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A Survey Study on Subject Competitions to Enhance Students' Innovation Ability in Engineering Practice—N Institute of Technology as an example

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Abstracts: *"Practice" is an essential attribute of engineering education, and practical innovation ability is the core of engineering practice ability. Although the 'scientific paradigm' teaching in colleges and universities and 'emphasizing on theory and light on practice' are constantly improving, students' engineering practice innovation ability is still difficult to meet the requirements of enterprises, especially in the context of new engineering discipline. Although the "scientific paradigm" teaching in colleges and universities, "emphasizing theory and neglecting practice" is constantly improving, it is still difficult for students' engineering practice and innovation ability to meet the requirements of enterprises, especially in the background of new engineering disciplines, accelerating the cultivation of students' engineering practice and innovation ability has become an important direction of development in line with the progress of the times. As a mode of promoting teaching and learning with the goal of enhancing students' practical innovation ability, academic competitions have attracted more and more attention from colleges and universities to the cultivation of college students' engineering practice and innovation ability. This study investigates the factors affecting the engineering practice and innovation ability of students participating in discipline competitions in N Polytechnic, reveals the kernel of influence of discipline competitions on improving students' practical ability, and proposes countermeasures to promote the improvement of practice and innovation ability by incorporating discipline competitions into talent cultivation programs, curricularizing or integrating them into the classroom, assisting students to participate in the competitions, and stimulating students' motivation to innovate.*

Keywords: *Academic competitions; Practical skills; Innovation*

1. Introduction

Colleges and universities take students' development as the center, improve students' engineering practice and innovation ability, and promote students' development to become an important goal of talent training for engineering majors. Although engineering accreditation of China's colleges and universities has been promoted for many years, in the process of engineering accreditation generally feel that the college teaching change to the depth of the classroom, change to the pain is the teacher, but the current lack of freshness in college students in class, or addicted to cell phone games, the Teachers focus on knowledge transfer, light practical application, students think no problem, innovation without goals, how to stimulate the desire to explore. Academic competition is a kind of competition for college students, which is both related to and higher than their majors, which is highly challenging and satisfies students' sense of achievement. It is an effective way to improve students' innovative spirit and practical ability, which can greatly promote students' inner potential and innovative thinking, their teamwork and practical problem solving ability. The author discusses this through personal experience.

2. The basic connotation of engineering practice innovation ability of college students

Engineering practice ability is one of the core abilities of engineering professional talent training, mainly the ability to solve complex problems in engineering practice, while engineering practice innovation ability is the ability to creatively solve complex problems in engineering practice. The

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essence of engineering practice innovation ability is the ability to break except the routine, explore the unknown, and form competitive new products, new processes, new production mode. The ability to apply theoretical knowledge to actual engineering projects, including engineering design, construction organization, equipment operation, quality testing and so on.

The innovation ability of engineering practice includes both the ability to use the basic knowledge learned in the specialty to guide practical activities and the ability to innovate the existing technology and theory in practical activities. [1] It can be seen that engineering practice innovation ability on the one hand refers to the application of theoretical knowledge to practical engineering projects by college students, and on the other hand refers to the ability to solve problems creatively in the process. Engineering practice innovation ability is firstly the practical operation ability, like the skilled use of a variety of engineering tools, instruments and equipment and other operations; secondly, it is the ability of innovative thinking, in the face of engineering problems or optimization of the engineering process, the ability to break out of the routine, put forward novel ideas. It also involves the ability to comprehensively analyze and solve complex engineering problems, and the ability to comprehensively consider the technical, economic, environmental and other factors in the project to find practical solutions. For example, in the development of new energy vehicle engineering, comprehensive consideration of battery technology, power system matching, cost control and other issues.

Innovation is an important way for enterprises to gain competitive advantage, and society and enterprises urgently need universities to cultivate a large number of talents with a good spirit of innovation and excellent engineering practice and innovation ability.In 2016, China formally joined the Washington Agreement, and in 2017, the “Fudan Consensus” was reached, which made the new engineering as a key point of education, and in the same year, the “Tianda Initiative” was launched. In the same year, the “Tianda Action” and “Beijing Guidelines” were formally put forward, which gradually started the reform of China's higher education sector, and cultivated a large number of talents with engineering innovation ability to provide talents for China's major strategic deployment and socialist construction. This is of great importance for college students to better adapt to the society after graduation and give full play to their value in social practice.

3. Intrinsic connection between disciplinary competitions and students' engineering practice and innovation ability

Discipline competitions represented by “Challenge Cup” and “China International Student Innovation Competition” are an important way to carry out innovation and entrepreneurship education reform in China's colleges and universities, and some competitions have already become a global event for college students around the world to realize their dreams of innovation and entrepreneurship. Academic discipline competitions have the functions of driving, pulling and expanding the engineering practice and innovation ability of college students, stimulating the intrinsic motivation for the cultivation of engineering practice and innovation ability, and empowering the direction leading, specialization and creation integration, thinking and creation integration and team cooperation ability cultivation. College students' disciplinary competitions have become an effective way to stimulate students' passion for innovation and train their thinking ability, as well as an important platform for college students to show their innovative creativity and creativity.

For example, the nine tracks of China International Student Innovation Competition (2024), among which the engineering projects of both undergraduate creative group and entrepreneurship group should focus on the innovation and effectiveness of the new engineering discipline, and on the ecological, economic and social benefits, and the four dimensions of education dimension, business dimension, innovation dimension and social value dimension included in its evaluation rules should have practical values and be able to solve the actual needs of the society and market, and produce certain social value. It should be able to address the actual needs of the society and the market, produce a certain quantity and quality of innovative results, and obtain corresponding market returns. It should be able to play a positive role in promoting social civilization, ecological civilization, reputation and welfare. Includes the consideration of all aspects of the engineering practice and innovation ability of the participating teams.

From the judging rules of engineering projects in discipline competitions such as “Challenge Cup” and “China International Innovation Competition for University Students”, we can see that it promotes the engineering practice and innovation ability of university students, which is reflected in the following points:

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3.1 The competition is oriented to emerging industries and future industries reverse drive engineering practice ability enhancement

The propositions of academic competitions are closely related to the needs of the society and oriented to emerging industries and future industries, which, such as artificial intelligence, new energy, biomedicine, etc., often involve cutting-edge technologies and complex engineering problems. Talents with engineering practice innovation ability can break through technical bottlenecks through research and development of new technologies and optimization of engineering processes, prompting emerging industries to move from the conceptual stage to practical application. Engineering practice innovation ability is the key driving force for the development of emerging and future industries. Emerging and future industries bring many new engineering challenges and opportunities, prompting colleges and enterprises to adjust the content and mode of engineering education and training. Actual engineering projects in these industries can enable engineers to get in touch with the latest technologies and concepts, accumulate practical experience, and further exercise and improve their innovation ability, thus promoting the deep integration of digital technology with education, medical care, transportation, finance, consumer life, cultural communication, etc. In-depth integration of digital technology with education, healthcare, transportation, finance, consumer life, cultural communication, etc. The projects should fully reflect the achievements made by the institutions in the “three-in-one” integrated promotion of education, science and technology, and talents, and the solid promotion of the construction of new engineering disciplines, etc. The projects should not only be oriented to leading emerging industries, but also to promoting the development of new industries.

The projects should not only be oriented to lead the emerging industries and future industries, but also take into account the various fields of various disciplines and specialties, so that students from all colleges and universities and all specialties across the country will have the opportunity to participate in the competition. The innovative nature of the competition guides and encourages students to put forward creative and practical application value solutions, and drives students to go beyond the traditional knowledge framework and explore new engineering ideas and methods.

3.2 The competition reflects the level of innovative education in schools

In subject competitions, students need to solve a variety of complex and challenging problems. This prompts them to break through the conventional way of thinking and use innovative thinking to find unique solutions. For example, the mathematical modeling competition requires students to establish mathematical models for practical problems, which requires students to creatively transform practical problems into mathematical language to describe. Subject competitions generally involve the application of interdisciplinary knowledge. Taking the Intelligent Vehicle Competition as an example, it covers multi-disciplinary knowledge such as mechanics, electronics, control, computers, etc. This comprehensiveness prompts students to integrate knowledge from different disciplines for innovation. The atmosphere of the competition will stimulate students' sense of competition, and in order to stand out, they will be more active in tapping their innovative potential. Team members give full play to their own professional advantages, effectively combining professional knowledge with business knowledge to realize accurate promotion and sales of products, focusing on communication and cooperation with enterprises.

Students participate in all kinds of disciplinary competitions, only the school carefully organized, school competitions, the formation of a competitive mechanism, to promote good projects to stand out, and to help students to overcome one problem after another in the process of competition project enhancement, to give students the necessary policies, funds, venues, faculty and other support, and to promote the project through the fusion of industry and education, the fusion of science and education, the intersection of multiple disciplines, the fusion of specialization and creation, and synergy of industry, academia and research to promote the project to continuously go from the theoretical to the practical , to the market. Therefore, the foundation and support of the school's disciplines are the guarantee for the excellent results of the disciplinary competitions, and the overall level of the disciplinary competitions also reflects the strength of the disciplines and the level of innovation and entrepreneurship education from one side.

3.3 The competition focuses on the innovation results reflecting the engineering practice ability

Innovation results are the results with novelty, creativity and practicality produced in the process of engineering practice, engineering practice ability is the prerequisite for producing innovation results,

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and the competitiveness of innovation results reflects the level of innovation ability. For example, in the face of the shortcomings of traditional building structure in seismic performance, through improving the structural design, adopting new seismic materials and so on, innovative results are produced, and the innovative results are also the embodiment and sublimation of engineering practice ability. When the innovation results are achieved, such as a new mechanical manufacturing process patent, it can in turn guide and optimize the engineering practice activities, so that the engineering practice in the efficiency, quality, environmental protection and other dimensions have been improved.

The academic competition focuses on the process of the team from creativity to practice. The team started from market research, gained a deep understanding of the market demand and consumer preference, made a model conception of the project, utilized professional knowledge, carried out in-depth research on the conception, and transformed it into a specific implementation plan, realizing the complete process from creativity to practice. Reflecting the students' use of professional knowledge to solve the needs of society and the market. Through product innovation, process innovation, service innovation, business model innovation and other practices, the team introduced new technologies and new materials to improve the performance and quality of the products, reflecting high-quality innovation results, which were recognized by a number of patents and awards, which not only reflect the team's innovative power.

3.4 Discipline competitions emphasize the innovative synergy of teamwork

Discipline competitions are mostly team competitions, reflecting the overall strength of teamwork, which requires team members to cooperate with each other for the sake of common goals. Discipline competition projects to improve not only solid engineering knowledge as a foundation, but also to use other disciplines, dare to try new ideas and methods, in the process of practice and constantly explore better solutions. This requires a variety of knowledge, a variety of ability to promote, good teamwork is conducive to the generation of innovative ideas and practice, and innovative practice often also requires the joint efforts of team members to complete.

The composition of team members is based on professional knowledge, technical ability and practical experience, to ensure that the team has the ability to support the growth of the project. For example, in the Challenge Cup Entrepreneurial Planning Competition and China International Student Innovation Competition, the team needs to be properly configured, with a clear division of labor, both professional technicians and marketing professionals, and in terms of ability and professional structure, the team focuses on diversity and complementarity to ensure that the team has the ability to solve various complex problems. In terms of the relationship between the team and the project, the team members are full of enthusiasm and commitment to the project, and in the process of implementing the project, the team members maintain close communication, jointly formulate strategic planning and implementation programs, and jointly promote market research, market development and marketing promotion.

In summary, as an essential part of integrating in-class teaching and extracurricular internship, college students' disciplinary competitions can continuously stimulate students' curiosity, which is very helpful for cultivating their innovative spirit, cooperative spirit, ability to deal with urgent problems and practical hands-on ability. [2] College students participate in discipline competitions, in which they learn how to analyze problems, think from many aspects, and design a new way to solve problems rationally and efficiently with a novel perspective, in the process, cultivating students' innovative thinking and practical ability. [3] Universities should incorporate the factor of disciplinary competitions into their teaching, so that the professional knowledge taught and real life are closely integrated, so that college students can become more active in their thinking, which can provide them with learning opportunities. It can also give them a desire for self-expression and a sense of self-identification, which can stimulate their enthusiasm for the study of specialized knowledge [4].

4. Design and Investigation of Factors of Discipline Competition in N Polytechnics

N Polytechnic is a full-time private undergraduate college approved by the Ministry of Education of the People's Republic of China, founded in 2000, with 14 secondary colleges and 52 undergraduate majors. Adhering to the “student-centered” philosophy of education, the university takes “establishing first-class character, learning first-class skills, creating first-class career” as the goal of education, and pays attention to promoting learning and teaching by competitions, and makes it clear that each student must complete 4 credits of disciplinary competitions and 4 credits of innovation and entrepreneurship

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practice in the talent cultivation program. credits and 4 credits of innovation and entrepreneurship practice, each college has a disciplinary competition leading group and disciplinary competition liaison person, regularly liaising and organizing school disciplinary competitions, since 2019, students have participated in municipal and above disciplinary competitions and won more than 7,500 awards, and are located in 204th place in 2023 in the national college student competitions of 1,218 general undergraduate colleges and universities, which is 88th place higher than the 2022 ranking. Meanwhile, for the first time, it entered the “2019-2023 National Private College Student Competition List (TOP20)” and “2019-2023 National New Undergraduate College Student Competition List (TOP100)”, ranking 17th and 61st respectively.

In order to enable each student to achieve the improvement of innovation and entrepreneurship in subject competitions, and to enhance the sense of acquisition and achievement in competitions, N Polytechnic 2024 has curricularized the contents of competitions, and opened an innovation experimental class, which is enrolled in the whole university, and concentrates the students with similar interests in an innovation experimental class, which not only improves the students' innovation ability in engineering practice and stimulates their interest in learning, but also provides a good opportunity for them to take part in the competitions of the provincial, municipal and above competitions in the future. This not only improves the students' engineering practice and innovation ability and stimulates their learning interest, but also lays a good foundation for them to participate in provincial, municipal and above competitions. At the same time, according to the actual situation of the local community, we also increase the cooperation with local enterprises, and transform the results of academic competitions. The themes of many academic competitions are closely related to real life, and most of the research content is at the forefront of academic disciplines or industries, which not only realizes the integration of industry and education, science and education and better serves the local economy, but also allows students to get more employment and entrepreneurship opportunities, giving them a sense of achievement. that gives them a sense of achievement.

The innovation ability of engineering practice includes both the ability to apply multidisciplinary knowledge, the ability to analyze as well as solve problems under multiple constraints, the ability to design solutions, the ability to use modern tools, etc., as well as the social ability such as communication and cooperation in multidisciplinary teams. [5] This paper draws on the questionnaire prepared by Jingjing Lu of Ningbo University and combines it with the characteristics of engineering practice to prepare a questionnaire entitled “The Influence of Discipline Competition on Enhancing the Innovative Ability of Engineering Practice of Students in N Polytechnic Institute”, which detects the students' ability to engage in engineering practice in the following five dimensions: the first dimension is the power of thinking; the second is the ability of design; the third is the ability of practical operation; the fourth is the ability of teamwork ; and the fifth dimension is creativity. Secondly, six factors were selected as the discipline competition factors affecting college students' engineering practice innovation ability, which are (1) diversity of knowledge structure (2) close connection with real life (3) teamwork (4) experimental operation (5) guidance from professional teachers (6) defense and reporting. The questionnaire surveyed 3296 undergraduate students of N Polytechnic through both online and offline methods.

5. Analysis of findings

5.1 Analysis of Participating Students' Motivation

The results of the questionnaire show that the number of students who participated in subject competitions for the purpose of improving their abilities was 1,944, accounting for 58.98%; the number of students who participated for the purpose of increasing their knowledge was 593, accounting for 17.99%; the number of students who participated for the purpose of obtaining prizes was 529, accounting for 16.05%; and the number of students who participated for the purpose of their hobbies was 230, accounting for 6.98%. From this, it can be seen that most of the students who participated in the subject competitions wanted to improve their various abilities, some of them did so to achieve a sense of accomplishment, and a few of them went to the competitions out of their own interests. From this it is clear that students generally believe that participation in subject competitions improves their abilities.

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5.2 Overall analysis of participating students' engineering practice innovation ability

The engineering practice innovation ability of the participating students is divided into five aspects, each ability corresponds to 3-4 questions, and the options of "not at all in line with", "relatively not in line with", "general", "relatively in line with" and "completely in line with" are assigned as continuous variables, respectively 1, 2, 3, 4, 5, "Comparatively conform", 'Completely conform', 'Completely conform' options as continuous variables, respectively assigned the value of 1, 2, 3, 4, 5. According to the question items, the overall competence and the average score of the different dimensions of competence are calculated, where the larger the score is, the higher the competence is.

The results of the study show that the total average score of engineering practice innovation ability of college students participating in disciplinary competitions is 4.09, which belongs to the category of "relatively conforming" to "fully conforming", and tends to "relatively conforming". "This indicates that the comprehensive quality of the participating students is basically at the level of "high". The five competencies, in descending order, are "teamwork ability", "practical ability", "thinking ability", "design ability", "creativity", and "creativity". "Thinking", 'Designing', 'Creativity'. Among them, the discrete degree of practical ability is the lowest, only 0.49, which indicates that the difference in the level of practical ability of the students participating in the competition is relatively small, while the discrete degree of design ability is the largest, with 0.69, which indicates that the level of design ability of the students is the most different from each other. Overall, students' self-perception of creativity is the lowest, followed by design ability and thinking ability, which also indicates on another level that the existing innovation and entrepreneurship competitions require high levels of innovation and design ability.

5.3 Students' Perception of the Importance of Different Factors for Innovation Competence in Engineering Practice

The importance of different factors for innovation competence in engineering practice was assigned values. "not important", 'not very important', 'average', 'more important' and 'very important' were assigned 1-5 respectively, "very important" were assigned as 1-5 respectively.

In descending order of importance, they are: "connection with real life", "diversity of knowledge structure", "defense and presentation", "guidance from professional teachers", "cooperation among teams", and "design and operation of experiments"; the highest average score is "design and operation of experiments". Teacher's guidance", 'Teamwork', 'Design and operation of experiments'; the highest mean score was for 'Design and operation of experiments', and the highest mean score for 'Teamwork' was for 'Design and operation of experiments', and the highest mean score was for 'Design and operation of experiments'. The highest mean score was for "experiment design and operation", followed by "cooperation among teams". However, the standard deviation of "cooperation between teams" is 0.56, with a high degree of dispersion, while the standard deviation of "design and operation of experiments" is 0.52, with a low degree of dispersion. This indicates that the opinions of those who think that the factor of "teamwork" is more important or even very important are not concentrated, while the opinions of those who think that the factor of "design and operation of experiments" is more important or even very important are more concentrated. The link with real life was considered to have the least impact on the ability to practice engineering, which is a design ability, indicating that students do not realize the importance of the ability to link with real life in the design ability.

5.4 Findings

From the results of the survey, firstly, students recognized the point that "participating in academic competitions can improve their ability" to a high degree. Secondly, most of the students think that they can improve their practical ability and innovation ability through academic competitions. Thirdly, students have a high degree of recognition that "every part of the competition can influence the practical and innovative ability of engineering". Fourthly, after participating in the competition, the students' ability indexes in all aspects are above average, and most of them are between good and good.

Through the survey, it was also found that students want to achieve good results in the academic competitions and have more sense of acquisition and achievement, and the participating students subjectively feel that they have insufficient motivation and interest, and their creativity has the lowest self-perception, and they don't realize the importance of the ability to combine the design with the real-life practice.

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6. Suggestions for giving full play to discipline competitions to promote students' engineering practice innovation ability

Through the study, it is concluded that disciplinary competitions have significant improvement on practical operation ability and teamwork ability of college students' engineering practice innovation ability, but how to give full play to the incentive role of disciplinary competitions, mobilize the enthusiasm of students to participate in the competitions, enhance creativity and pay more attention to the real life in the design, which has become the key to promote the teaching and learning by the competition, and to promote the enhancement of the engineering practice innovation ability by the competition.

6.1 Fully recognize the competition results to enhance students' sense of achievement

While encouraging college students to participate in disciplinary competitions, the university gives certain bonuses and financial support to the winning projects, especially for the achievement of national awards such as the national gold medal or the first prize to give incentives in terms of academic enhancement, recognition of credits, as well as recognition and so on. Set appropriate goals during the competition process. Such as school-level selection, provincial selection and other challenging events, which must be achieved step by step through efforts, so that students step by step efforts and success to experience the sense of achievement and sense of accomplishment of constantly innovating and challenging themselves.

6.2 Incorporate disciplinary competitions into talent training programs

Talent cultivation program is the foundation and important basis for universities to cultivate students, and set cultivation goals for college students in the school learning stage, so as to cultivate students purposefully. Schools can take the discipline competition as a mandatory content in the student training program, students through participation in the discipline competition to achieve certain innovation and practice results, according to the credit standard of the relevant content of the student training program, the innovation and practice results achieved by the students through the school's assessment into the corresponding innovation credits, so as to make the discipline competition to become a normalized education in colleges and universities to cultivate students' engineering practice and innovation ability.

6.3 Curricularization of discipline competitions to improve innovation ability

Discipline competitions, including mathematical modeling, robot design, mechanical design and other competitions, pay great attention to students' innovation ability, and many judging rules are to consider the students' ability to solve a specific problem. Some colleges and universities have curricularized discipline competitions, such as N Polytechnic Institute to open innovation experimental classes to cultivate students' practical and innovative ability, combining theoretical knowledge with practical problems, which exercises students' ability to flexibly apply knowledge, extends students' ideas and thinking, and improves students' innovation ability. , which extends the students' thinking and thinking mode.

6.4 Promote project-based teaching to enhance students' comprehensive ability

Through project teaching, the projects in the front line of enterprises are integrated into school teaching, through the step-by-step design of real scene projects, in the process of optimal design, fully consider enough to take into account the impact of engineering solutions in the global, economic, environmental and social, to increase the sense of social responsibility and a sense of mission, and to be mindful of other people and the society, in order to be able to fully understand the needs of the product and to enhance the ability of combining with the actual life in the design.

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