

# Research on the Training of Interdisciplinary-Based Intelligent Manufacturing Talents

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**Abstract:** As a significant field of research under the 14th Five Year Plan, intelligent manufacturing holds a special position in industrial upgrading and core technology independence. Intelligent manufacturing is an important support for building a “scientific and technological power” in the future. Cultivating creative interdisciplinary talents who can adapt to the development of intelligent manufacturing industry in the new era is of great significance for China to realize the modernization and autonomy of its industrial system. In view of the existing gap between the interdisciplinary talent training of intelligent manufacturing and the actual needs of the industry, this paper focuses on the concept of interdisciplinary construction. Based on the cycle improvement of professional construction, a curriculum system that integrates the interaction of interconnected projects is established. Through four specific measures, namely establishing the collaborative development system of intelligent manufacturing specialty, building a cycle diagnosis and reform system of intelligent manufacturing specialty, improving the curriculum system of integrated modular specialty group, and setting up an application scenario project-based curriculum, we hope to provide reference for the cross-training of compound intelligent manufacturing talents.

**Keywords:** Intelligent manufacturing; Personnel training; Specialty construction; Cycle diagnosis and correction

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## 1. Introduction

In accordance with the 14th Five Year Plan for National Economic and Social Development of the People’s Republic of China and the Outline of the Vision Goals for 2035, it is imperative for the country to cultivate high-quality talents with cross-cutting research capabilities for high-quality development. Since the country is vigorously advocating interdisciplinary talent training, the new-era talent training has also been entrusted with the mission of the times, which is to create innovative talents with interdisciplinary thinking in the new era <sup>[1]</sup>. There is theoretical significance and promotion value embodied in the organic integration of interdisciplinary construction, scientific research team, team guidance approach, and student innovation ability training; in building a multidisciplinary integrated intelligent manufacturing student training environment and mechanism; as well as in cultivating innovative talents with the potential to solve major scientific problems.

In order to train high-quality talents for the country to adapt to the development of the times, many colleges and universities are now promoting interdisciplinary convergence from a forward-looking and -thinking perspective. Each university, according to their own characteristics, has set up interdisciplinary research institutes and other institutions; gathered the advantages of artificial intelligence, computer science, communication engineering, mechanical design and manufacturing, as well as other disciplines; and formed

a series of cross-disciplinary landmark construction achievements. In the face of multiple issues that need to be addressed in the process of interdisciplinary curriculum integration in the development of intelligent manufacturing in colleges and universities, this paper takes the training of intelligent manufacturing professionals as an example to analyze the pain points in the construction of a professional system and to propose solutions to them.

## **2. Analysis on the pain points of intelligent manufacturing talent training**

Vigorously developing cross disciplines and cultivating interdisciplinary talents with the ability to integrate disciplines are strong guarantees for China's industrial upgrading in leading the fourth scientific and technological revolution<sup>[2]</sup>. In order to ensure the effect of cross-discipline construction, we should first consider the objectives of the construction, take the training of intelligent manufacturing professional and technical talents required by intelligent manufacturing enterprises and scientific research institutes as the starting point, and take meeting the future national science and technology development strategy and economic construction as the foothold in determining the capabilities that such talents should possess<sup>[3]</sup>. The issue faced by the talent training program for intelligent manufacturing specialty is the challenging construction method and curriculum system of this specialty compared to other specialties<sup>[4]</sup>.

### **2.1. Six core scenarios for building intelligent manufacturing specialty**

#### **(1) Construction planning**

The professional leader shall formulate the professional planning based on the development characteristics of domestic and foreign industries as well as the needs of China's economic construction to achieve a top-level design of professional planning by writing the planning document, task management, work assignment, *etc.*

#### **(2) Project implementation**

The professional project construction director shall complete the whole closed-loop management within the construction cycle, including the establishment, operation, change, completion, archiving, expert review, project data statistics, and other links of professional project construction.

#### **(3) Task management**

The task executor shall complete the disassembly of various subtasks of the project and carry out refined management on the specific implementation process of the task.

#### **(4) Management of landmark achievements**

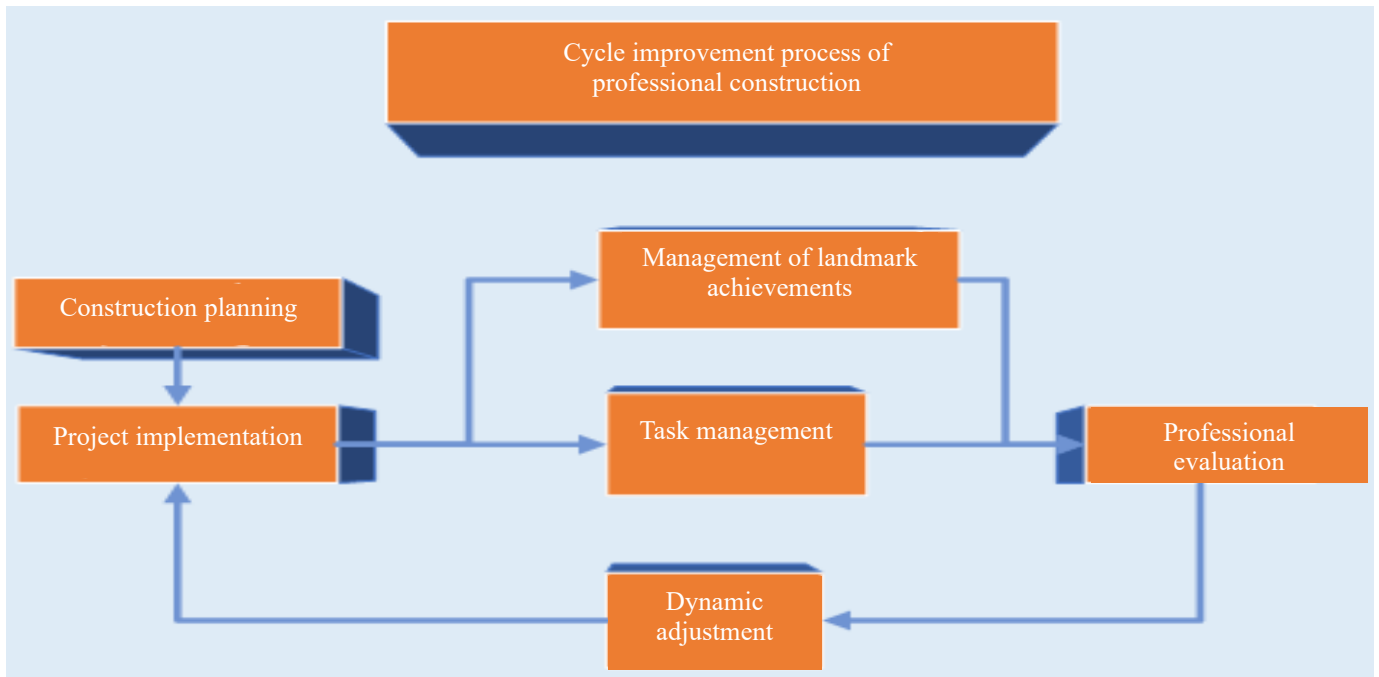
Teachers shall give lectures, summarize teaching experience, teaching achievements, and research achievements, as well as complete the management of landmark achievements.

#### **(5) Professional evaluation**

The academic affairs office and other management departments shall establish a professional model evaluation system, design a scientific and reasonable professional evaluation model, and complete the objective professional evaluation.

#### **(6) Dynamic adjustment**

The school management committee shall conduct dynamic adjustment of the specialty according to the real-time specialty construction data collected via the professional data platform and complete the gradual professional diagnosis and reform work. The cycle improvement process of professional construction is shown in **Figure 1**.



**Figure 1.** Cycle improvement process of professional construction

## 2.2. Main problems faced by and to be addressed during the construction of the cycle improvement system of intelligent manufacturing specialty

### (1) Lack of professional planning

The interdisciplinary construction lacks scientific and systematic professional planning. It cannot serve the national strategy of rejuvenating the country through science and education. At present, the designated professional development is too wide to conduct quantitative evaluation and assessment, and the lack of standardized top-level design makes it difficult to achieve real-time tracking and continuous improvement in subsequent professional construction.

### (2) Prioritizing project establishment while neglecting construction

The interdisciplinary construction emphasizes project establishment but neglects construction, resulting in a “head and tail” situation. The construction personnel are unable to keep abreast of the design progress in time, so a “surprise attack” is made during the construction acceptance process, resulting in a “loosening before tightening” situation. The project construction is unable to realize the scientific and reasonable use of construction funds or complete the tracking management task of the construction process.

### (3) Independent subtask

The subtasks that are set in the process of discipline integration are too independent and affected by the inertia of the development of a single discipline. Hence, they cannot be combined to form an organic whole or effectively create a system integration of industrial, university, and research subprojects.

### (4) Unclear organizational structure

The organizational structure of such landmark achievements as curriculum construction is unclear, and the ability-oriented curriculum construction plan, which is unable to meet the professional and scientific research quality requirements of graduate work units or achieve nationwide promotion, is lacking.

### (5) Unreasonable professional evaluation

The professional evaluation process stresses on theoretical content but neglects the practice link that engineering education pays more attention to. At present, due to factors such as the shortage of school land and the isolation during the pandemic situation, students’ use of off-campus training and

experimental sites is greatly affected; it is difficult to achieve interdisciplinary integration and the unity of theory and practice.

(6) Ineffective dynamic adjustment

The interdisciplinary integration and real-time monitoring of students' theoretical ability and practical level cannot be achieved through the dynamic adjustment process of majors. The outstanding scientific research and professional qualities of students are scattered in various courses, but the barriers between various disciplines have not been broken. The logical connection of curriculum design is beyond range and not reasonable enough to achieve cycle improvement.

**3. Professional construction ideas: Establish a collaborative development system for intelligent manufacturing**

The construction process is guided by the national 14th Five Year Plan intelligent manufacturing industry development plan, adheres to the educational concept of "three all-round education," adheres to the discipline connotation development path, and takes the national construction and development needs as guidance to cultivate highly skilled and innovative modern talents <sup>[5]</sup>. The construction process is characterized by the deep integration and practical application of the new generation of intelligent technology and equipment manufacturing industry, with the goal of training students' practical ability. A talent training mode for intelligent manufacturing professionals featuring school-enterprise cooperation, the integration of production and education, the combination of work and learning, and the integration of knowledge and practice should be established. Scientific research quality training, innovation and entrepreneurship education, as well as improvement of humanistic quality should be integrated into professional teaching practice. The specialty construction and industrial posts, the curriculum content and national standards, as well as the teaching and scientific research and production process should be combined to form a distinctive specialty construction route.

(1) Prospective specialty planning

Establish a professional construction committee composed of education and teaching experts, industry experts, and professional backbones; formulate practical normative systems according to the guidance and normative documents issued by the state at all levels; plan and carry out professional construction demonstration, the reform of talent training methods, school-enterprise cooperation curriculum development, teaching method reform, talent echelon construction, expansion of training bases, professional social services, training quality diagnosis, *etc.*

(2) Reasonable layout of project construction

Carry out demand research on intelligent manufacturing specialty construction projects, reasonably adjust the specialty structure, revise the talent training program, realize the "dynamic" transformation of specialty construction with the economic growth mode, follow the industry talent requirements, "shift" around the social market demand, and follow the "change" in industrial structure adjustment. In order to realize the deep connection between schools and enterprises, majors and industries, curriculum content and national standards, as well as the teaching process and scientific research and production process, cultivate high-efficiency and -quality talents and constantly improve the development ability of the professional service industry.

(3) Fine execution of task management

The university has taken the lead in setting up a professional management committee. The professional construction committee should follow the objective law of talent training in higher education, promote each major to provide high-quality scientific research and practical talents and intellectual support for national economic reform and technological development according to the needs of national economy

and social development, mobilize and encourage all members to pool their wisdom, as well as offer suggestions for the construction and development of the major.

(4) Scientific and standardized evaluation of teachers

Strengthen teaching management, scientifically and accurately evaluate the quality of the teaching work, grasp teachers' actual teaching ability and teaching level, as well as promote the moral cultivation and teaching ability of teachers. The evaluation of teachers' ability is carried out by investigating several indicators, including teaching preparation, teaching content, teaching process, teaching attitude, teaching effect, moral cultivation, guidance for competitions, social services, teaching reform, and other research results.

(5) Scientific evaluation of construction level

Based on the comprehensive data collection platform of the school, the process operation data generated in the process of running the school are collected, so that the intelligent manufacturing specialty can match the corresponding electronic information specialty group. Through the docking of specialty group setting and industrial demand, curriculum content and specialty specification, teaching and production process, as well as research ability training and lifelong learning, the specialty setting should be consistent with the requirements of industrial upgrading, and the school should be promoted to better serve the regional economy and the overall development of students.

(6) Steady progress of professional reform

The specialty construction committee should make overall plans for the layout of specialty groups, the construction of intelligent manufacturing specialty, and integrate with other plans that are related to courses, teachers, students, and international cooperation to form a specialty construction goal chain and standard chain of "connecting up and down, connecting left and right." According to the 14th Five Year Construction Plan and the Annual Work Plan of the specialty, the goal and task of the specialty construction and talent training should be defined, along with the specific construction goals and standards. Taking this as the basis for the cycle improvement of intelligent manufacturing, carry out professional self-diagnosis and write a professional diagnosis and reform report as a whole. The overall professional construction and development system is shown in **Figure 2**.

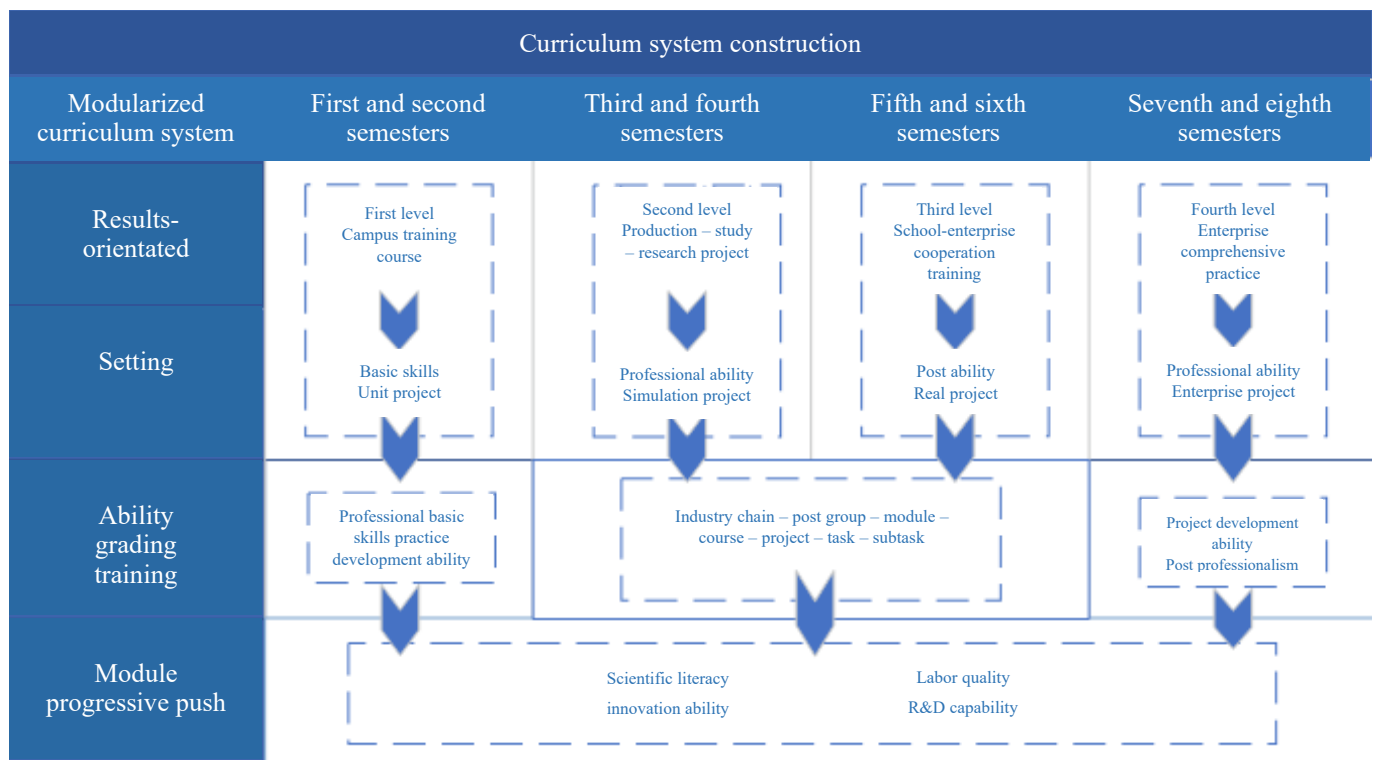


**Figure 2.** Professional construction and development system

#### 4. Thoughts on the construction of the curriculum system

Based on the national scientific and technological development needs, the regional economic development needs of Beijing Tianjin Hebei, the development needs of modern equipment manufacturing industry, and the development needs of students, the talent training objectives of intelligent manufacturing are determined. In combination with the requirements for professional talents required for national industrial upgrading,

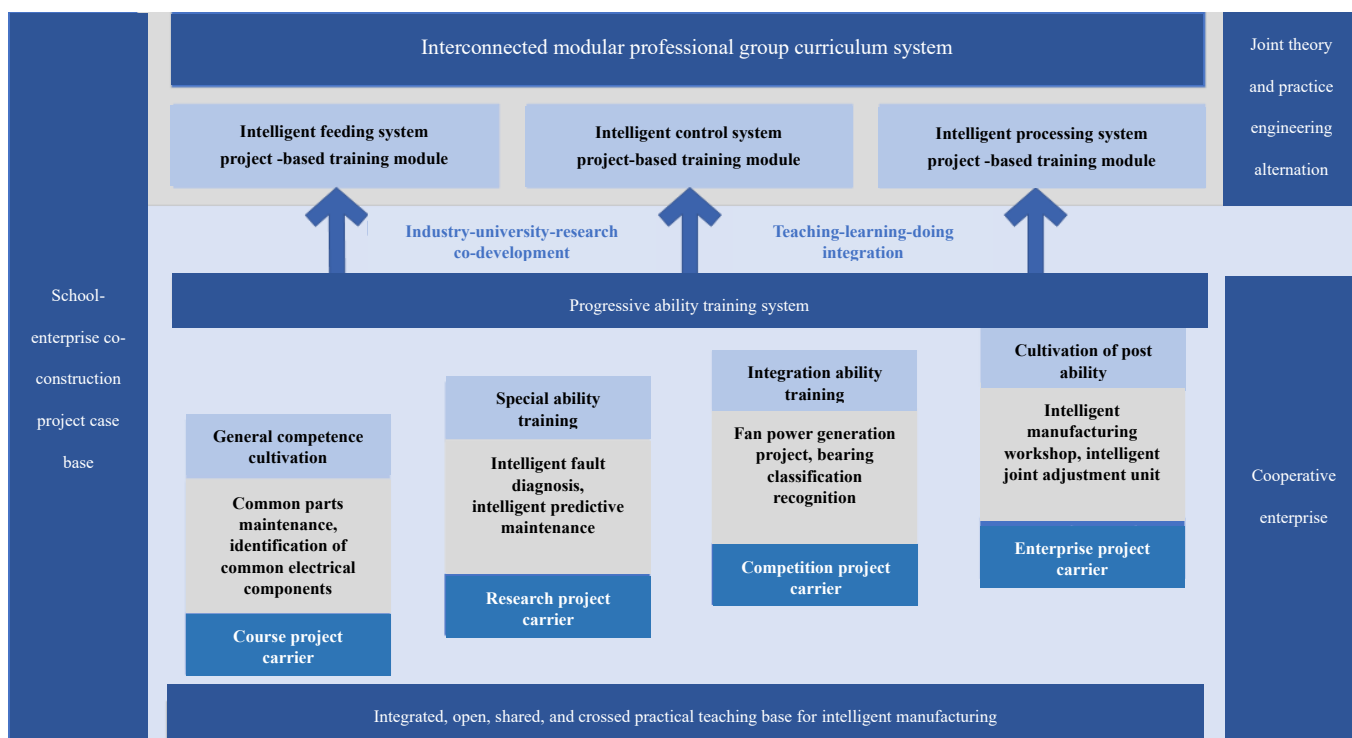
taking the training of students' comprehensive professional ability as a breakthrough, based on the idea of "industrial chain – post group – module – curriculum – project – task – subtask," the typical work tasks of the intelligent manufacturing industry, the industrial implementation standards and national occupational appraisal specifications, as well as the complexity of the working environment and objects of the occupational posts, the new technologies, new processes, new standard and scientific literacy, innovation ability, and labor quality are all introduced into the curriculum, integrating ideological and political education, labor education, aesthetic education, innovation and entrepreneurship education, research ability training, craftsmanship spirit, and foreign language certificate standards, and establishing a modularized curriculum system of "result-orientated setting, ability grading training, and module progressive pushing," as shown in **Figure 3**.



**Figure 3.** Intelligent manufacturing modularized curriculum system

Design application scenario project-based courses. In order to realize the integration of interdisciplinary courses, the intelligent manufacturing specialty should not only construct a system of relevant courses within the specialty group, but also pay attention to the cultivation of students' practical and scientific research innovation ability; achieve the integration of theory and practice, as well as knowledge and practice; and maximize the integration among disciplines. This is of great significance to the training research and development (R&D) personnel and engineers to become competent for work in intelligent manufacturing enterprises and scientific research institutes. Schools and enterprises cooperate to build a practical teaching base inside and outside the school. This teaching base acts as a platform to integrate teaching content and production practice, combining work with learning, so as to improve students' theoretical ability and cognitive level. Based on the interdisciplinary characteristics of the intelligent manufacturing discipline itself and the needs of the industry for compound talents, the online and offline, on- and off-campus hybrid teaching is realized to achieve an integrated production, teaching, and research development.

In order to achieve project-based teaching, the key is to effectively transfer the actual application scenarios in enterprises to the classroom. Schools and enterprises cooperate to build a project case base, adopt the online and offline hybrid teaching mode, flexibly conduct discussions; encourage heuristic group cooperation, cooperative inquiry, and other teaching methods; complete students' skill training, and achieve the integrated development of production, teaching, and research. The assessment method employed is process assessment (learning attitude, team cooperation, project completion quality, scientific research and innovation literacy, *etc.*). Students would be able to develop the ability to handle operation management, data management, and spare parts management of intelligent manufacturing equipment. They would also possess the basic ability of planning, implementation, acceptance, and quality management of intelligent manufacturing enterprises, as well as the ability to develop, design, operate, and maintain intelligent manufacturing equipment. According to the national strategic development goals and the industry's cutting-edge needs, an integrated curriculum should be created to adapt to interdisciplinary talent training. After training in follow-up enterprise practice, students would have solid theoretical basis and cutting-edge discipline thinking and also a sense of career planning, a strong team spirit, and win-win thinking. The design idea of application scenario project-based curriculum is shown in **Figure 4**.



**Figure 4.** Application scenario project-based curriculum design idea

## 5. Conclusion

With the increasingly prominent role of interdisciplinary majors, such as intelligent manufacturing, in the national economy, it is particularly important to integrate all relevant majors to form an intelligent manufacturing talent training program that is suitable for China's strategic development goals and industrial upgrading requirements based on the interdisciplinary concept. Four specific measures, namely, establishing a professional collaborative development system, creating a professional cycle diagnosis and reform system, building a curriculum system of integrated and interconnected modular professional groups, and designing application scenario project-based courses, are proposed in an effort to form a self-improving intelligent manufacturing talent training program, which will provide a reference for subsequent research.

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## Disclosure statement

The authors declare no conflict of interest.

## References

- [1] Wang T, 2022, Research on the Policy Process of Setting Up Cross Disciplinary Categories in China – Multi Source Flow Theory Based on Embedded System. *China Higher Education Research*, 2022(04): 23–28. <https://doi.org/10.16298/j.cnki.1004-3667.2022.04.04>
- [2] Wu X, Xiang Y, Li Y, et al., 2020, Exploration of the Collaborative Training Mode of Compound Innovative Talents Based on Interdisciplinary Integration. *Laboratory Research and Exploration*, 39(10): 146–148 + 194.
- [3] Xu D, Liu R, Wang Q, 2021, The Important Role of Interdisciplinary Team Building in the Reorganization of National Key Laboratories – Taking the National Key Laboratory of Ultrahard Materials of Jilin University as an Example. *Experimental Technology and Management*, 38(12): 14–18. <https://doi.org/10.16791/j.cnki.sjg.2021.12.003>
- [4] Liu K, 2020, New Engineering Education Governance: Framework, System and Mode, thesis, CNKI database, Tianjin University. <https://doi.org/10.27356/d.cnki.gtjdu.2020.000385>
- [5] Wang N, Shang L, Wang Y, 2020, Research on the Training Mode of Mechanical Applied Talents Based on the Mechanism of Industry Education Integration and Collaborative Education. *Journal of Higher Education*, 2020(27): 180–182 + 185.

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