Research on teaching mode of Introduction to Mechanical Engineering course

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Abstract. This article is aimed at the teaching status of domestic universities. A set of teaching mode and syllabus based on the improvement of the traditional Introduction to Mechanical Engineering course is proposed. It mainly introduces the nature and tasks of the course, the design of the syllabus content and the grading standard of the course. It also explains the specific implementation plan of the teaching mode. Introduction to Mechanical Engineering is intended for students who are in the first year of a typical university program in mechanical engineering. The main tasks of this course include increasing students' interest in mechanical engineering, enabling them to understand the role and skills of mechanical engineers in our society, deepening their understanding of the connotation of mechanical engineering and learning about modern tools for solving complex engineering problems and the development of typical marine structures. Course grades are evaluated based on the number of attendance and the completion of homework. While introducing online teaching, it also provides video lesson resources for students to learn after class because of the current impact of the "COVID-19". Considering about the teacher's own scientific research direction, the theoretical research and engineering practice content are combined. Through the study of the teaching cases proposed, it is concluded that the teaching mode has the advantages of not being restricted by the teaching location, enhancing students' enthusiasm for learning and guiding students to plan their future careers and make contributions to the society. The feasibility and effectiveness of the new model are verified.

1. Introduction

It is an important strategy for China's current economic development to drive industrialization with informatization and vigorously promote the integration of informatization and industrialization. These changes have made the mechanical profession more and more abundant. Introduction to Mechanical Engineering course is to combine the development trend of modern machinery to provide professional general education for mechanical students to help freshmen who have just entered the university understand the background of mechanical engineering, the latest developments and trends of the mechanical industry at home and abroad, and the industry knowledge [1]. These help them understand the composition of the professional knowledge chain and break through the "professional vision" and expansion of "knowledge horizon". The construction of introductory courses that adapt to the development of the times and modern teaching models is of great significance for guiding freshmen to understand the majors and solving the doubts and confusions about future university study [2].
2. Nature and Tasks of the Introduction to Mechanical Engineering Course

2.1. Nature of the Course
Introduction to Mechanical Engineering course is intended for students who are in the first year of a typical university program in mechanical engineering. It will introduce students to the ever-emerging field of mechanical engineering and help them appreciate how engineers design the hardware that improves societies all around the world. The whole course is devoted to the treatments of technical problem-solving skills, design, engineering analysis, and modern technology [3]. By learning these contents, students will develop a solid foundation of problem solving, design, and analysis skills that will help them make future contributions to mechanical engineering majors.

2.2. Tasks of the Course
The main tasks of this course include increasing students' interest in mechanical engineering, enabling them to understand the role and skills of mechanical engineers in our society, deepening their understanding of the connotation of mechanical engineering and learning about modern tools for solving complex engineering problems and the development of typical marine structures. At the same time, this Course will teach them how to master the overall design and production process of mechanical products, as well as master technical problem solving and communication skills [4]. Finally, teaching students the way of searching, reading, writing and submitting patents and scientific papers.

3. Teaching mode design based on the Introduction to Mechanical Engineering course

3.1. Teaching content design
The teaching content of the Introduction to Mechanical Engineering course needs to address the freshmen's concerns about their major, such as: what to do in this major, what can be learned in this major, and what can be done after graduation, mainly by teaching the students reflect around "Why, What, How" these three issues and guiding them to clarify their learning goals. These methods will help students to understand and love majors, stimulate students' enthusiasm for learning, and improve students' sense of identity with majors.

The curriculum is mainly set up in eight chapters, each chapter explains and discusses a key issue from many aspects, so that students can better grasp the knowledge they have learned. The main content is as follows:

Chapter 1 Mechanical Engineering Profession
  1.1 Overview
  1.2 What Is Engineering
  1.3 Who Are Mechanical Engineers
  1.4 Career Paths
  1.5 Typical Program of Study
  1.6 Summary

Chapter 2 Mechanical Design
  2.1 Review
  2.2 The Design Process
  2.3 Manufacturing Process

Chapter 3 Technical Problem-Solving and Communication Skills
  3.1 General Technical Problem-Solving Approach
  3.2 Unit Systems and Conversions
  3.3 Significant Digits
  3.4 Written Communication
  3.5 Graphical Communication
3.6 Technical Presentations

Chapter 4 Seminar
Some volunteers may prepare a PowerPoint presentation and communicate with us, covering the following contents:

4.1 Self-introduction: yourself, your family, your hometown.
4.2 Which job are you going to land? Which country? Which company? Why?
4.3 Briefly introduce a typical company, its job requirements.
4.4 How to achieve your goal? Knowledge, skills, tools?

Chapter 5 Patent writing
5.1 Overview
5.2 How to develop a patent
5.3 Patent search strategy and analysis
5.4 Structure and relations
5.5 General writing requirements
5.6 Example analysis

Chapter 6 Paper writing
6.1 Introduction
6.2 Preparing your manuscript
6.3 Structuring your article
6.4 Using proper language
6.5 Example analysis

Chapter 7 Computer-aided engineering
7.1 Concept
7.2 Finite element method
7.3 Main software
7.4 Application examples

Chapter 8 Development of Pressure hulls
8.1 Background
8.2 Spherical pressure hulls
8.3 Egg-shaped pressure hulls
8.4 Longan-shaped pressure hulls
8.5 Cylindrical pressure hull

The first, second and third chapters of the course mainly focus on what is mechanical engineering, the concepts and methods of mechanical design, and the solutions to mechanical problems. By studying these three chapters, students can establish a basic framework for the knowledge they have learned [5]. The fourth chapter is set as a seminar. Students can introduce their basic situation through this seminar, and they can also raise the problems encountered in the learning process for the courses they have learned, so as to lay the foundation for better learning courses in the later period. The fifth and sixth chapters mainly teach learning how to write patents and papers, and lay a solid foundation for later academic research. The seventh and eighth chapters teach students how to use finite element and other related software through computer operation, popularize the application of this course in the field of pressure hulls, provide students with the necessary tools and software for learning, and guide students to pay attention to the application of this course in the field of ocean exploration. The class schedule is as follows:
Table 1. The Distribution of the Total Hours

| Chapter | Lecture | Experiment | Discussion | Assignment | Total |
|---------|---------|------------|------------|------------|-------|
| Chapter 1 | The Mechanical Engineering Profession | 4 | 4 | | |
| Chapter 2 | Mechanical Design | 2 | 2 | 4 |
| Chapter 3 | Technical Problem-Solving and Communication Skills | 4 | | 4 |
| Chapter 4 | Seminar | 8 | 8 | | |
| Chapter 5 | Patent writing | 4 | 4 | | |
| Chapter 6 | Paper writing | 4 | | 4 |
| Chapter 7 | Computer-aided engineering | 2 | | 2 |
| Chapter 8 | Development of Pressure hulls | 2 | | 2 |
| Total | | | | 32 |

3.2. Score evaluation
The grade assessment of the Introduction to Mechanical Engineering can be divided into homework (40%) and project work (60%). Assignments are arranged after each topic. Since the standard answer for each homework has been discussed in the corresponding course, anyone who answers seriously and submits homework on time will get full marks. The work of this project is not only used for communication, but also for each evaluation of the student's course grade. In addition, everyone needs to prepare a PPT presentation, which involves self-introduction, learning goals and methods, and a brief introduction to a typical company and its job requirements. The above content containing relevant data requires students to display it in high-quality charts.

The project work is not only intended for communication, but also is intended for the project grade of each student. Each one needs to prepare a PowerPoint presentation and communicate with us, covering the following contents together with several high-quality figures and tables:

1. Self-introduction: yourself, your family, your hometown.
2. Which job are you going to land? In which country? In which company? Why?
3. Briefly introduce a typical company, its job requirements.
4. How to achieve your goal? Knowledge, skills, tools?

According to these requirements, a project report is required to submit in a word format. The project grade is evaluated based on the four contents together with the report layout. Full score is 60. Detailed distributed points are as follows:

1. Self-introduction: yourself, your family, your hometown. (10)
2. Which job are you going to land? In which country? In which company? Why? (10)
3. Briefly introduce a typical company, its job requirements. (10)
4. How to achieve your goal? Knowledge, skills, tools? (15)
5. Report layout should be concise and beautiful. (15)

3.3. Online teaching plan arrangement
We have adopted the following teaching mode in conjunction with the syllabus. It is mainly carried out
through teaching online, the main implementation steps is by:
1. Sign in from time to time during class to ensure that every student can participate in learning.
2. Provide classic teaching videos for students to learn online (as shown in Figure 1).
3. Intensive exercises after class. The answer to the question is mainly summarized through the course content.
4. Expand knowledge through multimedia resources outside class.

![Figure 1. Classic teaching videos.](image)

Online courses will be uploaded to the QQ group created before the class, including all students, to facilitate learning and preview. While conducting online classroom teaching, a mechanical engineering introduction course website was established, which provide course introductions, course features, course outlines, course teaching plans, multimedia teaching plans, courseware examples, teacher introduction, teaching Video etc. This will create a good condition for students to learn distance online.

4. Discussion on the Online Teaching Mode
Due to the impact of "COVID-19", most schools around the world have adopted an online teaching model, and the online teaching model may become one of the mainstream teaching models in the future. This model does not limited by the teaching venue and number of people and can also provide students with rich course video materials and extracurricular exercises with the help of network cloud resources. Furthermore, the online teaching model can help students to strengthen their knowledge learning after class, and also help students prepare in advance.

Through the introduction and analysis of the previous part, we can know that this course has the characteristics of low difficulty and teaching in the form of special video lectures with the above eight chapters as indicators, which correspond to the depth of students’ understanding [6].

During online teaching, considering about the teacher's own scientific research direction, the theoretical research and engineering practice content are combined, which reflected the engineering professional ability and standards, and kept close to the frontier of mechanical engineering development and professionalism. Through the combination of theory and case, students can have a more in-depth and specific understanding of machinery and understand the engineering value.

5. Conclusions
This paper provided an efficient and convenient teaching mode and showed that as the online teaching mode gradually becomes the mainstream, students can have a more systematic and complete understanding of mechanical engineering by learning the Introduction to Mechanical Engineering course through the online teaching program. They will have a deeper understanding of the major, and mobilize the enthusiasm for subsequent professional courses. At the same time, students have clearer goals for future studies or career choices, which is conducive to better planning of future study and life.

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