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Research on the Optimization of Practical Teaching System for Mechanical and Electrical Majors in Higher Vocational Education from the Perspective of Capability Based Approach

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Abstract: The development and advancement of intelligent technology has transformed industrial change into a new phase. In response to this development, China's manufacturing industry and manufacturing enterprises have proactively modified their production layout and talent requirements. This shift in talent demand has given rise to the reform of talent cultivation and the curriculum system in vocational colleges and universities. This reform is especially focused on the optimisation of the curriculum system based on the teaching of professional practice courses.

Keywords: Competency-Based, Higher Vocational Institutions, Electromechanical Specialities, Optimisation of Practice Teaching System

1. Introduction

In recent years, thanks to the gradual exploration of cutting-edge technologies such as artificial intelligence into the industrial sector, industrial production is gradually developing towards lean, customized, and intelligent directions [1,2]. The progress of productivity has forced many manufacturing related enterprises to adjust their production layout and their own talent needs. The equipment produced by it has evolved from a single, uncoordinated, and difficult to communicate production unit to an intelligent production network that is interconnected, information sharing, and coordinated. This has led to the need for frontline production technicians and supervisors to master the knowledge of using advanced equipment and advanced production concepts. The talent demand of enterprises has also shifted from skilled talents with a single knowledge structure to innovative skilled talents with a composite knowledge background.

Industrial upgrading prioritizes skills. The industrial upgrading and optimization of talent resource allocation of an enterprise require a team of highly skilled talents who possess exquisite skills, core technologies, and innovative consciousness as the starting point and support point. The changing demand for skilled talents also requires the education sector, especially vocational education related colleges, to make adjustments in talent cultivation, teaching knowledge system, and so on. The impact caused by the progress of industrial productivity on the business sector, education sector, research institutions, and other fields of society has also driven the transformation of vocational education towards a new stage of industry education integration that organically connects the education chain, talent chain, and industrial chain.

The tremendous changes in historical development are both opportunities and challenges. Only by constantly reforming, innovating, breaking free from outdated ideological constraints, and embracing new changes can we survive and gradually grow from this transformation. This is true for enterprises, especially for vocational education institutions in the education sector. The primary goal of vocational education is to cultivate skilled talents, and practical teaching is an important part of achieving high-quality skilled talents. It is also the main way to cultivate students' professional operational skills and comprehensive vocational abilities.

The key to measuring the effectiveness of cultivating skilled talents lies in whether

students' abilities meet the needs of enterprises and industries, whether their knowledge structure enables them to have the thinking ability to handle complex problems, and whether they possess the spirit of reform and innovation that breaks tradition, dares to practice, and reflect. These require vocational colleges to adjust and optimize the current practical teaching system, and build a comprehensive and diversified evaluation system [4-5] to meet the needs of today's society.

Standardizing and strengthening practical teaching, as well as deepening the mechanism of school enterprise cooperation, are important measures to promote educational reform, improve the quality of talent cultivation, and connect with technical and skill positions in enterprises. The focus of practical teaching is to cultivate students' ability to solve complex problems. Therefore, studying and optimizing the practical teaching system from the perspective of competency based approach is an important way to deepen research in higher vocational education. This article will explore and study the optimization of the practical teaching system for vocational mechanical and electrical majors.

2. Problems in the Practical Teaching System

Previous vocational education has trained many valuable skilled talents for the development of China's manufacturing industry, but there are already many inadequacies in the current transformation of intelligent productivity, which has affected the quality of vocational education talent cultivation and poor adaptability to the current industry. There are several issues with its existence.

(1) The integration degree of school enterprise cooperation is not deep, and it is difficult to match practical positions, which only stays on the surface

At present, the cooperation between many vocational colleges and enterprises is only superficial, and the integration of school enterprise cooperation is not deep. The integration of industry and education lacks process, depth, innovation, and comprehensiveness [8], that is, only maintaining a smooth employment path from schools to enterprises rather than strictly requiring job matching. The selected cooperative enterprises or recommended practical positions for students have poor compatibility with their own professionalism, and the practical work is difficult to reflect the professional skills they have learned. For example, students majoring in mechatronics and automation are only assigned mechanical and monotonous practical work, which makes it difficult for them to participate in valuable work in enterprises and complete the teaching content specified in the talent training plan.

Some cooperative enterprises even treat students who participate in practical training as cheap labor and do not cooperate with the school's practical education reform. They arrange students to work in high-intensity, highly repetitive, and low skilled assembly line positions, resulting in low interest and strong resistance among students towards practical education, making it difficult to carry out and deepen the reform.

(2) The curriculum system is far from the goals of talent cultivation and does not meet the needs of society

Since the Fourth Industrial Revolution, new technologies and concepts have gradually replaced various aspects of traditional manufacturing and have had a strong impact. The vocational education and engineering curriculum training system based on traditional manufacturing is no longer suitable for the talent training goals required by today's industries and enterprises [9,10].

It is manifested in the difficulty of systematizing and designing the original curriculum as a whole in response to today's social needs. The practical courses are scattered and fragmented, and the quality and efficiency of skill training are difficult to match the current level of productivity. The original course objectives were not accurately aligned with the job objectives of manufacturing enterprises today, and the course design did not effectively focus on students' job transfer abilities. Moreover, the teaching process has become disconnected from the actual production process, resulting in a fragmented curriculum content system, curriculum development, and implementation teaching plans that are difficult to adapt to the talent needs of the new industry reform.

In addition, the value orientation of the curriculum system is also difficult to adapt to the needs of targeted positions and the equal emphasis on abilities and qualities in enterprises. The value orientation is single, and the demand for abilities or qualities is heavily biased and

incomplete.

(3) The training method is single and difficult to connect with the actual production of enterprises

At present, some colleges lack diversity in their practical training methods and have a single teaching approach. The main form of practical education within the school makes it difficult for students to truly engage with actual production, and practical teaching is not truly oriented towards students and enterprises, resulting in serious distortion of practical teaching.

The supply of practical teaching subjects is single, the training equipment inside and outside the school is inconsistent, the supply of off campus training bases is limited, and the participation of enterprises is low. Most practical teaching only involves teachers guiding students in simple operations, explaining basic operating methods, and lacking detailed research and analysis of job requirements, professional ethics, etc., resulting in inconsistencies between the content learned in school and the job requirements. This deficiency often stems from the lack of effective intervention from the enterprise side, that is, the cooperation between schools and enterprises is not flexible, comprehensive, and in-depth enough.

With the continuous rapid iteration of production equipment in enterprises, the training equipment in schools has formed a serious generation gap with today's advanced production equipment. This generation gap is manifested in the fact that the operational skills of teaching are completely incompatible with today's equipment, which makes it difficult for students to quickly adapt to the operation of advanced equipment after leaving the school and entering the enterprise. Just like how people who have been proficient in operating carriages for a long time find it difficult to quickly and smoothly get started with cars, which leads to a deviation between practical teaching and actual production, seriously violating the original intention of practical education.

(4) Some teachers lack practical abilities and practical experience

Currently, some vocational college teachers lack practical skills. Most vocational colleges recruit undergraduate, graduate, and even doctoral students, but generally lack the stage of practical training in engineering projects in enterprises. Their application level and equipment usage experience often lag behind front-line technical personnel in enterprises. Moreover, there is a problem that professional teachers are unable to handle the practical teaching of technical skills in their field. They lack advantages in accumulating technical skills, especially in high-level technical projects such as technological innovation and new product development in cooperative enterprises, with low or almost no participation. Resulting in little knowledge about the current actual production situation and advanced production level.

The lack of practical experience and practical ability has made it difficult for teachers to propose practical and feasible implementation plans to solve the current difficulties in practical education for vocational college students and improve the level of practical education in vocational colleges, as well as to solve many problems in the implementation process.

The teaching content and methods of teachers basically continue the traditional education model of "emphasizing theory and neglecting practice", and theoretical teaching lacks practical support as an effective approach. The lack of practical experience makes it difficult for them to integrate the technical knowledge points and key technologies of enterprise cases into classroom teaching, resulting in a serious lack of precise alignment between teaching content and enterprise requirements.

(5) The relevant rules and regulations of vocational colleges are outdated and difficult to adapt to the new training mode

The rules and regulations of vocational colleges formulated under the background of traditional manufacturing are difficult to adapt to the talent training mode under the new industrial revolution. The traditional manufacturing industry requires proficient mastery of knowledge from a single disciplinary background, which conflicts with the current demand for talent from a composite disciplinary background. However, old rules and regulations often hinder the cultivation of talents in a multidisciplinary context, lacking effective policy paths and institutional support to support multidisciplinary talent development.

The new training model places more emphasis on the cross disciplinary and integrated practical education and training between enterprises and schools, often requiring vocational colleges to develop new rules and regulations that are suitable for the two-way training. The formulation of such rules often conflicts with the old system, leading to bottlenecks in the reform

of the system.

Based on the main problems mentioned above, it is necessary to conduct research and practice on practical teaching in vocational colleges under the background of "precision supply". The significance of this lies in:

(1) It is conducive to promoting the improvement of the quality of education and teaching in vocational colleges, achieving the cultivation of talents needed by enterprises, and eliminating the need for secondary processing of talents by enterprises. It maximizes the assistance of students in adapting to job abilities and improving employment competitiveness, achieving a supply-demand balance and virtuous cycle between schools and enterprises.

(2) Beneficial for the supply side structural reform of vocational education, promoting the adjustment of vocational education structure, expanding the effective supply of vocational education, meeting the needs of economic transformation and development, and achieving sustainable development of vocational education.

(3) Optimizing the evaluation and assessment system, focusing on evaluating students' comprehensive abilities and qualities, and accurately aligning with the actual needs of enterprises, is of great significance.

3. Optimization of Teaching System for Mechanical and Electrical Majors

The optimization of the teaching system for mechanical and electrical majors can enhance students' technical skills through practical experience in mechanical and electrical majors. Through in-depth analysis of the integration of industry and education in schools and enterprises and professional practical teaching, we can adhere to the optimization and improvement design of the practical teaching system in talent training programs based on the deep integration of industry and education, and establish a multi-dimensional evaluation system for effectiveness. Through the "dual mentor degree" industry education integration training model, the training of enterprises and the education of schools are integrated to solve the problem of enterprises' ability to analyze and solve problems for new talents right out of school. This further achieves precise alignment between the job requirements of enterprises and the practical experience of students majoring in mechanical and electrical engineering, improves the practicality and efficiency of technical talent cultivation, promotes the "seamless integration" of school talent cultivation and enterprise employment demand, and realizes the optimization reform of talent cultivation supply side and the two-way supply-demand balance with the demand side of enterprise structure. This can be achieved through the following measures.

(1) Build a talent cultivation model of "building nests to attract phoenixes, attracting phoenixes to build nests, having enterprises within schools, and having schools within enterprises"

By introducing production-oriented enterprises and establishing a key industry technology and skill accumulation cooperation platform, we aim to achieve a deep integration of schools and enterprises, such as "building nests to attract phoenixes, attracting phoenixes to build nests, having enterprises within schools, and having schools within enterprises", and a talent cultivation model of school enterprise collaboration. This talent cultivation model is similar to Germany's dual system, where schools complete the supply side training of talents and enterprises complete the demand side training of talents.

Both schools and enterprises work together to complete the talent design and training process, allowing students to directly experience the production process of real projects and products in the enterprise, and bringing students closer to the enterprise. At the same time, through the cooperation of the electromechanical industry technology skills platform, the school's social service function can be completed, the practical education goals of students can be achieved, and the advanced productivity needs of enterprises can be met.

This talent cultivation model not only cultivates students' practical skills but also cultivates the practical abilities of new teachers. Its core lies in the planning, management, and top-level system design carried out by teachers and enterprise technical personnel with rich project experience. Senior teachers and technicians are responsible for teaching and practical management. New teachers and students analyze engineering problems, propose relevant solutions, and conduct practical verification during the joint project promotion process. Through project-based practical teaching methods and the close integration of theory and practice, it not only meets the needs of enterprise production

innovation and solving engineering problems, but also meets the needs of new teachers to enrich their practical abilities. Moreover, it cultivates students' ability to analyze and solve problems, as well as the spirit of exploration and innovation, with a real engineering project background.

(2) Design a new system of practical courses based on occupational ability analysis of enterprise job groups

Based on the analysis of occupational ability positions in the vocational job group of mechanical and electrical enterprises, offer practical courses in mechanical and electrical majors that match the job abilities, and develop course content that matches the job requirements. At the same time, based on the classification of practical courses, such as dividing courses into general practical courses, individual technical practical courses, and comprehensive technical practical courses for course development.

This grading system is conducive to separating knowledge intensive courses, single technical requirement courses, and courses with complex technical requirements. Because courses with different focuses have significant differences in the difficulty of construction, required disciplinary backgrounds, and practical skills required. It is beneficial for teachers with different knowledge backgrounds and practical abilities to construct a curriculum system that is suitable for their own abilities.

(3) Develop a diverse curriculum assessment and evaluation system

The course assessment and evaluation system for composite talents requires diversified and diversified evaluation systems to support it. Based on the competency based approach, the method of process based assessment is integrated into it, while emphasizing the diversity of assessment methods and evaluation subjects, in order to form an assessment and evaluation system for mechanical and electrical professional courses targeting interdisciplinary and composite skilled talents in the context of new productivity.

For example, reforming the assessment and evaluation system of the curriculum, focusing on skill assessment and evaluation, emphasizing process assessment, and combining on-site practical operation with paper-based assessment. Explore a flexible credit exchange system, flexible assessment, effective evaluation, and use evaluation to promote learning. Explore the implementation of a flexible "competition instead of examination" mechanism to stimulate students' learning enthusiasm and initiative.

4. Summary

The transformation of China's manufacturing industry has entered a new stage, and the demand for composite high-quality skilled talents will continue to increase, which poses a challenge to the current vocational education reform. The new vocational education reform urgently requires exploration and optimization of the teaching system. Vocational education focuses on practical exploration, and optimizing the teaching system of practical courses is of utmost importance. This article explores the reform methods for optimizing the teaching system of practical courses in mechanical and electrical majors from a competency based perspective, hoping to provide ideas for optimizing the curriculum system of other majors.

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