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Research and practice of training of innovative talents in vocational undergraduate education

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Abstract: *Vocational undergraduate education is an inevitable product of China's economic and social development in the contemporary era and a necessary measure to adapt to the current global trends in vocational education and higher education. After years of discussion and research, there is now a clear understanding of the positioning of vocational undergraduate education in nurturing high-level technical and skill-oriented talents. However, the development of high-level technical and skill-oriented talents with qualities such as innovation, versatility, and sustainability is still in the exploratory phase. This article proposes the application of innovative theories to innovate talent cultivation in vocational undergraduate education, addressing the challenge of fostering innovation capabilities in high-level technical and skill-oriented talents. Through reforms and implementation of talent cultivation systems, a series of innovative achievements have been made, promoting innovation in talent cultivation models in vocational undergraduate education.*

Keywords: *Vocational undergraduate education; Innovation theory; Talent cultivation*

1. Vocational Undergraduate Education

China's higher vocational education has undergone over a century of development, gradually filling the gaps in the vocational education system. In practical terms, there are 32 vocational schools at the undergraduate level, 1486 junior colleges (specialized colleges), with 129,300 students enrolled in vocational undergraduate programs, and 15.9 million students in junior college programs. During the same period, there were 1238 regular undergraduate institutions with 18.93 million students, indicating that vocational education has already claimed a substantial share of higher education. According to American scholars, this functional differentiation may lead educational institutions to focus increasingly differently on educational positioning, talent cultivation, teaching, research, and social services. Therefore, the vocational education sector is actively exploring the development model of vocational education in universities. Since the issuance of the "Decision of the State Council on Accelerating the Development of Modern Vocational Education" in 2014, China's vocational education has encountered unprecedented opportunities for development, entering a new stage of high-quality development. Guided by national policies, several junior colleges have been upgraded to vocational technical universities, pioneering the development of vocational undergraduate education. Consequently, fundamental questions about the development, objectives, and methods of vocational undergraduate education need systematic answers from both theoretical and practical perspectives.

In recent years, there has been extensive discussion in the vocational education sector regarding the positioning of talent cultivation in vocational undergraduate education [1-6]. Xu Guoqing and others [3-4] believe that the talent cultivation positioning in vocational specialized education is for specialized skill talents, while the positioning in vocational undergraduate education is for professionally skilled talents. Guo Jianru [7] contends that vocational undergraduate education cultivates high-level technical and skill-oriented talents for frontline industries. These high-level skill talents are expected to have a deep understanding of technical systems, possess advanced technical operation capabilities for handling complex problems efficiently, and demonstrate the ability to address intricate and challenging faults.

It is evident that vocational undergraduate education differs from higher vocational education and applied undergraduate education in terms of talent cultivation. The focus of vocational undergraduate education is on nurturing high-level professional technical and skill-oriented talents, such as technical experts and senior technicians. These talents must meet the knowledge and technical requirements of vocational education while also showcasing their unique characteristics.

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Firstly, they should possess creativity. Vocational undergraduate education aims to cultivate high-level technical and skill-oriented talents, such as senior technicians. These talents must not only master theoretical knowledge but also apply it creatively to solve complex practical technical issues. They need to have not only a deep understanding of the theory but also a high level of operational and application capabilities.

Secondly, they should have versatility. Vocational undergraduate education nurtures versatile talents who are proficient in both "things" and "people." The former entails the ability to comprehensively apply knowledge and technology creatively to solve production and technical problems in real-life scenarios. The latter entails efficient communication, coordination, and management skills to organize personnel for on-site management and supervision.

Lastly, they should possess sustainability. Technical engineers are the main target of vocational undergraduate education, and technical directors and chief engineers are their subsequent career development goals. Therefore, they need to acquire the theoretical literacy and technical foundation that support their ongoing career development. It is important to note that graduates of junior colleges and specialized colleges are not required to be familiar with industry formats, whereas graduates of vocational undergraduate education are expected to be acquainted with the current state and development trends of the entire industry.

In summary, innovation, versatility, and sustainability are the key qualities of talents cultivated in vocational undergraduate education. In relative terms, the difference between vocational undergraduate education and specialized vocational education is not in the "quantity" of knowledge, skills, and qualities but rather in their "quality." Consequently, domestic scholars have provided clear answers to the question of the positioning of talent cultivation in vocational undergraduate education. However, the key challenge currently lies in how to nurture talents in vocational undergraduate education.

2. Vocational Undergraduate Education Talent Cultivation Characteristics

2.1 The method of cultivating professional skills

Vocational undergraduate education aims to cultivate high-end professional skill-oriented talents in frontline industries. This primarily refers to individuals who excel in technical systems on production positions, possess high-level technical operational capabilities, can efficiently diagnose complex faults, and have the ability to handle intricate and challenging issues. In the approval letter for the establishment of undergraduate-level vocational universities issued by the Ministry of Education, it is explicitly required to "maintain the attributes and characteristics of vocational education" and "adhere to the positioning of cultivating high-level technical skill-oriented talents." Experts and scholars have discussed how to cultivate professional skill talents in vocational education.

Yang Xiuying of Hainan University of Science and Technology believes that vocational undergraduate education should adhere to the concept of "integrating theory with practice and aligning knowledge with action" with the aim of "cultivating students' abilities to solve high-level operational problems" [8]. Han Changri and others argue that the positioning for talent cultivation in vocational undergraduate education "firstly involves solving high-level operational problems and, at the same time, being capable of technological innovation and process transformation, along with having strong adaptability to cope with changing job requirements" [9]. Xu Guoqing and others suggest that vocational undergraduate education should "cover the cultivation of skills-based talents with high theoretical knowledge requirements in some high-tech industries," emphasizing the primary focus on cultivating technical talents in undergraduate vocational education [10]. Peng Guangbin and others believe that vocational undergraduate education is oriented toward professionalism and technology application, and the students it cultivates should possess professional skills based on advanced theoretical foundations [11].

It is evident that the transformation from specialized vocational education to vocational undergraduate education needs further acceleration. Improvements and enhancements are required in various aspects, including talent cultivation, the layout of professional groups, teacher team construction, and experimental and practical training conditions. Governance systems and governance capacity to match the needs of vocational undergraduate education also require further development. This article discusses talent cultivation using the example of a university's talent cultivation program.

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2.2 Discussion on Talent Cultivation in Vocational Undergraduate Education

A cultivation program is the blueprint for planning and designing talent cultivation goals and the educational process, serving as the guiding document for organizing teaching activities. Currently, the curriculum system in vocational education is solid in terms of foundational theory, broad in terms of specialized knowledge, and strong in practical skills. However, it falls short in terms of fostering innovative traits, especially in terms of innovation and sustainability. This misalignment with the talent cultivation positioning in vocational undergraduate education hinders the achievement of the requirements for cultivating high-level professional skill-oriented talents. Therefore, reforms and enrichments are needed in the current talent cultivation to align with the goals of vocational undergraduate education.

Innovativeness, versatility, and sustainability are the characteristics of talents cultivated in undergraduate vocational education. This can be understood as requiring professional skill-oriented talents to have the ability to discover, clearly express, and solve complex engineering problems that are not limited to the present or specific situations. To meet this positioning in vocational undergraduate education, additional innovative capacity modules should be incorporated into the talent cultivation curriculum. As shown in the figure, the innovative curriculum modules should run through various stages of talent cultivation, integrated into public foundational courses, specialized courses, and quality expansion courses, aiming to nurture innovation, versatility, and sustainability in professional skill-oriented talents.

However, in the cultivation of professional skill talents in undergraduate vocational education, due to the new demands for talent traits, the talent cultivation program becomes more complex compared to the program for specialized vocational education. Monitoring and testing the talent cultivation process become more challenging. This process introduces new issues that require theoretical and methodological solutions.

3. Innovative Methods in Talent Cultivation

Innovative education aims to cultivate individuals' innovative consciousness, innovative spirit, innovative thinking, and innovative abilities. It is an educational activity guided by modern quality education theories with the goal of enhancing students' innovative qualities. Innovation is a process of problem-solving based on knowledge and involves the introduction and application of knowledge in technical systems within problem situations. In this process, the knowledge of high-level invention methods is more crucial than the application of specialized knowledge. TRIZ is considered the most efficient and widely applicable systematic methodology for "solving inventive problems."

3.1 TRIZ Theory

TRIZ, developed by Altshuller, provides a theoretical framework for finding and solving challenging issues in the inventive process, making it a classic theory and methodology in innovation [12]. Since its introduction to China in the 1990s, scholars in Chinese universities and experts in enterprises have conducted extensive research on the application of TRIZ theory. Universities play a key role in cultivating innovative talents, and in recent years, various universities in China have been striving to create innovative talent cultivation models, attempting to find the most suitable approaches.

3.2 Application of TRIZ Theory

Technical conflicts are classic tools in TRIZ for solving problems. The process involves transforming a specific problem conflict into a general technical conflict using two of the 39 engineering parameters, which represent the performance of the conflicting parties. The real-world problem conflict is thus transformed into a general technical conflict. Using the conflict matrix, one can obtain the general solution corresponding to the problem. By analogizing the inventive principle with the actual problem, a specific solution can be derived and applied to solve the real-world problem.

Viewing the cultivation of professional skill-oriented talents as a complex engineering system, the application of TRIZ theory's conflict resolution principles and methods is explored to address the issue of fostering innovative traits in talent cultivation programs. As mentioned earlier, the current challenge in the cultivation of skill-oriented talents is to enhance adaptability and versatility. This necessitates the enrichment and expansion of talent cultivation methods in vocational undergraduate education, such as

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the incorporation of modules on innovation capabilities. However, this will increase the complexity of talent cultivation and the difficulty of monitoring and testing the process.

The application of TRIZ's technical conflict problem-solving principles can be summarized as follows: To address the issue of inadequate innovation traits in talent cultivation for professional skill-oriented talents, a curriculum module on innovative capabilities is added to the talent cultivation system within vocational undergraduate education. However, this increases the complexity of the talent cultivation system and the difficulty of monitoring and testing the process. This problem can be transformed into a general problem: improving Engineering Parameter 35 - adaptability and versatility while worsening Engineering Parameter 37 - the difficulty of monitoring and testing.

By searching the conflict matrix, the inventive principle obtained is: 1. Segmentation: Divide an object into independent parts. Based on this inventive principle, the cultivation of innovation capabilities for professional skill-oriented talents is divided into three levels within the existing talent cultivation system. Each level offers corresponding innovative courses. Based on the school's unique characteristics, a "1+N+Z" innovation cultivation system is constructed and promoted throughout the institution. Through the construction of the innovative curriculum system, students' innovative thinking is nurtured, and their paths for developing innovative thinking are expanded, sparking students' enthusiasm for innovation and enhancing their ability to identify and solve problems innovatively.

3.3 Solutions

Compared to other innovation methods, TRIZ offers unique advantages. Research on TRIZ has found that most innovative behaviors follow certain patterns of intellectual activities, and innovative abilities can be systematically cultivated through methods and tools. This article combines empirical research on innovation and entrepreneurship courses in vocational technical undergraduate universities with theoretical analysis of innovation. It incorporates the principles of TRIZ innovation methods to construct a "1+N+Z" pyramid-shaped innovation education curriculum system, meeting the diverse needs of students at different stages and levels in developing their innovation capabilities.

"1" forms the foundation of the curriculum system pyramid. It is a concept that integrates "innovation" awareness into all courses throughout the institution, covering all students. It transforms from "innovation courses" to the idea of "course innovation." For example, offering foundational compulsory courses such as "Fundamentals of Innovation and Entrepreneurship for College Students" to all students. In these foundational courses, the focus is on cultivating students' innovative thinking.

"N" constitutes the middle support of the curriculum system. It is designed for certain majors and the majority of students, offering diverse and personalized N high-quality innovation and specialized fusion courses based on the characteristics of the majors. Examples include "Innovative Design Practice in Intelligent Manufacturing" for the intelligent manufacturing major and "Application of TRIZ in Architecture" for architecture majors. The aim is to create more specialized courses that reflect industry characteristics and incorporate innovative thinking and methods, enabling students to master innovative tools and techniques.

"Z" forms the pinnacle of the curriculum system. It is designed for a minority of elite students with strong innovative awareness and certain innovation capabilities, focusing on intensive practical training to enhance their innovation abilities. Examples include establishing innovation platforms such as the "Yumimi Makerspace," "Innovation Café," "3D Printing Center," and "BIM Technology Application Research Center." Students participate in platform research projects and engage in innovation and entrepreneurship practices, including competitions such as "Internet+" competitions, innovation method competitions, and innovation and entrepreneurship competitions. The goal is to achieve deep integration of students' professional skills and innovation capabilities, applying what they have learned effectively.

4. Application of Innovative

In order to solve the problem of insufficient innovation characteristics in professional undergraduate talent training, a university took the lead in integrating TRIZ method theory system into every link of talent training and throughout. Through the cultivation of the new system, the teachers and students of the school have made breakthroughs in patent application and innovation and entrepreneurship competitions in the past two years, and won a number of national innovation and entrepreneurship awards such as "Internet +", Challenge Cup and TRIZ Cup, realizing the goal of training professional

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skills talents.

5. Conclusion

After over a century of development, innovation theory has had a profound impact on various fields such as economics, management, politics, and geography, leading to diverse research in the realm of innovation. The ideas derived from innovation theory have offered fresh perspectives for problem-solving in other disciplines, while research from other disciplines has enriched the content of innovation theory. TRIZ theory, constructed by Altshuller, provides a classic theoretical and methodological framework for tackling challenging issues in the inventive process, making it a cornerstone in the field of innovation methods. This article applies the TRIZ theory from innovation methodology to the development of an innovative talent cultivation system in vocational undergraduate education. Based on conflict resolution theory and methods, as well as the characteristics of cultivating professional skill-oriented talents, it has established a "1+N+Z" innovation talent cultivation system. This system is integrated with existing talent cultivation programs, driving innovation in talent cultivation models and promoting curriculum development and reform in vocational undergraduate education. Through the implementation of this new approach, the school's faculty and students have achieved a series of "TRIZ+" innovative results. This practical validation demonstrates that applying the principles and perspectives of innovation theory to the issue of cultivating innovative talents in undergraduate vocational education is a viable path, expanding the horizons of innovative models and enriching the content of innovation theory.

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