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Original Paper

Research on Innovation Mechanism and Path of Engineering Talents Cultivation in Applied Colleges and Universities in the Context of "Made in China 2025"

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Abstract

This paper examines the essential attributes of engineering and the new requirements of the development of the times for talent cultivation, probes into the existing problems in engineering talents cultivation in applied colleges and universities and proposes the innovative mechanism of engineering talents cultivation and corresponding talents cultivation paths in the context of "Made in China 2025".

Keywords

Made in China 2025, engineering talents innovation mechanism, path

1. Introduction

"Made in China 2025" clearly states that manufacturing is the mainstay of the national economy, the foundation of a nation, the instrument of revitalizing a nation and the foundation of a powerful nation. The development of manufacturing industry cannot be separated from the cultivation of engineering talents. China initiated a Plan for Educating and Training Outstanding Engineers as early as 2010 in order to improve the quality of engineering talents cultivation in colleges and universities, which has explicitly defined the strategic focus of China's engineering education reform and development. Furthermore, in 2018, China launched the Plan for Educating and Training Outstanding Engineers 2.0 to continuously deepen the engineering education reform. The implementation of "Made in China 2025", as a new industrial model characterized by intelligent manufacturing, has been more clearly proposed to improve talents cultivation system at multi-levels in terms of talents cultivation characteristics, strengthen the major construction of information technology, engineering technology

and management disciplines related to universities and manufacturing industries and reform the talents cultivation model with emphasis on strengthening innovation and engineering capabilities.

With the continuous promotion of engineering education reform, in recent years, new breakthroughs have been made in China's engineering education: the structural layout has been continuously optimized, the education levels, types and types setting are more focused on adapting to industrial development and coordinating with regional development, which has provided sufficient reserve talents for the economic and social development during this period and has become a solid foundation and strong support for China's industrial development.

However, applied college graduates have been widely criticized by the society for their poor engineering practice ability and ability to solve practical problems, insufficient innovation capability, and lack of adaptability to social and economic situation, unobvious advantages and weak international competitiveness. On the one hand, these problems show that the applied colleges and universities are not accurate enough in setting their own macro indicators such as their own positioning, characteristic development and talents cultivation objectives and cannot adapt to the rapid development of social economy and changes in industrial structure. On the other hand, it also shows that the applied universities need to strengthen the connotation construction and seek room for continuous improvement in the school's curriculum, students' ability cultivation, construction of teaching staff, teaching management mode, resource allocation, administration and engineering culture construction. This paper mainly examines the innovative mechanism and development path of engineering talents cultivation in applied universities based on the new requirements of the development of the times for engineering talents cultivation in applied universities.

2. The Essential Attributes of Engineering and New Requirements for Talents Cultivation Presented by the Development of the Times

2.1 The Essential Attribute of Engineering

Practicality, comprehensiveness and innovation are the essential attributes of engineering. Practicality comes from the fact that engineering is a "creation" process and only through practice can the envisioned things become reality. Comprehensiveness is first reflected in the fact that engineering is the integration, selection and optimization of scientific elements, technical elements, economic elements, management elements, cultural elements, environmental elements and some other multiple elements. The construction of an engineering object often involves multiple disciplines; Secondly, engineering activity itself is a process of strategy, decision-making, planning, design, construction, operation and management, which involves the integration and application of engineering ideas, engineering epistemology and engineering methodology. Innovation mainly derives from the creativity of engineering. There are no two identical projects in the world. Each project has its own characteristics and innovation is one of them.

2.2 The Development of the Times Endows Engineering with More Characteristics

With the advancement of economic globalization, the scale, complexity and uncertainty of engineering projects are increasing. With the advent of the era of knowledge economy, knowledge, as the most important resource, plays an increasingly important role in the construction and development of engineering projects. The implementation of engineering projects face more and more severe and complex external environment resulting from a series of problems such as aging population, lack of resources and environmental pollution caused by social, political, economic, cultural and environmental changes. “Made in China 2025” focuses on promoting intelligent manufacturing and opens a new industrial mode characterized by intelligent manufacturing.

2.3 The Essential Attributes of Engineering and New Requirements for Talents Cultivation Presented by the Development of the Times

Firstly, engineering talents are required to have broad vision, flexible thinking and overall cognitive ability, be able to understand the close connection and essential difference among science, technology and engineering, especially the transformation relationship among the three; be able to understand the value and status of engineering activities in the process of natural-human-social interaction; and they can consciously incorporate the knowledge of social science, natural science and humanities into the learning and construction process of scientific knowledge of engineering.

Secondly, engineering talents need to have strong knowledge updating ability and learning ability. With the advent of the era of knowledge economy, the information explosion has accelerated the speed of knowledge updating and the complexity and uncertainty of engineering are increasing. Engineering talents need to have the ability to quickly accept and learn new things.

Thirdly, it is necessary to effectively improve the practical ability and innovation ability of engineering talents. At present, China is weak in independent innovation capability in the field of engineering. It is an indisputable fact that core technologies and high-end equipment are highly dependent on foreign countries. Both the innovation capability of individual technologies and the integrated innovation capability of engineering systems need to be continuously and effectively strengthened.

Fourthly, engineering talents need to have strong organizational leadership and team-work capabilities. With the development of science and technology, engineering activities have increasingly become the central field of human activities. As one of the principal parts of engineering projects, engineers have more and more opportunities to become leaders of engineering organizations. Thus they are required not only to make strategic decisions, plans and construction of engineering projects, but also to coordinate and deal with possible conflicts in engineering activities at any time to ensure the harmony and efficiency of the engineering community.

3. Problems in the Cultivation of Engineering Talents in Applied Universities

Serving the society and cultivating excellent engineering talents for the society are the important aims of applied universities. Applied colleges and universities have been continuously exploring new models

of engineering talents cultivation and carrying out continuous reforms in order to cater to the needs of social development, which have also gained fruitful achievements. However, some fundamental problems affecting the cultivation of engineering talents have not been well resolved.

3.1 There Is a Lack of Understanding of the Characteristics and Laws of the Cultivation of Engineering Talents and Scientific Talents, a Lack of a Good Understanding of the Essential Differences between the Two and Engineering Talents Are Cultivated in Accordance with the Cultivation Model of Scientific Talents for a Long Period of Time

Engineering talents have unique growth characteristics and laws different from scientific talents. Engineering talents cannot be cultivated simply according to the cultivation model and mechanism of scientific talents. In particular, applied universities need to speed up the reform of education and teaching modes and mechanisms, cooperate with industry, promote the systematic differentiation of engineering education and science education and strengthen the cultivation of students' engineering practice ability, comprehensive cognitive ability and innovation ability.

3.2 The Reform of the Cultivation Model of Engineering Talents Lacks the Overall Planning and Guidance of the School and the Reform Is Scattered, Slow, Chaotic and Ineffective

The reform of the cultivation model of engineering talents is not only a partial reform of teaching activities, it also involves the reform of the overall structure, teaching system and support system of the school and is a paradigm change. The reform involves the entire school system, such as campus culture, resource allocation, teaching activities, administrative management, and technical environment and so on. To achieve the success of the reform, the school must make overall planning, straighten out the cross-links, each department should coordinate with each other and each teaching organization should implement and advance the scheme on this basis.

3.3 The Construction of Engineering Culture Lags behind

The construction of engineering cultural environment in applied universities lags behind. Engineering ethics, engineering philosophy, engineering development history, innovative thinking of engineering and other courses related to engineering epistemology and methodology in general education are not offered adequately or of low quality, and students lack approaches to form correct and effective engineering concepts. The main line of engineering was not introduced into the professional learning process. The curriculum and discipline construction were all carried out centered on scientific talents cultivation and had nothing to do with engineering. There is no or little introduction of engineering case teaching; it is based on theoretical teaching with fewer links with experiment and practice and fewer links with project-based practice characterized by conception- design-implementation-operation. The proportion of double professionally-titled teachers is small and the teachers themselves lack engineering science knowledge, engineering practice ability and engineering cultural background.

3.4 It Is Difficult to Construct the Intramural and Out-College Engineering Practice Bases with Unsatisfying Results

The applied universities should strengthen the cooperation with the industry and try every means to build a platform for students to participate in engineering practice both inside and outside the school. There is no engineering without practice and there is no cultivation of engineering talents without engineering. However difficult the construction of intramural and out-college practice bases is, applied universities must properly solve the problem.

3.5 The Number of Courses Offered by the School Is rather Small

Teachers generally lack the concept of "teaching for learning". The teaching contents are relatively outdated and are mostly based on factual materials. Some valuable knowledge such as interdisciplinary frontier science, industrial development trends and engineering thinking methods have not been introduced into the teaching.

4. Research on Innovation Mechanism and Path of Engineering Talents Cultivation

The construction of innovative mechanism for talent cultivation is a complex and systematic project. The basic elements to maintain the sustainable and effective development of schools are to improve the quality of talents, to guarantee efficient operation and to focus on innovative development. According to the development needs of the times and the characteristics of engineering talents cultivation, objective mechanism, operation mechanism and development mechanism jointly constitute the main body of the innovation mechanism system of engineering talents cultivation.

4.1 Objective Mechanism

To ensure the cultivation quality of engineering talents and comprehensively improve the students' engineering practice and innovation ability, it is necessary to take the construction of teaching system for engineering talents cultivation as the starting point, emphasize the main line of engineering ability, highlight the two principles of versatility and creativity, pay special attention to the three combinations of theory and practice, practice and application, application and society. It is also significant to build an on-campus and off-campus practice platform containing four levels of basic practice, professional practice, project practice and innovation training and highlight the five dimensions of science-learning, engineering culture, subject and professional knowledge, international vision and organizational leadership in an integrated engineering talents cultivation system.

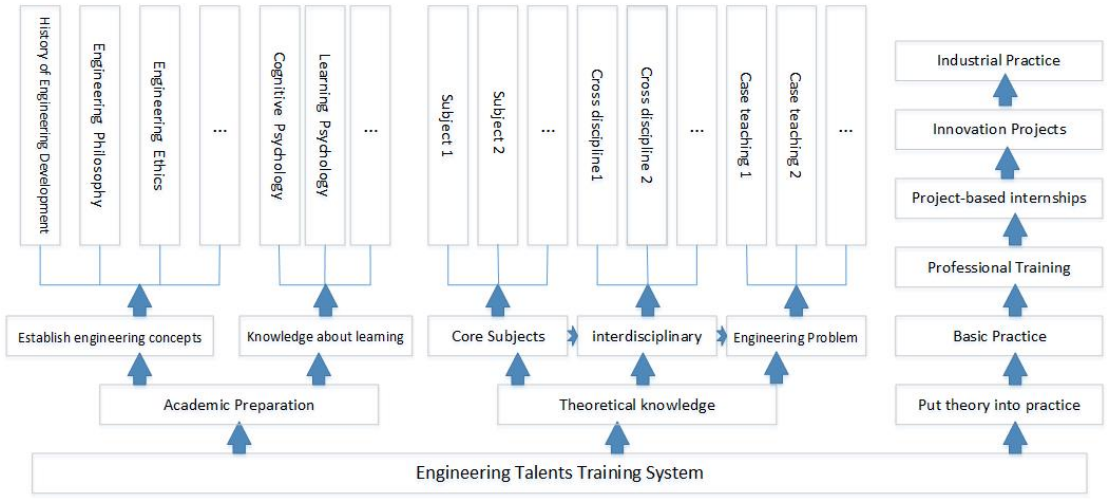

Figure 1. Engineering Talents Training System

The construction of the objective mechanism needs to be equipped with the path of realization. It is necessary to strengthen the course construction of metacognition on concepts such as engineering and learning in order to enable students to better understand engineering and the learning process. First of all, it is necessary to strengthen the construction of cognitive psychology and science-learning courses: cognitive psychology and science-learning knowledge can deepen students' comprehension of the nature of ability and the principles of knowledge organization. The deepening of these understandings is the ability foundation to solve problems in natural science, humanities, social research and so on and plays an important role in engineering talents' mastering scientific learning methods and improving their lifelong learning ability. Secondly, it is necessary to strengthen the construction of courses concerning engineering thought and concepts such as engineering development history, engineering philosophy, engineering ethics, engineering thinking, etc. The cultivation of engineering talents requires students to establish correct engineering thoughts and engineering concepts, be able to view the relationship among science, technology, engineering, industry, economy and society from a historical perspective, to understand the layout of national strategic development and to make individual development plans accordingly in terms of their own positioning.

The constructions of practice links need to be strengthened and a practice platform for students from "learning theory" to "applying theory" also need to be built. "Learning by doing" should be emphasized. The school should promote the reform of project-based teaching mode, actively seek internal and external resources, and do a good job in the construction of four levels of practice platform. Besides, the school should actively understand and summarize the characteristics and development direction of contemporary engineering project construction, carry out interdisciplinary frontier scientific research in combination with the superior disciplines of the school and timely incorporate the research content into teaching to further strengthen the construction of interdisciplinary course.

The school should deepen the reform of teaching approaches and methods and adopt advanced teaching

methods to ensure the effective integration of teaching depth, breadth and effect.

4.2 Operating Mechanism

Colleges and universities are a social organism. Its operation and development such as implementing a new talent cultivation plan, reforming the existing teaching model, improving the level of teachers, strengthening the quality monitoring, forming a new personnel allocation incentive system, ensuring the rational resource allocation, etc., all require a certain dynamic system to promote them. The complexity of teaching and supplementary activities in schools determines that these systems are bound to interplay, intersect and interact with each other. Rationalizing the relationship and establishing an effective operation mechanism are the basis to ensure their flexible, harmonious and efficient operation. First of all, talent cultivation is the fundamental mission of applied universities and the construction of the operating mechanism of each system in the university must be carried out based on this major task.

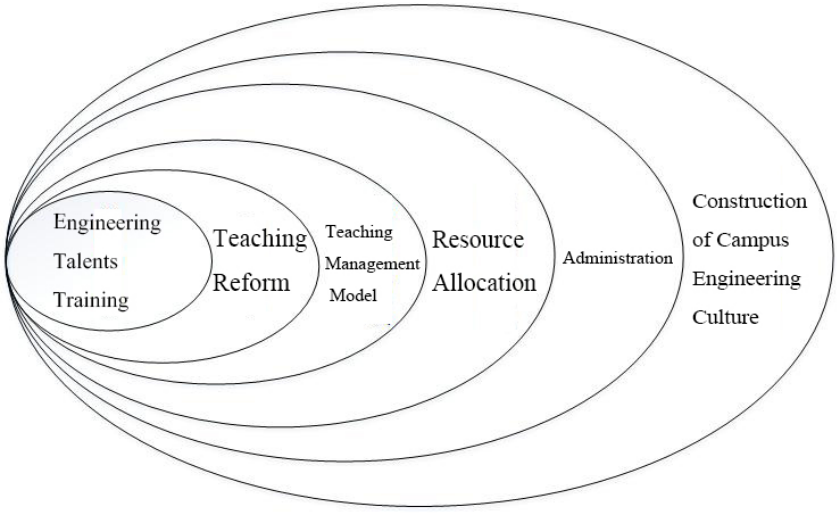

Figure 2. The Personnel Training as the Core Mechanism

Secondly, as the starting point for the implementation of the school operation mechanism, the teaching operation mechanism should not only guarantee the successful implementation of various engineering talents training programs in the school, but also plays a significant role in providing direction for the reform of other various mechanisms.

Thirdly, the improvement of the operation mechanism needs to promote the integration of teaching reform and management reform. In colleges and universities, teaching and management are complementary to each other. Disjunction, dislocation or even mutual interference between teaching and management will only lead to chaos in the operation mechanism.

Fourthly, a sound operation mechanism has certain subjective initiative and flexibility and can prepare for the transformation of talent cultivation model according to changes in society, economy, industry, international environment, etc.

4.3 Development Mechanism

Development is the theme of the construction of colleges and universities, the development mechanism is a powerful guarantee to ensure the high-quality and long-term operation of this organism. Applied universities should take innovation as the driving force for development, improve the cultivation quality of engineering talents as the development goal, take sustainable development as the development pattern, and take deepening reform and strengthening connotative development as the development means. And the applied universities should strengthen cooperation with enterprises and industries and continuously strengthen systematicness, coordination and flexibility in the process of organic development.

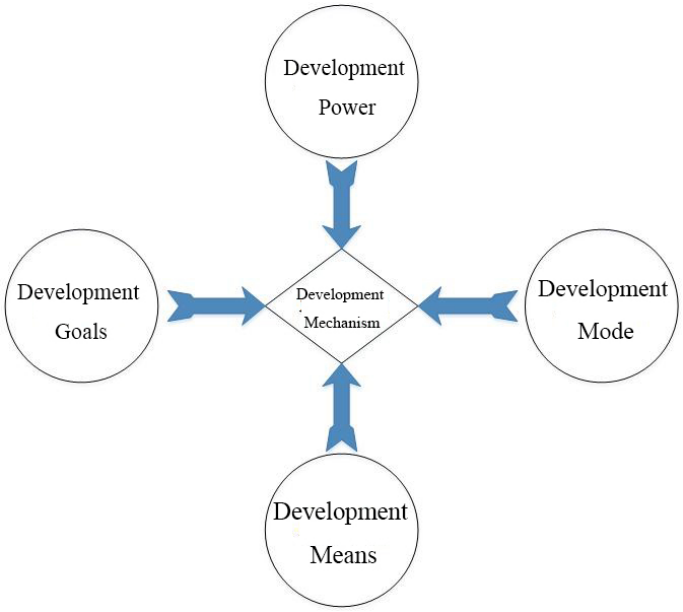

Figure 3. Development Mechanism

In order to establish a sound development mechanism, applied universities should also consider dealing with the following ten relationships: first, handle the relationship between long-term development and short-term benefits of the university; second, handle the relationship between school characteristic construction and regional economic development. Third, handle the relationship between talent cultivation and industrial structure adjustment; Fourth, handle the relationship between internationalization and localization of engineering education; Fifth, handle the relationship between teaching and scientific research; Sixth, handle the relationship between academic management and administrative management; seventh, handle the relationship between the goal of talent cultivation and the curriculum; eighth, handle the relationship between teachers and students; ninth, handle the relationship between teaching model reform and teaching management; Tenth, handle the relationship between the construction of campus culture and social orientation. The key for schools to strengthen connotation construction and explore a sustainable development path is to deal with these relations

mentioned above.

As the main base for cultivating engineering talents, applied universities undertake the important mission of providing talents for the transformation of China's manufacturing industry from a big country to a powerful country. Therefore, we should join hands with industry, have a foothold on the local area and have a world vision and adhere to the road of connotative development. We should keep our feet on the ground, deepen the reform of education and teaching in schools and make good use of the achievements of the reform so as to provide talented human resources for the realization of the Chinese dream of building a powerful nation.

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