Practice of Integrating Advanced Manufacturing Technology into Mechanical Specialty Teaching

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Abstract: This article focuses on the research of integrating advanced manufacturing technology into the teaching of mechanical specialty. This article deeply analyzes the internal relationship between advanced manufacturing technology and mechanical specialty teaching, and sorts out many problems and challenges faced in the process of integration. It mainly includes insufficient adaptation of teaching resources, the ability of teachers to be improved, and the difficulty in matching teaching methods with actual needs. Based on these problems, the article puts forward a series of targeted strategies. In the optimization of curriculum system, we should increase the proportion of courses related to advanced manufacturing technology, update the content of traditional courses, and build a curriculum group to form a systematic teaching system. In view of the construction of teaching staff, the professional ability of teaching staff is improved by organizing professional training and encouraging teachers to participate in scientific research practice. In the innovation of teaching methods, diversified teaching methods such as case teaching and project teaching are adopted, and virtual simulation teaching and school-enterprise cooperation practice are strengthened to enhance students' practical ability and innovative thinking. The purpose of this study is to provide reference for the effective integration of advanced manufacturing technology in the teaching of mechanical specialty and help the teaching reform of mechanical specialty.

1. Introduction

As the core driving force of modern manufacturing industry, advanced manufacturing technology is leading the machinery industry to a new development stage of intelligence, high efficiency and greening [1]. With the increasingly fierce competition in the global manufacturing industry, the innovative and forward-looking advanced manufacturing technology plays a decisive role in enhancing the overall strength of the national manufacturing industry [2]. From precision machining technology to intelligent manufacturing system, from digital design to green manufacturing concept, every breakthrough of advanced manufacturing technology reshapes the production mode and industrial pattern of machinery industry [3]. As an important discipline to transport professionals for the mechanical industry, the teaching quality and direction of mechanical specialty are directly related to the future development of the industry [4]. With the extensive application of advanced manufacturing technology in machinery industry, the teaching of machinery specialty must keep up with the pace of the times and adjust the teaching contents and methods in time to cultivate high-quality talents who can adapt to the changes in the industry and master advanced technology [5].

It is of great practical significance to integrate advanced manufacturing technology into the teaching of mechanical specialty. For individual students, it can broaden their knowledge horizons, so that they can be exposed to the cutting-edge technology of the industry during their school days, and enhance their employment competitiveness and career development potential [6]. From the perspective of industry, it is helpful to continuously transport professionals with advanced manufacturing technology literacy for the machinery industry and promote technological innovation

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and transformation and upgrading of the industry [7]. As far as education itself is concerned, this is an inevitable requirement for the close connection between education and industrial demand, which can promote the optimization and improvement of the teaching system of mechanical specialty and improve the quality and pertinence of professional education.

The purpose of this article is to explore the effective path of integrating advanced manufacturing technology into mechanical specialty teaching. By analyzing the internal relationship between the two, the problems and challenges faced in the process of integration are sorted out, and on this basis, scientific and reasonable integration strategies are constructed.

2. Analysis of the relationship between advanced manufacturing technology and mechanical specialty teaching

With its unique connotation and characteristics, advanced manufacturing technology covers many fields, such as digital design and manufacturing, automatic processing technology, intelligent manufacturing system and so on. It has the remarkable characteristics of high precision, high efficiency and intelligence, and represents the frontier development direction in the field of mechanical manufacturing. The teaching of mechanical specialty aims at cultivating professionals with knowledge and skills in mechanical design, manufacturing and automation. Its curriculum system includes basic courses such as mechanical drawing, mechanical design and mechanical manufacturing technology, as well as specialized courses such as automation control and numerical control technology. Through the mode of combining theoretical teaching with practical teaching, students can master solid professional knowledge and skills [8]. Advanced manufacturing technology is closely related to the teaching of mechanical specialty in many aspects. On the knowledge level, the contents of digital design and intelligent manufacturing in advanced manufacturing technology are interrelated and expanded with the knowledge of design theory and automatic control in mechanical specialty courses. In terms of skills training, the skills such as high-precision machining operation and intelligent system operation and maintenance required by advanced manufacturing technology are highly consistent with the training objectives of students' hands-on ability and innovation ability in practical teaching of mechanical specialty. From the perspective of talent training, the major of machinery aims to transport talents for the industry, and the development trend of advanced manufacturing technology determines the new demand of the industry for talents' knowledge structure and ability, and the teaching of machinery specialty must be adjusted and optimized according to these demands.

3. Advanced manufacturing technology into the teaching of mechanical problems and challenges

Advanced manufacturing technology is developing rapidly, but it is difficult to update the teaching materials, equipment and other resources that mechanical specialty depends on. At present, most of the teaching materials are outdated and fail to cover the cutting-edge knowledge of advanced manufacturing technologies such as industrial internet and the application of artificial intelligence in manufacturing field in time. In terms of teaching equipment, high-end CNC machine tools, industrial robots and other equipment required for advanced manufacturing technology are expensive, and it is difficult for most colleges and universities to equip them with sufficient quantities due to financial constraints, resulting in fewer practical operation opportunities for students and inability to master relevant technologies in depth. Table 1 takes the present situation of teaching resources of mechanical specialty in some colleges and universities as an example. The content of advanced manufacturing technology in teaching materials is lagging behind, and the number of equipment and advanced technology can not meet the practical needs of students.

The professionalism and cutting-edge of advanced manufacturing technology put forward high requirements for teachers' knowledge reserve and practical ability. However, the reality is that most mechanical teachers have been focusing on traditional teaching content for a long time, lacking in-depth understanding and practical experience of advanced manufacturing technology. A survey

of mechanical teachers in some universities shows that only 20% teachers have participated in advanced manufacturing technology-related training or enterprise practice. This makes it difficult for teachers to integrate practical application cases of advanced manufacturing technology into the classroom in the teaching process, unable to provide students with vivid and practical teaching content, and affecting students' understanding and mastery of advanced manufacturing technology.

Table 1: Overview of Advanced Manufacturing Technology Teaching Resources in Mechanical Engineering at Selected Universities

University Name	Version Year of Advanced Manufacturing Technology Textbook	Number of Textbook Updates in the Last Three Years	Number of High-End CNC Machine Tools (Units)	Number of Industrial Robots (Units)	Years Since Equipment Purchase
University A	2015	1 time	3	2	5 years
University B	2017	0 times	2	1	6 years
University C	2016	1 time	4	3	4 years

Advanced manufacturing technology emphasizes the comprehensiveness of knowledge and the innovation of practice, while the traditional teaching method of mechanical specialty focuses on theoretical teaching, and practical teaching is often step by step, which lacks the effective cultivation of students' innovative thinking and practical ability. In the experimental teaching, most students complete the experiment according to the established steps, lacking the space for independent design and exploration, and it is difficult to stimulate students' interest in learning advanced manufacturing technology and their enthusiasm for innovation. New teaching modes such as virtual simulation and online collaboration in advanced manufacturing technology have not been widely used in the teaching of mechanical specialty, which can not meet the teaching needs of complex knowledge of advanced manufacturing technology.

4. Strategy construction of integrating advanced manufacturing technology into mechanical specialty teaching

Table 2: Integration Plan for Advanced Manufacturing Technology Content in the "Mechanical Manufacturing Technology" Course

Chapter	Existing Content	Proposed Advanced Manufacturing Technology Content to Integrate	Integration Ratio
Principles of Metal Cutting	Traditional Cutting Tool Theory	Intelligent Tool Monitoring and Management Technology	20%
Machine Tool Fixture Design	General Fixture Design Methods	Flexible Fixture Design Based on Intelligent Manufacturing	15%
Formulation of Mechanical Processing Technology Procedures	Conventional Process Route Planning	Digital Process Planning and Simulation Optimization	25%
Processing Technology for Typical Parts	Traditional Processing Technology for Shaft and Sleeve Parts	Additive Manufacturing Process for Complex Components	20%
Mechanical Processing Accuracy and Surface Quality	Analysis and Control of Processing Errors	Big Data-Based Processing Quality Prediction and Control	20%

In the face of various problems faced by the integration of advanced manufacturing technology into the teaching of mechanical specialty, it is necessary to build a scientific and reasonable strategy system. In order to promote the innovation of mechanical specialty teaching, it can better meet the

needs of the development of advanced manufacturing technology. Curriculum system is the core framework of teaching, and optimizing curriculum system is the key step to integrate advanced manufacturing technology. First, the proportion of courses related to advanced manufacturing technology should be increased. Taking the course of Mechanical Manufacturing Technology as an example, we can add additive manufacturing and green manufacturing on the basis of traditional processing technology. Teachers need to make a detailed course content adjustment plan (see Table 2), and make clear the updating direction and proportion of knowledge points in each chapter.

Teachers should construct the organic connection between courses and form the course group of advanced manufacturing technology. See Table 3 for the curriculum cohesion and collaborative teaching plan of the design curriculum group.

Table 3: Collaborative Teaching Plan for Advanced Manufacturing Technology Course Group

Course Name	Teaching Sequence	Teaching Objectives	Connection Points with Other Courses
Intelligent Manufacturing Systems	1st Semester	Enable students to understand the concept, architecture, and development trends of intelligent manufacturing	Provide a theoretical framework for subsequent courses and jointly build the foundation of intelligent manufacturing knowledge with "Industrial Big Data Analysis and Application"
Industrial Big Data Analysis and Application	2nd Semester	Cultivate students' ability to collect, analyze, and apply industrial data	Based on the data-driven concept in "Intelligent Manufacturing Systems," provide data support and decision-making basis for "CNC Technology and Programming" and "Industrial Robot Programming and Operation"
CNC Technology and Programming	3rd Semester	Enable students to master CNC machining principles, programming methods, and operational skills	Apply the digital control concept from "Intelligent Manufacturing Systems" and combine the data analysis results from "Industrial Big Data Analysis and Application" to optimize the CNC machining process
Industrial Robot Programming and Operation	4th Semester	Familiarize students with the structure, programming, and operation of industrial robots	Against the background of the automated execution unit in "Intelligent Manufacturing Systems," draw on the data processing results from "Industrial Big Data Analysis and Application" to achieve intelligent control and task optimization of robots

Teachers are the implementers of teaching, and it is very important to improve the teaching ability of advanced manufacturing technology. On the one hand, the school should organize teachers to participate in all kinds of advanced manufacturing technology training, including online and offline professional course training, academic seminars and short-term study for enterprises. For example, vocational institutions cooperate with well-known manufacturing enterprises to implement the “Advanced Manufacturing Technology Teacher Training Program,” enabling teachers to immerse themselves in enterprise production lines and gain firsthand understanding of the latest technological applications and production processes. On the other hand, schools should encourage teachers to participate in scientific research projects and enterprise practice, and feed back teaching with scientific research. At the same time, the school should introduce high-level talents with practical experience of advanced manufacturing technology in enterprises, enrich the

teaching staff, and bring the latest industry trends and practical application cases to students.

The complexity and innovation of advanced manufacturing technology require diversified teaching methods. In theoretical teaching, the case teaching method is used to introduce advanced manufacturing cases in actual production to guide students to analyze and solve problems. For example, when explaining the intelligent manufacturing system, taking the intelligent factory construction of an automobile manufacturing enterprise as an example, the system architecture, operation mode and benefit improvement are analyzed. Using project-based teaching method, students can complete advanced manufacturing-related projects in groups and cultivate their teamwork and innovation ability. In practice teaching, teachers should strengthen virtual simulation teaching and use virtual simulation software to simulate the operation and technological process of advanced manufacturing equipment to solve the problem of insufficient equipment.

5. Conclusions

It is self-evident that advanced manufacturing technology promotes the development of machinery industry, and its integration into the teaching of machinery specialty is an inevitable requirement of the development of the times. Through the in-depth analysis of the relationship between the two, this study clearly presents a series of problems faced in the current integration process. The lag of teaching resources, the limitation of teachers' ability and the mismatch of teaching methods have seriously restricted the effective integration of advanced manufacturing technology in mechanical specialty teaching. In order to solve these problems, this article constructs a comprehensive and targeted strategy. In the optimization of curriculum system, not only advanced manufacturing technology courses are added, but also traditional courses are innovated, and curriculum groups are carefully created, so that students can learn relevant knowledge systematically. The strategy of improving teachers' ability focuses on providing teachers with diversified training opportunities, encouraging them to participate in scientific research and enterprise practice, and introducing talents with practical experience, so as to build a teaching staff capable of teaching advanced manufacturing technology. The innovation of teaching methods emphasizes the combination of theory and practice. Through case teaching, project-based teaching, virtual simulation teaching and school-enterprise cooperation practice, students' interest in learning is stimulated and their innovation and practical ability is improved.

If these strategies can be effectively implemented, it is expected to significantly improve the status quo of the integration of advanced manufacturing technology into the teaching of mechanical specialty, improve the teaching quality, and cultivate more high-quality talents with solid professional knowledge and familiarity with advanced manufacturing technology for the mechanical industry. However, this goal cannot be achieved overnight, and it requires the cooperation of schools, teachers and enterprises, and continuous investment of resources and energy. With the continuous development of advanced manufacturing technology, the teaching of mechanical specialty should continue to follow up and constantly optimize teaching strategies to better meet the needs of the industry and provide strong talent support for promoting the innovative development of the mechanical industry.

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