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Research on the Cultivation of College Students' Innovative Ability from the Perspective of Disciplinary Competitions

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Abstract: Disciplinary Competitions have emerged as a pivotal avenue for fostering students' innovative capabilities. In the modern educational context, cultivating the innovative acumen of contemporary college students demands the seamless integration of theory and hands - on practice. This paper delves into constructing an innovative practice platform, using the college students' robot innovation competition as its core carrier. By leveraging the 'learning through competitions, teaching promoted by competitions' model, it aims to stimulate students' latent innovative potential. Moreover, this initiative creates a vibrant campus innovation ecosystem. This ecosystem serves to enhance students' engineering practice prowess and their aptitude for interdisciplinary collaboration. The paper further puts forward an innovative quality cultivation strategy centered around robot competitions. The educational efficacy of the competition - teaching integration mechanism is thoroughly verified by incorporating practical cases, like the real - world scenarios and outcomes from the College Students' Robot Competition.

1. Introduction

In the contemporary context, the scale of higher education in China has been experiencing a continuous expansionary trend. As per the '2021 National Education Development Statistical Bulletin' promulgated by the Ministry of Education, the aggregate scale of graduates from regular institutions of higher learning in the 2021 graduating class attained 9.09 million, denoting a 4% increment relative to the 8.74 million in 2020 [1]. At the current critical juncture of the manufacturing industry's transformation and upgrading, given that China is the sole nation globally encompassing all 41 industrial categories, 207 medium - level categories, and 666 sub - categories as per the United Nations Industrial Classification [2], the nation's exigency for high - calibre

innovative talents has become increasingly acute.

Against this backdrop, the construction of an innovative talent cultivation mechanism centered around the concept of 'learning through competitions, teaching promoted by competitions' assumes substantial practical significance. Empirical research has indicated that the traditional knowledge - indoctrination - based pedagogical model exhibits circumscribed efficacy in fostering students' innovative capabilities [3]. Conversely, the practical teaching system propelled by disciplinary competitions can markedly elevate students' innovative thinking echelons [4]. Through the establishment of a three - dimensional interconnected curriculum system integrating 'professional practice, disciplinary competitions, and innovation education', three pivotal transformations can be effectively materialized. These include the shift of the teaching emphasis from mere knowledge dissemination to the cultivation of practical abilities, the transition of the learning approach from passive reception to active exploration, and the alteration of the evaluation criterion from a score - centric orientation to an innovation - output - oriented one [5].

Substantiated by practical data, in institutions of higher learning that have implemented the subject - competition - driven paradigm, the annual average growth rate of students' patent applications registers at 23%, and the quantity of subject - competition accolades has witnessed a 45% upsurge [5]. This education - industry convergence talent cultivation model not only fortifies students' engineering practice proficiencies but also nurtures their systematic thinking and cross - disciplinary integration capabilities via real - world project - based impetus. Consequently, it furnishes robust talent support for the high - quality evolution of the manufacturing industry, facilitating the seamless integration of academic knowledge with industrial demands and promoting the overall progress of the manufacturing sector in the context of technological innovation and global competition.

2. Construction of the Synergy Mechanism between Disciplinary Competitions and Innovative Ability Cultivation

2.1. Combining Competition and Training to Construct a Progressive Cultivation System for Innovative Abilities

As seen in Fig.1, Improving the innovative abilities of college students and building an innovative society have become important development strategies in China. In line with the training plan, the cultivation of college students' innovative abilities should be carried out through Disciplinary Competitions to construct an educational model for cultivating college students' innovative abilities. Students deepen and understand the theoretical knowledge learned in the classroom through Disciplinary Competitions. Taking subject - competition projects as the carrier, the theoretical teaching content is integrated into the subject - competition projects, enabling students to apply the knowledge learned in the classroom to the competitions and reserve a theoretical basis and knowledge system for the competitions.

The freshman year of college is the stage of innovation enlightenment. It focuses on cultivating the interests and hobbies of freshmen. Relevant professional experts and scholars are invited to give lectures, and freshmen are encouraged to participate in senior students' scientific and technological activities to develop their interests, opening the door to innovative thinking for freshmen and completing the introductory cultivation of innovative abilities as soon as possible.

In the sophomore year, the ‘competition - oriented curriculum’ reform is carried out. The requirements of competitions such as the College Students' Innovative Robot Competition are integrated into professional courses to form a teaching loop of ‘classroom theory - virtual simulation - competition practice’. Under the guidance of teachers, students can participate in some Disciplinary Competitions they are interested in. At the same time, in the classroom, teachers can

intersperse some subject - competition projects to stimulate sophomores' interest in learning, encourage them to strive for the best, and actively participate in campus Disciplinary Competitions to master the general rules and practical skills of Disciplinary Competitions.

For senior students, a ‘school - provincial- national’ competition advancement channel is constructed. Through the introduction of real - enterprise projects and the feedback of scientific research on teaching, the innovative abilities are enhanced in a spiral manner.

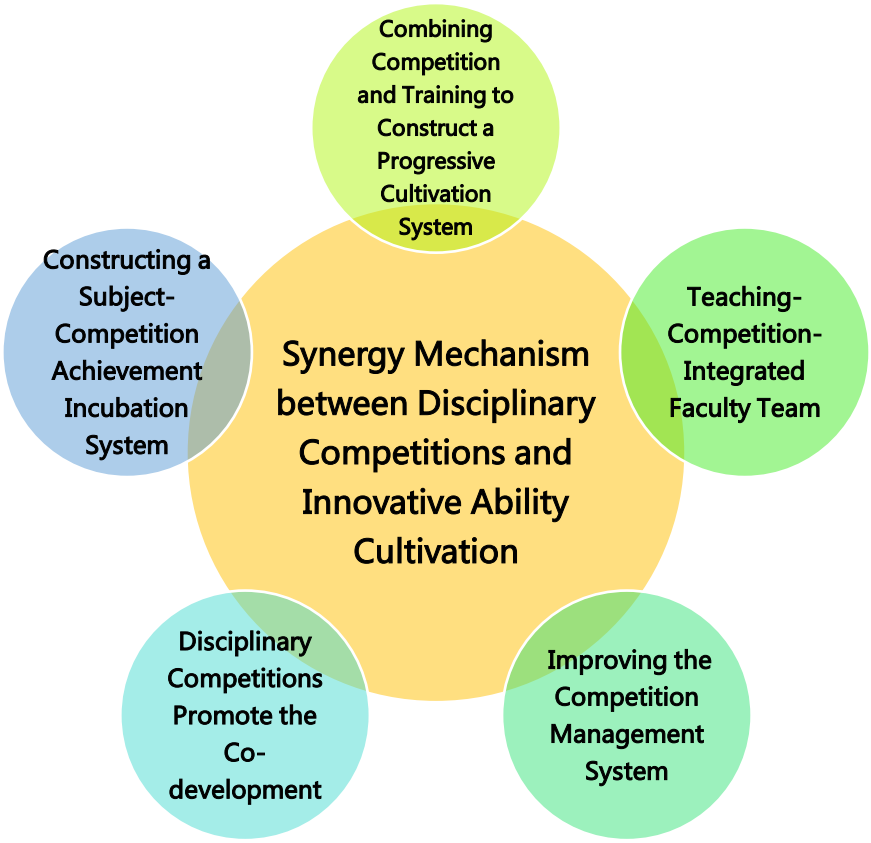

Fig.1 Synergy Mechanism between Disciplinary Competitions and Innovative Ability Cultivation

2.2.Building a Teaching - Competition - Integrated Faculty Team

Strengthen the innovative awareness of the teaching staff in colleges and universities, and construct a three - dimensional guidance system of ‘academic tutors + industrial tutors + competition coaches’. Improve teachers' innovative theories, encourage teachers to lead college students to participate in Disciplinary Competitions, cultivate students' innovative abilities, and accumulate teachers' experience in guiding Disciplinary Competitions. Teachers should deeply understand the production and operation activities of enterprises, as well as the bottlenecks and pain points of the industry during their spare time, so as to have a clear understanding of the relevant industries. Enterprise managers and engineers with rich innovation and entrepreneurship experience are hired as part - time teachers or visiting professors to teach students, opening up a broader vision for students and providing an entry point for innovation education. Through Disciplinary Competitions, the combination of theoretical teaching and innovative practice is realized, and a teaching staff with innovative abilities is built to provide a strong guarantee for innovation - ability education in colleges and universities.

2.3. Disciplinary Competitions Promote the Co-development of Innovative Ability Cultivation and Scientific Research

Disciplinary Competitions are becoming the ‘experimental field’ of scientific research and innovation. In the process of participating in Disciplinary Competitions, most of the college students' entries are derived from the scientific research projects of their instructors or the technical problems urgently needed to be solved by enterprises. During the communication with peers, the instructors continuously adjust and improve their guidance ideas for subject - competition awards, enabling college students to exercise and grow during the competition. With the rapid development of cutting - edge technologies and the shortening of product iteration cycles, the practical content in textbooks seems very outdated. It is an important teaching task to convey cutting - edge scientific and technological knowledge to students. The enthusiasm for improving college students' innovative abilities can be increased by changing teaching methods, such as introducing curriculum design and annual innovation design. By participating in Disciplinary Competitions, students can understand the development of cutting - edge science and technology by consulting scientific and technological papers, providing new inspiration for teachers and promoting the continuous development of scientific research activities.

2.4. Mechanism Innovation: Improving the Competition Management System

A three - level management system of ‘university - college - department’ is established, and the corresponding incentive and guarantee measures for Disciplinary Competitions are improved to provide supporting resources for teachers to guide students to participate in Disciplinary Competitions and enhance teachers' enthusiasm for innovation education. First, improve the operation mechanism of college - level Disciplinary Competitions, explore and improve the subject - competition system of secondary colleges, and create a practical teaching system that can stimulate the innovative abilities of college students. Second, organize college students to participate in Disciplinary Competitions such as the ‘College Students' Innovative Robot Competition’, ‘College Students' Electronic Design Competition’, and ‘College Students' Intelligent Vehicle Competition’ to train students and explore the competition skills of Disciplinary Competitions. By organizing students to participate in Disciplinary Competitions, the innovation points and technical problems solved during the competition are sorted out in the standard form of Disciplinary Competitions. Through the implementation of the competition, a cultivation model for the innovative abilities of college students with the characteristics of application - oriented universities is formed, and an innovative teaching system and a cultivation model for scientific - research and innovative talents are initially established. At the same time, a diversified evaluation system for college students' innovation and a feedback system for college students' innovative learning achievements should be established starting from the goals of subject - competition projects.

2.5. Strengthening Subject Knowledge Education and Constructing a Subject - Competition Achievement Incubation System

The foundation for college students to participate in Disciplinary Competitions is to master professional knowledge. In order to encourage college students to actively participate in Disciplinary Competitions, first, it is necessary to improve college students' mastery of the basic content of the subject and flexibly apply basic knowledge to solve practical problems, so as to improve their innovative abilities. Innovation is not daydreaming; it is a further sublimation of the knowledge system on the basis of fully mastering the relevant knowledge content. The main form of

Disciplinary Competitions is based on basic knowledge. During the subject - competition process, college students are required to strengthen their mastery of basic knowledge, learn to innovate, and solve problems independently without reference, so as to objectively enable college students to have the ability to participate in Disciplinary Competitions. Second, change the traditional model of Disciplinary Competitions and hold novel - content Disciplinary Competitions to attract more college students' attention and encourage more students to participate. Through the competition, college students can not only learn more knowledge but also improve their personal abilities and make new friends during the competition, so as to subjectively make college students hope to participate in Disciplinary Competitions. Third, the students' innovative abilities can be improved by constructing the achievement incubation of Disciplinary Competitions. At present, numerous subject - competition achievements have emerged, but these achievements have not been well utilized, resulting in the inability to continue relevant research. Colleges and universities should increase financial support for Disciplinary Competitions and achieve greater success on the basis of existing achievements. At present, most colleges and universities have college - student entrepreneurship incubation parks. Limited funds are used to support excellent and development - potential competition achievements, and college students are encouraged to continue in the form of ‘seniors leading juniors’, so as to objectively provide college students with the motivation to participate in Disciplinary Competitions.

3. Construction of the Innovative Ability Cultivation Model Driven by Disciplinary Competitions

As shown in the following figure of the innovative - ability cultivation model, the first classroom is centered around professional - theory classroom teaching and is the foundation for cultivating college students' innovative abilities; the second classroom is an extracurricular scientific and technological activity with teacher participation and student - centered, which initially cultivates college students' innovative abilities; the third classroom is off - campus innovation practice (Disciplinary Competitions hosted by functional departments or enterprises), which exercises students' innovative abilities [6]. First, integrate innovative elements and innovative knowledge points into the curriculum system, and carry out inquiry - based classroom teaching and experimental teaching to improve college students' innovative abilities and related knowledge. Second, student management departments of colleges and universities, such as the Communist Youth League committees and student work committees, organize extracurricular scientific and technological activities. At the same time, with the assistance of departments, the Communist Youth League committees, or student associations, scientific and technological innovation competitions, innovation and entrepreneurship achievement exhibitions, and other scientific and technological activities are held to allow college students to carry out innovation activities. Students transform their innovative thinking and innovative concepts into their own skills, academic, and scientific research achievements. Third, connect various Disciplinary Competitions with the third classroom, take Disciplinary Competitions as the starting point, and continuously improve the innovation - cultivation model. At the same time, relying on subject and professional platforms, feed back the achievements and experience obtained in Disciplinary Competitions to teaching, and construct a comprehensive innovation - cultivation system. Efforts should be made to make the first classroom, the second classroom, and the third classroom form a complete system, so as to achieve the best effect in cultivating college students' innovative abilities [7].

The cultivation of application - oriented innovative talents should combine subject - competition - based teaching with subject teaching to promote each other. In the process of participating in professional Disciplinary Competitions, college students actively learn professional knowledge,

actively transform the knowledge into ideas for solving practical problems, and then transform the ideas into practical plans. In the second and third classrooms, the problem - solving plans can also be verified. Therefore, subject - competition - based teaching has great advantages in cultivating college students' innovative abilities. At the same time, strategies for cultivating innovative talents should be explored from multiple aspects such as courses, teaching staff, and Disciplinary Competitions. Industry enterprises should actively participate, enabling students to form teams to solve the problems encountered by enterprises, and training college students' abilities in cooperation, division of labor, close cooperation, and coordinated decision - making. At the same time, school - enterprise cooperation projects should receive strong support from the government and society, providing a broad platform for cultivating innovative talents. In the process of Disciplinary Competitions, students have the opportunity to practice and study in enterprises, or senior engineers from enterprises can enter the campus to provide practical guidance to students, enabling students to gradually improve their innovative abilities in practice, discover and solve problems in practice, understand social needs in a timely manner, and integrate into society quickly after graduation.

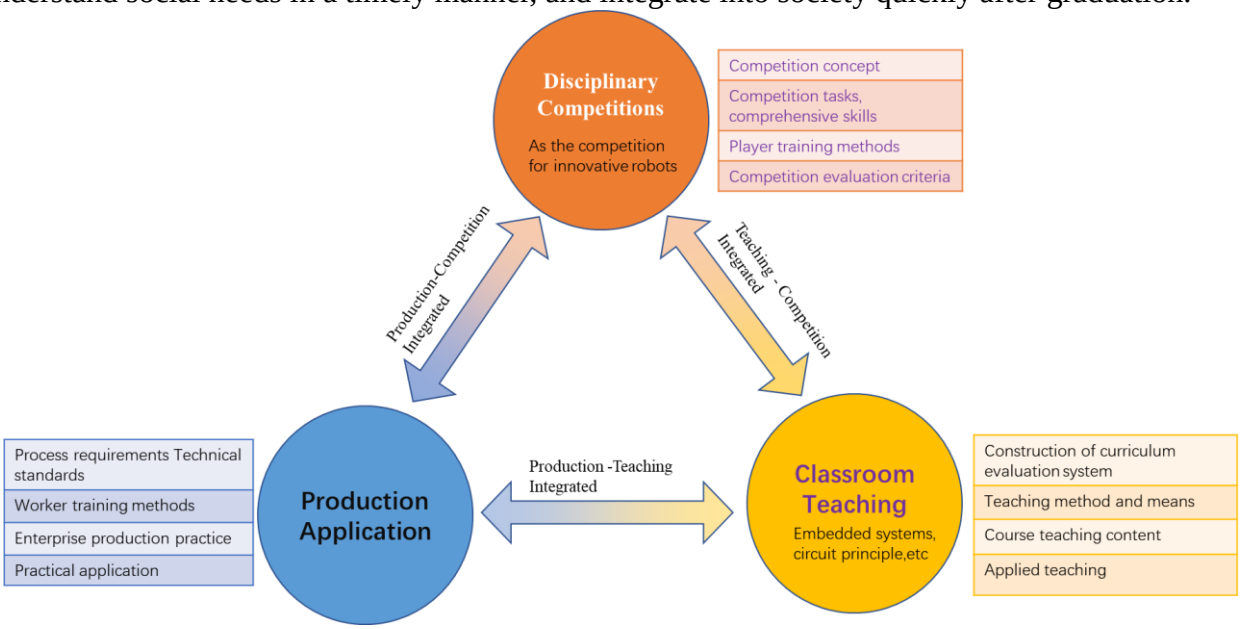

Fig.2 Cultivate students' innovative ability by combining production, competition and teaching

4. Practical Paths of the College Students' Innovative Robot Competition

4.1. Constructing a Matrix - Type Publicity System to Stimulate the Internal Motivation for Participation

Considering the high - level professionalism and remarkable interdisciplinary integration inherent in robot competitions, our school has meticulously constructed a comprehensive three - dimensional publicity matrix, which encompasses the 'online + offline + immersive' approach. Online, we leverage digital platforms like the competition official website and the robot - association WeChat official account. Through these channels, we ensure that competition - related information, including registration details, competition rules, and past achievements, is accurately pushed to the target audience, especially potential participants. Offline, we implement a well - thought - out combined strategy. We organize professor lecture halls where renowned experts explain the latest trends in robotics. Achievement exhibitions showcase past winning robots and their innovative features. Experience workshops offer hands - on opportunities for students.

Moreover, we conduct a robot - competition experience week, specifically designed to pique the interest of freshmen and boost their participation willingness. Additionally, at the end of each autumn semester, our school hosts the 'Robot Open Day' activity. On this day, innovative competition robots, intelligent vehicles used in competitions, and industrial robotic arms are on full display. Freshmen can walk around, observe these high - tech devices closely, and directly experience the allure and excitement of the robot competitions.

4.2.Implementing a Full - Cycle Preparation - for - Competition Guidance Mechanism

We have established a meticulous three - stage guidance system named 'selection - cultivation - optimization' to support students in robot - related competitions. In the initial team - formation stage, students have the freedom to sign up and form teams autonomously. To enhance the competitiveness of the teams, we place great emphasis on optimizing the interdisciplinary nature of team members. For instance, we actively encourage students majoring in mechanical design, automation control, and computer science to collaborate. This diverse combination can bring together different expertise, from mechanical structure design to intelligent control algorithms. During the preparation - for - competition period, we implement the 'dual - tutor system'. Tutors from various disciplines within the school, like mechanical engineering professors and computer science experts, are assigned. One focuses on theoretical guidance, helping students build a solid knowledge base, while the other is responsible for technical breakthroughs. Taking the innovation group and confrontation group projects of the 'Zhejiang Provincial College Students' Robot Competition' as examples, the guidance team conducts systematic training. This includes modeling and simulation to predict the performance of the robots, prototype testing to identify and fix problems, and competition - strategy optimization to ensure the teams can perform their best, thus significantly improving the reliability of the works.

4.3.Innovating the Incentive Mechanism for the Transformation of Competition Achievements

A credit - evaluation and recognition system for Disciplinary Competitions is developed to encourage college students who actively participate in Disciplinary Competitions. Compared with the higher education in Western developed countries, the credit - evaluation and recognition system in domestic colleges and universities has not formed a unified standard. Schools should recognize a certain number of credits according to the level of the Disciplinary Competitions in which college students participate and the award levels they obtain. If conditions permit, these credits can partially replace the credits of courses with similar contents. In the year - end excellence - evaluation and commendation activities, schools should give comprehensive - ability bonus points to college students who win awards in Disciplinary Competitions. In addition, the credit recognition for Disciplinary Competitions should be comprehensive. For college students who participate in Disciplinary Competitions recognized by the school but do not win awards, their efforts in problem - solving, communication, innovation practice, and cooperation and coordination should be fully affirmed. We should not judge success or failure solely by the result. Schools should recognize a small number of credits according to the level of the Disciplinary Competitions in which non - award - winning college students participate, so as to improve the enthusiasm of college students to actively participate in Disciplinary Competitions and stimulate their innovative abilities.

5. Conclusion

Higher education stands as the cornerstone within the national innovation framework, shouldering a crucial strategic responsibility in nurturing innovative talents. In application -

oriented colleges and universities, however, disciplinary competitions currently face several issues. To propel the future development and effective implementation of these competitions in colleges and universities, the following well - considered suggestions are proposed.

Firstly, it's essential to innovate the cultivation model. By introducing novel teaching methods and project - based learning, we can heighten students' eagerness to participate and teachers' enthusiasm for guidance. Secondly, strengthening the teaching staff for disciplinary competitions is vital. Universities should actively recruit and train educators with innovative mindsets to form a high - caliber faculty. Thirdly, promoting the co - development of competitions and scientific research, along with establishing and refining the undergraduate - tutor system, can provide students with more in - depth learning and research opportunities. Fourthly, reforming the management system of disciplinary competitions and constructing a comprehensive cultivation model can streamline operations. Finally, setting up and improving the credit - evaluation and recognition system for college students in these competitions will effectively stimulate their innovative spirit. Through these measures, a closed - loop of innovative - talent cultivation, centered around 'goal - orientation - competition - driving - ability - improvement', will be successfully constructed.

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