Teaching Reform of Technical Economics for Engineering Postgraduates

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Abstract. The core content of "technical economics" course teaching is the decision-making analysis and evaluation of the project, and the course teaching is the main channel to cultivate students' innovation ability. Based on the analysis of the connotation and implementation path of engineering postgraduate education, this paper points out that it is one of the best practical ways for students to obtain "application innovation" education which integrates innovative knowledge with practical ability training into professional curriculum teaching.

1 Introduction

For a long time, Science and Technology Universities in China, the engineering technology education and economic management education are separated from each other. As a result, a large number of engineering graduates who only know technology are trained and participated in the jobs. Due to the lack of economic knowledge, they do not care about the economic problems related to the jobs which they are engaged in. Without the consideration about reducing costs and increasing profit and the necessary economic analysis in the design of engineering drawings.

The course of "technical economics" can provide postgraduates with ideas and thoughts of economic analysis in the process of scientific and technological research, which enables them to integrate the theory of technical economics into the scientific research process, and then realize the effective combination of technological advancement and economic rationality of scientific and technological work, so as to enable future engineering and technical personnel to master the necessary theory and method of technical and economic analysis\textsuperscript{[1]}.

2 Ideas and objectives of teaching reform of “technical economics”

The course of "technical economics" for postgraduates is of great practical significance to cultivate high-quality compound applied talents. Through the study of "technical economics", the students can master the basic theory and method of economic evaluation of various technical schemes, and play an important role in business decision-making, project investment evaluation, and technical and economic demonstration, etc. The effect of classroom teaching has a direct impact on the quality of teaching and the realization of the goal of talent training. At present, the class hours of “technical economics” for postgraduates in our school are 32 hours. Most of the teaching methods focus on explaining the theoretical system of technical economics in class, and analyzing the difficulties through examples. According to the feedback of students' learning, students have certain difficulty in learning this course.

Therefore, the teaching of technical economics should not only focus on basic theories and methods, but also meet the requirements of training objectives by combining the characteristics of engineering majors, so as to optimize and integrate the teaching contents.

Following the framework of "theory-method-application", we will explain in detail the basic principles of technical economics, the time value of funds, the economic evaluation indexes and risk and uncertainty decision-making, etc.. Meanwhile, we will increase case teaching based on the characteristics of engineering specialty and project orientation\textsuperscript{[2]}. The teaching of “technical economics” must attach importance to and strengthen the combination with engineering practice\textsuperscript{[3]}.

With the development of social economy and modern science and technology, there is an urgent
need for high-quality comprehensive talents who can understand both technology and economy, engaged in production technology, scientific research and design, and scientifically make scheme comparison and correct decision making. The course of “technical economics” is the most powerful tool to train engineering students to become such high-quality comprehensive talents.

3 Contents of the course reform of “technical economics”

3.1 Optimizing and integrating teaching content

Current, the research and application of “technical economics” has gone far beyond the scope of the original engineering economics. It integrates several theories of natural science and social science into the behavioral research to achieve the goal of economic activities, and make people realize that technology management, technology innovation, production, finance, economy, market, environment and even society must be regarded as a system, so this kind of compound knowledge is more likely to stimulate innovative thinking and help to achieve the purpose of transforming science and technology into productivity through scientific and technological innovation. In the process of teaching, the introduction and part of the theories can be relatively weakened, and some theories and basic methods can be selected for key explanation; and the research methods of technical economics and its application in the engineering field are highlighted. Accordingly, three teaching modules are set up: basic theory, basic method and application analysis.

The first module "Basic Theory", (1) introduction, including some basic concepts of technical economics, research purpose, research content, and research methodology, etc. (2) composition and estimation of cash flow, including the concept of cash flow, and constituent elements of cash flow, such as investment, cost, income, etc. (3) Time value of capital and its equivalent calculation, etc.

The second module "Basic Methods", (1)The basic methods of technical and economic evaluation, including index system of project economic evaluation and static and dynamic evaluation methods, such as net present value, internal rate of return, etc. (2) Risk and uncertainty analysis, including break even analysis, sensitivity analysis, probability analysis and risk decision. (3) The economic analysis of equipment renewal, to clarify and determine whether, when and how to renew the equipment. (4) Financial evaluation, introducing the main contents, theories and methods of financial evaluation. (5) National economic evaluation.

The third module "Application Analysis", the basic construction procedure of engineering project is taken as the main line and the basic theories and methods are applied around the construction process of project. Three application modules are set up: technical and economic analysis in the decision-making stage, technical and economic analysis in the design stage and technical and economic analysis in the construction stage.

3.2 Explore diversified teaching mode

Postgraduate teaching is different from undergraduate teaching. Postgraduates have strong initiatives in learning and active thinking. They have mastered the basic knowledge in the field of engineering, and can think and explore the economic problems related to technology from the perspective of engineering practice. Therefore the different teaching models are utilized.

(1) Classroom teaching

The basic theory and method modules need to adopt the traditional teaching mode of classroom teaching. Classroom teaching is an important link for students to master knowledge, cultivate ability and improve quality. It is also an important channel for students to acquire knowledge, which is directly related to the teaching quality of the school and the realization of talent training objectives. we can also encourage students to read academic monographs, broadening their professional vision, and cultivate students' ability to think independently, dare to explore and to find new problems.

(2) Case teaching

Technical economics is a subject that seeks the best combination of engineering technology and economy. The case teaching refers to taking the classroom teaching as the platform, through teaching ideas, key points and knowledge system, and then relying on the engineering examples, to
understand and deepen the theoretical knowledge. This way can make students change passive listening to active participation, participate in the analysis and solution of problems. Which constantly arouses students' enthusiasm and initiative in learning, cultivates students' ability of independent thinking and innovation, and enhances the scope and depth of teaching content. The teacher will sort out and analyze the content of the report of the economic evaluation of real engineering, extract the background information of the engineering to do the economic evaluation and transfer it to the students, guide the students to be familiar with the background of the engineering, and complete the engineering case by using the computer-aided method. The same case is completed by groups of 3-5 students. This process can not only connect many knowledge points involved in economic evaluation, but also cultivate students' ability to use tools and software to process a large number of data and team spirit, and experience how to evaluate engineering and technical programs from an economic perspective.

(3) Group discussion teaching

The teaching process of "technical economics" for postgraduates should be guided by teaching and self-study, with the purpose of cultivating students' comprehensive practical ability and innovation ability. Group discussion teaching can be combined with case teaching of application modules. After students do case analysis of cases in groups, groups can discuss with each other to determine the best scheme or summarize the characteristics of theoretical methods through discussion. Different discussion topics can also be arranged to clarify the key points of each topic, and students can collect data in groups. Besides, teachers can provide data, select group representatives to make speeches, create an atmosphere of free discussion, encourage students to actively ask questions, participate in discussions, and achieve the purpose of mutual inspiration and promotion. The teacher should actively guide and encourage students to ask questions to achieve the purpose of common learning. During the process of free exploration, students can also find the unsolved problems of the theme, and find the materials and space for their innovation ability.

(4) Individual speech

The teaching mode of individual speech designed in this course is to refine, experience and summarize the course content. The theme of speech is how to implement the idea of technical and economic analysis in the process of construction. Students need to analyze and summarize from the perspective of different participants in the construction. The students who make this keynote speech have more senses of substitution in the process of preparation, which can make them think deeply about the combination of theory and reality.

3.3 Reform teaching evaluation and assessment methods

Curriculum assessment is not only a test of students' learning, but also a measure of teachers' teaching effect. How to truly and effectively reflect the students' learning of the curriculum has always been a problem for teachers. The course of “technical economics” is not only theoretical, but also closely combined with reality. The assessment of this course requires not only the assessment of students' mastery of basic theories and knowledge, but also the assessment of students' ability to flexibly use basic principles to propose, analyze and solve practical problems. Therefore, it is necessary to assess the whole process of curriculum learning through multiple and compound assessment methods, which can be adopted (20% in class + 20% after class + 60% in paper), namely (2+2+6) mode. On the one hand, the homework, speech, written examination and other methods are combined in the classroom for evaluation, and on the other hand, strengthen the evaluation of extracurricular learning. In the process of research oriented learning, under the guidance of teachers, students rely on the wisdom of group students to complete their homework relatively independently, which not only cultivates students' enthusiasm, initiative and creativity, but also cultivates their ability to find and solve practical problems, as well as team spirit.
4 Analysis of results of the curriculum reform of “technical economics”

Two classes of “technical economics” were taught in two semesters before and after the reform. The two classes selected this course for 2019 and 2018 respectively. In order to understand the promotion effect of different teaching methods on students’ learning, class 2019 is regarded as the experimental class and class 2018 as the comparative class. Through the comparison of the results, the differences between the grades of 2019 and 2018 are analyzed.

| Table 1. Group statistics. |
|---------------------------|
| Category                  | N   | Mean value | Standard deviation | Standard error of mean value |
| paper score               |     |            |                   |                             |
| Grade 2019                | 52  | 87.596     | 4.3080            | .5974                       |
| Grade 2018                | 70  | 84.243     | 3.8502            | .4602                       |
| Usual performance         |     |            |                   |                             |
| Grade 2019                | 52  | 34.192     | 3.1563            | .4377                       |
| Grade 2018                | 70  | 32.600     | 4.6420            | .5548                       |
| Total score               |     |            |                   |                             |
| Grade 2019                | 52  | 86.75      | 4.520             | .627                        |
| Grade 2018                | 70  | 83.15      | 6.164             | .737                        |

Table 1 shows the statistical analysis results of the two classes' paper scores, usual performance and total scores. From the results, no matter the test scores, usual performance or total scores of students in 2019 are slightly higher than those of students in 2018.

Table 2 shows the results of independent sample t-test. In terms of paper scores, $t = 4.51$, $P = 0.000 < 0.01$, indicating that there is a significant difference between 2019 and 2018, which has reached a significant level of 0.01. In terms of usual performance, $t = 2.133$, $0.01 < P = 0.035 < 0.05$, which means that the difference between 2019 and 2018 is significant in a significant level of 0.05, but not significant in a significant level of 0.01. In terms of the total scores, $t = 3.563$, $P = 0.001 < 0.01$, indicating that the difference between the total score of 2019 and 2018 has reached the significant level of 0.01. Through the analysis, we can see that after the reform of the class, whether in usual performance, paper scores or total scores are significantly higher than before the reform of the class, and the difference is significant.

| Table 2. Independent sample test. |
|----------------------------------|
| Mean comparison                   |
| Levene test of variance equation |
| F      | Sig.  | t     | df    | Sig.(both sides) |
| paper score                       |
| Assuming equal variance          | .331  | .566  | 4.521 | 120   | .000 |
| Assuming unequal variance         | 4.447 |      | 102.742 | .000 |
| Usual performance                 |
| Assuming equal variance           | 1.443 | .232  | 2.133 | 120   | .035 |
| Assuming unequal variance         | 2.253 |      | 119.165 | .026 |
| Total score                       |
| Assuming equal variance           | 2.799 | .097  | 3.563 | 120   | .001 |
| Assuming unequal variance         | 3.726 |      | 119.987 | .000 |

5 Conclusion

Through the teaching reform, in the process of the course reform of “technical economics”, we should optimize and integrate the teaching content of technical economics, pay attention to improve the teaching quality, efficiency and effect, actively explore a new teaching mode of the course, and furthermore cultivate students’ innovation consciousness and practical ability. According to the training objectives of the major, the teaching objectives of the course are defined; the teaching
objects are analyzed, and the teaching reform measures and strategies are determined. To stimulate students’ interest in learning, improve students’ high-level thinking ability, and ultimately improve the training quality of application-oriented composite talents to meet the needs of social talents.

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