Research on the Cultivation of "Dual-teacher" Teacher in Mechanical Majors: Taking the Study of Tool Wear Monitoring and Turning Simulation Research as an Example

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Abstract. Under the concept of lifelong education, as an important base for adult education, the construction of a "dual teacher" teacher team in open universities is of great significance for improving the quality of teaching and promoting the cultivation of students' practical abilities. The practice of teachers in enterprises is an important form and effective measure to promote the professional development of school teachers and enhance their practical teaching abilities. Taking the mechanical major as an example, it is very important to monitor tool condition in cutting process. The on line monitoring of tool wear is an important topic in the research of flexible manufacturing system. As an important component of advanced manufacturing technology, tool condition monitoring technology is an emerging technology developed on the basis of signal processing technology, computer technology, modern manufacturing technology, and sensor technology.

Keywords: "dual-teacher"; machinery; tool; computer technology

1 Introduction

With the upgrading of industrial structure and continuous technological progress, the demand for high-quality skilled talents in the machinery industry is increasing day by day. As an important base for cultivating such talents, the Open University bear an important mission in the construction of "dual teacher" teacher teams in mechanical major. This article deeply analyzes the main issues of the "dual teacher" teachers in the mechanical major, proposes practical and feasible countermeasures and suggestions, explores the construction path suitable for open university "dual-teacher" teacher team, gradually builds a "dual teacher" teacher team with reasonable structure, strong quality, vitality, and promotes the overall improvement of teachers' quality. These experiences and practices can promote the development of mechanical major, and also provide useful references and guidance for related fields such as electronics, automotive, CNC technology, etc.

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To ensure the quality of vocational education in nurturing talents, countries around the world are actively exploring training programs for vocational education teachers. Through continuous efforts, European and American countries have established relatively sound "dual teacher" teacher training systems for vocational education, among which the United States, Germany, the United Kingdom, and Australia are more representative.[1]. The cultivation of "dual teacher" vocational teachers in the United States mainly revolves around the development of faculty in community colleges. From the perspective of the sources for cultivating "dual teacher" teachers in Germany, there are specifically two types: one is teacher training centered on vocational normal schools; the other is technical personnel or managers with enterprise work experience who obtain teaching qualifications through part-time study and become teachers in vocational and technical colleges. The "dual teacher" training model for vocational education in the UK is mainly reflected in two aspects: 'three-stage integration' and 'three-party participation'. Among them, 'three-stage integration' refers to the integration of preservice training, in-service training, and post-service education. The 'three parties' refer to three entities: universities, vocational colleges, and enterprises. Australia has effectively ensured a high level of vocational education teachers by implementing strict teacher entry requirements and qualification standards training packages.

Analyzing the main achievements and advanced experiences of "dual teacher" teacher training for vocational education in European and American countries, and drawing targeted lessons and absorbing them in combination with the actual development of China's vocational education, will help promote the effective implementation of "dual teacher" teacher training in China's vocational education. This paper proposes a cultivation path for "dual teacher" teachers in mechanical majors of open universities from the following aspects: Establishing a diversified training system; Optimize evaluation system; Strengthen the planning of teacher team construction.

Taking the mechanical major of the Open University as an example, this article investigates the current status of the cultivation of "dual teacher" teachers, analyzes existing shortcomings, proposes reform ideas and cultivation strategies, and explores a path for building a "dual teacher" teacher team suitable for the Open University.

2 Training Countermeasures for "Dual Teacher" Teacher in Mechanical Majors at the Open University

By integrating educational and management theories, such as the theory of teacher professional development, we provide a theoretical basis for the proposed measures. For example, building an integrated pre-service and in-service training system for TPACK based on the improvement of the quality of "dual teacher" teachers.

TPACK is an acronym for Technological Pedagogical Content Knowledge, which refers to the integration of technology into subject teaching knowledge. Based on this TPACK knowledge and ability framework, the training objectives for 'dual-teacher' educators can be defined as utilizing modern information technology means to enhance teachers' educational concepts, expand their professional theoretical

knowledge, and improve their professional practical abilities. Drawing on European and American experiences, China's vocational colleges should build an integrated pre-service and in-service training system based on TPACK. They should conduct 'dual-teacher' training around the three aspects of 'technicality, professionalism, and academic rigor', with the ultimate goal of improving teachers' qualities. The integrated pre-service and in-service training system based on TPACK mainly includes three modules: first, the module of modern vocational education concepts and teaching methods; second, the professional knowledge and skills module; third, the module of deep integration of information technology with classroom teaching.

To address the training countermeasures for "dual teacher" teacher in the mechanical major, specific implementation can be approached from several aspects:

2.1 Establishing a Diversified Training System

① School enterprise cooperation: Deepen school enterprise cooperation by establishing internship bases in teacher enterprises, encourage teachers to regularly visit enterprises for training, participate in technology research and project cooperation. Carry out school enterprise cooperation in various forms, organize teachers to work in enterprises, carry out school enterprise cooperation, undertake enterprise technology projects, hire senior technical personnel from enterprises as foreign teachers, and establish school practice bases suitable for enterprises[2].

The practice of teachers in enterprises is an important form and effective measure to promote the professional development of school teachers and enhance their practical teaching abilities. Through enterprise practice, teachers' professional and practical teaching abilities have significantly improved, and their ideological concepts have undergone tremendous changes. The practice of teacher enterprises will also become a powerful lever for the construction of a dual teacher team.

Based on this, when carrying out the construction of the "dual teacher" teaching team, author went to the enterprise for practice, aiming to participate in tool cutting experiments, deeply understand the application of tools in enterprise production, master advanced cutting processes and tool management methods, enhance my practical operation ability and problem-solving ability, and integrate the practical gains into teaching to improve students' practical hands-on ability and professional ethics.

As a key link connecting the processing accuracy, efficiency and cost in advanced manufacturing technology, tool condition monitoring (TCM) technology has achieved real-time perception and intelligent decision-making of tool wear, damage and other conditions by integrating multi-disciplinary technologies, and has become one of the core supporting technologies to promote the transformation of intelligent manufacturing. Many scholars are devoted to the research of on-line monitoring technology for tool wear, among them, ZHOU Dan[3], GUO Jingchao et al. [4], LIU Hongzhi[5] and TIAN Peibin et al. [6] summarized the physical signals during the machining process are perceived through sensors, key features are extracted from them through signal processing, and finally the wear condition is judged using pattern recognition algorithms.

The experimental cutting tool is a YW1 cemented carbide tool, and the workpiece material is 304 stainless steel. The cutting tool is used to turn the outer circle on a CNC lathe.

The finite element method is a computer simulation technique. The finite element method (FEM) is a numerical solution method for elasticity mechanics problems that has developed rapidly with the advancement of electronic computers.

The application of finite element method in the field of machining has achieved remarkable results, especially in the study of tool wear mechanism and the simulation of turning process, which has shown strong advantages. Based on the simulation research of turning process by Deform 3D software, the stress, strain, temperature field distribution and wear evolution law of the tool can be accurately predicted by integrating the material flow stress model, thermo-mechanical coupling algorithm and tool wear criterion, which provides theoretical basis for the design optimization and process parameter regulation of the tool. Through the in-depth application of Deform 3D, turning machining has shifted from experience-driven to data-driven, providing strong technical support for the manufacturing industry to achieve efficient, precise, and sustainable machining.

Figure 1 showed the diagram of the simulation analysis of turning process in Deform-3D environment.

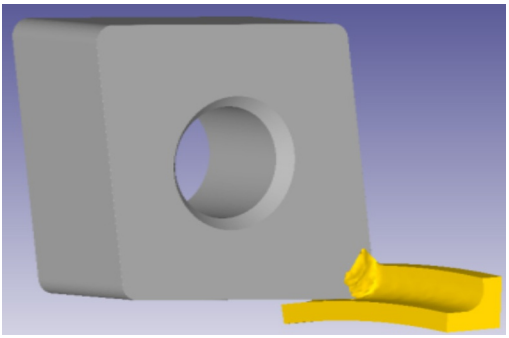

Fig. 1. The diagram of the simulation analysis of turning process

The orthogonal experimental parameter and numerical comparison of cutting force simulation and experimental results was shown in Table 1.

Table 1. Orthogonal experimental parameter and simulation and experimental results

Nuber	Vc	ap	f	experiment values (N)	simulation values (N)	Error (%)
1	50	0.5	0.15	883.6	806	9.62
2	60	0.5	0.2	879.2	841	4.54
3	70	0.5	0.25	905.5	874	3.60
4	60	0.8	0.15	854.8	862	-0.83
5	70	0.8	0.2	913.2	883	3.42
6	50	0.8	0.25	946.1	958	-1.24

7	70	1.1	0.15	935.6	894	4.65
8	50	1.1	0.2	981.3	956	2.64
9	60	1.1	0.25	1012.2	982	3.07

It can be seen from Table 1 that the error is within 10%, considering that the failure and friction conditions of the material in the actual cutting are complicated, so the simulation results are acceptable. The DEFORM finite element simulation is based on idealized assumptions, including uniform material properties, constant friction coefficient, and adiabatic boundary conditions, while the actual cutting process involves multi-physical coupling effects, resulting in inevitable deviations between simulated and experimental values. Specifically, the differences in local plastic deformation resistance caused by the inhomogeneity of the material microstructure, the dynamic changes in the friction state of the tool-chip contact zone, and the softening effect of the cutting heat on the material are not fully captured by the idealized model.

The simulation model can effectively predict the variation trend and magnitude of cutting force, providing a reliable numerical analysis tool for process parameter optimization, and the error between the simulation results and experimental data is within the engineering acceptable range.

② Specialized training: Organize targeted professional skills training and certification exams to enhance teachers' professional skills. In addition, industry experts and scholars are invited to provide professional knowledge, practical teaching and skill operation training for teachers, helping them update their knowledge systems and improve their practical abilities. In terms of form, comprehensive and systematic training can also be conducted through strengthened training for young teachers, expert lectures, practical case sharing, and backbone training[7].

2.2 Optimize Evaluation System

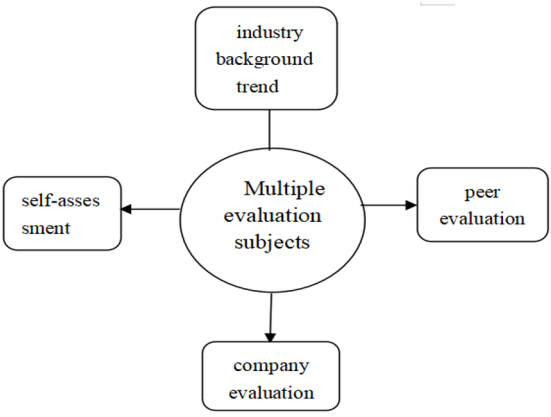

Fig. 2. Multiple evaluation subjects

The evaluation system plays a crucial role in the construction of the "dual teacher" teacher team. It is not only an important yardstick for measuring the "dual teacher"

ability of teachers, but also an important means to motivate teachers to continuously improve themselves and optimize teaching quality. Firstly, it is necessary to establish an evaluation system framework, which mainly includes core dimensions and multiple evaluation subjects. The multiple evaluation subjects was shown in Figure 2.

2.3 Strengthen the Planning of Teacher Team Construction

Based on the characteristics of mechanical major and industry demands, clarify the specific training objectives for "dual teacher" teachers, including requirements for teaching ability, practical ability, scientific research ability, and other aspects. Through systematic training, "dual teacher" teachers in the field of mechanical major possess solid theoretical knowledge, rich practical experience, and strong teaching abilities. They are capable of theoretical teaching, practical teaching, and scientific research innovation work, providing strong support for cultivating high-quality skilled talents. The specific training content was shown in Figure 3.

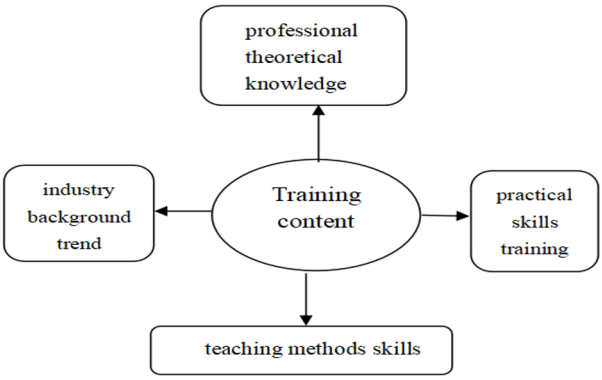

Fig. 3. Teaching team construction and training content

Through the above-mentioned "dual teacher" teacher training countermeasures, the number of dual teacher personnel in the entire school has increased, taking 2021, 2024 and 2025 as examples.

The junior 'dual teacher' teacher and intermediate 'dual teacher' teacher results was shown in Table 2. The junior and intermediate 'dual teacher' teacher situation was shown in Figure 4.

Table 2. Junior 'dual teacher' teacher and intermediate 'dual teacher' teacher results

Year	junior	intermediate	Total
2021	6	0	6
2024	43	4	47
2025	68	14	82
Total	117	18	135

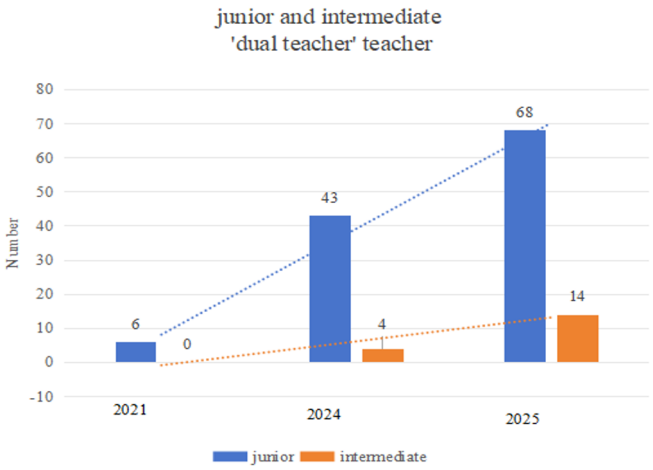

Fig. 4. The junior and intermediate 'dual teacher' teacher situation

It can be seen from the Table 2 and Figure 4 that rom 2021, 2024 to 2025, there will be a significant growth trend in the number of junior and intermediate "dual teacher" teachers, especially the rapid increase in the number of junior "dual teacher" teachers. Organizing teachers to participate in enterprise practice is an important measure to strengthen the construction of the "dual teacher" teaching team in schools and increase the number of personnel in the team.

As the social economy develops, the demand for talent in certain industries has changed, placing greater emphasis on practical abilities and overall quality of talent. To meet industry needs, schools require more "dual teacher" teachers who possess both practical experience and teaching capabilities, thus driving the transformation of teachers into "dual teacher" ones and leading to an increase in their numbers. For example, some vocational colleges, which aim to cultivate applied talents, emphasize teachers' practical guidance abilities, so they actively recruit and train "dual teacher" teachers, which has prompted an increase in the number of junior and intermediate "dual teacher" teachers. In addition, schools have established a sound training system for "dual teacher" teachers, offering a rich variety of training courses and practical opportunities.

3 Conclusion

This article analyzes the current situation of "dual teacher" teacher training in mechanical majors and proposes corresponding training strategies and construction paths. The practice of teachers in enterprises is an important form and effective measure to promote the professional development of school teachers and enhance their practical teaching abilities. Taking the mechanical major as an example, it is very important to monitor tool condition in cutting process. The simulation study of turning processing based on finite element analysis software Deform 3D. The size distri-

bution of cutting force was simulated, the simulation results and the test results were compared and analyzed, which provided guiding significance for the determination of process parameters.

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