Research and Analysis of Talent Training Programmes Based on Big Data Background and Ideological and Political Models

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Abstract. This study is based on the background of big data algorithms. The aim of the study was to improve the quality of training in higher vocational education, and the German dual system model was implemented in the talent development programme for forming machinists. In addition, forming machinists were trained in the fields of forming design and professional practical forming machinery manufacturing by incorporating ideological and political elements in the curriculum. This process included adjusting the existing talent training programme, developing curriculum resources, forming a team of highly qualified teachers, reforming assessment methods and evaluation elements, and organising learning seminars. The three-year talent training programme was implemented in Ningbo Vocational and Technical College's forming design and manufacturing programme, and 94% of the students obtained the vocational qualification certificate for forming and machining workers after the project was completed. The study provides a reference for talent cultivation in higher vocational colleges.

Keywords: Big data background; ideological–political elements; German dual-system; molding machinist; talent training

1 Introduction

Developed countries and regions, such as Europe and the United States, have accelerated their progress in advanced manufacturing since the 21st century, with the most typical examples being the “Industrial Internet of Things” of the United States and “Industrie 4.0” of Germany. The rapid developments of these two initiatives have sparked changes in product development, production models, and implementation methods for manufacturing value in the global manufacturing industry. Using the new trends in international industrial development as the basis and focusing on the strategic goal of becoming a manufacturing superpower, China has successively proposed various plans including “Made in China 2025” and “Strengthening China’s Industrial Development” [1,2].

Being the foundation of modern industries, the level of molding technology has become an important indicator of a country’s manufacturing capabilities. “High precision, intelligentization, and automation” mark the future directions of development for the molding industry. This, in

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turn, determines the demand for talents in the industry, making it necessary to cultivate a large batch of professionals with high-end technical skills. They must possess high professional qualities, strong basic theoretical knowledge, and good practical abilities, as well as the capabilities for digital design and smart processing and molding.

2 Existing problems in the talent training process for molding design and manufacturing and solutions to them

2.1 Existing problems in the talent training process

(1) Difficulties in integrating ideological–political elements into talent training

The fundamental missions of colleges are to nurture morality and cultivate talents among the students, that should be regarded as the central link between the various courses and management of colleges. Lesson hours typically account for more than 70% of the total lesson hours in professional courses for talent training [3]. During implementation, however, top-level planning relating to ideological–political (IP) developments is lacking. Some teachers of such courses implement IP education independently and based on their own understanding, resulting in incomplete or repeated explanations of IP elements (IPEs). Other teachers lack training in IP education and, thus, are incapable of discovering the IP educational resources available in the professional courses. The professional and IP courses are simply superimposed during the teaching process, resulting in the weak implementation effects of IP courses as part of the professional courses [4].

(2) Low level of "matching" between vocational education and demand for talents

There still exists a gap between (i) the talent training of molding design and manufacturing professionals in higher vocational and technical colleges and (ii) the professional abilities and quality requirements for the six core job groups of molding enterprises: project management and molding design, processing, testing, assembly, and trial. During the first and second years of study, the students' focus in school is theoretical learning, supplemented by practical training. The training components are simple, and the lessons on skill operations, technological innovation, commercialization of results, and professional quality cannot effectively connect with the core job requirements of enterprises. Consequently, there is a low level of "matching" between the outputs of vocational education and talent requirements by enterprises. During their third year of study, students undergo job internships at enterprises; however, there is the issue of misaligned goals between schools and enterprises. The schools aim at improving the quality of talent training, whereas enterprises aim at gaining commercial interests. A unified educational standard has not been established between colleges and enterprises and the participation level of enterprises is not high, resulting in the inability to create a community for talent cultivation.

2.2 Talent training of molding machinists with the integration of ipes into the dual-system model

During the 2016 National Conference on Ideological and Political Work in Colleges, Xi Jinping, the general secretary, emphasized the needs to nurture morality and cultivate talents as the central link, integrate IP work throughout the entire process of education and teaching, provide complete and all-round education, and strive to create a new situation in the development of higher education in China [5]. The "Guidelines for the Ideological and Political Construction of Higher Education Curriculum," issued by the Ministry of Education (MOE) in 2020, emphasizes that colleges must revise their talent training programs in a targeted manner, effectively implement the professional teaching standards of higher vocational schools, and build a scientific and rational teaching system for the IP curriculum [6].

The instructions from the general secretary and the MOE documents indicate the direction for solving the fundamental problems of "who to train, how to train them, and for whom to train them." Moreover, they provide the fundamental guidance for strengthening college courses and education on IP theories and comprehensively promote the development of IP courses. Furthermore, the "Implementation Plan for the Reform of the National Vocational Education" issued in 2019 clearly states that the reform in China's vocational education shall promote dual education integrating colleges and enterprises and draw lessons from the German dual-system model and others [7].

Germany is a global manufacturing superpower and its dual-system model of vocational education attaches great importance to the participation of industries and enterprises in vocational education, which in turn supports the rapid development of the entire manufacturing industry [8]. The dual-system model for the talent training of molding machinist was implemented for students majoring in molding design and manufacturing to explore its effectiveness. Additionally, for talent cultivation, IPEs were integrated into the exploratory and practical curricula. Specifically, new IP goals were added to the curriculum, the curriculum system was revised to be modular-based[9], and programs for talent training were reconstructed. New technologies, processes, and norms were also promptly incorporated into teaching standards and contents, combined with curriculum standardization, and design for the overall courses and the individual modules therein. Development of curriculum resources included the introduction of IP case studies and loose-leaf teaching materials. Enterprises participate in talent training programs of colleges, leading to the formation of dual-qualified teaching teams. Assessments of IPEs in the curriculum were incorporated into evaluations made during the learning process and a final comprehensive evaluation, and third-party assessment methods were used as reference to reform the assessment methods and evaluation elements. Lastly, lessons were learned from the operational and management model of workshops owned by enterprises, leading to the construction of learning factories for strengthening the students' internship training and cultivating high-level talents for the molding industry [10].

3 Organization and implementation of talent training for molding machinists

3.1 Reconstruction of the talent training program

The following IPEs were integrated into the talent training of molding machinists under the new program: spirits of innovation, craftsmanship, model worker, research, and professionalism; honesty and trustworthiness; unity and cooperation; awareness of intellectual property protection, norms, quality, responsibility, service, and confidentiality; compliance with laws and regulations; enterprise culture; social responsibility; core values; civility and courtesy; and learning attitudes. Typical projects under the work processes of enterprises were used as teaching carriers. With the main focus being the training of students' professional abilities and integration of IPEs, the professional program on molding design and manufacturing was reconstructed into 14 learning fields relating to molding machinists. The curriculum structure was also constructed with an integrated approach, such that the contents of the teaching and training frameworks were designed holistically, leading to the formation of a system of modular courses for molding machinists (Table 1).

Table 1 System of modular courses for training of molding machinists

S/No.	Contents of learning field	Teaching carrier
1	Machining parts using manual tools	Bottle opener, burr puzzle, box for drill bits
2	Machining parts using machines	Pressure plate for machine tool, hollowed-out handicrafts
3	Making simple parts	Nutcracker, protection hammer
4	Maintaining technical systems	Drilling press, pneumatic motor
5	Manufacturing parts by cutting processing	Precision vise, milling machine models
6	Creating technical subsystems for mold manufacturing	Molding subsystem
7	Processing using computer numerical control (CNC) machines	Cores and cavities on regular surfaces, guide pillars and bushings
8	Planning and commissioning machine control systems	Control system for material sorting device
9	Surface finishing of machined and formed workpieces	Bottle opener
10	Machining parts with the support of computer equipment	Cores and cavities on complex curved surfaces
11	Establishing technological systems for mold manufacturing	Plastic molds, stamping molds
12	Commissioning and maintaining technological systems for mold manufacturing	Plastic molds, stamping molds
13	Planning and processing technological systems for mold manufacturing	
14	Modifying and adapting technological systems for mold manufacturing	

Continued from table 1

Courses	
Teaching framework	Training framework
Mechanical drawing I, Metal materials and thermal treatment I, Tolerance fitting and measurement techniques I	Comprehensive practical training on machining parts using manual tools
Mechanical drawing II, Metal materials and thermal treatment II, Tolerance fitting and measurement techniques II	Comprehensive practical training on machining parts using machines
Mechanical drawing III, Basics of mechanical design	Comprehensive practical training on making simple components
Pneumatic transmission technology I, electrical and electronic technology I	Comprehensive practical training on repair and maintenance of machines
Computer-aided drafting, accessories and assembly technology	Comprehensive practical training on manufacturing parts by cutting process
Application of molding CAD/CAM technology	Comprehensive practical training on technical subsystems for mold manufacturing
CNC programming and machining technology I	Comprehensive practical training on manual programming of CNC machines
Pneumatic transmission technology II, electrical and electronic technology II	Comprehensive practical training on planning and debugging machine control systems
Electrical discharge machining technology	Comprehensive practical training on surface finishing of machined and molded workpieces
CNC programming and machining technology II	Comprehensive practical training on computer programming of CNC machines
Basics of molding design	Comprehensive practical training in mold designing
Mold manufacturing technology	Comprehensive practical training in mold manufacturing

4 Relevant big data technologies

4.1 Classical recall layer model

(1) collaborative filtering algorithm family

Collaborative filtering relies entirely on the behavioural relationships between users and items to make recommendations, and the idea can be summarised as "things are grouped together, people are grouped together". The principle of item-based collaborative filtering recommendation is "clustering", i.e., recommending to the user the items that are most similar to the items for which the user has generated behaviour. The preference of user u for an item v $sim(u,v)$ can be expressed as:

$$sim(u,v) = \sum_{v_i \in V} score(u,v_i) \times sim(v_i,v) \quad (1)$$

where V is the set of items for which the user has generated behaviour, $score(u,v_i)$ is the degree of user u's preference for item v_i, the $sim(u,v)$ is the degree of similarity between item v_i and item v.

User-based collaborative filtering recommendation principle is "people to group", that is, with the user most similar to the user's favourite items recommended to the user, the user u on an item v preferences expressed as:

$$sim(u,v) = \sum_{u_i \in U} sim(u,u_i) \times score(u_i,v) \quad (2)$$

where U is the set of similar users of user u, $sim(u,u_i)$ is the degree of similarity between user u and user u_i, and $score(u_i,v)$ has the same meaning as Eq. 1.

The matrix decomposition algorithm generates a hermit vector for each user and item so that the users and items can characterise the similarity in the space of hermit vectors of the same dimension, which is essentially a decomposition of the co-occurrence matrix into the form of a product of hermit vectors. Hidden vectors are denser, thus enhancing the ability to handle sparse matrices.

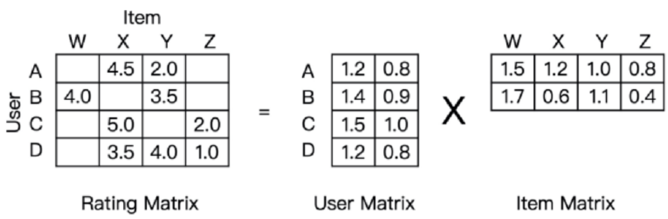

Figure 1. Matrix Decomposition Schematic

Eq. 3 shows the decomposition of the $m \times n$ dimensional co-occurrence matrix R into the product of the user matrix $U_{m\times k}$ item matrix $V_{k\times n}$. where m is the number of users, n is the number of items, and k is the hidden vector dimension. The size of the dimension of k determines the expressiveness of the hidden vectors, and once the hidden vectors are obtained they can be recommended using the similarity methods of Eqs. 1 and 2.

$$R_{m\times n} = U_{m\times k} * V_{k\times n} \quad (3)$$

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Let the prediction score of user u for an item v be $\hat{r}_{uv} = p_u * q_v^T, \Delta r = r_{uv} - \hat{r}_{uv}$ denoting the error between the true value and the predicted value, the smalle $||\Delta r||$, the more accurate the prediction. Transforming the above problem into an optimisation problem to find the minimum value of $||\Delta r||$ by adding the regularisation term, the objective function obtained is shown below:

$$\min_{p^* q^*} \sum_{(u,v)\in A} (r_{uv} - p_u * q_v^T)^2 + \lambda(||p_u||^2 + ||q_v||^2) \quad (4)$$

ALS finds the minimum value by alternating optimisation as follows:

(1) Generate random initialisation values for p_u, q_v;

(2) Fixing p_u, solves for the minimum value of q_v by gradient descent;

(3) Fixing the current q_v, solves p_u for the minimum value by gradient descent;

(4) Repeat steps (2) and (3) until the objective function converges or the maximum number of iterations is reached.

5 Implementation of innovative talent training program for molding machinists

Smart manufacturing is the core driver of "Made in China 2025," for which Ningbo was selected as the pilot demonstration city. The Ningbo Municipal People's Government has signed a strategic cooperation agreement with Professor Li Zexiang and his team in 2018, clearly stating the intention of both the parties to jointly establish "two institutes and one park." The two institutes refer to the Ningbo TechX Institute and Ningbo Qingshuiwan Smart Technology Research Institute; the park is called the Qingshuiwan (Ningbo) Smart Industrial Park. Separately, the Ningbo Polytechnic set up the Sino-German Smart Manufacturing Institute, a component of the Ningbo TechX Institute. The molding design and manufacturing major explores the talent training of molding machinists and undertakes the task of cultivating talents for the smart manufacturing of precision molds.

6 Conclusion

Based on the background of big data, this paper researches and analyses the mode as well as the way of talent cultivation. The dual system talent cultivation mode of moulding pliers is based on the syllabus, training protocols and standards under the vocational training framework of AHK moulding pliers. IPE is integrated into the curriculum, the talent training programme is reconstructed, and a modular curriculum system with actual enterprise projects as the teaching carrier is introduced to standardize the curriculum. The resources developed include IPE case studies, teaching carriers and flipchart teaching materials. The proposed model has been verified by the teaching practice of moulding and processing majors in Ningbo Vocational and Technical College, and can provide reference for the cultivation of higher vocational talents. Future trends are as follow:

1. Exploring the rules and paths of cultivating innovative talents by type and level

2. Explore the cultivation mode of top innovative talents relying on the construction of "double first-class".

3. Explore the cultivation of innovative talents in engineering field under the background of new engineering discipline

4. Explore the supporting role of internationalisation of education on the cultivation of innovative talents

5. Explore the construction of innovative talents training faculty based on the perspective of "cultivating people with moral integrity".

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