# Research on Engineering Ethics Education in China's Science and Engineering Universities

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**Abstract:** With the rapid development of the times and the advancement of technology, China is moving from a major country to a powerhouse in engineering education. But engineering projects and practical activities are becoming increasingly complex. Engineers who act as the closely related community of responsibility are faced with difficulties in coordinating conflicts of interest and making ethical decisions in engineering practice. Universities of Science and Technology play the pivotal role of cultivating innovative engineering talents and shoulder the mission of innovating China's engineering ethics education, unleashing the value of engineers. Since the 1970s, engineering ethics education has emerged in developed countries abroad and has been officially established as a discipline for cultivating engineering and technical talents. The new engineering and engineering ethics education which emerged in recent years has also been extended from individual universities to science and engineering universities. However, China is currently in the initial and exploratory stage. The forms and implementation effects of engineering ethics education in science and engineering universities, a series of difficult problems such as existing problems have not yet been clearly answered by scholars.

This study analyzed two excellent cases: Beijing Institute of Technology and Dalian University of Technology and summarized the successful experiences of two universities in engineering ethics teaching and practice. However, the data in our country is limited. The author conducted an empirical survey based on E University by searching for appearances that could not represent the overall problem. To change the situation of science and engineering universities in China, a questionnaire was distributed to 369 students majoring in science and engineering at different stages, and 338 copies were effectively collected. It was found that the university lack of systematic support and external teaching staff. The teaching method of the course is single and the cases are outdated. Suggestions for improvement were proposed at the four levels of universities, universities clarify training objectives and improve the comprehensive construction of courses, strengthen cooperation and exchange with the outside world to improve their teaching staff; teachers update teaching concepts and improve teaching methods; government establishes an incentive mechanism for engineering ethical behavior.

**Keywords:** University of Science and Technology; Engineering ethics education; Problem; Countermeasure

## 1.The Background of Strengthening Engineering Ethics Education

In the wave of the knowledge economy era, the quality of innovative engineering and technology talents represents the comprehensive strength of the country. Although China currently has the largest higher engineering education system, the total number of students and graduates in engineering majors in science and engineering universities has exceeded one-third of the total number of general higher education in the country. Compared with developed countries, the number of engineering graduates in China is also dozens of times higher. However, the so-called "strong" not only means an advantage in quantity, but also requires an increase in value [1]. China's engineering ethics education started relatively later. The "Engineering Ethics Research" conducted by Southwest Jiaotong University in 1998 represented the first attention paid by Chinese universities to engineering ethics, and the research results were ultimately transformed into China's first engineering ethics characteristic textbook. The official birth mark can be traced back to 2000, when various universities established elective courses. In 2007, Zhejiang University, a science and engineering university in China, held the first conference on engineering ethics. Experts and scholars from multiple universities, including Southwest Jiaotong University and Dalian University of Technology, participated in the conference and provided prospects for China's engineering ethics industry, such as building a curriculum system, improving status, and integrating with engineering education.

At present, the overall quality of engineering activity teams in our country is difficult to ensure, and engineers who enter society have not fully realized their true value, and their role in enterprises is not prominent. Engineering students from science and engineering universities, as potential targets for engineers, are closely related to the prosperity and future development of the country. They play an important role in the process of national engineering education moving towards practice and engineering technology transforming towards innovation. To achieve the transformation of engineering education, it is necessary to break the phenomenon of "engineering only", break down the barriers between humanities and social sciences and science and technology, and cultivate innovative and composite engineers who can adapt to practical needs. In 2016, China became a formal signatory to the Washington Accord and the solid promotion of the New Engineering Project provided an important opportunity for China to move towards becoming a strong engineering education country [2]. The Washington Accord

requires engineering students to have the ability to correctly apply ethical principles, abide by professional ethics, and assume social responsibility in engineering [3]. They should refer to current international engineering education standards (such as the Washington Accord, Sydney Accord, Dublin Accord, etc.) to improve the quality of engineering talent in China. In the context of new engineering disciplines and the new era, the standards for engineering ethics education and engineers in science and engineering colleges are gradually being raised to composite talents with various qualities such as patriotism, innovation and critical thinking, global perspective, and sustainable development concepts [4].

Chinese scholars have consciously explored engineering ethics education in depth since the official document in 2018: "Cultivating engineering professional master's degrees" has become a focus of attention for various universities, and engineering ethics courses have been listed as mandatory courses for engineering professional master's degrees. At present, engineering ethics education is extending from individual universities to science and engineering universities, and its importance and necessity are self-evident, objectively determining the cultivation of engineering and technology talents. Exploring how to promote engineering ethics education in China, creating a positive and favorable teaching environment, improving the engineering ethics education system, and cultivating outstanding engineers who possess both professional ethics knowledge learning and ethical responsibility and behavior, based on the actual situation in our country, is an urgent problem that needs to be solved in the field of engineering in China.

## 2.The Representative Cases in China

In order to comprehensively understand the forms and existing problems of engineering ethics education, this study starts from two science and engineering universities in China——Beijing Institute of Technology and Dalian University of Technology, which successfully carried out implementation of engineering ethics education to draws on beneficial experiences.

Beijing Institute of Technology attaches great importance to the reform of the theory and teaching practice system of engineering ethics. Initially, it focused on teaching engineering ethics to undergraduate students, offering elective courses related to science and engineering ethics. In 2013, it also offered compulsory courses on science and engineering ethics, making it the first university in China to offer engineering ethics courses.

The engineering ethics education at Dalian University of Technology started early. It cultivates students' awareness in humanities, economic accounting, environmental protection, and ethics through the infiltration of engineering and culture. At the National Symposium on Engineering Ethics Teaching and Research, Professor Wang Guoyu from Dalian University of Technology pointed out the relationship between engineering, ethics, and engineers, emphasizing key principles such as fairness and justice in engineering, and made prospects for the future development of engineering ethics education in our university [5].

### 2.1 The Training Goal

#### 2.1.1 Beijing Institute of Technology: Goal of 'Awareness-Knowledge and Criteria-Innovation and Decision Making'

The articles of association in Beijing Institute of Technology clearly state that high-quality engineering talents should be cultivated with a sense of social responsibility, mastery of engineering professional norms and ethical norms, the spirit of engineering innovation, and the ability to make correct ethical decisions. It is committed to building a unique engineering ethics teaching system with the characteristics and brand of Beijing Institute of Technology. It requires science and engineering talents not only to have specialized knowledge and technical abilities in the engineering profession, but also to be able to flexibly handle future engineering practice project problems based on a series of quality foundations such as honesty, trustworthiness, pragmatism, scientific rigor, and compliance with laws and regulations. Then they can make correct and firm ethical decisions when faced with ethical challenges in engineering [6].

At present, various industries are faced with great competition pressure of creating new projects and using new technologies have become the requirements of the times. In order to adapt to the needs of national economic and social development, the cultivation of applied and composite high-level engineering technology and management talents with innovative ability, engineering decision-making and practical ability are considered as a basic requirement to meet the needs of national economic and social development.

#### 2.1.2 Dalian University of Technology: Goal of 'Knowledge-Consciousness-Ability'

Dalian University of Technology not only requires students to master basic professional theoretical knowledge, but also to possess basic ethical qualities: sound personal qualities and humanistic qualities, a sense of social responsibility and professional ethics, engineering

innovation and practical abilities and the ability to flexibly handle difficult decision-making problems in engineering activities. In the University's training objectives, it is explicitly stipulated that students majoring in science and engineering not only need to master scientific knowledge such as mathematics and chemistry, as well as basic engineering techniques, but also need to understand the development trends of modern engineering [7]. To ensure that they have moral integrity and a sense of responsibility in their future careers, and can consciously protect the environment and achieve sustainable development while considering economic and social benefits. The University also provides technical ethics and personal value orientation education to engineering students, requiring future engineers to be research-oriented and innovative engineering and technical talents who possess both basic theoretical knowledge of engineering and engineering ethics, humanistic ethics spirit, and professional ethics of engineers. They should assume a sense of social responsibility in response to major national and industry needs, and make correct ethical decisions in the face of difficulties in engineering practice.

Table 2-1 The comparisons of the two universities' training goal of engineering ethics education

| | **Beijing Institute of Technology** | **Dalian University of Technology** |
|---|---|---|
| **Training Goal** | Awareness | Knowledge |
| | Knowledge | Consciousness |
| | Criteria-Innovation | Ability |
| | Decision Making | |
| **Common advantages** | Meeting the needs of national economic and social development | |

## 2.2 Teaching Forms: Theory Combined with Practice

### 2.2.1 Beijing Institute of Technology

#### 2.2.1.1 Theoretical courses: Compulsory Courses and Elective Courses

The "Engineering Ethics" course at Beijing Institute of Technology is a 16 hour, 1 credit public compulsory course aimed at enhancing students' awareness of engineering ethics, enabling them to apply the basic norms of engineering ethics they have mastered to solve problems in engineering practice, and make correct engineering ethics decisions. The

theoretical knowledge of the course contains concepts related to engineering and ethics, principles for dealing with ethical problems, and analysis of responsibility ethics, fair distribution of interests, and environmental ethics to explore common problems in engineering practice.

The interdisciplinary course of "Engineering Ethics" is combined with ideological and political education, and has been selected as a “National Course Ideological and Political Demonstration Course”. The ideological and political education in the course of Engineering Ethics mainly focuses on ecological teaching. Under the concept of innovation, coordination, green, openness, and sharing, innovative engineering education is combined with ethical education to form a unique “ideological and political integration” engineering ethics teaching strategy.

In addition, the elective course “Engineering Ethics and Comprehensive Quality” offered by Beijing Institute of Technology aims to build a new ecosystem for the coordinated cultivation of engineering thinking ability and innovation ability, form a diversified training system, and cultivate high-level engineering talents with strong engineering ethics knowledge and innovative practical ability. The main content is divided into three modules: “Engineering Ethics”, “Information Retrieval and Technology Writing”, and “Psychological Health”. Each module is independent of each other, but the content of each module is helpful for improving students’ basic qualities and engineering ethics literacy.

#### 2.2.1.2 The Activities to Increase Student’s Interests

Compulsory courses can enhance students’ awareness of engineering ethics, while practical activities in engineering ethics can enhance their subjective initiative and fully mobilize the enthusiasm of each student.

Beijing Institute of Technology organizes a debate competition with the theme of “engineering ethics” to stimulate students’ engineering ethics thinking. By simulating real engineering scenarios, students are trained to apply engineering ethics knowledge to practice. Implement educational reform in the form of debate competitions, and conduct engineering ethics debate competitions in various engineering ethics course teaching classes.

Practical activities not only fully leverage the leading role of teachers, but also reflect the subjectivity of students. Student debaters can gain a deeper understanding of the basic concepts,

principles, guidelines, moral values, public safety obligations, social responsibilities, and other elements of engineering ethics from different perspectives through discussions and in-depth analysis of the topic. This can enhance moral awareness, cultivate moral emotions, and regulate moral behavior. Under the guidance of debaters, one can gain a deeper understanding of engineering ethics knowledge and enhance their ethical awareness. At the same time, the professional attitude of debaters can serve as a role model and motivation for students, interpreting a responsible and professional attitude towards engineering ethics.

### 2.2.2 Dalian University of Technology

#### 2.2.2.1 “Online and Offline” Courses

Dalian University of Technology offers engineering ethics courses for different levels of groups. This contains four aspects: ethical theoretical foundations, case studies, professional ethics and social responsibility, team collaboration and professional communication. The course first introduces the basic concepts and principles of ethics, laying the foundation for students to construct the theoretical framework of engineering ethics; Then, analyzing real engineering cases can inspire students to think about ethical issues and attach importance to safety, environmental protection, human rights, privacy, and other aspects; The section on professional ethics and social responsibility emphasizes the basic qualities that qualified engineers should possess and their responsibility to society, and clarifies the ethical norms and requirements that they should follow in their career; Team collaboration and professional communication focus on cultivating students' professional communication skills, as well as their ability to handle ethical and interest conflicts.

In addition to offline large class teaching, it also creates unique online courses. The online course “Science, Technology and Engineering Ethics” was first launched in 2012, leading the development of online courses in China. It mainly includes academic ethics and morality, ethical issues related to high-tech and conventional technologies, and ethical issues in engineering accidents. It is supplemented by case video teaching, and the combination of theory and practice puts students in an engineering experience environment.

#### 2.2.2.2 Engineering Ethics Practice Activities and Projects

Dalian University of Technology holds various practical activities to enrich students’ access to engineering ethics knowledge. The teaching salon organized by the School of

Humanities with the theme of "Engineering Ethics Awareness and Professional Ethics Standards for New Engineering Talents" and the series of lectures on "Engineering Ethics" courses regularly held by various science and engineering colleges mainly include topics such as the relationship between engineering and ethics, risks in engineering, safety and responsibility, engineering value, interests and justice.

Dalian University of Technology has also successfully held the 8th National Cyber Ethics Symposium and the 3rd Academic Symposium on Science, Technology, and Engineering Ethics in China. It has exchanged ethical governance systems with scholars from universities across the country, implemented the Philosophy and Social Science Prosperity Plan, and built a platform for strengthening humanities to develop engineering ethics and technology ethics into advantageous and characteristic disciplines. Strengthen engineering ethics education from the perspectives of disciplinary system, scope, principles, etc., and encourage and support graduate students to participate in international academic seminars.

**2.3 Teaching staff team**

The teaching staff of the Engineering Ethics course at Beijing Institute of Technology is rich. The teachers who teach the course come from the School of Automation, School of Computer Science, School of Optoelectronics, and other colleges, and have established a unique "dual mentor" system, with mentors with theoretical foundations and project experience teaching together.

Part of the science and engineering majors at Beijing Institute of Technology are established through a “dual mentor system”, with academic mentors and mentors from external social practice departments jointly participating in guiding students. Senior technical personnel from enterprises and universities with rich practical experience and teaching guidance form a mentor team, with on campus mentors taking the lead, and off campus mentors assisting students in practical project research, courses and papers in some engineering majors. Divided by professional title level, both leaders and teachers participate in the construction of this course; According to the organizational form, the Graduate School has established a course construction group for Engineering Ethics, and the rich teaching staff reflects the importance placed on engineering ethics education.

Dalian University of Technology attaches great importance to its faculty and has created a

composite engineering ethics education faculty team that combines humanities and sciences. From the perspective of teaching profession, most of the teachers who hold seminars and salons on engineering ethics are humanities and social sciences majors. For example, Professor Wang Qian is the head of the doctoral program in the first level discipline of philosophy and the director of the Philosophy and Social Sciences Special Committee of the Academic Committee of the university. He was approved for the 2020 Ministry of Education's New Engineering Research and Practice Project "Research on Engineering Ethics Awareness and Professional Ethics Standards of New Engineering Talents". He attaches great importance to the study of practical problems, and particularly points out that in the process of cultivating engineering ethics awareness for new engineering talents, attention should be paid to engineering technology issues. In terms of moral standards and engineering ethics, consensus should be reached with domestic and foreign peers to maintain the social, engineering, and ethical responsibilities that engineers should undertake. At the same time, he serves as the deputy editor in chief and participates in the compilation of the textbook "Engineering Ethics". In addition to professional professors, university leaders assume the responsibility of teaching courses, reflecting their emphasis on engineering ethics.

Humanities and social science teachers ensure solid ethical knowledge; Science and engineering teachers have in-depth experience in engineering and enterprise practice, and their explanations of cases are more specific and vivid; university leaders are more familiar with the management and overview of the university, and can provide improvement suggestions for curriculum adjustments through teaching. At the same time, it also reflects the importance of engineering ethics, thereby enhancing students' ethical awareness.

### 2.4 Organizational Support

#### 2.4.1 Emphasizing teacher training

In terms of teacher training, Beijing Institute of Technology has established the first batch of national excellent engineering college construction forums, with the following requirements for excellent engineers: a knowledge structure centered on humanities and social sciences, enriched and improved; Engineering and technical capabilities; High moral cultivation and ethical qualities; Proficient in understanding the social responsibilities that engineers should undertake. The cultivation of outstanding engineers is also a way to ensure the quality of the

engineering ethics teaching staff and improve teaching effectiveness.

Dalian University of Technology established the “Teacher Training Center” in 2003, which not only has a service nature, but also undertakes functions such as teaching quality monitoring and business training. Through training teachers’ work abilities and standardizing teaching activities, it can also be called an academic institution that involves renowned teachers, comprehensive guidance from experts, and a combination of full-time and part-time teachers. At the same time, actively organize teacher seminars and exchanges with teachers from different fields to enhance new insights into engineering theory knowledge.

### 2.4.2 Increasing textbook resources and research center construction

In terms of textbook resources, professors from Beijing Institute of Technology are responsible for the writing of Chapter 3 of the textbook “Engineering Ethics”, and have authored works such as “Introduction to Engineering Ethics” and “Engineering Ethics”. They have published multiple engineering ethics related papers, including “Models and Approaches of Engineering Ethics Education Abroad”, “Drawing on Foreign Experience to Carry out Engineering Ethics Education”, and “Analysis of the Reasons for the Lack of Engineering Ethics Awareness”, Enriched the teaching resources of Beijing Institute of Technology, ensuring the efficient development of engineering ethics education in both practical and theoretical aspects.

Dalian University of Technology has made significant investments in various aspects to ensure the smooth development of engineering ethics education. It has established a Research Center on Science and Technology Ethics and Technology Management, mainly focusing on research in the fields of science and technology ethics, management, and policy. The research center pays special attention to engineering and technology ethics education, and relies on the advantages of the university’s science and engineering disciplines to not only form a team of engineering and technology ethics teachers with both humanities and sciences, but also expand teaching resources, responsible for editing works such as “Internet, Big Data, and Artificial Intelligence Ethics Series” and “Engineering, Technology, and Philosophy: China Technical Philosophy Research Yearbook”, ensuring the transmission of engineering ethics knowledge, playing a leading role in the field of science, technology, and engineering ethics research at Dalian University of Technology, and forming its own characteristics.

## 3.The Summary of Case Experience

The purpose of analyzing case studies is to learn advanced experience and lay a foundation for establishing a more comprehensive teaching system. The engineering ethics education in two domestic science and engineering universities has their own characteristics and focuses on the future. The experience of science and engineering universities also provides ideas for improving and innovating teaching and practice in the future.

### 3.1 The ethical goals of engineering meet the requirements of society for new talents

Firstly, at the level of teaching objectives, the focus is on cultivating comprehensive and versatile engineering and technology talents that meet the needs of social development. The two universities not only require students to master basic ethical knowledge, but also pay attention to their ability to solve practical ethical problems, which meets the requirements of engineering talents in contemporary society.

The training objectives of engineering ethics education are clear and specific in the talent cultivation plan, progressing from knowledge to ability, penetrating from professional basic knowledge to problem-solving ability, and ultimately rising to ethical awareness.

As a complex interdisciplinary field, engineering ethics has always been difficult to provide a clear answer to what kind of engineering talents to cultivate. Through the successful experiences of several universities, it is known that the theoretical learning ability is relatively weaker than the problem-solving ability, and the ability to make ethical judgments and decisions in the face of practical engineering problems meets the requirements of new engineering talents.

### 3.2 A New Direction of Combining Theory Teaching with Practice

#### 3.2.1 The teaching content is closely integrated with theory and practice

Both universities closely integrate theoretical knowledge with community practice projects in the field of engineering ethics teaching. The debate competition on the theme of “Engineering Ethics” at Beijing Institute of Technology can stimulate students’ thinking on engineering ethics. By simulating real engineering scenarios, students can exercise their ability to apply engineering ethics knowledge to practice; The online ethics course at Dalian University of Technology incorporates case videos, allowing students to immerse themselves in real engineering environments to assess ethical issues and closely connect engineering ethics with their professional studies and future engineering practices. In the process of learning theoretical

knowledge, students do not consider the relationship between economy, environment, society, and engineers. Strict assessment requirements cannot represent students' engineering abilities. Through long-term and in-depth practice, students can cultivate their attitude towards engineering and improve their professional ethics in engineering.

In the teaching process, several universities have permeated the relationships between engineering, technology, society, and people through real-life scenario cases, cultivating students' ethical awareness and viewing problems from an ethical perspective. For example, the courses on Engineering Ethics at Beijing Institute of Technology and Dalian University of Technology both include case studies.

### 3.2.2. Explore "all-round" ethical courses with abundant teaching resources

Teaching engineering ethics is not a short-term task. Infiltrating ethical knowledge from various stages and offering comprehensive courses can make engineering ethics concepts ubiquitous and help enhance students' ethical awareness.

Beijing Institute of Technology and Dalian University of Technology not only offer specialized compulsory courses, but also offer elective courses and ideological and political courses to fully integrate engineering ethics knowledge, and offer courses for both undergraduate and graduate students. For example, Beijing Institute of Technology has established a course ideological and political education research center, incorporating "Engineering Ethics" into it, offering a distinctive case library and teaching courseware, and forming a unique "ideological and political integration" engineering ethics teaching strategy. Dalian University of Technology's self-created online ethics course——the "Science and Technology" course, which was first launched in 2012.

## 3.3 Integration of external teachers into the teaching team

The engineering ethics teachers from the two universities not only have a complex cross disciplinary background combining humanities and science, but also have practical experience in engineering. The advantage of entrepreneurs or project leaders lies in their ability to lead by example. Personal practice cases will be more in line with real-life situations. During the process of explaining knowledge, students will be inspired to learn through engineering project cases they have personally experienced, which will enhance their confidence in the teacher. With the advancement of engineering education towards interdisciplinary and diversified

approaches, higher requirements are being placed on the teaching staff of engineering ethics. The integration of external teachers with engineering practical experience into the university teaching team can promote students' comprehensive understanding of engineering ethics issues, deepen their trust in teachers, and improve the effectiveness of engineering ethics teaching.

## 4. Empirical investigation

In order to deeply explore the current situation of engineering ethics education in science and engineering colleges in China, a survey and research will be conducted in higher education institutions of science and engineering in China. E University has strong strength in science and engineering, and has formed a unique engineering ethics teaching system. Therefore, taking E University as an example, using quantitative methods, this study explores the existing problems in engineering ethics education in Chinese science and engineering universities, analyzes the influencing factors, and proposes countermeasures and suggestions.

The investigation of the current situation and problems in engineering ethics education needs to be based on the situation of students who have direct or indirect exposure to relevant knowledge. Therefore, this study is aimed at all science and engineering majors at E University. The survey was designed through Questionnaire Star and distributed online. Before conducting the formal survey, 40 samples were distributed to classmates for small-scale prediction, and reliability, validity, and results were tested. After slight modifications and improvements, the survey was officially distributed.

### 4.1 Basic situation of investigation and research

#### 4.1.1 Questionnaire survey design

In order to understand the ethical literacy of all engineering students in engineering colleges, this study conducted a survey from the aspects of basic information of students, awareness and importance of engineering ethics, curriculum and practical activities of E University, teaching staff, organizational support, and student ability improvement. The questionnaire structure is shown in the following table.

Table 4-1 Survey questionnaire design on the current situation and problems of engineering ethics education in universities

| Questionnaire Section | Investigate Dimension | Corresponding Questions |
|---|---|---|
| Basic Information | Basic information of students (Gender, grade, college, etc.) | 1-3 |
| Understanding of Engineering Ethics | The level of Emphasis | 4（Matrix scale） |
| | Cognitive ability in engineering ethics | 5（Matrix scale） |
| | The ways of understanding | 6、7、11、12 |
| The Forms of Teaching | Engineering Ethics Courses | 8（Matrix scale） |
| | Related professional Courses | 9（Matrix scale） |
| | Practical Activities | 10（Matrix scale） |
| Teaching Staff | | 13、14（Matrix scale） |
| Organizational Support | | 15（Matrix scale） |
| The effect of learning | The results of courses | 16（Matrix scale） |
| | The results of activities | 17（Matrix scale） |
| Improvement Suggestions proposed by students | | 18 |

### 4.1.2 Distribution and collection of survey questionnaires

This study conducted a survey on all students majoring in science and engineering at E University. Before conducting the formal investigation, 40 samples were distributed to classmates for small-scale prediction, and their reliability, validity, and results were tested. After slight modifications and improvements, the samples were officially distributed. A total of 369 questionnaires were collected, with 338 valid questionnaires and an effective rate of 91.60%. The basic information of the investigated subjects is as follows.

Table 4-2 Basic Information of Respondents

| Category | | Number | Proportion |
|---|---|---|---|
| Gender | Male | 229 | 67.8% |
| | Female | 109 | 32.2% |
| Stage | Undergraduate degree | 67 | 19.8% |
| | Professional Master's degree | 154 | 45.6% |
| | Academic Master's degree | 84 | 24.9% |
| | Doctoral students | 33 | 9.8% |
| Institution | The institution of Chemical Engineering | 69 | 20.4% |
| | The institution of Chemical Molecules and Engineering | 62 | 18.3% |
| | The institution of Biotechnology | 29 | 8.6% |
| | The institution of Pharmacy | 29 | 8.6% |
| | The institution of Materials Science and Engineering | 17 | 5.0% |
| | The institution of Mechanical and Power Engineering | 39 | 11.5% |
| | The institution of Information Science and Engineering | 58 | 17.2% |
| | The institution of Resource and Environmental Engineering | 15 | 4.4% |
| | The institution of Art, Design and Media | 9 | 2.7% |
| | Excellent Engineers | 11 | 3.3% |

### 4.1.3 Reliability and Validity Testing of the Questionnaire

#### 4.1.3.1 Reliability Analysis

Reliability is a check of the reliability of the collected data, examining the internal consistency of the scale. The reliability test results of this questionnaire are shown in the table below. The test results of the four dimensions divided are all above 0.9, indicating that the reliability of the scale is very high.

Table 4-3 Reliability Analysis

| Dimension | Alpha | Number of Items |
|---|---|---|
| The level of Emphasis | 0.922 | 6 |
| Cognitive ability in engineering ethics | 0.959 | 7 |
| Teaching Measures and Organizational Guarantee | 0.957 | 15 |
| Effect of Teaching | 0.973 | 8 |

#### 4.1.3.2 Validity Analysis

Validity is an evaluation of the accuracy of measurement properties and the correctness of measurement results, reflecting the scientific and rigorous nature of data collection. After testing the dimensions of the scale using the Cronbach coefficient, this study used KMO and Bartlett's sphericity tests to analyze validity. The results are shown in the table below.

Table 4-4 KMO and Bartlett's test

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Appropriateness of measurement sampling | 0.936 | |
| Bartlett's sphericity test | Approximate chi square value | 5449.493 |
| | df | 105 |
| | Significance（P） | 0.000 |

When the KMO value is ≥ 0.9, it indicates that the measurement validity is very good. As shown in the table, the KMO measurement sampling suitability value is 0.936, which is greater than 0.9. The correlation between the variables is good, and the significance is 0.000, which is less than 0.05. Through the significance test, the validity of the questionnaire is high.

## 4.2 Analysis of the survey results on the current situation of engineering ethics education in E University

### 4.2.1 The degree of importance and cognitive level of students towards engineering ethics

The importance of engineering ethics to every student majoring in science and engineering is self-evident. In the survey results of the understanding of engineering ethics among students majoring in science and engineering at E University, it was found that although engineering ethics did not reach a high level of popularity, the average score of each question set was above 3 points, indicating that the surveyed students were aware of the importance of engineering ethics to engineering students.

Table 4-5 Degree of emphasis on engineering ethics among students

| | Statistical items | Number | Minimum | Maximum | Average | Standard Deviation |
|---|---|---|---|---|---|---|
| The level of emphasis | Understand the content of engineering ethics | 338 | 1.0 | 5.0 | 3.36 | 1.0474 |
| | Understand professional ethics standards | 338 | 1.0 | 5.0 | 3.81 | 0.9773 |
| | Engineering ethics occupies an important position in engineering education | 338 | 1.0 | 5.0 | 3.89 | 0.9355 |
| | Engineering ethics education is important for science and engineering students | 338 | 1.0 | 5.0 | 3.95 | 0.9486 |
| | universities attach great importance to engineering ethics education | 338 | 1.0 | 5.0 | 3.70 | 1.0109 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Specialized courses need to be offered** | 338 | 1.0 | 5.0 | 3.91 | 0.9958 |

When it comes to the issue of the status of engineering ethics in the engineering discipline, the scores are almost all close to 4 points, and students believe that the university also attaches enough importance to engineering ethics education, which occupies an irreplaceable position in engineering education. According to the questionnaire results, it can be concluded that engineering ethics education is an important discipline in the entire engineering education.

However, students do not have a clear understanding of what is included in engineering ethics, with an average score of 3.36, which is only at an average level. From this, it can be seen that students have a somewhat one-sided understanding of the content contained in engineering ethics, and cannot understand it from a broader perspective. When facing engineering problems, they cannot fully consider the interests of all parties.

Table 4-6 Student Engineering Ethics Awareness Level

| **Statistical items** | **Number** | **Minimum** | **Maximum** | **Average** | **Standard Deviation** |
|---|---|---|---|---|---|
| Putting life and health before economic benefits | 338 | 1.0 | 5.0 | 4.22 | 1.0041 |
| Engineering safety should be higher than economic benefits | 338 | 1.0 | 5.0 | 4.28 | 0.9384 |
| The ecological environment should be higher than economic benefits | 338 | 1.0 | 5.0 | 4.15 | 0.9276 |
| Starting from the overall situation and considering collective interests | 338 | 1.0 | 5.0 | 4.25 | 0.9109 |
| Lack of awareness of engineering ethics can lead to the occurrence of engineering accidents | 338 | 1.0 | 5.0 | 4.30 | 0.9063 |
| We should vigorously promote engineering ethics and create a good industry atmosphere | 338 | 1.0 | 5.0 | 4.25 | 0.9182 |

Students majoring in science and engineering need to have a certain level of engineering ethics awareness and judgment ability, and be able to handle moral difficulties in engineering activities. The average score for the choices made by students when facing engineering projects

is above 4 points, indicating that students have sufficient ethical awareness, can prioritize human life safety, engineering safety, ecological interests, and collective interests, and believe that having ethical knowledge awareness is very important. The students as a whole attach great importance to engineering ethics and have a high level of ethical awareness, but their understanding of specific content is still not comprehensive and in-depth enough.

### 4.2.2 Teaching Forms of Engineering Ethics

#### 4.2.2.1 Access to engineering ethics knowledge

The classroom is widely recognized as the most extensive channel for acquiring knowledge of engineering ethics. According to the survey results, E University offers specialized compulsory extracurricular courses for graduate students and relevant public elective courses, providing necessary guarantees for students to acquire knowledge. The group that obtains ethical knowledge through course methods accounts for the largest proportion, up to 73.37%. The collective learning method of large class teaching puts certain requirements on the learning results of students. The second channel, second only to the classroom, is the internet, accounting for 66.86%, making it the mainstream channel for students to independently learn engineering ethics knowledge. However, E University needs to strengthen its practical activities, with only 32.25% of students enriching their ethical knowledge base by participating in practical activities.

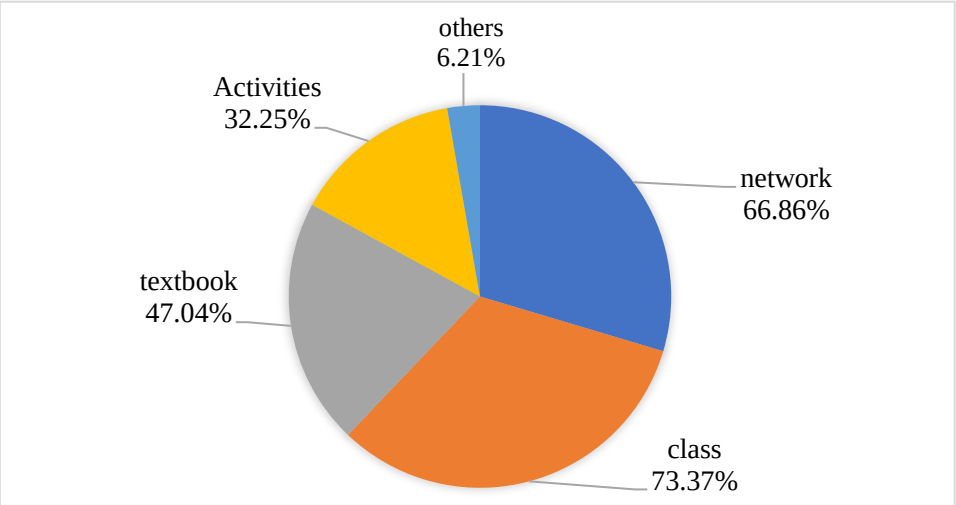


Figure 4-1 Sources of Engineering Ethics Knowledge Channels

Offering compulsory courses is the preferred channel for students to acquire knowledge, up to 72.49%. Curriculum has become the main channel for students to acquire knowledge, so

universities should increase their investment in curriculum construction and expand the group receiving education. Secondly, interspersed explanations of engineering ethics knowledge and the combination of engineering ethics knowledge and humanities courses in professional courses are also the most desirable learning methods for students, accounting for 70.12% and 56.12% respectively. It can be seen that students urgently need to learn in a strong ethical atmosphere and feel the interdisciplinary nature of engineering ethics. Practical activities, as the second classroom, play an important role in disseminating knowledge and values, and half of the students hope to enrich the forms of practical activities.

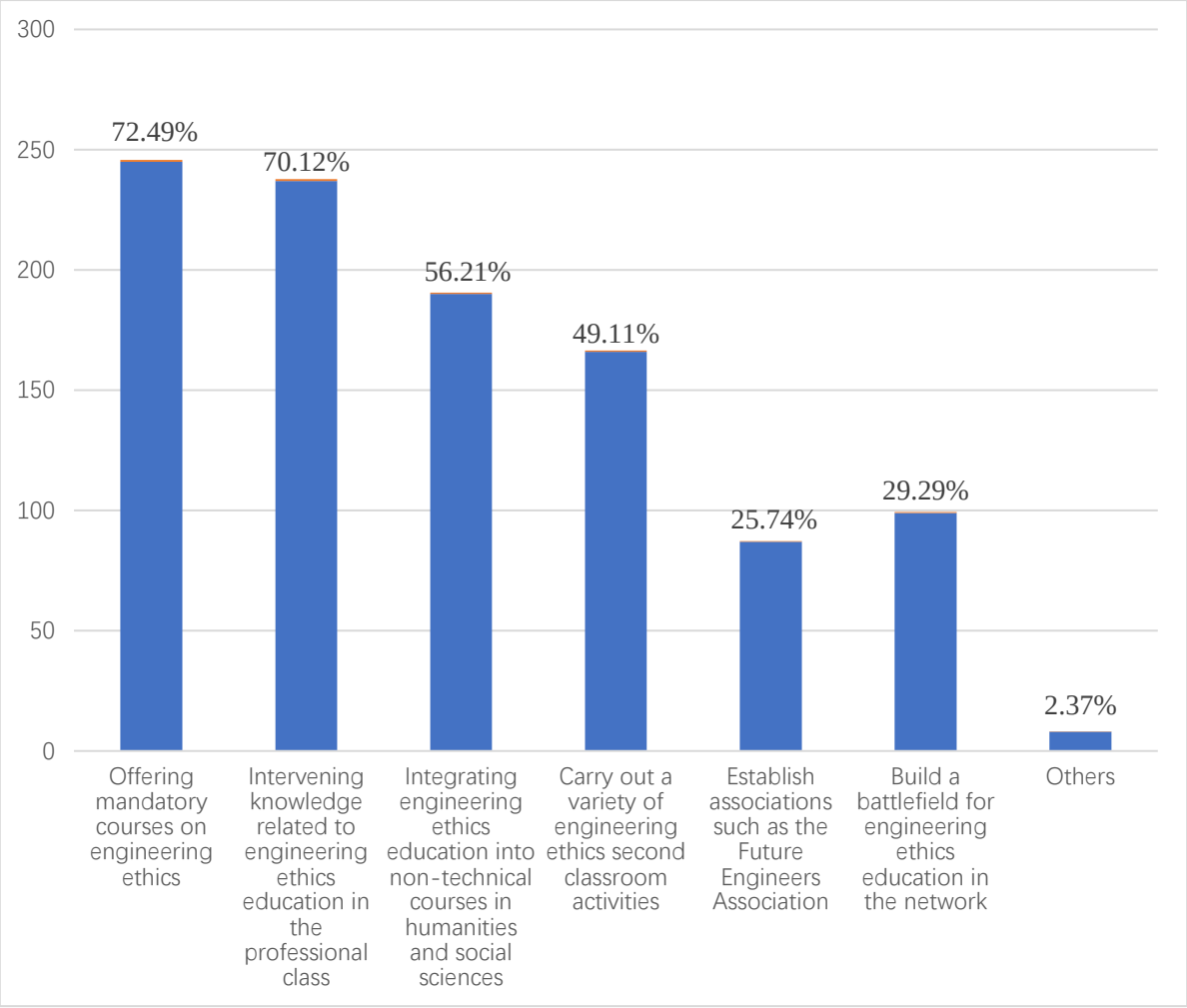


Figure 4-2 Engineering Ethics Education Channels

#### 4.2.2.2 Current status of course offerings

The number of respondents participating in mandatory courses on engineering ethics is the highest, with only 26.92% of students taking elective courses on engineering ethics, and about 30% of students still not systematically taking courses. As the main channel for students to

acquire engineering ethics knowledge, the popularization of courses in universities is still insufficient.

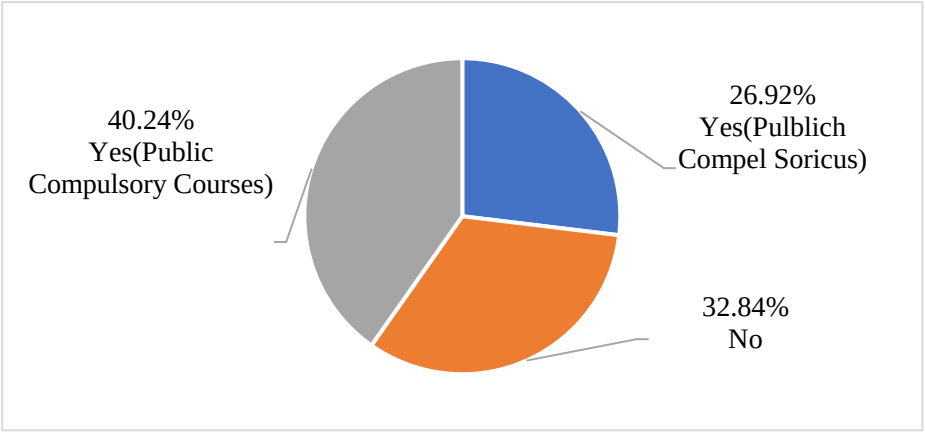


Figure 4-3 Is an engineering ethics course offered

The survey results show that the highest score in the mandatory engineering ethics courses offered is 3.85 points, which proves that almost all teachers who teach engineering ethics mandatory courses use the case method, and students fully recognize the cases. The shortcoming is that there are few teachers who explain personally experienced cases. It can be seen that how to enrich the diversity of cases is also something that Chinese universities need to explore.

The survey results of courses related to ethical knowledge show that the score for engineering courses with interspersed engineering ethical knowledge is relatively high, close to 4 points, while the score for courses combining ideological and political education with engineering ethics is relatively low. The professional and experimental courses of science and engineering students involve a lot of engineering ethics knowledge and professional ethics issues, and the ideological and political courses are mostly pure moral knowledge, making it difficult to hear teachers explain engineering ethics knowledge.

Table 4-7 Situation of Engineering Ethics Courses

| | **Numbers** | **Statistical items** | **Minimum** | **Maximum** | **Average** | **Standard Deviation** |
|---|---|---|---|---|---|---|
| Compulsory Courses | 338 | Explain the concept of engineering ethics | 1.0 | 5.0 | 3.81 | 0.9188 |
| | 338 | Explain theoretical | 1.0 | 5.0 | 3.79 | 0.9373 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | knowledge | | | | |
| | 338 | Analyze by classic case | 1.0 | 5.0 | 3.85 | 0.9286 |
| | 338 | Teaching combined with interaction | 1.0 | 5.0 | 3.77 | 0.9521 |
| Related Courses | 338 | Professional courses involve ethical knowledge | 1.0 | 5.0 | 3.86 | 1.0150 |
| | 338 | Ideological and political courses involve ethical knowledge | 1.0 | 5.0 | 3.79 | 1.0172 |

The score of ethical knowledge in ideological and political courses is lower than that in practical courses. Some universities classify engineering ethics as ideological and political courses, emphasizing the role of ideological and political courses. However, E University does not emphasize enough in ideological and political courses. Almost all interviewees deny that engineering ethics knowledge is involved in courses such as "ideological training" and "dialectics of nature". In the survey of professional courses and ideological and political courses, the difference is greater than 1, There is a significant difference in the degree of agreement among students in these two aspects. It is necessary to combine the special professional background of science and engineering students, fully play the key role of ideological and political courses, emphasize ethical knowledge in professional courses and ideological and political courses, and increase popularization efforts. Realize the cross integration of humanities and sciences.

#### 4.2.2.3 At the level of practical activities

Through a survey of engineering ethics practice activities at E University, it was found that the practical activities offered are at an average level, with the most ethical knowledge involved in graduation internships. Not all graduate students have engineering practical experience. Through investigation, it was found that professional master's degree programs require internships as credits, and students are personally responsible for projects or observe some engineering cases. The series of processes from planning, design, construction to project completion involve environmental, ethical, safety, and interests issues.

The projects under different majors and research groups also vary greatly. The survey results on the satisfaction level of students with seminars, lectures, or forums related to engineering ethics held by the university show a score of 3.68, which is at an average level. Through interviews, it was found that the university does not systematically offer lectures, and some colleges occasionally hold activities. However, there are fewer lectures on engineering ethics, and most of the lectures are related to professional knowledge. Apart from internships, the university also does not provide opportunities for science and engineering students to engage in engineering projects.

Table 4-8 Situation of Practical Activities

| Statistical items | Numbers | Minimum | Maximum | Average | Standard Deviation |
|---|---|---|---|---|---|
| Graduation internship involves relevant knowledge | 338 | 1.0 | 5.0 | 3.81 | 0.9792 |
| Organize seminars, lectures, or forums | 338 | 1.0 | 5.0 | 3.68 | 0.9863 |
| Possess practical experience | 338 | 1.0 | 5.0 | 3.60 | 1.1595 |
| The research group establishes projects related to engineering ethics | 338 | 1.0 | 5.0 | 3.68 | 1.0607 |

### 4.2.3 At the level of teaching staff

The survey results show that the overall level of the teaching staff at E University is relatively high, and teachers with engineering practical experience are most in line with students' ideal expectations. Experimental and professional course teachers also emphasize relevant knowledge. In terms of whether teachers attach importance to it, the average score exceeds 4 points, proving that the university's teaching team on engineering ethics is more responsible and values engineering ethics.

Table 4-9 Situation of Teaching Staff

| Statistical items | Numbers | Minimum | Maximum | Average | Standard Deviation |
|---|---|---|---|---|---|
| Teachers possess engineering practical experience | 338 | 1.0 | 5.0 | 4.07 | 0.8623 |
| Experimental or professional course teachers emphasize it | 338 | 1.0 | 5.0 | 4.07 | 0.8701 |

The survey results on the professional knowledge background of engineering ethics teachers show that most students believe that teachers who teach engineering ethics not only possess knowledge and skills in science and engineering, but also have a certain understanding of humanities and social sciences. From this, it can be seen that professional knowledge in science and engineering is the professional background that engineering ethics teachers need to possess. On this basis, exploring humanities and social science knowledge to the fullest extent and depth can be more helpful for this course.

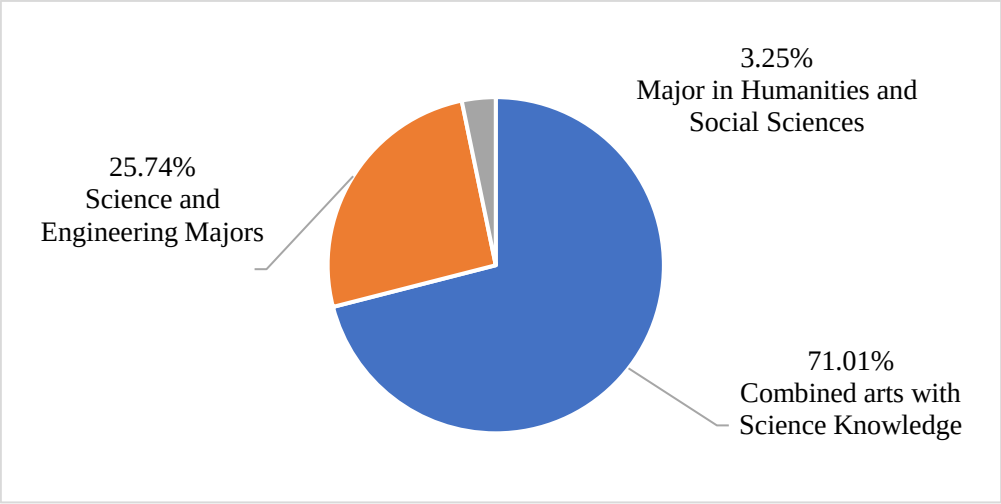


Figure 4-4 Survey of Professional Background of Engineering Ethics Teachers

### 4.2.3 At the level of university security investment

In the survey on the organizational guarantee level of universities, the highest score was 3.99 for specialized training of teachers, which reached the satisfaction level of students. In terms of teaching resources, students believe that the university library, internet and other resources are relatively abundant. However, in terms of publicity efforts, the score is relatively low, and the university's engineering ethics atmosphere is insufficient. From this, it can be seen that universities still need to strengthen their propaganda investment in organizational support.

Table 4-10 Organizational Guarantee of Universities

| Statistical items | Numbers | Minimum | Maximum | Average | Standard Deviation |
|---|---|---|---|---|---|
| Rich teaching resources | 338 | 1.0 | 5.0 | 3.76 | 0.9117 |
| Strong publicity efforts | 338 | 1.0 | 5.0 | 3.68 | 1.0066 |
| Teachers have received professional training | 338 | 1.0 | 5.0 | 3.99 | 0.8630 |

## 4.3 Analysis of Engineering Ethics Education Issues

### 4.3.1 Factors affecting teaching effectiveness

This study used multiple regression analysis to establish a model, with 8 factors as independent variables and the improvement of students' engineering ethics quality as the dependent variable. Subsequently, demographic factors such as gender, stage, and teacher professional background were added as control variables to explore the impact of independent variables on the dependent variable after excluding control variables.

#### 4.3.1.1 Basic problem testing in regression analysis

Regression models need to ensure the reliability and stability of the analysis results, so we first test whether the model has three major problems: multicollinearity, sequence correlation, and heteroscedasticity. In this study, the VIF of all three models is less than 5, so there is no multicollinearity problem between the variables; In this study, the Durbin Watson values were 1.866, indicating that there were no sequence related issues; The scatter plot of the residuals of the independent and dependent variables in this study can determine that the regression model does not have heteroscedasticity issues.

#### 4.3.1.2 Multiple linear regression analysis

This study takes the improvement effect of students' comprehensive engineering ethics quality as the dependent variable, with 8 factors as independent variables, including course teaching methods, relevant course penetration effects, student participation in practical activities, teacher attention, teacher's engineering practice experience, strong university engineering ethics atmosphere, teacher's professional training, and sufficient teaching resources. At the same time, student gender, stage, and teacher's professional background knowledge are set as control variables, among them, female gender, doctoral students at different stages, and teachers with both liberal arts and science backgrounds were used as reference groups, and were

set as dummy variables to explore the impact of the independent variable on the dependent variable after excluding control variables.

Table 4-11 Regression analysis of the impact of control variables on the improvement of students' engineering ethics quality

| **Model 3 (Improvement of Engineering Ethics)** | | | **Beta** |
|---|---|---|---|
| **Control Variable** | constant | | |
| | Gender | Male | -0.095* |
| | Stage | Undergraduate degree | -0.033 |
| | | Professional Master's degree | 0.201** |
| | | Academic Master's degree | 0.028 |
| | Teacher's professional background | science and engineering | -0.174*** |
| | | social science | -0.215*** |
| **$R^2$** | | | 0.110 |
| **F** | | | 6.813 |
| **P** | | | ＜0.001 |
| **Dependent variable: Improvement of student's engineering ethics quality** | | | |

The analysis of the impact of three types of control variables on the improvement of students' engineering ethics quality shows that at the gender level, with women as the reference group, there is a significant negative correlation between men and the improvement of engineering ethics quality; At the level of student stage, with doctoral students as the reference group, there is a significant positive correlation between professional master's degree and the improvement of student ethical quality. Professional master's degree can enhance engineering ethical quality by participating in compulsory courses and practical activities; At the level of teacher professional background, using teachers with both liberal arts and science knowledge as the reference group, there is a negative and significant correlation between teachers with knowledge in science, engineering, humanities, and social sciences and the improvement of students' engineering ethics quality. A teacher background with a combination of liberal arts and science knowledge can help students improve their engineering ethics quality.

Table 4-12 Regression Analysis of Factors Influencing the Improvement of Engineering Ethics Quality among Students

| Model 3 (Improvement of Engineering Ethics) | | | Beta |
|---|---|---|---|
| Independent Variable | (Constant) | | |
| | Course teaching methods | | 0.058 |
| | Penetration of related courses | | 0.102** |
| | Student participation in practical activities | | 0.072* |
| | Teachers attach great importance to it | | 0.126*** |
| | Teachers have experience in engineering practice | | 0.253*** |
| | Strong ethical atmosphere in university engineering | | 0.236*** |
| | Teachers have received professional training | | 0.135*** |
| | Adequate teaching resources | | 0.077 |
| Control Variable | Gender | Male | 0.011 |
| | Stage | Undergraduate degree | 0.016 |
| | | Professional Master's degree | 0.001 |
| | | Academic Master's degree | 0.008 |
| | Teacher's professional background | science and engineering | -0.060** |
| | | social science | -0.062** |
| $R^2$ | | | 0.828 |
| F | | | 111.202 |
| P | | | ＜0.001 |
| Dependent variable: Improvement of student's engineering ethics quality | | | |

After excluding confounding factors such as gender, stage, and professional background of engineering ethics teachers, the linear regression model has a good fit, with R3 in Model 3 $^2$= 0.828>0.6 means that the results of this calculation accurately and reliably reflect the impact

of eight factors on the improvement of engineering ethics among students majoring in science and engineering. All VIFs are less than 5, and there is no multicollinearity between independent variables. The regression equation is significant, F3=111.202, and the P-value of the model three is less than 0.001, indicating that at least one of the eight independent variables has a significant impact on the improvement of the dependent variable student's engineering ethics quality.

According to the results of Model 3, the infiltration of relevant courses, student participation in practical activities, teacher emphasis, teacher experience in engineering practice, strong university atmosphere, and teacher training have a significant positive impact on the improvement of student engineering ethics quality.

In addition, using teachers with both humanities and science knowledge as the reference group, it was found through setting two control dummy variables that the professional knowledge background of teachers is significantly correlated with student learning outcomes. Only when teachers possess both science and engineering professional skills and theoretical knowledge of humanities and social sciences can they significantly increase students' engineering ethics knowledge and enhance their engineering ethics abilities.

### 4.3.2 Existing problems in engineering ethics education at E University

#### 4.3.2.1 Lack of systematic support in universities

Through empirical investigation in the previous text, it was found that although students have certain ethical cognitive abilities and attach great importance to engineering ethics, there are too few channels for students to understand engineering ethics in university, and their cognitive abilities cannot be fully verified.

Firstly, engineering ethics have not been included in talent development goals. As the main source of knowledge acquisition for students, the requirements for courses are not clearly defined, and the target audience is not broad enough.

Secondly, there is insufficient guarantee for practical activities. The university has not specifically organized projects for engineering ethics, and students are unable to participate in engineering projects through university channels. The knowledge competitions and special lectures offered are not highly targeted, mostly focused on engineering topics in science and engineering, and practical activities are not included in the training program. Teaching and

practice are two major forms of engineering ethics teaching, with universities placing more emphasis on teaching and less emphasis on practice.

#### 4.3.2.2 Lack of external teaching staff

E University has a sufficient teaching staff and diverse professional knowledge backgrounds, not only possessing literary knowledge such as philosophy, ethics, and education, but also possessing engineering professional skills. However, through interviews, it was found that the current engineering ethics teachers at E University have insufficient practical experience in engineering projects and lack teachers with enterprise work experience. The cultural knowledge background is far from in-depth engineering practice, Unable to deeply understand engineering problems like professional engineers in enterprises or companies.

#### 4.3.2.3 The teaching method of the course is single and the cases are outdated

The engineering ethics course at E University generally adopts the case teaching method. Although case studies can help students perceive ethical issues in real engineering events, they have not been personally put into practice and lack a sense of immersion. Although group collaboration is adopted in the teaching process, reflecting the student-centered teaching philosophy, the use of the same method in each class is slightly monotonous.

In terms of teaching resources, students from E University mentioned that some of the cases used by teachers in class can be easily searched online, cannot keep up with current events, has weak representativeness, and is mostly foreign cases, without forming a distinctive case library. Real and distinctive cases can examine the ethical dilemmas of engineering from multiple perspectives, deepening students' understanding of engineering ethics knowledge.

## 5. Suggestions for countermeasures

This study combines the experience summarized from case studies with empirical investigation of the influencing factors of the problem, and proposes the following countermeasures and suggestions.

### 5.1 Universities clarify training objectives and improve the comprehensive construction of courses

Firstly, at the national level, policies related to engineering ethics education should be promulgated, and various sectors of society should refine ethical standards, form norms for engineering ethics systems, and comprehensively strengthen engineering ethics awareness.

Universities should formulate distinctive engineering ethics teaching rules and regulations based on the characteristics of different departments and majors, make teaching plans, form distinctive engineering ethics teaching objectives, and incorporate engineering ethics into the standard system of talent cultivation and evaluation.

Secondly, to promote the implementation of the goals, we should start with curriculum construction as the main channel for acquiring knowledge, set different courses and arrangements for different majors and groups, and incorporate them into the university's training program. At the same time, strengthen the ideological and theoretical knowledge of engineering ethics, keep pace with the technical knowledge of other professional courses, interweave and blend, form a synergistic effect, maximize the popularity of the course, and provide more students with opportunities to experience engineering ethics classrooms within limited resources.

Thirdly, utilizing the positive role played by campus culture to achieve ubiquitous engineering ethics. Campus culture involves a wide range of material forms such as campus architecture, landscape, and green beautification, as well as university customs, university culture, and public opinion. Students majoring in science and engineering have limited opportunities to learn about engineering ethics in campus life. They may insert slogans about engineering ethics into the university's ethos and motto, or create monuments and signature walls that reflect the university's unique engineering projects and famous engineering ethics events. This will spread the moral qualities related to engineering throughout the university and create a public opinion atmosphere that focuses on public health, safety, and well-being.

### 5.2 Universities strengthen cooperation and exchange with the outside world to improve their teaching staff

Firstly, university enterprise cooperation is the most convenient way to serve society and transport engineering talents. At present, there is limited cooperation between universities and enterprises, and students lack opportunities to directly participate in engineering projects. Science and engineering universities strengthen communication and cooperation with local enterprises, forming a two-way industry chain of "university enterprise individual", and promoting ethical education in engineering projects. As an institution that gathers multiple resources, universities should provide students with more opportunities for engineering practice

and enhance their ethical abilities in specific projects.

Secondly, invite excellent corporate mentors to share engineering experience and explain engineering ethics knowledge. By sharing with teachers with engineering practice experience, students can gain a deeper understanding of potential ethical challenges and moral risks in the industry, enhance their sense of responsibility, and regulate engineering behavior.

### 5.3 Teachers update teaching concepts and improve teaching methods

Firstly, in the process of explaining theoretical knowledge, Chinese universities should improve and optimize the existing large class teaching method, learn from foreign small class teaching methods, and have no more than 30 students in the classroom, striving to consider each student and improve teaching quality. Secondly, as a science and engineering major course, engineering ethics education should break away from the previous dull and single teaching methods. In addition to case teaching methods, more student-centered methods that can stimulate students' learning interest should be developed, reflecting the integration of education and entertainment. Finally, enrich the theme content of lectures and seminars. Teachers should set aside utilitarian goals and actively conduct engineering ethics lectures in addition to lectures related to projects and topics. Simulating real-life engineering scenarios can stimulate students' engineering ethics thinking, which helps to apply engineering ethics knowledge to practice.

Engineering ethics course teachers should expand their learning communities, lectures, seminars, and other teaching forms around the classroom, organize knowledge competitions in various engineering ethics course teaching classes, and implement educational reforms.

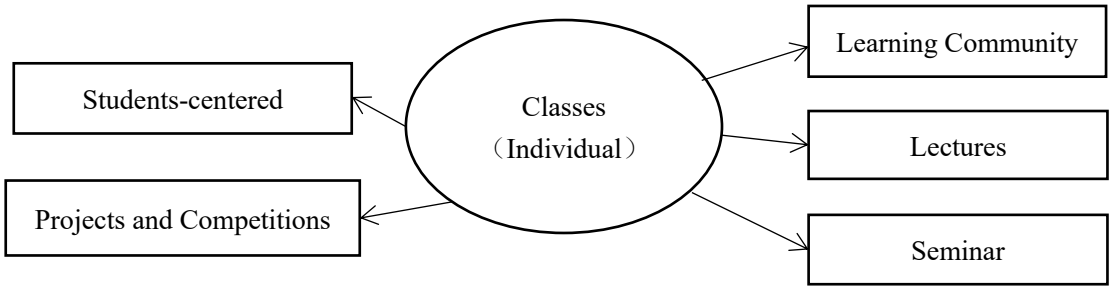


Figure 5-1 The teaching forms of Engineering Ethics Courses

### 5.4 Establish an incentive mechanism for engineering ethical behavior

The government and engineering professional associations should establish a reward and punishment incentive mechanism to play a supervisory role. Establish an incentive mechanism for engineering ethical behavior from the perspective of public welfare and interests. Reward

high-quality engineers who are honest, trustworthy, fair, and have high moral standards, such as setting up honors and awards related to qualified engineers, providing financial assistance, and promoting the deeds of celebrities in various regions, to stimulate the enthusiasm of future engineers to participate in engineering activities; Continuously investigate engineers who engage in improper behavior in engineering practice, revoke industry qualifications for those who seriously violate engineering industry regulations, educate them through legal means, raise ethical warning standards, and establish an engineering ethics education mechanism of "professional associations ethical regulations education". Through the positive influence and warning role of the government and social institutions, engineering ethics will be conveyed to universities, and universities will be urged to consciously and autonomously develop engineering ethics education.

**Acknowledgments**

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