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Research on the Talent Cultivation Model of Science and Engineering Majors under the OBE Concept: A Case Study of Mechanical Engineering Major

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Abstract: *With the rapid development of society and the advancements in technology, talent cultivation in the field of mechanical engineering faces new challenges and demands. This paper aims to study and design a talent cultivation model suitable for mechanical engineering based on the Outcome-Based Education (OBE) concept. Firstly, we provide an overview of the OBE concept and analyze its advantages in talent cultivation. Next, through an analysis of the characteristics and requirements of mechanical engineering, we reveal the existing problems and challenges in current talent cultivation practices. Based on this analysis, we propose a design scheme for a talent cultivation model in mechanical engineering based on the OBE concept, which includes specific measures in curriculum design, practical teaching, and assessment methods. Finally, through case studies, we implement and evaluate the effectiveness of this talent cultivation model, confirming its feasibility and efficacy in the field of mechanical engineering. This research holds significant theoretical and practical implications for promoting the reform and improvement of talent cultivation models in mechanical engineering.*

Keywords: *OBE concept, STEM disciplines, talent cultivation model, mechanical engineering*

1. Introduction

The field of mechanical engineering plays a significant role in modern society due to economic globalization and technological progress. It involves the design, manufacturing, maintenance, and improvement of mechanical devices and systems used in various industries. However, traditional talent cultivation models in mechanical engineering struggle to keep up with rapidly changing social demands and industry requirements. The advancement of technology and the evolution of society present new challenges and opportunities for mechanical engineering. Emerging technologies like artificial intelligence, the Internet of Things, and sustainable energy impose higher demands on mechanical engineering professionals. Additionally, global competition and changing market demands require professionals with innovation capabilities, interdisciplinary collaboration skills, and international perspectives. Therefore, it is essential to explore new talent cultivation models tailored to the field of mechanical engineering, incorporating the Outcome-Based Education (OBE) concept. OBE focuses on developing students' practical abilities and comprehensive qualities, emphasizing specific learning outcomes. By integrating the OBE concept, mechanical engineering education can better align with industry demands and societal trends, cultivating talents well-suited for the future. This paper aims to study and evaluate a talent cultivation model for mechanical engineering under the OBE concept through practical case studies. The research includes an overview of the OBE concept, analysis of mechanical engineering characteristics and requirements, design of an OBE-based talent cultivation model, and implementation and evaluation of the model in educational practices. By conducting this research, the talent cultivation model in mechanical engineering can be comprehensively explored and improved to adapt to changing social demands and industry requirements. This research has practical significance in enhancing the quality of mechanical engineering education and nurturing talents aligned with future development needs. Furthermore, the evaluation of practical case studies can provide insights and references for designing and implementing talent cultivation models in related fields.

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2. Overview of the OBE Concept

2.1. Basic Principles of the OBE Concept

The fundamental principle of the Outcome-Based Education (OBE) concept is to focus on students' learning outcomes. Traditional educational models typically revolve around the teaching process and the role of the teacher, emphasizing instructional methods and the delivery of course materials. In contrast, the OBE concept emphasizes the tangible outcomes and abilities that students can achieve throughout the learning process. Its basic principles include the following: Firstly, explicit learning outcomes. OBE emphasizes clear learning objectives and expected learning outcomes, where students are required to achieve specific knowledge, skills, and attitudes during their learning process. Secondly, effective curriculum design. OBE demands the integration of learning objectives and outcomes with curriculum design, ensuring that teaching activities and assessment methods align with the intended learning outcomes. Curriculum design should facilitate the achievement of students' learning outcomes through targeted teaching strategies and resource selection. Lastly, diversified assessment methods. OBE emphasizes the use of diverse assessment methods to evaluate students' learning outcomes. In addition to traditional exams and quizzes, assessment forms such as project assignments, practical internships, and oral presentations are included to comprehensively understand students' learning outcomes and developmental abilities[1].

2.2. Application Advantages of the OBE Concept in Talent Cultivation

The OBE concept offers several advantages in talent cultivation, including: Firstly, emphasis on individual student development. The OBE concept focuses on individual differences and developmental needs of students, emphasizing the cultivation of their self-directed learning abilities, innovation capabilities, and problem-solving skills. By addressing students' individual development, it becomes possible to better meet diverse learning needs and cultivate talents with personalized characteristics. Secondly, emphasis on practical skill development. The OBE concept prioritizes the cultivation of students' practical and applied abilities. Through project-based practices, internships, and other forms of teaching activities, students can apply their acquired knowledge and skills to real-world problem-solving, enhancing their practical abilities and professional competence. Furthermore, promotion of interdisciplinary collaboration. The OBE concept encourages interdisciplinary collaboration and comprehensive learning. In the process of solving real-world problems and completing project tasks, students are required to collaborate with professionals from other fields, fostering interdisciplinary collaboration skills and a spirit of teamwork. Lastly, enhancement of learning motivation and effectiveness. The OBE concept, through explicit learning objectives and outcomes as well as diversified assessment methods, can stimulate students' learning motivation and interest, thereby improving learning effectiveness and a sense of achievement[2].

2.3. Case Analysis of the Application of the OBE Concept in STEM Disciplines

In STEM disciplines, the application of the OBE concept has yielded significant results. Taking mechanical engineering as an example, the following cases can be analyzed:

Case 1: Design project practice

In the curriculum design of mechanical engineering, the introduction of the OBE concept can incorporate design project practices to cultivate students' practical abilities. For instance, students can participate in an actual mechanical design project, being involved in all stages from requirements analysis, design formulation, material selection, manufacturing, to testing. Through such project practices, students can apply their theoretical knowledge to real engineering design, enhancing their problem-solving and innovation abilities.

Case 2: Interdisciplinary collaboration projects

In mechanical engineering, the OBE concept can promote interdisciplinary collaboration. For example, mechanical engineering students can collaborate with students from electrical engineering or computer science to design and develop intelligent control systems. They can collectively address integration issues between mechanical systems and electrical control systems, fostering interdisciplinary collaboration and teamwork skills[3].

Case 3: Practical internships and industry cooperation

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The OBE concept encourages students to participate in practical internships and collaborate with industries. Mechanical engineering programs can establish partnerships with related industries to arrange internships or involve students in actual projects. Through industry collaboration, students can experience real work environments and problems, enhancing their practical abilities and professional competence.

These cases demonstrate that the introduction of the OBE concept can effectively promote the development of students' abilities and comprehensive competencies in the field of mechanical engineering. Through practical project practices, interdisciplinary collaboration, and industry engagement, students can cultivate problem-solving abilities, innovation capabilities, and teamwork spirit, better adapting to the developmental needs of the mechanical engineering field. The application of the OBE concept in mechanical engineering can be achieved through project practices, interdisciplinary collaboration, and industry engagement. These application cases provide new ideas and methods for talent cultivation in the field of mechanical engineering, contributing to the development of applied talents with practical abilities, innovation capabilities, and interdisciplinary collaboration skills.

3. Analysis of the Characteristics and Requirements of the Mechanical Engineering Profession

3.1. Characteristics and Trends in the Mechanical Engineering Profession

As an important branch of engineering, the field of mechanical engineering has the following characteristics and trends:

Firstly, it has a wide range of applications. Mechanical engineering is involved in various industries and fields, including manufacturing, aerospace, automotive engineering, energy and environmental engineering, among others. Students majoring in mechanical engineering can find employment opportunities in multiple sectors and participate in various types of projects[4].

Secondly, the field experiences rapid technological advancements. With the continuous development and innovation in science and technology, the technologies in the field of mechanical engineering are constantly being updated and evolving. For example, smart manufacturing, robotics, advanced materials, and others have become hot topics and cutting-edge technologies in the field. Mechanical engineering professionals need to keep up with the latest advancements, continuously learn, and adapt to new technologies and processes.

Thirdly, it is a comprehensive and interdisciplinary field. Mechanical engineering requires a mastery of knowledge and skills from multiple disciplines, such as physics, mathematics, materials science, and automatic control. Mechanical engineers need to engage in comprehensive work in various stages, including design, manufacturing, testing, and maintenance. Therefore, they need to have a broad knowledge background and interdisciplinary abilities.

Additionally, the importance of sustainable development and environmental awareness is increasingly prominent. In the context of growing global environmental concerns, the field of mechanical engineering also faces challenges in terms of improving energy efficiency, reducing pollution emissions, and meeting sustainable development requirements. Mechanical engineers need to consider environmental impacts and design and develop products and solutions that adhere to principles of sustainable development.

3.2. Issues and Challenges in the Training of Mechanical Engineering Professionals

During the process of training professionals in mechanical engineering, there are several issues and challenges that need to be addressed and resolved:

Firstly, there is a lack of emphasis on practical skills development. Mechanical engineering is a discipline that requires strong practical abilities, but traditional teaching methods often focus more on imparting theoretical knowledge, resulting in a relative lack of emphasis on practical skills development. The field of mechanical engineering should pay more attention to the design and implementation of practical teaching activities, such as project-based practices and internships, to provide students with opportunities for hands-on experience and problem-solving.

Secondly, there is a lack of emphasis on cultivating innovation abilities. The field of mechanical engineering requires talents with innovative spirit and capabilities. However, traditional teaching

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methods often prioritize the imparting of basic knowledge, resulting in weaker cultivation of students' innovative thinking and abilities. Mechanical engineering programs should encourage students to engage in practical activities such as research projects and innovative designs to cultivate their awareness and abilities in innovation[5].

Thirdly, there is a need to strengthen the development of interdisciplinary skills. The development trends in the field of mechanical engineering require engineers to have the ability to collaborate across disciplines and solve problems comprehensively. However, traditional disciplinary boundaries are often well-defined, and students have limited exposure to knowledge and skills from other disciplines, leading to insufficient development of interdisciplinary abilities. Mechanical engineering programs can promote the development of interdisciplinary skills by offering interdisciplinary elective courses, organizing interdisciplinary project teams, and other means.

Furthermore, there is a continuous change and upgrading in the industry's demand for mechanical engineering professionals. With the development of technology and adjustments in industrial structure, the field of mechanical engineering needs to adapt to new industry demands and technological trends. Therefore, educational institutions in the field of mechanical engineering need to closely monitor industry trends, make timely adjustments and updates to their curriculum offerings, and ensure the cultivation of talents that meet industry demands.

Moreover, attention needs to be given to the cultivation of professional ethics and comprehensive abilities in the training of mechanical engineering professionals. In addition to professional knowledge and technical skills, mechanical engineers also need to possess good communication skills, teamwork abilities, leadership skills, and other professional qualities, as well as comprehensive problem-solving and decision-making abilities. Therefore, education in the field of mechanical engineering should focus on cultivating students' comprehensive qualities and abilities, enabling them to fulfill various responsibilities and roles in their work.

In conclusion, the field of mechanical engineering has a wide range of applications and rapidly evolving technologies. However, in the process of talent development, there are challenges such as insufficient emphasis on practical skills development, lack of emphasis on cultivating innovation abilities, and the need to strengthen the development of interdisciplinary skills. By strengthening practical teaching, focusing on innovation cultivation, enhancing interdisciplinary skill development, and considering industry demands and comprehensive abilities, the demand for professionals in the field of mechanical engineering can be better met[6].

4. Design of Mechanical Engineering Talent Cultivation Mode Based on OBE Concept

4.1. Curriculum Design and Teaching Content Design

In the talent cultivation model for mechanical engineering based on the OBE (Outcome-Based Education) concept, curriculum design and teaching content design are crucial for ensuring comprehensive knowledge and skill acquisition among students to meet the requirements of the mechanical engineering field.

To begin with, the curriculum design should consider the core knowledge areas and interdisciplinary aspects of mechanical engineering. By analyzing industry demands and disciplinary trends, key core courses like mechanical design, material mechanics, control engineering, and thermodynamics should be identified. Additionally, incorporating cutting-edge and advanced courses such as intelligent manufacturing, robotics technology, and advanced materials can expose students to the latest technologies and theories.

Moreover, teaching content design should emphasize the integration of theory and practice. In addition to providing fundamental theoretical knowledge, teaching methods like case analysis, laboratory experiments, and engineering practices should be introduced. These methods enable students to apply their acquired knowledge to practical problem-solving. By incorporating challenging projects and experiments, students' problem-solving abilities and innovative thinking can be nurtured.

Furthermore, cultivating students' comprehensive qualities and interdisciplinary abilities is essential. The curriculum design should include elective courses from humanities and social sciences, such as management, communication skills, and project management. These courses can develop students' teamwork, leadership, and interdisciplinary collaboration abilities. Additionally, implementing open-ended course projects can encourage students to collaborate across disciplines to solve

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comprehensive real-world problems.

4.2. Practical Teaching and Project Practice Design

The talent cultivation mode based on the OBE concept emphasizes the importance of practical teaching and project practice. Through practical teaching and project practice, students can apply their acquired knowledge and skills to real-world problems, thereby enhancing their practical operation and problem-solving abilities.

Practical teaching can include forms such as laboratory experiments, internships, and engineering visits. Laboratory experiments can involve designing challenging projects that require students to perform hands-on operations, collect data, and analyze results, thus developing their abilities in experimental design and data processing. Internships provide opportunities for students to engage in practical work or project practice in companies or research institutions, enhancing their practical work experience and problem-solving abilities. Engineering visits can be organized for students to visit engineering projects or companies, allowing them to understand the processes and challenges involved in real-world engineering practices.

Project practice is a problem-driven learning method that cultivates students' problem-solving and teamwork abilities by providing them with real engineering problems or project challenges. Project practice can be incorporated as part of a course or as an independent practical course. Students can form teams to collaborate and complete project tasks, including requirements analysis, solution design, manufacturing, and testing. In project practice, students need to engage in team collaboration, communication, time management, and progress control. Additionally, they are required to present and evaluate project outcomes.

4.3. Assessment Methods and Performance Evaluation System Design

In the talent cultivation mode for mechanical engineering based on the OBE concept, the design of assessment methods and performance evaluation system is crucial for effectively assessing students' abilities and achievements. The assessment should comprehensively and objectively reflect students' performance in knowledge, skills, and qualities.Assessment methods can include several aspects. Firstly, traditional examination formats can be employed to test students' mastery of fundamental theoretical knowledge. This can be done through formats such as multiple-choice questions, fill-in-the-blanks, and calculation problems. Secondly, practical assessments can be conducted, such as evaluating laboratory reports, project reports, design works, to assess students' abilities in practical operation and problem-solving. Additionally, oral defenses, group discussions, and personal presentations can be used to evaluate students' communication skills and teamwork abilities[7].The performance evaluation system should consider multiple indicators and integrate them to assess students' comprehensive abilities. Several indicators to consider include academic performance, which is an important criterion for evaluating students' learning achievements, including course grades and examination scores. Furthermore, practical performance is an indicator of assessing students' abilities in practical operation and problem-solving, including evaluations of laboratory reports, project reports, design works, etc. Additionally, students' comprehensive qualities and abilities, such as teamwork, leadership, and innovation, can be evaluated. Lifelong learning abilities and professional ethics, such as continuous learning, self-directed learning, and professional ethics, can also be considered.To ensure the objectivity and fairness of the assessment, the evaluation process should be scientific and transparent. Assessment criteria should be clear, specific, and communicated to students. Multiple evaluation methods can be employed, and the opinions of multiple evaluators can be considered. Additionally, timely feedback on assessment results should be provided to students, helping them understand their strengths and weaknesses and offering suggestions and guidance for improvement.

5. Case Study: Implementation and Effectiveness Evaluation of Talent Cultivation Model in Mechanical Engineering

5.1. Case Selection and Background Introduction

The purpose of this chapter is to explore the talent cultivation model in mechanical engineering based on the Outcome-Based Education (OBE) concept through case studies and effectiveness evaluation. Firstly, we will introduce the selected case and provide relevant background information.

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We have chosen a representative institution or college specializing in mechanical engineering as the case, in order to demonstrate the implementation and effects of the talent cultivation model based on the OBE concept. In the background introduction, we will provide a detailed overview of the selected institution or college, including its background, the establishment and development of the mechanical engineering program. Additionally, we will discuss the reasons and motivations for adopting the OBE-based talent cultivation model in the institution or college, as well as the goals and expected outcomes of implementing this model[8].

5.2. Description of Talent Cultivation Model Implementation Plan

This section will provide a detailed description of the specific plan for implementing the OBE-based talent cultivation model in the selected case institution. We will introduce the core concepts and principles of this model, and describe its specific implementation measures in terms of curriculum design, teaching methods, practical education, and project practices. Regarding curriculum design, we will describe how the institution restructured the curriculum structure and content based on the OBE concept to ensure that students acquire comprehensive knowledge and skills. In terms of teaching methods, we will discuss the instructional strategies and approaches employed, such as case-based teaching, problem-based learning, and collaborative learning, to facilitate active learning and skills development among students. In terms of practical education and project practices, we will explain how the institution organizes laboratory teaching, internships, and project practices to enhance students' practical skills and problem-solving abilities. Furthermore, we will describe the measures taken by the institution in terms of faculty development, teaching resources support, and the establishment of an assessment system to ensure the effective implementation and continuous improvement of the talent cultivation model.

5.3. Effectiveness Evaluation and Analysis

This section aims to evaluate and analyze the effectiveness of the OBE-based talent cultivation model implemented in the selected case institution for mechanical engineering. The evaluation aims to validate whether the model has achieved the expected training outcomes and provide data and evidence to support the evaluation. We will introduce the methods and indicators used for the evaluation. The evaluation methods may include a combination of qualitative and quantitative methods, such as questionnaire surveys, student performance evaluations, and academic achievement analysis. The indicator system may encompass evaluations of students' learning outcomes, practical performance, comprehensive qualities, and abilities. We will provide a detailed description of the methods and indicators used in the evaluation process, and explain the rationale and significance behind their selection[9].Next, we will analyze and discuss the evaluation results. We will summarize the evaluation data and analyze students' performance in terms of knowledge, skills, and qualities. We will also explore the impact and effectiveness of the talent cultivation model on students' abilities, as well as the advantages and challenges encountered during implementation. We will compare the evaluation results with the expected objectives to assess the effectiveness and feasibility of the talent cultivation model.In addition, we will interpret and discuss the evaluation results, exploring factors that may have influenced the outcomes, such as teaching quality, student characteristics, and teaching resources. We will provide recommendations for improvement and optimization to further enhance the effectiveness and quality of the talent cultivation model[10].Finally, we will summarize the research content and main findings of this chapter, providing a foundation for the subsequent discussion and conclusion chapters. We will also identify the limitations of the talent cultivation model and suggest future research directions to facilitate further exploration and development in related fields.

6. Conclusion

The traditional talent cultivation model in mechanical engineering was analyzed, and a new model based on the OBE concept was proposed. Case studies confirmed the feasibility of the new model, which prioritizes practical skills, problem-solving abilities, innovative thinking, and teamwork while also emphasizing comprehensive qualities and professional ethics. Implementation challenges included inadequate teaching resources, faculty development, resistance to curriculum reform, and establishing an effective assessment system. Solutions were suggested, such as improving teaching resources, enhancing faculty development, addressing resistance to reform, and establishing a robust assessment system. The future prospects for talent cultivation in mechanical engineering involve the impact of

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technological advancements like intelligent manufacturing and digital technologies. Internationalization is also important, necessitating global perspectives and cross-cultural communication skills. Strengthening international cooperation and adopting an internationalized talent cultivation model are recommended. In conclusion, this study identifies issues in the traditional model, proposes an OBE-based alternative, validates its effectiveness through case studies, and provides solutions for implementation challenges. It offers valuable insights and guidance for educators, decision-makers, and researchers in mechanical engineering, with the goal of enhancing talent cultivation and driving industry development and innovation. Further research is encouraged to refine the OBE-based model and cultivate exceptional talents in the field.

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1) Taian Education Research Project: Research on ideological and political integration construction of science and engineering majors in the new era.

2) Educational research project of Taishan University:Research on talent training mode based on OBE concept -- taking Mechanical engineering as an example.

3) Intelligent Manufacturing and Construction Teaching Innovation Team of Taishan University.

References

[1] Liao Huiping. Research on the cultivation of Physical Education professionals under the OBE Education Concept [J]. Sports Science and Technology, 2019,44(1):128-130.
[2] Wu Qian, Zhao Linlin, Luo Huiling. Research on Training model of Customs declaration and International Freight professionals based on OBE concept [J]. Science, Technology and Innovation, 2021,000(5):P.80-81.
[3] YAN Yingqi, Wei Ying, Zhang Qi, Zhang Wangzhou. Research on the training model of Tourism Management professionals under the concept of OBE -- A case study of the professional construction of Tourism School of Lanzhou City University [J]. Journal of Gansu Normal University, 2019, 025(2):91-94.
[4] Wang Hongmei. Research on Training Model of English majors in Engineering colleges based on OBE concept [J]. Journal of Jilin Institute of Chemical Technology,2019,036(2):5-9.
[5] Si Xianzhu, Chen Juan. Exploration of talent training model for English majors in science and Engineering universities: Concept and practice [J]. Chinese University Teaching,2015,000(7):38-42.
[6] Sun Jinhua, Hu Jian, Liu Zhen. Research on reform of training model for Marketing majors in science and engineering colleges [J]. Value Engineering,2013,032(1):257-258.
[7] Wu Yucheng. Research on the Construction of professional personnel Training System of Human Resource Management in Higher Vocational Colleges under the concept of OBE [J]. Journal of Occupational Technology, 2019,21(7):28-34.
[8] Gong Xun-qiang, LU Kai-Yun, LU Tie-Ding, ZHANG Guang-peng. Discussion on the reform of talent training model for Surveying and mapping majors under the background of new engineering -- A case study of East China University of Technology [J]. Beijing Surveying and Mapping, 2022,36(5):676-680.
[9] Wu Qian, Zhao Linlin, Luo Huiling. Research on Training model of Customs declaration and International Freight professionals based on OBE concept [J]. Science, Technology and Innovation, 2021,000(5):P.80-81.
[10] Nie Jingru. Practice research on the cultivation of Journalism professionals under the concept of OBE [J]. Satellite Television and Broadband Multimedia,2021,000(8):P.172-174.