-driven".

### 2.1. Design of Teaching Content

This course focuses on the most critical scientific issue in microforming technology-scale effects, and focuses on four

researching modules of materials, technology, tooling and equipment involved in theory and technology of microforming. The content of the course is transformed with scientific research advantages, scientific research feeds back teaching, pays attention to cultivating students' scientific research literacy, highlights research, practicality and academic expression. Based on this, the teaching content of this course is optimized. Course teaching content mainly includes: (1) Research background, development history, research hotspots and development trends of microforming technology; (2) The characteristics of micro forming technology and the difference from traditional plastic processing; (3) Design and micro-fabrication technology of micro-molds for microforming; (4) Requirements for microforming equipment and existing research results; (5) Microforming process and typical applications, etc. The teaching content of this course is designed to enable students to understand the forming objects, forming methods and forming characteristics of micro forming technology through the learning of this course; On the other hand, this course mobilizes students' learning enthusiasm and initiative, focusing on improving students' comprehensive ability.

### 2.2. Teaching Model Innovation

Aiming at the education and teaching concept of "student-centered, learning effect-driven", a diversified teaching model based on project-based learning that combines theoretical teaching and practical teaching is constructed. The teaching is based on the theoretical knowledge learning of the course "Theory and technology of microforming", and the theoretical knowledge modules are set up with the corresponding research and innovative practice content. Guide students to carry out innovative exploration and research, and master the research objectives, research methods, technical routes, and feasibility analysis of scientific research projects. Guided by practical problems, aiming at scientific exploration, around the connection between basic theoretical knowledge and practice, students are guided to design research and innovative experimental projects. It enables students to master the methods and means of studying and exploring scientific research, cultivate students' engineering application ability and innovative thinking, guide students to master scientific research methods and ways of thinking, and improve their ability to learn to analyze and solve problems.

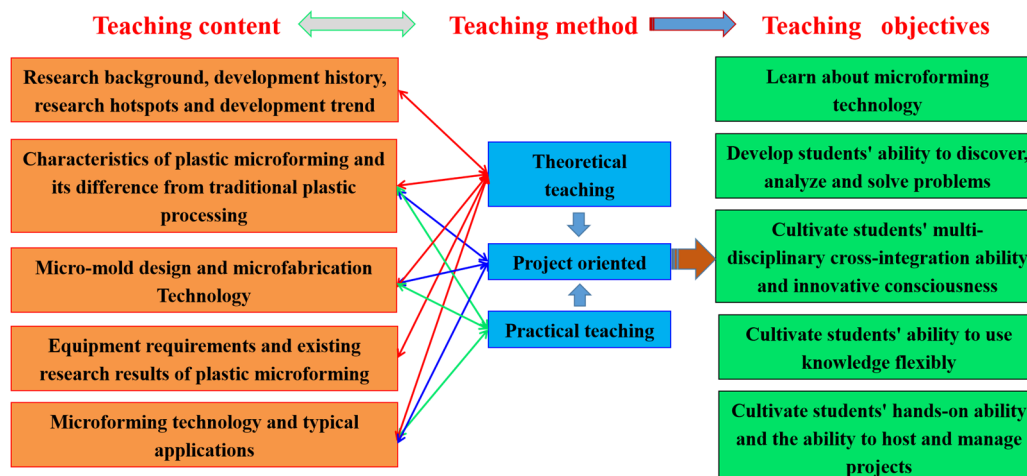


Figure 1. Design framework of course content and teaching mode of innovative researching course

### 3. Teaching Practice and Effect of Innovative Researching Course

Focusing on the reform of the construction of the diversified research teaching mode of the course "Theory and technology of microforming", the design of the project-based research and innovative experimental content, and the construction of the diversified teaching assessment and evaluation system, the author has carried out the construction and practice of innovative training courses and achieved certain teaching results.

#### 3.1. Construction of Diversified Research Teaching Mode

A diversified research teaching mode of "Theory and technology of microforming" is constructed, which combines theoretical teaching, experimental teaching and innovative project research. Theoretical teaching adopts the offline teaching mode, mainly explaining the basic theory of microforming, including the latest knowledge related to flow stress, interface friction, formability scale effect and microforming process design, etc., and clarify the difference and correlation between microforming technology and traditional macroforming technology. The experimental teaching adopts a combination of online and offline methods. Online experimental teaching mainly publishes experimental teaching tasks and online experimental teaching resources through the online platform before class, so that students can understand the experimental purpose, experimental principle, experimental steps, precautions, etc., which is convenient for offline experimental teaching. Deepen the understanding and understanding of the theoretical knowledge of flow stress and friction scale effect in microforming through basic experiments such as uniaxial tension and unidirectional compression. Turn students from passive recipients into course leaders. Innovative project research teaching mode, around the course students' knowledge learning and innovative ability training goals. On the basis of previous basic experiments, project-based innovative experiments are carried out. Based on the previous theoretical and basic experimental learning, combined with the current research situation at home and abroad, students propose innovative project practice themes, review literature materials, analyze problems, and propose experimental plans according to research projects. And carry out feasibility analysis, carry out experiments on this basis, and finally form a research report and defend it. Through project-based learning, the basic knowledge of theory and technology of microforming course is integrated with practical problems. To cultivate students' engineering application ability and innovative thinking. Improve students' ability to ask, analyze and solve problems.

#### 3.2. Construction of Diversified Teaching Assessment and Evaluation System

According to the characteristics of the course teaching mode of "Theory and technology of microforming", a set of matching diversified course evaluation system is constructed to comprehensively assess students' course mastery and achievement of learning objectives. Table 1 shows that the assessment and evaluation system mainly includes the course theoretical learning module, the experimental module and the project learning effect module. The evaluation focuses on

assessing students' communication and cooperation ability and innovation ability.

**Table 1.** Table of diversified teaching assessment and evaluation

Assessment module	Proportion	Assessment requirements
Theoretical study	25%	Complete offline theoretical knowledge learning, and complete classroom interaction and meet the standards
Experimental	25%	Complete the basic experiment and complete the experiment report
Project learning	50%	Complete the links of topic selection, team formation, experimental design, analysis, verification, experimental report writing and defense

### 4. Conclusion

The innovative researching course "Theory and technology of microforming" has explored an innovative researching course teaching mode and evaluation system after 4 rounds of teaching practice. Students are very interested in the course. The students who have studied in this course are obviously better than those who have participated in this type of course in entering the subject in the later course graduation design process, and the teaching effect is remarkable. The teaching practice of this course has created a positive exploration for the cultivation of innovative talents, and improved students' innovative awareness and practical ability.

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