The Educational Review, USA, 2023, 7(11), 1763-1767
https://www.hillpublisher.com/journals/er/
ISSN Online: 2575-7946
ISSN Print: 2575-7938

Reform and Exploration of Application-oriented Advanced Manufacturing Technology Course Teaching

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How to cite this paper: Qi Wang, Xi Chen, Hun Guo, Yafeng He. (2023). Reform and Exploration of Application-oriented Advanced Manufacturing Technology Course Teaching. *The Educational Review, USA*, 7(11), 1763-1767.
DOI: 10.26855/er.2023.11.023

Received: October 25, 2023
Accepted: November 23, 2023
Published: December 19, 2023

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Abstract

With the advancement of technology, advanced manufacturing has become a crucial force propelling the industrial revolution and economic development. The development of individuals with the skills to apply advanced manufacturing technology has become a widespread necessity for countries. However, the traditional teaching model of manufacturing technology can no longer meet this demand. Hence, it is especially important to implement the reform of application-oriented advanced manufacturing technology course instruction. We will actively collaborate with enterprises to offer students more practical opportunities and projects, enabling them to better understand modern manufacturing technology and processes, and enhance their professional competence and competitiveness. The article analyzes the current situation and teaching challenges of advanced manufacturing technology courses, and proposes the requirements and design plans for teaching reform. By clarifying the goals of teaching reform and exploring the optimization of teaching content, improvement of teaching methods, and reform of teaching evaluation, the teaching of advanced manufacturing technology courses can better meet the needs of high-quality training for application-oriented innovative talents in the new era.

Keywords

Advanced manufacturing technology courses, application-oriented, teaching reform exploration

1. Introduction

With the continuous development of technology, advanced manufacturing technology has become an important force driving the industrial revolution and economic development (Ke J., 2021). In this context, the cultivation of talents with the ability to apply advanced manufacturing technology has become a common requirement for countries (Deng J. & He J., 2023). However, the traditional teaching model of manufacturing technology can no longer meet this demand. Therefore, it is particularly important to carry out the reform of application-oriented advanced manufacturing technology course teaching (Wen S., 2023).

In the context of the new era, universities actively carry out engineering education professional certification and curriculum ideological and political construction work, which puts forward higher requirements for the teaching quality and talent cultivation of basic courses such as advanced manufacturing technology (Wang Q et al., 2022). Relying on the advanced industrial cluster in the Yangtze River Delta, Changzhou Institute of Technology has deeply explored the

cooperative education model of industry, academia, and research, and is committed to cultivating students' application and practical abilities. In recent years, the development of the mechanical discipline in the university has been rapid, based on the intelligent manufacturing city of Changzhou, highlighting the characteristics of "integrating industry and education, international collaboration." It is of great significance for higher education to train talents with comprehensive development of professional and ideological qualities, and it is also important for the construction of socialism with Chinese characteristics and the realization of the great rejuvenation of the Chinese nation (Liu Q., 2020).

2. Analysis of the Current Situation of Advanced Manufacturing Technology Courses

The advanced manufacturing technology course is designed to meet the needs of the rapid development of the modern manufacturing industry. Currently, the advanced manufacturing technology course is widely offered and promoted in higher education institutions, becoming a mandatory course for many majors. The course mainly covers knowledge in areas such as CAD/CAM technology, CNC machining technology, advanced manufacturing materials technology, rapid prototyping technology, etc., and is a combination of theory and practice. By studying this course, students can grasp the basic principles and application skills of modern manufacturing technology, and gradually improve their practical and innovative abilities.

Currently, the teaching methods of the advanced manufacturing technology course are also constantly innovating and improving. The teaching methods mainly include theoretical explanations, experimental operations, course designs, practical projects, etc., aiming to enable students to fully understand and master the course content and improve their practical application abilities. In general, the advanced manufacturing technology course has been widely offered and promoted in higher education, continuously updating and improving its teaching content and methods, providing important support for cultivating high-quality talents required by the modern manufacturing industry.

2.1 Teaching Content and Methods of Advanced Manufacturing Technology Courses

The teaching content of the advanced manufacturing technology course includes: an overview and introduction to the application areas of advanced manufacturing technology; basic knowledge of advanced manufacturing technology, such as CAD, CAM, CAE, CNC, etc.; materials and processes, such as laser cutting, EDM, 3D printing, etc.; automation and intelligence, such as robotics, sensors, control systems, etc.; quality control and inspection, such as optical imaging, X-ray detection, infrared imaging, etc.; application case analysis, such as automotive manufacturing, aerospace, medical devices, etc.

The teaching methods of the advanced manufacturing technology course include:

(1) Theoretical lectures: By teaching the basic knowledge, materials and processes, automation and intelligence, quality control and inspection, etc., of advanced manufacturing technology, students can understand the current development status and future trends of advanced manufacturing technology.

(2) Experimental teaching: Through experimental courses, students can master the practical operation skills of advanced manufacturing technology and deepen their understanding and application of theoretical knowledge.

(3) Seminar teaching: Through discussing the application cases of advanced manufacturing technology, students can understand the specific application scenarios and methods for solving practical problems in the practical application of advanced manufacturing technology.

(4) Course design: Through course designs, students can grasp the application and problem-solving abilities of advanced manufacturing technology in practice.

(5) Practical teaching: Through company visits, field research, and other practical activities, students can understand the application and actual situation of advanced manufacturing technology in actual production.

2.2 Teaching issues and reform requirements for Advanced Manufacturing Technology courses:

Teaching issues in Advanced Manufacturing Technology courses: (1) The content of textbooks updates at a fast pace, requiring teachers to constantly update their teaching materials. (2) The lack of equipment and tools for practical activities makes it difficult to meet students' practical needs. (3) Students have limited practical skills in advanced manufacturing technology and need to strengthen practical teaching and guidance. (4) Students have a shallow understanding of the application scenarios and practical value of advanced manufacturing technology, and therefore, teaching on real-life case studies needs to be enhanced.

Reform requirements for Advanced Manufacturing Technology courses: (1) Combine with real-life application scenarios and enhance the teaching of case studies. (2) Strengthen practical teaching to improve students' practical skills. (3) Teachers need to constantly update their teaching materials to stay in sync with the development of advanced

manufacturing technology. (4) Enhance cooperation with companies to provide more practical opportunities and resources. (5) Introduce advanced teaching technologies and methods such as virtual simulation technology and online teaching to improve teaching effectiveness.

3. Advanced Manufacturing Technology Course Teaching Reform Design for Applications

3.1 Design of Teaching Objectives

This course aims to develop students' understanding of the basic concepts, principles, and applications of advanced manufacturing technology. It aims to equip them with the ability to apply advanced manufacturing technology in product design, manufacturing, and quality control, and to proficiently use relevant software and equipment for digital manufacturing, intelligent manufacturing, and flexible manufacturing. The specific objectives include:

(1) Master the basic concepts, principles, and applications of advanced manufacturing technology.
(2) Understand the development trends and application scenarios of advanced manufacturing technologies such as digital manufacturing, intelligent manufacturing, and flexible manufacturing.
(3) Master the operation methods of relevant software and equipment and be able to apply them in product design, manufacturing, and quality control.
(4) Possess the capability to apply advanced manufacturing technology in product design, manufacturing, and quality control.
(5) Have teamwork and communication skills and be able to assume appropriate roles and tasks within a team.

3.2 Design of Teaching Content

The teaching content of this course includes the following aspects:

(1) Concepts and development process of advanced manufacturing technology.
(2) Principles and applications of advanced manufacturing technologies such as digital manufacturing, intelligent manufacturing, and flexible manufacturing.
(3) Use of digital manufacturing software tools (such as CAD, CAM, CAE, PLM, etc.).
(4) Use of digital manufacturing equipment (such as 3D printers, CNC machine tools, etc.).
(5) Composition and application of intelligent manufacturing systems.
(6) Composition and application of flexible manufacturing systems.
(7) Application of quality control methods (such as SPC, FMEA, DOE, etc.).
(8) Case analysis and practical operations.

3.3 Design of Teaching Methods

This course adopts a student-centered teaching approach that emphasizes the integration of theory and practice, individualization, and teamwork. The specific teaching methods include:

(1) Lecture method: Helping students master the basic concepts, principles, and applications of advanced manufacturing technology through theoretical knowledge.
(2) Case analysis method: Helping students understand the role and value of advanced manufacturing technology in practical applications through case analysis.
(3) Practical operation method: Helping students master the use of relevant software and equipment through practical operations, and fostering their ability to apply advanced manufacturing technology in product design, manufacturing, and quality control.
(4) Teamwork method: Helping students develop teamwork and communication skills, and enhancing their ability to assume roles and tasks within a team.

3.4 Design of Teaching Evaluation

The teaching evaluation of this course aims to comprehensively and objectively assess students' learning outcomes and abilities. It includes the following aspects:

(1) Regular performance: Including class participation, completion of assignments, teamwork, etc.
(2) Mid-term exam: Assessing students' understanding of the basic concepts, principles, and applications of advanced manufacturing technology.
(3) Laboratory reports: Assessing students' mastery of the use of relevant software and equipment.

(4) Project reports: Assessing students' ability to apply advanced manufacturing technology in product design, manufacturing, and quality control.
(5) Comprehensive assessment: Taking into account the above aspects of performance and results to evaluate students' learning outcomes and abilities.

4. Application-oriented Advanced Manufacturing Technology Course Teaching Reform Implementation

4.1 Implementation Plan for Teaching Reform

For application-oriented advanced manufacturing technology courses, teaching reform should be conducted from the following aspects:

(1) Update the teaching content: Update the existing content of advanced manufacturing technology courses by incorporating the latest technological applications, industry development trends, and other relevant information to ensure the timeliness and practicality of the teaching content.
(2) Improve teaching methods: Utilize various teaching methods such as case studies, project-based learning, and laboratory experiments to enhance students' understanding and mastery of technical knowledge, as well as improve their practical skills.
(3) Optimize course design: Classify application-oriented advanced manufacturing technology courses based on students' professional directions and actual needs, enabling students to better choose and study relevant courses.
(4) Develop teaching faculty: Strengthen teacher training and enhance their professional qualifications to improve their teaching abilities and practical experience in order to provide better teaching services for students.

4.2 Process of Teaching Reform Implementation

The following measures should be taken during the process of teaching reform implementation:

(1) Develop an implementation plan for teaching reform, clearly defining the objectives, content, methods, and timeline of the reform.
(2) Strengthen the development of teaching faculty to improve their teaching abilities and practical experience.
(3) Optimize and adjust course offerings based on students' actual needs, ensuring the practicality and timeliness of the course content.
(4) Adopt various teaching methods such as case studies, laboratory experiments, and project-based learning to help students better understand and master technical knowledge.
(5) Strengthen the inclusion of practical components, encourage student participation in practical operations and project-based learning, and enhance their practical and innovative abilities.
(6) Continuously evaluate and assess the effectiveness of teaching reform and continuously optimize and refine the reform plan.

4.3 Evaluation of Teaching Reform Implementation Effectiveness

The evaluation of the effectiveness of teaching reform implementation should be conducted from the following perspectives:

(1) Employment status of graduates: Evaluate the impact of teaching reform on students' employment by investigating and analyzing the employment situation of graduates.
(2) Improvement in students' knowledge and skills: Assess the improvement in students' knowledge and skills by conducting tests and evaluations.
(3) Participation in practical components: Evaluate the enhancement of students' practical skills and innovation abilities by investigating and analyzing their participation in practical components.
(4) Improvement in teachers' teaching abilities: Evaluate the improvement in teachers' teaching abilities by assessing and comparing their teaching performance.
(5) Students' feedback on teaching reform: Assess the satisfaction and effectiveness of teaching reform by conducting surveys and analyzing students' feedback.

5. Summary and Prospects of Teaching Reform for Application-oriented Advanced Manufacturing Technology Courses

5.1 Summary of Teaching Reform

The teaching reform of application-oriented advanced manufacturing technology courses is carried out to cultivate high-quality talents with modern manufacturing technology and theoretical knowledge. The main goal of teaching reform is to improve students' comprehensive quality and practical ability so that they can meet the needs of the modern manufacturing industry.

In the teaching reform, we have adopted a series of effective measures, including updating teaching content, improving teaching methods, and increasing practical components. Specifically, we have combined the course content with the development of the modern manufacturing industry and added some new teaching content, such as intelligent manufacturing and digital manufacturing. We have also used various teaching methods, such as case-based teaching and project practice, to improve students' practical ability and problem-solving skills. In addition, we have strengthened the setting of practical components, such as experiments, training, and internships, to enhance students' practical ability and professional competence.

The implementation of teaching reform has achieved remarkable results. Students' interest and enthusiasm for learning have been improved, and their practical ability and problem-solving skills have also been significantly enhanced. Students have demonstrated strong innovation ability and teamwork skills in practical components, further enhancing their competitiveness in the job market.

5.2 Prospects of Teaching Reform

The teaching reform of application-oriented advanced manufacturing technology courses is a long-term work. We will continue to make efforts to further improve teaching content and methods, and enhance teaching quality and effectiveness.

Firstly, we will continue to update teaching content, constantly adding new teaching content based on the development trends and demands of the modern manufacturing industry, such as big data, cloud computing, and artificial intelligence. At the same time, we will further strengthen the integration of theory and practice, and improve students' practical ability and problem-solving skills.

Secondly, we will further improve teaching methods, adopting more diverse and flexible teaching approaches, such as online teaching, distance teaching, and network teaching, to meet the needs and learning styles of different students.

Lastly, we will further strengthen the setting and management of practical components, and improve the quality and effectiveness of practical teaching. We will actively cooperate with enterprises to provide students with more practical opportunities and projects, helping them better grasp modern manufacturing technology and processes, and improve their professional competence and competitiveness.

Funding

This study is co-supported by the Ministry of Education's Industry School Cooperation Collaborative Education Project (No. 22107068032002), the Project of Changzhou Basic Research Program (No. CJ20220239), and the general project of basic science (natural science) research in colleges and universities of Jiangsu Province (No. 22KJB460014).

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