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Student-centred, Outcome-based and Competition-driven Course Design for Innovation and Entrepreneurship Training

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Abstract: *In the age of information technology, high and new technology has become the core driving force of social development. This new trend requires universities and colleges to continuously increase the training of technological innovation and entrepreneurship engineering talents. In this paper, an innovation and entrepreneurship training course is innovatively designed. Based on the idea of outcome-based education, the teaching objectives of innovation and entrepreneurship are first designed. The teaching contents, teaching process and teaching evaluation methods are reversely designed based on the teaching objectives. In teaching methods and management, it reconstructs teaching ideas and pays attention to the student-centred teaching and learning, giving full play to the leading role of teachers and the principal role of students. Discipline competitions run through the whole process of course teaching. Driven by actual competitions, it uses subject contests to promote course learning and teaching, and help train engineering talents with innovative spirit and entrepreneurial spirit.*

Keywords: *Innovation and Entrepreneurship Education, Course Design, Discipline Competition, Cultivation of Innovative Talents.*

1. Introduction

The ability and level of engineering talents have great and far-reaching influence on national economic competitiveness and industrial dominance. With the rapid development of information technology, the teaching of colleges and universities urgently needs to keep up with the development of the industry. Colleges and universities need to carry out teaching reform to enhance the engineering and technological level as well as innovation and entrepreneurship ability of students, so as to cultivate high-level innovation and entrepreneurship talents to meet the needs of the new generation of information technology development. Teaching reform is also an effective way to promote high-quality employment and entrepreneurship of college students [1].

Innovation and entrepreneurship education has the advantage of interdisciplinary talent training. Through interdisciplinary integration, it can improve students' learning ability of interdisciplinary knowledge integration, scientific research innovation quality and the ability to solve complex engineering. It is helpful to cultivate compound innovative and entrepreneurial engineering talents [2]. More and more colleges and universities are establishing learning environments for entrepreneurship education to promote the development of engineering students' innovation and entrepreneurial skills. These include courses focusing on innovation and entrepreneurship, engineering core courses with elements of entrepreneurship, establishment of technology entrepreneurship centers, development of engineering projects incorporating entrepreneurship and innovation, and provision of business incubators [3].

In recent years, discipline competitions have gradually become one of the important platforms for extracurricular innovation and entrepreneurship training. Most of the competitions adopt the operation mode of "teacher-guided, student-dominated and research project-led". Students are encouraged to set up research teams to undertake research projects of enterprises and society and solve practical problems through independent research projects. One of the main purposes of discipline competitions is to facilitate the training of innovative talents. It can stimulate students' innovation ability, enable students to directly contact the actual needs of enterprises and the forefront of technology, and apply the theoretical knowledge to solve practical problems [4]. More and more competitions are organized and more and

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more teachers and students take part in them. Since 2019, the China Association for Higher Education has published the ranking list of undergraduate competitions in regular colleges and universities every year, to continuously standardize discipline competitions and improve the quality of competition projects.

This paper innovatively moves the discipline competition from extracurricular training to classroom. A competition-driven innovation and entrepreneurship training course is designed based on the ideas of student-centred and engineering education certification. The aim is to promote learning by competition, promote education by competition, and help to cultivate innovative engineering technology talents.

2. Student-centred, Outcome-based and Competition-driven Course Design

To give full play to the role of subject competition in students' innovation practice, we develop the course of innovation and entrepreneurship competition training camp. Taking the curriculum program of computer science and technology major of Beijing Institute of Petrochemical Technology as an example, this course is a major limited elective course, with 2 credits and 32 class hours. As shown in Figure 1, the course is designed based three aspects: the overall design based on the idea of outcome-based education, teaching process management based on competition activities, and student-centred teaching activities. Detailed designs and descriptions are shown in the following sub sections.

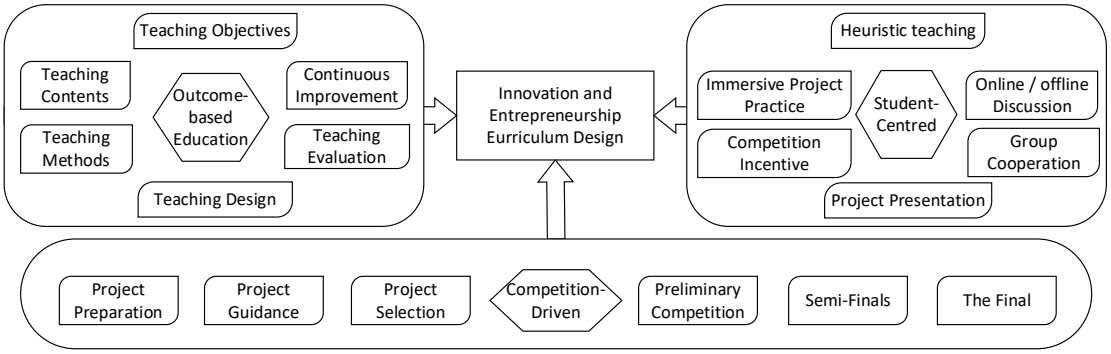

Figure 1: Tripartite driven innovation and entrepreneurship training course design.

2.1. Overall Design based on the idea of Outcome-Based Education

Outcome-based education (OBE) means clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences [5]. It has become one of the most important trends in engineering education in the last 20 years. The core of OBE lies in that the goal of teaching design and teaching implementation, is the final learning achievement of students through the educational process. OBE emphasizes four questions:

- what are the learning outcomes we want students to achieve?
- Why should students achieve such learning results?
- How to effectively help students achieve these learning outcomes?
- How do you know that students have achieved these learning results?

Based on the above ideas, we design the course according to the following overall scheme, shown in Figure 2. Details are given in the following sub sections.

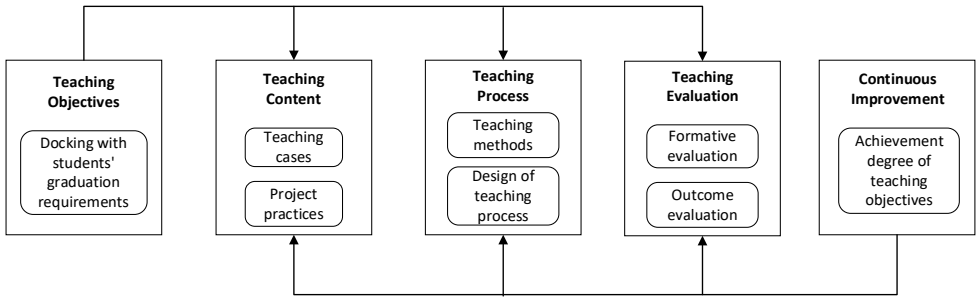

Figure 2: Overall course design based on OBE.

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2.1.1. Teaching Objectives

Under the teaching ideas of OBE, the graduation requirements undertaken by the course determines its teaching objectives. From the perspective of competition driven, three teaching objectives are designed by combing the innovation education function and the students' graduation requirements. The relationship between course objectives and graduation requirements is shown in Table 1.

- **Objective 1:** able to complete engineering project and simulation analysis, while deepening the understanding of innovative thinking and business model methodology.

- **Objective 2:** able to carry out multidisciplinary team cooperation in projects, based on practical application scenarios such as innovation and entrepreneurship competitions

- **Objective 3:** able to carry out project design, planning, presentation and other work, based on engineering competition or application background.

Table 1: The relationship between course objectives and graduation requirements.

Graduation requirement	Detail requirement index point	Teaching objective
4. Research	4.3 be able to analyze and interpret data and obtain reasonable and effective conclusions through information synthesis.	Objective 1
9. Individuals and Teams	9.1 have teamwork spirits and be able to work in a team in a multidisciplinary context.	Objective 2
11. Project management	11.2 be able to carry out real engineering project management activities in a multidisciplinary environment.	Objective 3

2.1.2. Teaching Contents

Design teaching contents according to teaching objectives. The training camp course mainly includes theoretical teaching and practical teaching.

- **Theoretical teaching:** This aims to make students fully understand discipline competitions, learn to write project plan and presentation slides through class explanation. Moreover, let the students understand their own shortcomings and optimize them, by learning the advantages of excellent competition cases. Teaching cases can be found from competition works that won the championship in previous years.

- **Practical teaching:** This mainly completes the guidance of competition projects, including the whole process of project design, implementation, optimization and presentation. Students' comprehensive ability of interdisciplinary engineering practice is cultivated through design project report review, project defense and other contents.

2.1.3. Teaching Process Design

Based on the teaching contents, it is very important to use appropriate teaching methods for teaching design. Hybrid teaching is a kind of "online" + "offline" teaching that combines the advantages of online teaching and traditional teaching. For the competition-driven course teaching, we can adopt the online and offline mixed teaching mode based on the competition project. For example, we can use the Internet, Big Data, MOOC and other educational carriers and platforms to introduce scenario-based teaching, case-based teaching, task-driven and outcome-based teaching methods.

The teaching of competition projects is designed based on the ideas of CDIO [6] engineering education. Take a visualization project from a big data application competition as an example. Table 2 gives the teaching design of the "Beijing air quality analysis" project.

Table 2: Designing ideas of competition project driven teaching based on CDIO mode.

CDIO Mode	Student activities (dominated)	Teacher activities (guided)
Conceive	Analyze project requirements, factors affecting air quality, data sources and characteristics, and tool selection	guide
Design	Program design and draw flow chart, including crawler program, data processing, data analysis, data visualization, etc.	guide
Implement	Coding, debugging, optimizing visualizations	guide
Operate	Write analysis report and finish project presentation.	evaluate

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2.1.4. Teaching Evaluation

Based on the ideas of OBE, the teaching evaluation is designed according to the teaching objectives. Specifically, the evaluation methods include usual performance, presentation, project report and competition results. They connect teaching objectives, teaching process, assessment methods and achievement evaluation.

2.1.5. Continuous Improvement

At the end of each round of courses, it is necessary to summarize the courses according to the achievement evaluation, teachers' self-evaluation, students' evaluation, as well as the teaching and assessment of the courses. Describe the content and effect of continuous improvement of the course, and point out the improvement ideas in the future.

2.2. Student-centred Course Activity Design

Student-centred [7,8] view of learning and teaching includes that knowledge is constructed by students and that the lecturer is a facilitator of learning. With discipline competition as the driving force, all activities of the course focus on guiding students to complete the competition project and strive for winning. During the whole progress of discipline competition, classroom is no longer a direct knowledge infusion, but a joint creative practice between students and teachers.

The student-centred course scheme is shown in Figure 3. Firstly, through online learning channels such as MOOC and Mosoink WebSite[1], we provide students with a variety of competition resources. We use online teaching platform to organize course teaching, including releasing resources, assigning classroom activities, submitting project work and student evaluation, etc. Students can interact with teachers and ask questions through online learning platform. Secondly, the whole theoretical teaching is carried out around the discipline competition, with teachers responsible for the competition guidance. Students have full autonomy to choose the competition, propose projects and select the technology according to their own majors and interests. Thirdly, in the competition practice, 3-5 students form groups freely, and several teachers are arranged to guide 3-5 groups of students according to their majors and research fields. The emphasis is to promote students' autonomous learning with projects, stimulate students' innovative spirit and promote their engineering technology level. Finally, by establishing QQ and WeChat learning groups, it is convenient for teachers to communicate with students in real time after class, understand students' dynamics, answer questions and discuss. The connection between teachers and students after class is also helpful for students' personalized guidance.

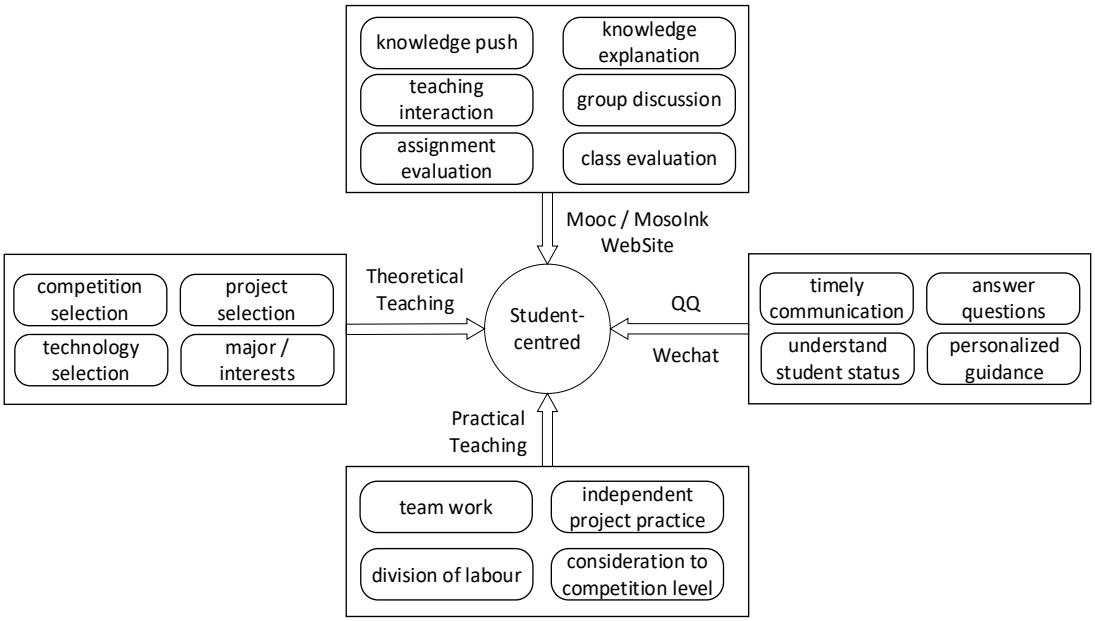

Figure 3. Student-centred Course Activity Design

[1] Mosoink is one of the famous online teaching platforms in China. https://www.mosoteach.cn/

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2.3. Competition-driven Course Process Design

The competition driven innovation and entrepreneurship talent training model aims at the close combination of classroom teaching and information technology. It can expand the theoretical teaching content through competition and stimulate students' learning enthusiasm. It emphasizes cultivating students' ability of comprehensive application of knowledge and unity and cooperation, to promote the formation of students' innovative spirit and entrepreneurial ability [9].

For seamlessly linking the course with practical discipline competitions, we design the whole process of course teaching based on one target competition. We complete the training course mainly by the target competition, supplemented by other competitions. The overall course design is shown in Figure 4.

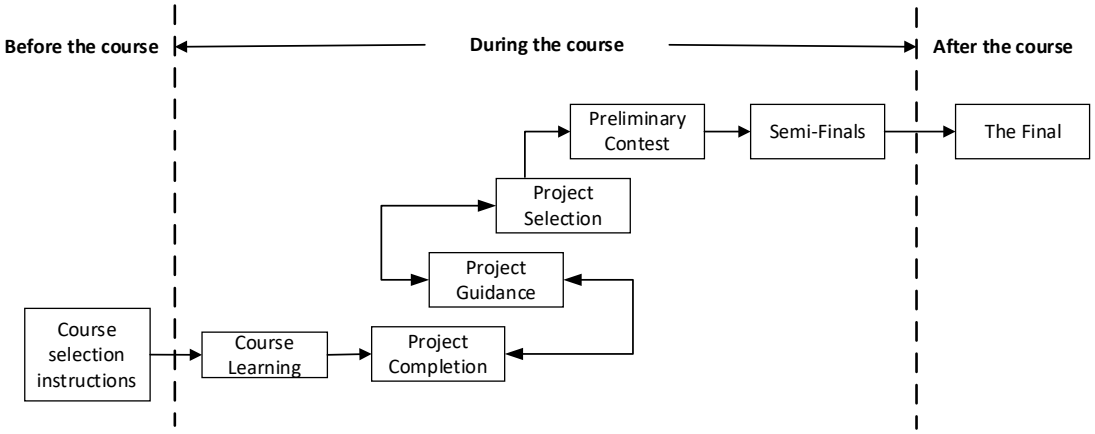

Figure 4. Competition-driven Course Process Design

The whole process of this course is divided into three parts: before the course, during the course and after the course.

▪ **Before the course:** Driven by discipline competition, this course requires students to prepare competition projects in advance according to previous practical experience and learning interest. Therefore, it is necessary to do course selection instructions before the course, to clarify the requirements and assessment criteria of the course in advance, and leave enough time for students to prepare for the project.

▪ **During the course:** During the course, teachers guide students to carry out targeted learning, the students complete projects independently, and teachers direct the whole competition process. In the form of preliminary contest at the school level, we organize students to finish the defense, and select outstanding projects to participate in the semi-final at provincial and ministerial level. Since the competition cycle lags the course grade assessment, we only record the results of the semi-finals. Course scores may also be added if other competitions are won during this period.

▪ **After the course:** During this period, the enthusiasm of students and teachers are fully mobilized. Students and teachers have a common goal —— competition award, which has a positive role in promoting both teaching and learning.

3. Conclusions

Based on the actual needs of new engineering talent training, this paper has constructed a student-centred, outcome-based and competition-driven training course to promote the cultivation of innovative and entrepreneurial talents. This paper provides a new idea for the transformation from competition training to curriculum. It transforms the competition training with high relevance to students' professional learning and relatively perfect content into innovation and entrepreneurship course. In this way, the competition management will be standardized and large-scaled. It is conducive to promoting students' participation in competition, strengthening teachers' guidance and promoting the output of competition results. It is also a beneficial exploration for boosting the reform of innovative talent training mode in higher education and the operation mechanism of innovative talent training.

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