Higher Education and Practice Vol. 2 No. 9, 2025

Exploration and Practice of Curriculum Development in Engineering Economics under the Context of New Engineering Disciplines

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Abstract: The emergence of new engineering disciplines poses heightened demands on the cultivation of engineering talents in China. This paper takes the Engineering Economics course within the Master of Engineering Management (MEM) program at Shanghai University of Electric Power as a case study to dissect the challenges facing course instruction. These challenges encompass the lack of prerequisite knowledge among students, the necessity to emphasize the distinctive features of the power industry in the curriculum, constraints imposed by limited teaching hours, and discrepancies between teaching materials and regulatory changes. In response to these hurdles, this paper puts forward a pathway for curriculum development within the paradigm of new engineering disciplines: advocating for a harmonious blend of knowledge dissemination and skill cultivation, while reinforcing vocational education; upgrading teaching methodologies by incorporating a hybrid online and offline approach to stimulate student autonomy; refining course contents to closely align with the developments in the energy industry; and implementing a systematic course evaluation. Through practical implementation, the course has developed distinctive features such as content redesign aligned with the trends in the energy and power sector, innovative teaching methodologies to unleash student potential, and the establishment of a specialized case database, effectively enhancing students' analytical and practical skills in engineering investment decisions to meet the burgeoning demand for high-level applied management talents in the industry under the backdrop of new engineering disciplines.

Keywords: New Engineering Disciplines; Engineering Economics; Curriculum Development; Teaching Reform

1. Introduction

Shanghai University of Electric Power, as one of the three independently established power universities in China, bears the mission of nurturing advanced management talents in the field of electric power and energy engineering. Since 2015, the university has been enrolling students in the Master of Engineering Management (MEM) program, which is primarily designed for training professionals in the electric power and energy industry, characterized by distinct features of the power sector. Engineering Economics is a core course under the "Master of Engineering Management (MEM)" program at Shanghai University of Electric Power, and is also a core course for the undergraduate program in "Engineering Management" and an elective course for the "Business Management" major. Furthermore, the content taught in this course serves as the core material for the foundational course in the "Energy Service Engineering" program at Shanghai University of Electric Power, the elective course Electric Power Project Decision Analysis and Evaluation for the entire university, and the core content of the elective course Techno-Economic Analysis of Electric Power Engineering in the School of Electrical Engineering.

Engineering Economics represents an interdisciplinary field at the intersection of engineering and economic sciences, emphasizing the study of the interplay between technology and economics in pursuit of their optimal merger. With the goal of enhancing economic efficiency, this discipline employs various cost-benefit analysis methods to provide scientific analytical and decision-making approaches for real-world economic activities. Through the study of this course, students

acquire a foundational understanding of the theory, methods, and skills of engineering economics, along with their practical application in pre-project decision-making. This equips students with a comprehensive understanding of aspects such as project funding, financial evaluation, national economic assessment, uncertainty analysis, equipment renewal analysis, asset valuation, value engineering, risk decision-making, risk management, evaluation of technological progress, innovation, and technology introduction, enabling them to conduct impartial, objective, rational, and accurate assessments of projects [1-3].

Against the backdrop of implementing innovation-driven development, China's "Made in China 2025" initiative, the Belt and Road Initiative, and other significant national development strategies, there exists a pressing demand for outstanding professionals who can seamlessly integrate theoretical knowledge, innovative practical skills, and engineering application capabilities [4-6]. In response, the Ministry of Education proposed the strategy for the development of new engineering disciplines in 2016, launching the New Engineering Disciplines program in 2017, heralding a new era in talent cultivation. The construction of new engineering disciplines transcends traditional disciplinary frameworks, revolutionizes talent cultivation models, and amid this background, the imperative to develop the Engineering Economics course within the MEM program at Shanghai University of Electric Power is imminent [7-8].

2. Challenges in the Development of the Engineering Economics Course

As a pivotal course in the field of management studies, Engineering Economics is commonly listed as a major-specific or compulsory course in various universities. However, when compared with this course at other institutions and in the context of evolving economic and social environments, there exist areas in need of improvement or enhancement:

(1) Given the specialized focus on the power industry at our institution, students enrolled in the MEM program primarily come from engineering disciplines such as power systems during their undergraduate studies. Consequently, these students generally lack exposure to prerequisite courses like Accounting and Financial Management and Analysis, which are essential for studying Engineering Economics. Therefore, it is imperative to contemplate how to integrate accounting and financial knowledge within this course to effectively enhance its pedagogical impact within the current 2-credit framework.

(2) Considering the curriculum structure of MEM and the focus on three key development directions: "Smart Grid Engineering Management," "New Energy Engineering Management", and "Power Engineering Safety Management," the course undeniably carries significant characteristics of the power industry. Consequently, it is crucial to incorporate the unique attributes of the power energy sector into the teaching of Engineering Economics. Notably, the utilization of case studies, a critical component of the course, necessitates further enrichment by aligning them with the intricacies of the power energy industry.

(3) With the current 2-credit structure, relying solely on traditional classroom teaching methods proves inadequate for achieving the course's educational objectives given the profile of the student cohort. Therefore, enhancing online teaching resources is essential to provide students with sufficient opportunities for effective learning beyond classroom hours.

(4) Engineering Economics is closely intertwined with disciplines such as accounting and tax law. In recent years, significant changes have occurred in China's enterprise accounting standards and tax laws, such as the introduction of the "business tax to value-added tax" reform and annual adjustments in VAT rates. However, the course materials exhibit a certain degree of obsolescence. Consequently, there is a need to promptly adjust the classic content, cases, and exercises of Engineering Economics in line with current enterprise accounting standards and tax laws during classroom instruction.

(5) Building on the distinctive characteristics of the power industry at our university and the positioning of the MEM program in cultivating high-level, applied engineering management talents for the power sector, the teaching of Engineering Economics necessitates customizing content in alignment with the postgraduate training objectives and characteristics, closely integrating with the developments in the power energy industry. Particularly concerning case studies, it is crucial to construct cutting-edge and relevant teaching content [9-10]. To address the evolving needs of

the new era, where adjustments in the strategic development of China's power energy industry are ongoing, it is essential to make corresponding adaptations to the course content. This will enable graduate students to apply the fundamental theoretical knowledge of Engineering Economics to practical work and research paper writing, nurturing their ability to translate theory into practice. By meeting the fundamental requirements of research and teaching development at our university, this approach equips graduates with the skills to effectively adapt to the management roles in the power energy industry under the new circumstances.

Given the above analysis, it is imperative to reconsider, within the framework of new engineering disciplines, how to explore innovative methods on top of existing teaching models to significantly enhance the quality of education.

3. Development Path of the Engineering Economics Course in the Context of New Engineering

(1) Balancing Knowledge Dissemination and Competency Cultivation: Emphasizing the integration of professional ethics education alongside the systematic teaching of engineering economics, this approach merges theoretical instruction with modern engineering project introductions. By employing immersive and embedded education practices, students are guided to transform knowledge into intrinsic qualities and comprehensive capabilities. The fusion of academic knowledge, skill cultivation, and professional ethics education promotes the cultivation of correct professional values, ethics, and teamwork spirit among students, enhancing their non-technical competencies.

(2) Enhancing Teaching Methods to Unleash Student Potential: Recognizing the interdisciplinary and practical nature of studying engineering economics, traditional teaching methods fall short in achieving optimal results. Therefore, in the course implementation process, we leverage platforms like Chaoxing Learning Platform, to share educational videos, lecture slides, post-class exercises, phased tests, and online Q&A sessions related to the course based on the current circumstances. By adopting a combination of online resources for self-directed learning and a flipped classroom approach offline, along with flexible utilization of case studies and critical discussions, students' interest and proactive engagement are heightened. This transition from passive to active learning facilitates the effective absorption of professional knowledge, while enhancing students' overall literacy and teamwork skills.

(3) Enhancing Teaching Content and Restructuring Course Curriculum: Presently, the MEM program's Engineering Economics course is structured around 2 credits. To address this, the teaching team, drawing from the latest theoretical advancements and practical developments in engineering economics, aligns closely with emerging trends in the energy and power industry and construction management domain. Through a thorough review and refinement of the syllabus and instructional plans while incorporating insights from renowned domestic and international textbooks, the curriculum is restructured. Concurrently, drawing upon representative case studies globally and utilizing research projects commissioned by energy and power enterprises undertaken by the teaching team, specialized problem-centered thematic studies and teaching cases are systematically compiled focusing on knowledge modules such as "Financial Evaluation of Construction Projects", "National Economic Evaluation of Construction Projects", "Feasibility Studies for Construction Projects", "Equipment Renewal Analysis", and "Value Engineering".

(4) Comprehensive Course Evaluation System: The method of assessing courses not only impacts students' final grades but also influences their future development trajectory. A fair and systematic assessment approach promotes holistic student development, transcending mere surface-level scores. Evaluation encompasses multi-faceted assessments to gauge students' achievement of course objectives, including regular academic performance and end-of-term exam results, culminating in a weighted total score out of 100 points. Regular assessment components include assignments, attendance, classroom interactions, among others. The weightage of each assessment component is fine-tuned based on the specific circumstances each year.

4. Distinctive Features of Engineering Economics Course in the Context of New Engineering

(1) Aligning Content with Industry Trends in

Energy and Power Sectors and Engineering Construction Management: The instructional team closely monitors the latest developments in the energy and power sectors as well as engineering construction management domains. Drawing insights from research at other institutions and aligning with the unique characteristics of the school, the team refines and enhances the syllabus and instructional plans to create suitable and cutting-edge teaching content. Special focus is placed on problem-oriented thematic topics and teaching cases to meet the fundamental requirements of the course and equip graduating students with the necessary skills to effectively adapt to the evolving landscape of energy and power-related engineering construction industries.

(2) Innovative Teaching Approaches to Stimulate Student Potential and Enhance Comprehensive Skills: Given the interdisciplinary and practical nature of engineering economics, leveraging platforms like Superstar Learning Network, as well as internet tools like WeChat, is essential. Through a blend of online self-directed learning resources and offline hybrid teaching, the course integrates classroom knowledge explanation with case discussions, post-class exercises with Q&A sessions, and problem-driven thematic discussions during class time. Encouraging students to engage in project research under the guidance of teachers post-class promotes a research-oriented learning approach, stimulating students' intellectual potential. Through theoretical and practical exploration, students are taught methods and approaches to analyze and resolve problems, enhancing their skills and analytical capabilities while reinforcing their qualities during the knowledge acquisition process. Furthermore, comprehensive thematic exercises enhance students' mastery and application of engineering economic knowledge.

(3) Systematic Development of Engineering Economics Teaching Case Database: By meticulously selecting representative teaching cases from both domestic and international spheres based on specific knowledge points, and utilizing research projects undertaken by the teaching team in energy and power enterprises, a teaching case database is compiled. This initiative aims to integrate research insights into teaching methodologies, facilitating a reciprocal knowledge exchange between research and education.

5. Conclusions

Drawing on the case study of the Engineering Economics foundational course in the Master of Engineering Management program at Shanghai University of Electric Power, this paper initially dissected the challenges encountered during course development in the context of the new engineering paradigm. Subsequently, by unraveling the instructional processes and integrating flipped classroom methodologies, the fusion of knowledge dissemination, skill cultivation, and professional ethics education was examined. This analysis aims to fully mine and integrate elements of character development within the course content, embodying the principles of holistic education in curriculum construction and guiding its manifestation. The ultimate objective was to effectively marry curriculum development with societal talent cultivation goals. Moreover, proposed strategies for course development included upgrading teaching methodologies to unleash student potential, transitioning from passive to active learning, enhancing instructional content, restructuring course delivery, and implementing a systematic course evaluation framework. These initiatives aim to cultivate students' abilities in self-directed learning, problem identification, synthesis, and solution-finding. This fosters innovative thinking and hones students' ability to comprehensively apply knowledge, aiming to significantly enhance students' capacity for analyzing investment decisions in real engineering projects. This prepares them to adeptly navigate management roles in the engineering construction industry within the evolving landscape of the new engineering paradigm.

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