

Research on the Curriculum Reform of “Materials for Mechanical Engineering” Course Based on Big Data

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Abstract: Under the background of big data, the curriculum reform is significant for universities to improve the quality of engineering education. “Materials for Mechanical Engineering” is an essential foundational course for the students majoring in mechanical engineering. To improve the teaching quality of “Materials for Mechanical Engineering”, the teaching problems are analysed and summarized in this work. Besides, the curriculum reform is explored, including developing a teaching content system and updating teaching courseware, innovating teaching methods and reforming assessment approaches, strengthening faculty development and building high-quality teaching teams.

1. Introduction

With the developing of big data technology in the domain of higher education, the teaching methods in universities are progressively evolving towards enhanced intelligence, personalization, and scientific precision. In the face of the vast and complex educational data, a critical issue in higher education is that how to effectively utilize valuable data to improve the teaching strategies. Recently, this challenge has gained increasing attention in educational circles [1,2].

The “Materials for Mechanical Engineering” is a fundamental course for students majoring in mechanical and related engineering fields [3,4]. It addresses the study of engineering materials by investigating the composition, microstructure, heat treatment processes, properties, and applications. The course places significant emphasis on the performance and characteristics of various engineering materials, and the critical task is to select appropriate materials for specific engineering applications. Through this curriculum, students are expected to acquire the skills to formulate processing routes and engage in the design of new materials. Such skills are significant for fostering students’ innovation and practical abilities, and they serve as a foundation for students’ further coursework and future careers. Thus, research on the curriculum reform of “Materials for Mechanical Engineering” course under the background of big data is important. It is meaningful for improving both the quality of education and the cultivation of skilled engineers. Moreover, it also contributes to the development of core technologies in the engineering field.

2. Teaching Problems in “Materials for Mechanical Engineering” Course

2.1. Incomplete Teaching Contents

The “Materials for Mechanical Engineering” course encompasses a broad range of theoretical concepts which are abstract in nature. Besides, the course is constrained by a limited number of teaching hours, which is a significant challenge in comprehensively covering all knowledge within this timeframe. Additionally, the traditional course contents mainly focus on the basic theoretical principles. This is now considered outdated and insufficiently connected to practical applications. For students, these problems will result in an unclear understanding of essential concepts and a reduced interest in the course. What’s worse, the traditional contents often fail to equip students with the skills of contemporary societal demands. Thus, under the background of big data, it is important for teachers to improve the course contents and update teaching courseware in time.

2.2. Simplistic Teaching and Assessment Methods

With the rapid development of information technology, the integration of multimedia into education has become increasingly popular. However, the teaching methods employed in the “Materials for Mechanical Engineering” course are still relatively simplistic. Traditional teaching methods generally involve the repeated use of courseware, and many teachers apply the cramming method in teaching. Teachers don’t take students as the main body and always blindly impart knowledge to them. This results in a one-way transmission of knowledge from teacher to student, leading to a passive information reception. Furthermore, current assessment methods usually evaluate students based on midterm and final examination scores. Some students are not serious enough in class and do not pay enough attention to course assignments. Before the exam, students mainly rely on the cramming and rote learning. Actually, they cannot truly master the core knowledge of the course. In order to improve the learning situation, it is necessary to reform and innovate the teaching and assessment methods.

2.3. Insufficiently Developed Faculty Teams

In “Materials for Mechanical Engineering” course, many of the knowledge points are quite abstract and combined with both theoretical and practical aspects. However, most university teachers, especially young teachers, directly enter the universities to conduct teaching work after graduation. They usually don’t have the experience in production practice and lack sufficient understanding of engineering practice. Thus, these teachers have weak practical teaching abilities and are unable to combine theoretical knowledge with practical engineering. Besides, the teaching concept of teachers is very important for students’ education work. The teaching process is essentially an integrated process that teachers impart knowledge, cultivate skills, and guide values to students. Therefore, the faculty team must possess advanced educational concepts and take on the responsibility of nurturing students.

3. Reforms in the Teaching of “Materials for Mechanical Engineering” Course

3.1. Developing a Teaching Content System and Updating Teaching Courseware

With the rapid development of big data, effectively constructing a teaching content system for “Materials for Mechanical Engineering” course has become a pressing issue in higher education. Big data not only provides rich information and technological support for curriculum design, but

also encourages teachers to innovate their teaching methods and resource management. By analysing extensive data from various academic studies, engineering cases, and practical applications, teachers can gain deeper insights into the latest trends and technical demands in the field of mechanical engineering. It is beneficial to incorporate these developments into teaching. To ensure the content consistent with industry frontiers, the course should not only cover traditional material science, but also introduce advancements in new materials, such as the high-performance alloys, smart materials, and nanomaterials.

Besides, the big data technology is a powerful tool for updating teaching courseware. Traditional teaching courseware often rely on static text and images. However, with the support of big data, teachers can integrate rich multimedia resources, such as dynamic simulations, 3D models, and virtual experiments. This will make the content visually intuitive, and thereby enhance students' learning interest. For example, when teaching about the relationship between material microstructures and properties, teachers can use the big data platforms to access actual material test data and present it through charts or simulations. This approach helps students not only understand the material characteristics theoretically but also deepen their comprehension of complex concepts through data-driven visualizations. Moreover, updating teaching courseware should not only focus on improving the format but also pay attention to the timely updates of contents. With the aid of big data, teachers can access the latest research findings and applications from academia and industry. Teachers should reflect these developments in their teaching. This dynamic updating allows students to engage with cutting-edge knowledge during their studies and enhances their ability to solve engineering problems.

3.2. Innovating Teaching Methods and Reforming Assessment Approaches

During the teaching process, teachers should fully utilize various multimedia tools to improve the teaching methods. It is crucial to emphasize “teacher-student interaction” and “student-student interaction”. Compared to primary and secondary education, higher education institutions impose fewer restrictions on personal devices and offer more flexible classroom organization. Teachers and students can effectively use mobile devices to participate in various forms of interactive learning, such as timed responses, online voting, synchronous discussions, and brainstorming sessions. The real-time data generated during these activities can help teachers quickly understand students' performance and make timely adjustments.

Regarding the assessment methods, adjustments have to be made to better reflect students' engagement. The weight of students' regular performance, including class participation, in-class performance, and assignments, should be increased. Students are encouraged to actively participate in the classroom. Homework should be done in a flexible and diverse way, with more practical works in addition to writing assignments. Furthermore, the evaluation of experimental courses has to be strengthened. Students are required to design the material experiments in groups, conduct experiments together, and write reports independently. In the midterm and final examinations, efforts should be made to avoid the questions related to rote memorization and emphasize the understanding of knowledge. The inclusion of more subjective questions will enhance students' ability of comprehensive analysis.

3.3. Strengthening Faculty Development and Building High-quality Teaching Teams

The development of big data has not only changed the state of education, but also posed new challenges and requirements for the professional development of teachers. Teachers have to enhance their digital social communication skills and cultivate a sense of responsibility in digital teaching. Besides, digital teaching also provides a new way for communication, cooperation, and

resource sharing among teachers. This will break through the limitations of time and space, thus promoting the widespread of educational experience and teaching concepts. In this context, universities should put great importance on the core role of teachers in the digital transformation of higher education. More technical support and training opportunities should be provided to help teachers proficiently master various digital teaching tools, such as the blended learning technologies, intelligent teaching systems, and intelligent teaching assistants.

In addition, universities should actively promote cross-school and cross-border cooperation among teachers, especially in today's rapidly developing globalization and informatization. Building an international teacher collaboration network has become an important way for teachers' professional development. Through this network, teachers can share teaching resources, better respond to the diverse needs of students from different backgrounds, and enhance the inclusiveness teaching. At the same time, universities should strongly encourage teachers to participate in projects that combine industry, academia, and research. Through these projects, teachers can enhance their practical teaching abilities and make the teaching content more closely related to practical applications. In summary, in the face of the big data, universities must fully support the digital transformation of teachers and helping teachers cope with the challenges of education in the new era.

4. Conclusions

Curriculum reform is one of the pressing issues in higher education under the background of big data. This paper uses the "Materials for Mechanical Engineering" course as a case study, identifying the problems such as incomplete course content, simplistic teaching and assessment methods, and weak teaching teams through course surveys and relevant teaching experience. Meanwhile, a detailed analysis of the causes behind these issues is also provided. To conduct the reform of the "Materials for Mechanical Engineering" course, the paper proposes detailed reform suggestions focusing on three aspects, i.e., developing a comprehensive teaching content system, innovating teaching and assessment methods, and enhancing the overall quality of teaching team.

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