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A Review of the Influence of Innovation Platforms and School-Enterprise Cooperation on Engineering Innovation in Henan's Vocational Education

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Abstract: This review explores the role of innovation platforms and school-enterprise cooperations in enhancing the engineering innovation abilities of students in Henan's higher vocational education institutions. Henan has invested in over 20 innovation platforms, providing practical learning opportunities and fostering collaborations between universities, industries and government agencies. These platforms enable students to engage in real-world engineering challenges, enhancing their creativity and problem-solving skills. Additionally, school-enterprise cooperations have surged in Henan, with over 30 significant partnerships formed, offering students industry-relevant curriculum designs and practical experiences. The review also identifies challenges including outdated curricula and a lack of structured communication between educational institutions and industries. Henan's institutions are responding by integrating technology, interdisciplinary learning and project-based methods into the curriculum. The review highlights the importance of fostering practical innovation abilities, combining theoretical knowledge with real-world application, arguing that cultivating engineering innovation abilities through experiential learning, internships and cross-sector cooperation is essential for aligning vocational education with industry demands, ultimately producing graduates equipped to meet modern market challenges.

Keywords: Innovation Platforms; School-Enterprise Cooperation; Engineering Innovation; Vocational Education.

1. Introduction

Henan, with its rich heritage and economic dynamism, has always been a region of strategic importance in China's development trajectory. The province has vigorously embraced the wave of technological advancements, ensuring its continued significance in the modern era. Central to this drive is the province's investment in innovation platforms, particularly as they relate to enhancing the quality and relevance of vocational education (Zhang et al., 2020). According to Zhang et al.'s (2020) study, the Henan province has initiated the establishment of over 20 innovation platforms, serving as hubs of creativity, cooperation and practical learning and are instrumental in fostering a culture of innovation among the students and faculty of vocational institutions. Similarly, Zhao & Wang (2018) argues that the strategic importance of these platforms can't be overstated, as global industries become increasingly competitive and technologically-driven, the need for a workforce that is not only skilled but also innovative becomes paramount.

Through active investing in these innovation platforms, Henan is ensuring that its vocational graduates are equipped not just with technical know-how, but also with the ability to think creatively and approach problems with an innovative mindset (Huishuang, 2015). Particularly in the engineering discipline, these platforms facilitate a multifaceted learning experience by offering students real-world engineering challenges to solve, foster cooperations between different institutions and industries and allow for a hands-on approach to learning that goes beyond traditional classroom-based instruction (Sui et al., 2022). Moreover, they also serve as incubators for startups, providing budding entrepreneurs with the resources and mentorship they need to transform their innovative ideas into viable commercial ventures (Sui et al., 2022). Another significant aspect of Henan's commitment to these platforms is the cross-cooperation they engender. Universities, research institutions, industries and government agencies come together, bridging the traditional divides and working towards a common goal of advancing technological prowess and fostering innovation (Wu et al., 2022).

In today's globally competitive landscape, the symbiotic relationship between academia and industry is becoming increasingly vital (Bian & Wang, 2021). As for Henan, a province historically recognized for its economic dynamism, has been at the forefront in fostering such cooperations, ensuring that its educational establishments, especially vocational institutions, are aligned with the needs of modern industries (Yuan et al., 2022). This alignment is particularly pronounced in the realm of engineering innovation, where the confluence of theoretical knowledge and practical application is imperative. Recent studies by local scholars have highlighted a surge in School-Enterprise Cooperations (SEC) in Henan, with over 30 significant partnerships being formed between vocational institutions and industries in the past decade (He & Sun, 2022). These cooperations transcend traditional internships, innovating curriculum design influenced by real-world industry needs, joint research and development projects and shared resources and facilities (He & Sun, 2022).

As Liu & Qin (2019) argued, the impetus behind this surge is clear, industries are in dire need of a workforce that is not only technically competent but are also attuned to the evolving challenges and dynamics of the modern marketplace. On the other hand, vocational institutions aim to enhance their curriculum's relevancy, ensuring their graduates are both employable and capable of driving innovation (Li et al., 2023).

Engineering, given its inherent reliance on practical application, stands to benefit immensely from these partnerships. Take the platform partnership courses (circuit analysis, analogue electronics technology, digital electronics technology) of Zhengzhou Institute of Vocational Technology as an example, the courses make full use of the simulation software, network teaching platform and "Mobile Lab" to assist teaching and help students to learn on their own (Yao et al., 2023). Through simulation and breadboard-based circuit experiments, the course helps students to digest and absorb knowledge easily and subconsciously, stimulates students' curiosity and trains their practical ability. At the same time, each student is equipped with a "DIY experiment box", so that experimental teaching no longer rely on a dedicated laboratory and truly realize that each class is "learning to do, doing in the middle" (Guo, 2022).

Another example is the department of electronic information engineering of Zhengzhou Institute of Vocational Technology, the department integrates relevant resources and establishes a professional association - Electronic Information Association, which is based on teachers' scientific research projects and students' innovation and entrepreneurship training programs and trains students who are members of the association to become the student research team of relevant projects and to assist teachers in completing various scientific research projects or their sub-projects (Guo, 2022). The students are trained to organize themselves into student research teams for relevant projects and assist teachers in completing various scientific research projects or their sub-projects. After several years of practice and exploration, the program has achieved certain results in the cultivation of students' innovation and entrepreneurship ability and the dual-creation competition (Guo, 2022). The apparent increase in school-enterprise cooperations in Henan's vocational education have led to the establishment of several on-campus innovation centres funded and co-managed by industry partners. These centres serve as hubs for research, innovation and practical learning, ensuring students are exposed to the latest technological advancements and industry trends (Nie et al., 2022).

2. Challenges in Aligning and Innovating Education Curriculums with Industry Demands in Henan

A predominant challenge that emerges is the curriculum's inability to keep up with the swift pace of industry advancements. As Wu & Yan (2016) identified, there is often a time lag between the emergence of new technologies or methods in the engineering field and their incorporation into the educational curriculum. This lag results in students being trained in outdated techniques, rendering them less effective in contemporary industry settings. Another significant issue lies in the instructional methods employed. Traditional pedagogies, reliant on rote learning, are still predominant in many vocational institutions in Henan (Li & Li, 2021). While these methods might ensure that students are well-versed in theoretical concepts, they often fail to provide the hands-on, practical experience that the engineering industry values. This theoretical-practical divide widens the gap between what students are taught and what the industry expects from them.

Moreover, communication and cooperation between educational institutions and industries remain sporadic and unstructured. Zhang et al. (2020) argue that many vocational schools and colleges in Henan operate in silos, with limited industry outreach. As a result, there's a lack of mutual understanding as institutions are unaware of industry needs and industries are often uninformed about the skills and competencies that recent graduates possess. This disconnect also extends to faculty qualifications and experience. A significant proportion of vocational educators in Henan, as highlighted by Zhao & Wang (2018), possess strong academic backgrounds but lack substantial industry experience. This means that while they might be adept at teaching theoretical concepts, they might not be well-equipped to provide insights into real-world industry applications and challenges. The dynamic nature of the engineering industry, with its ever-changing technological and methodological advancements, also means that the skills and knowledge required can shift rapidly. Given the traditional structure of most educational curricula, which are often revised only every few years, this dynamism presents a significant challenge (Liu & Hardy, 2021).

Nonetheless, Henan has illustrated strong engagement in pressing need to reform its curricula to address the demands of industries in recent years, especially in fostering innovation (Li & Li, 2021). This has necessitated a shift from traditional teaching paradigms to more contemporary approaches that balance both theoretical knowledge and practical applications. A notable feature of the curriculum innovations in Henan is the increased emphasis on experiential learning. As observed by Wu et al. (2022), a majority of vocational institutions in Henan have adopted project-based learning methods, where students are given real-world engineering challenges to address. This not only allows them to apply theoretical knowledge but also hones their problem-solving and innovative thinking skills. The integration of technology into the curriculum is another significant step taken by Henan's vocational schools. Liu (2023) found that many institutions have introduced advanced simulation tools, digital design platforms and AI-driven analysis software in their teaching, ensuring that students are conversant with the latest tools used in the engineering industry. This tech-driven approach also facilitates a more interactive and engaging learning experience.

Additionally, the curriculum now places a profound emphasis on interdisciplinary learning, recognizing that engineering innovation often requires insights from various domains, vocational institutions have incorporated courses from related disciplines such as economics, environmental science and even social sciences. This holistic approach ensures that students gain a comprehensive understanding of the broader implications of their engineering innovations (Song & Wang, 2021). Feedback mechanisms have also been introduced to ensure the curriculum remains relevant. According to research by Wu et al. (2022), many vocational institutions in Henan have established committees consisting of industry professionals, alumni and academic experts. These committees regularly review and provide input on the curriculum, ensuring it aligns with industry requirements. Their insights often lead to timely updates, introducing new modules or revising existing ones to address the dynamic nature of the engineering sector. Additionally, on-site training sessions have become integral components of the curriculum, as such endeavours expose students to actual engineering environments, enabling them to contextualize their academic knowledge (Liu & Schuppener, 2019).

3. Requirements of Engineering Innovation Ability of Skilled Personnel in Higher Education Institutions

The goal of engineering education is to cultivate skilled talents for the country and the society and engineering innovation ability is the basic quality of first-line skilled talents and one of the identity characteristics (Ramirez-Mendoza et al, 2020). Skilled personnel play a key role in the fields of product production, creation, energy development and transmission management, transportation management and construction, environmental improvement and maintenance and health care (Spottl & Windelband, 2021). According to Spottl & Windelband (2021), skilled human resources are engineers who build bridges between technology and society, making important contributions to the creation of wealth and ensuring the prosperity of the nation.

Specific engineering innovation ability is the ability that should be possessed under specific positions and the engineering innovation ability of students in higher vocational colleges and universities is the embodiment of the comprehensive quality of students in the process of engineering practice and the demonstration of students' breakthrough innovation ability in the process of practice (Graham, 2018). Engineering innovation ability contains various connotations, including innovation of academic knowledge, innovation of social ability, innovation of critical thinking ability, innovation of application ability and innovation of practical ability (Zhao et al., 2022). Among them, the most important one is the innovation of practical ability.

The innovation of practical ability of students in higher vocational colleges and universities consists of interconnected, influential and promotional abilities that constitute the innovation ability system (Gong & Mei, 2017). In this system, practice is the foundation of innovation, specialty is the core of innovation and comprehensive innovation ability is the direction of cultivation and development. In the process of engineering innovation, students of higher vocational colleges and universities should focus on cultivating the following relevant abilities in their study, life and work (Ye et al, 2022).

Upon obtaining the knowledge of academic theories and theoretical foundations, students of higher vocational colleges and universities should use language or other ways to express their ideas, thoughts, opinions and feelings, which is the basic quality of emotional communication and exchange of ideas among college students (Wu & Yan, 2016). The rapidly evolving nature of contemporary society requires students to continuously adapt and evolve. Specifically, students from higher vocational colleges and universities must revise their theories, actions and thought processes to meet the changing expectations and responsibilities set by their respective nations. Theoretical knowledge, while foundational, is only part of the equation in both research and frontline duties; practice is crucial for nurturing talent, augmenting theoretical comprehension and facilitating engineering innovation (Freeman et al., 2014). Within this educational paradigm, the interpersonal competencies of students in higher vocational institutions are increasingly significant. Such skills pave the way for these students to exhibit their capabilities and gain societal recognition (Ambrose et al., 2010). Establishing trust, developing a robust platform for personal growth and ensuring efficiency are pivotal in the continuity and enhancement of engineering innovation.

As students in higher vocational institutions employ their professional expertise to instigate innovation, their linguistic prowess, adaptability, hands-on experience and social acumen become critical. These intertwined capabilities form the essence of practical innovation. Equipped with these foundational attributes, individuals are well-poised to significantly contribute to engineering innovation, meeting the demands of the modern-day society (Prince, 2013).

4. Importance of Cultivating Students' Engineering Innovation Ability in Higher Vocational Colleges and Universities

China's higher vocational colleges and universities, specializing in engineering, have been instrumental in nurturing talents that align with the country's frontline engineering and industrial requisites. They've designed a curriculum that emphasizes both students' technical proficiencies and the fusion of theory with hands-on experience. This synergy between society, academia, industries and technological advancements facilitates the production of skilled professionals with a penchant for innovation (Wang et al., 2015). Two distinct features characterize China's higher vocational engineering education: a specific cultivation goal and an emphasis on practical training during the teaching process. The mission of these institutions isn't solely to equip students with vocational skills but to ensure holistic growth encompassing moral, intellectual and physical dimensions, thus meeting societal demands (Zhao & Zhang, 2016).

By focusing on these core objectives, these institutions continuously refine their pedagogical structures, thereby enhancing the innovative capacities of their students. In this process, practical teaching in higher vocational colleges is the key way to realize. Practical teaching is limited and non-limited in form and specialized and non-specialized in nature (Liu et al, 2018). In order to achieve the overall goal, the practice place and organization form have detailed and complex characteristics, no matter it is stage or level, all towards the target direction of cultivation, in the subtle realization of the influence on the three outlooks and qualities of the students of higher vocational colleges and universities, so as to pave the way for the quality of engineering innovation and theoretical foundation (Liu et al, 2018).

Vocational education, complementing general education, primarily aims at nurturing proficient technical and skilled individuals (Wang & Bai, 2017). Historical documents and decisions by the Party and the nation underscore the pivotal role and strategic importance of vocational education for socialist modernization, advocating for robust strategies to expedite its wholesome and swift development (Chen, 2018). As China embarks on a novel developmental phase, rapid industrial advancements intensify the demand for skilled professionals adept in engineering innovation across sectors, amplifying the significance of engineering innovation training in vocational education (Li & Zheng, 2016).

Higher vocational colleges, with their twin-fold emphasis on pedagogy and scientific research, evidently possess enhanced research capabilities compared to secondary vocational institutes primarily focusing on skill cultivation (Zhang et al., 2019). Leveraging the innovation platforms

already in place for innovative personnel training optimally utilizes the rich educational resources of higher vocational institutions. This strategy not only elevates the engineering innovation prowess and employability of graduates but also bolsters the societal service role of these institutions, potentially heralding a fresh wave of reforms in vocational education.

5. Effective Pathways to Cultivate Student's Engineering Innovation Ability

In accordance with the stipulated objectives for engineering innovation capabilities, there's a pressing need to seamlessly combine practical instruction with theoretical pedagogy, design distinct curricular programs emblematic of individual higher vocational institutions and establish platforms conducive to innovation (Johri & Olds, 2011). Higher vocational education entities must remain steadfast in upholding their institutional philosophies and distinctive pedagogical attributes, champion reforms that counter traditional educational paradigms, zero in on enhancing engineering pragmatism and innovation skills, adopt a synergy between vocational pursuits and academic learnings and invigorate the initiation and mentorship of pertinent vocational certification programs (Lester & Costley, 2010). These institutions should cultivate a dialogue with industry stalwarts promptly, sculpting capability enhancement programs that are reflective of the precise needs articulated by corporate entities for each specialization.

(1) **Theoretical teaching methods –** These methods incorporate contemporary pedagogical techniques that engage students through interactive lectures, case studies and simulations that mirror real-world engineering challenges. Educators often integrate multimedia presentations and collaborative projects that encourage creative problem-solving and theoretical application in practical scenarios (Khurramov, 2021).

(2) **Practical teaching methods -** The realm of practical teaching aims to cultivate students' practical skills such as installation, splicing and use of instruments, as well as the ability to combine with employment positions. For the cultivation of engineering innovation ability, it is very important to correctly deal with the relationship between theoretical teaching content and practical teaching content and formulate a talent training program focusing on ability cultivation (Khurramov, 2021).

(3) Internship - Internship is a kind of internship, which can further improve students' engineering innovation ability and promote the effective combination of theory and practice (Ranabahu et al, 2020). During the internship, students can effectively utilize the company's learning opportunities, strengthen their engineering ability, link theory with practice and solve practical problems. At the same time, using the basic theories and professional knowledge learned in school, in production practice, boldly put forward innovative ideas and innovative technological measures and other proposals, combining the spirit of innovation and scientific attitude, to realize the cultivation of all-round comprehensive ability (Shi, 2014).

(4) School-enterprise cooperation - This is a strategic approach that bridges the gap between academic theories and industrial practices, significantly enhancing engineering innovation by forging partnerships with leading industry players, educational institutions can provide students with real-time exposure to current technologies and engineering practices. This cooperation often involves co-developed curricula that reflect the latest industry standards and requirements, ensuring that students are well-prepared for professional demands.

6. Conclusion

In contemporary society, colleges and universities should follow the pace of the times, conform to the needs of social and economic development in all aspects, so as to further improve the training mode of engineering innovation talents. Adopting the education mode of cooperation between colleges and enterprises can effectively make up for the shortcomings in the cultivation of students' engineering innovation ability and enable students to complete the study of specialized knowledge and at the same time, they can also carry out internships under the guidance and help of the enterprise management personnel (Cheng et al, 2020). Under the education mode of school-enterprise cooperation, the cultivation of students' engineering innovation consciousness requires the guidance of students' engineering practice ability (Qianyi et al., 2018). Guiding students to study in enterprises can stimulate students' innovative consciousness, establish students' ideal of practical innovation, improve students' interest in engineering practice during the internship process, enable students to have the various engineering innovation talents and also enhance students' innovative and practical ability after employment (Qianyi et al., 2018). Cultivate students' engineering innovation consciousness in practice, also can let students understand and adapt to the working procedure and environment faster and the enterprise can provide more engineering practice opportunities for excellent students, so that students can have a clear goal of practice as early as possible and further enhance the students' practical ability and innovation consciousness (Ling et al., 2021).

School-enterprise cooperation is an important way to cultivate engineering talents' practical ability and engineering innovation ability and it is also a crucial measure to guarantee the quality and characteristics of higher vocational colleges and universities (Ding & Wang, 2021). Moreover, through the construction of school-enterprise cooperation system, it can promote the positive and effective integration between schools and enterprises, which further favours the comprehensive development of vocational education and promotes the cultivation of skilled talents in higher vocational colleges and universities (Ding & Wang, 2021). In addition, in order to carry out diversified and all-round deep integration between universities and enterprises and in order to further promote the development of enterprises and satisfy the thirst of enterprises for skilled talents, it is necessary for enterprises and schools to realize the sharing of resources and complementary advantages, so as to realize the common development and win-win cooperation between schools and enterprises (Xia & Ahmad, 2022).

First of all, the reasonable construction of the curriculum system, set the learning content of the combination of work and study, in the completion of the theoretical knowledge of the implementation of the teaching at the same time, appropriate to add the content of the practical teaching and in the overall teaching process pay attention to the cultivation of the students' vocational literacy, guide students to form the appropriate vocational awareness and to improve the social adaptability of the students (Ma et al., 2018). Secondly,

schools and enterprises jointly build training bases, which can provide students with a place to master technical skills and schools can provide more services for the society through this channel, so as to practically improve students' engineering practice and innovation ability (Zhang, 2020). Finally, to comprehensively improve the overall quality of the faculty, in terms of scientific research ability and teaching practice level and other aspects of the comprehensive improvement, such as the use of teachers to regular learning exchanges in the enterprise, participate in the enterprise technology research and development activities, etc., to realize the regular cooperation between the school and the enterprise and the common development and also to promote the students to keep abreast of the development trend of the industry, to clarify the direction of their own learning and to improve their own practice actively (Ling & Wang, 2021).

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