Research on the Course Reform of Mechanical Manufacturing Technology Based on the German Dual System Training Model

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Abstract. This article aims to reform the course of mechanical manufacturing technology, referring to the German dual system training model. Through the analysis of the current situation of mechanical manufacturing technology course, the teaching content of the course has been reduced in order to ensure that students effectively master key knowledge points. The practical content of the course has also undergone modular reform, which enhance the practicality of practical operations. Reforming the course of mechanical manufacturing technology aims to improve professional skills and innovation abilities of students majoring in mechanical manufacturing, and adapt to the current development status of the industry.

Keywords: Course Reform, Mechanical Manufacturing Technology, German Dual System Training Model.

1 Introduction

Today, the development of the industry is based on the new industrial revolution characterized by the Internet, intelligent manufacturing, big data, and new material technology [1]. In response to the current development status of the industry, school education must keep pace with the times and cultivate talents that meet the needs of the industry [2].

At the same time, research has found that the cultivation of German mechanical manufacturing professionals focuses on the development of methodological, professional, social, personal, and innovative abilities [3]. When cultivating students majoring in mechanical manufacturing, we can align with international standards, analyze the German dual system training model, reform the content of course in mechanical manufacturing technology, aiming to cultivate the practical ability and innovative awareness of mechanical manufacturing students, promote the improvement of students' professional competence, and adapt to the current development status of the industry.

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2 German Dual System Training Model

Vocational schools and universities in Germany have dual learning methods, which are mainly based on the Enterprise+School model, where students alternate between studying in school and working in enterprises. In the dual learning process of vocational schools, the focus of enterprise training is on the business processes and quality assurance systems of the job field. The school cultivates teaching within the scope of abilities, through career orientation, practice orientation, and social ability orientation, following the specific tasks given by the teacher---students obtain task information---students formulate task implementation plans---specific task implementation---the process of teacher inspection, grading, and feedback, so that students understand where and how to apply the theoretical knowledge they have learned. And when teachers check and grade, they do not use the specific results of task implementation as the basis for grading. Errors are allowed, but students are required to identify the reasons for the errors. Through the implementation of tasks, students' methodological abilities, professional abilities, social abilities, and personal abilities are exercised, while also cultivating enthusiasm and focus [4,5].

In Germany, there are mainly dual training vocational positions in the field of mechanical manufacturing, including mechanical engineer (ZerSpanungsmechiner/in for both men and women), metal expert processing technology (Fachkraft für Metalltechnik Zerspanungstechnik), and metalworker (Metallwerker/in for both men and women). Its vocational training is more detailed, with more targeted job positions, and is systematically trained according to the actual process of enterprise job work. Starting from the analysis of work tasks, it forms work ideas, scientifically selects work methods and required tools and equipment, implements the work process in detail, inspects and approves after the work is completed, and follows the system and safety guidelines that need to be followed throughout the entire process. At the same time, the three occupational positions mentioned above have established content training agreements for scientifically selecting processing methods, equipment, and tools, clamping and positioning workpieces, and processing and manufacturing workpieces of different materials based on technical documents. These contents are also the core of course in mechanical manufacturing technology offered by our mechanical major. By analyzing the current situation of the course and combining it with the German dual system training model, this paper proposes a reform idea for the course in mechanical manufacturing technology.

3 Reform Ideas for the Course in Mechanical Manufacturing Technology

Analyzing the current situation of mechanical manufacturing technology course, it was found that the course covers a wide range of content, and students need to learn a large number of professional knowledge points within limited class hours, which reduces the effectiveness of mastering key knowledge, thereby affecting teaching effectiveness and the cultivation of innovative awareness in mechanical manufactur-

ing. At the same time, it was found that the practical content of the course is not practical enough and disconnected from the actual production situation of the industry, which leads to the inability to effectively stimulate students' practical willingness and restricts the cultivation of their professional skills and innovation abilities.

In order to effectively improve students' professional competence, based on the above analysis and combined with the German dual system training model, the following reform ideas are proposed for the course of mechanical manufacturing technology.

(1) Reduce course content and only retain key knowledge points

The teaching content of mechanical manufacturing technology course is based on the principle of Necessary and Sufficient. The teaching process only focuses on solving the problems of What and How to Use", enhancing the flexibility of theoretical teaching content, improving students' professional interest and learning willingness, and strengthening the connection with industry job requirements.

The curriculum content after the reform includes four sections (as shown in Table1).

① Machining Basic Knowledge

This section covers mechanical processing methods, cutting tools, cutting parameters, as well as the structural of mechanical parts.

② Manufacturing of Shaft Parts

This section covers the structural characteristics of shaft parts, commonly used blanks, fixtures, processing methods, as well as the formulation of process planning.

③ Manufacturing of Sleeve Parts

This section covers the structural characteristics of sleeve parts, commonly used blanks, fixtures, processing methods, as well as the formulation of process planning.

④ Manufacturing of Box Parts

This section covers the structural characteristics of box parts, commonly used blanks, fixtures, processing methods, as well as the formulation of process planning.

Table 1. The content of mechanical manufacturing technology course after the reform.

	Section	Key Knowledge Points	Industry Job Requirements
①	Machining Basic Knowledge	(1) Mechanical processing methods (2) The formation pattern of chips (3) Selection of cutting tools (4) Selection of cutting parameters (5) Structure of mechanical parts	(1) Drilling, turning, milling, and grinding process (2) Determine the type and material of cutting tools (3) Set the cutting parameters (4) Optimize structure of mechanical parts

②	Manufacturing of Shaft Parts	(1) External structural characteristics (2) Selection of part blank (3) Determination of processing methods (4) Selection of cutting tools and fixtures (5) Selection of locating datum (6) Arrangement of machining process (7) Formulation of process planning	(1) Determine processing methods (2) Select part blank (3) Select cutting tools and fixtures (4) Determine process dimensions and tolerances (5) Formulate process planning (6) Proper use of measuring tools (7) Refer to reference books and picture books (8) Guide on-site operation
③	Manufacturing of Sleeve Parts		
④	Manufacturing of Box Parts		

In the above table, the key knowledge points of the section ②,③,④ are consistent, but the specific mechanical parts are different. This enables students to not only vertically focus on mastering the manufacturing process of mechanical components, but also horizontally memorize the differences in manufacturing processes of different types of pars, which can effectively consolidate the key knowledge points of teaching content.

(2) Modularize the practical content and enhance its practicality

Increase the proportion of practical operations in the total class hours, based on the professional knowledge points mastered, guided by industry job requirements, and with the goal of practical operation in parts processing, modularize the practical content [6].

After the reform of practical content in the course of mechanical manufacturing technology, it includes three modules (as shown in Table 2).

① Mechanical Manufacturing Practice of Shaft Parts

This module focuses on the practical processing of output shafts for small reducers.

② Mechanical Manufacturing Practice of Sleeve Parts

This module focuses on the practical processing of positioning shaft sleeves.

③ Mechanical Manufacturing Practice of Box Parts

This module focuses on the practical processing of simple assembly boxes.

Table 2. The practical content of mechanical manufacturing technology course after the reform.

	Module	Practical Content	Knowledge Points Application	Practical Ability Training
①	Mechanical Manufacturing Practice of Shaft Parts	Processing output shafts for small reducers	Shaft, sleeve, and box parts: (1) External structural characteristics (2) Selection of	(1) Familiar with the scope of drilling, turning, milling, and grinding processing

②	Mechanical Manufacturing Practice of Sleeve Parts	Processing positioning shaft sleeves	part blank (3) Determination of processing methods (4) Selection of cutting tools and fixtures (5) Selection of locating datum (6) Selection of cutting parameters (7) Arrangement of machining process (8) Formulation of process planning (9) Measuring parts	(2) Proficient in analyzing part drawings (3) Familiar with the arrangement of machining process for various parts (4) Familiar with the formulation of process planning for various parts (5) Proficient in using measuring tools (6) Proficient in using reference books and picture books (7) Guiding on-site operation
③	Mechanical Manufacturing Practice of Box Parts	processing simple assembly boxes		

Through the specific part processing tasks in the practical module, students have undergone practical exercises, which not only deepen their memory of the course knowledge points, but also enhance their ability to connect theory with practice. The task setting of the practical module is combined with actual mechanical parts, enhancing practicality while providing students with more independent learning space. This not only stimulates students' practical willingness, but also improves their professional skills and innovation abilities.

4 Conclusions

Reforming the content of course in mechanical manufacturing technology aims to cultivate the practical ability and innovative awareness of mechanical manufacturing students, promote the improvement of their professional competence, and adapt to the current development status of the industry. Based on the analysis of the current situation of mechanical manufacturing technology course and combined with the German dual system training model, the reform content of the curriculum is as follows:

(1) Reduce course content and only retain key knowledge points. The reformed curriculum includes four sections: machining basic knowledge, manufacturing of shaft parts, manufacturing of sleeve parts, and manufacturing of box parts.

(2) The course content after the reform covers the key knowledge points, such as mechanical processing methods, cutting parameters, cutting tools, structure of mechanical parts, commonly used blanks, fixtures, and processing methods, and the arrangement of machining process.

(3) Modularize the practical content and enhance its practicality. The modular course practice content includes three modules: mechanical manufacturing practice of shaft parts, mechanical manufacturing practice of sleeve parts, and mechanical manufacturing practice of box parts.

(4) The practical module focuses on actual parts processing, enabling students to further consolidate knowledge points of mechanical processing methods selection, selection of cutting parameters and tools, parts positioning, arrangement of machining process for various parts, and formulation of process planning. At the same time, enhance the ability to connect theory with practice, improve professional skills and innovation abilities of students majoring in mechanical manufacturing, and adapt to the current development status of the industry.

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