Research on the Teaching Reform of the Material Mechanics Course for Applied Undergraduates under the Background of New Engineering

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Abstract. In order to meet the needs of new engineering construction and keep up with the pace of the civil engineering industry, this paper puts forward teaching reform measures including the engineering case analysis and Midas software from two aspects, the teaching content and the teaching method, by combining the characteristics of the specialties of civil engineering and teaching status quo of our school. The teaching practice demonstrates that they have a good effect on stimulating students' interest, improving the engineering case analysis ability and improving the teaching quality. It is expected to provide some reference for the research on the teaching reform of the mechanics course.

Introduction

Material mechanics is a basic course of the civil engineering major of applied undergraduates, which is both theoretical and practical. It is an important course under the new engineering construction. Material mechanics mainly studies the stress, deformation and failure of components under various external forces, and provides the basic theory and calculation method of strength, stiffness and stability analysis for the rational design of components. This course is theoretical and has a strong engineering application background.

This paper analyzes the present situation of the material mechanics course in our school and puts forward the teaching reform direction of this course according to the training requirements of new engineering. On the basis of the orientation of our school and the student level optimization of the teaching content, it adopts various teaching modes including the engineering case, Midas software numerical analysis and the network communication platform, which will help students fully master the theory, understand the link between the theoretical knowledge and engineering practice, improve the students’ awareness of innovation and equip them with the ability to solve practical engineering problems by using relevant calculation methods.

The Status and Main Problems of the Material Mechanics Course

As an ordinary local application-orientation undergraduate college, the Civil Engineering construction in City College of Wuhan University of Science and Technology adapts to the new normal of our country’s economy in response to social needs, oriented by the market demand and employment, starting with the innovative talents training mode. The purpose is to train applied and technical talents, strengthen students' employment and entrepreneurial ability, and improve the ability to serve the regional economy and social development. In the reform of talent training program, in order to consider not only social needs but also students’ interests and personality differences, the "A+B" course selection module is proposed, and the corresponding professional compulsory courses and professional optional courses of different modules are different. A stands for the design module, suitable for students who will be engaged in design and students preparing for postgraduates entrance examinations. B stands for the construction module, suitable for students who will be engaged in construction.
Material Mechanics, as an important basic course for civil engineering majors A and B, takes advanced mathematics and college physics as prerequisite courses and is open to sophomore students in the first semester. There are 64 class hours for the course, 56 class hours of theory and 8 class hours of experiment.

At present, the main problems in the teaching of material mechanics are as follows:

**Various Contents, Limited Class Hours and Few New Materials**

The course contents of all kinds of teaching materials include the calculation of internal force, stress and deformation of tension and compression, torsion, bending and shear under four basic deformations and combined deformation, the instability of compression bar and the strength theory[1,2]. Many teaching chapters lead to too many teaching knowledge points and formulas in each class, making it difficult for students with uneven learning foundation to understand and grasp. The teaching effect of the same syllabus is not ideal for students of different module levels. There is little introduction of new materials and techniques in the current textbooks, which cannot meet the new requirements of engineering education on teaching contents under the background of new engineering.

**Disjointed from Engineering Practice**

The research object of material mechanics is the idealized bar model, which satisfies the three basic assumptions of continuity and isotropy. The examples in the book are almost simplified models, and students do not understand how these simplified mechanical example models are transformed from engineering examples [3,4]. In the teaching process, if the model simplification and stress analysis are not carried out in combination with specific engineering examples, and the students' abstract construction process of mechanical models of practical engineering is not paid attention to, it will make it difficult for students to combine the theory with practice and apply the theory to practice. In the later practice of the course design and graduation design, students will have no way to start the project, which is not in line with the goal of cultivating the practical ability and the innovative awareness of application-oriented undergraduate students.

**Not Flexible Teaching Methods and Means**

In the course of material mechanics, the ubiquitous teaching method is cramming, which leads to students' low learning enthusiasm, little interaction with teachers, and students' few questions in class. According to the learning situation of all previous students in our school, the teaching effect of the course of material mechanics is not good, the phenomenon that students are not serious in class and play mobile phones seriously in class is serious, and the exam result is not ideal, which greatly affects the study of structural mechanics and other professional courses. Therefore, it is imperative to reform the teaching content and teaching method of material mechanics under the background of new engineering.

**Teaching Reform under the Background of New Engineering**

**The Reform of the Teaching Content**

In order to make effective use of the limited class hours, the course of material mechanics should simplify the teaching content according to the talent training program, and avoid the repetition with the teaching content of the first course, theoretical mechanics, and the follow-up courses, structural mechanics and the steel structure.

At the same time, for the civil engineering major A and B module students, different syllabus are chosen for teaching to achieve the purpose of classification teaching. Both modules need to focus on stress and strain calculation and strength and stiffness calculation under axial force, torque, bending and shear basic deformation, stress and strain calculation and strength and stiffness calculation under combined deformations, stress states and four major strength theories. Module A puts focuses on the
design direction, and the derivation process of each formula should be emphasized. B module focuses
the construction direction, so the application of the formula is emphasized.

Secondly, the cutting-edge material mechanics knowledge is blended into the teaching to ensure
the advanced content. With the rapid development of science and technology, new materials are
emerging, such as composite materials and engineering plastics[5]. But at present, there is little
knowledge about new materials in engineering in textbooks, all of which almost introduce the tensile
and compressive properties of common mild steel and cast iron. Teachers can make handouts to teach
the cutting-edge research content of materials to students so that students can understand the latest
development trend of materials and the difference between new materials and traditional materials,
which can enrich students' theoretical knowledge and broaden their horizons.

Teaching Method Reform

Under the background of new engineering, the teaching of material mechanics should pay attention
to the combination of traditional and modern teaching methods, make full use of the Internet, the
flipped class, the micro class and other teaching methods, and combine blackboard writing and PPT
teaching so that the teaching content can be more intuitive, deepen students' understanding and grasp
of knowledge points. The laboratory should be opened as much as possible in the experimental
teaching so that students have more hands-on opportunities.

In addition, in order to cultivate students' innovation and engineering practice ability, engineering
case teaching and civil engineering software modeling analysis should also be carried out.

Engineering Case Teaching

Material mechanics is an important basic subject to solve problems in engineering practice, whose
content is about the stress, strain, strength, stiffness and stability of components. The content of the
textbook is mainly based on concepts, principles, formulas and calculation examples, which is not
closely related to engineering practice. Therefore, teachers should combine professional background
and textbook chapters, carefully collect relevant latest engineering cases, and carry out engineering
case analysis teaching of some important knowledge points, which can stimulate students' learning
enthusiasm, strengthen the understanding of knowledge points and improve students' ability to
combine the theory with practice.

In the course of introduction teaching of material mechanics for the civil engineering major, after
teaching the definition of the main research object of material mechanics, the rod, the teacher can give
examples to illustrate that the typical component of engineering structure in life is the rod. In this way,
students know that the research of material mechanics has engineering practicality, and is not just an
idle talk. For example, the Hong Kong-Zhuai-Macao bridge, which was officially opened to traffic
in October 2018, has cable-stayed bridge components such as cables, main towers, main girders and
piers, which can be simplified into rods for material mechanics analysis.

Midas Software Teaching

Civil structural analysis software includes ANSYS, Midas and Dr. Bridge, etc., all of which can
display the image and analysis results of components so that students have a more intuitive and
profound understanding of relevant knowledge principles, phenomena and conclusions[6,7]. Midas is
a Chinese language interface, easy to operate and widely used. Midas is used for modeling and
analysis, especially for understanding knowledge points that are difficult to understand and
materializing abstract knowledge, which effectively reduces the difficulty of learning.

For example, students generally believe that it is very difficult to analyze the stress of components
under combined deformation of tension, bending and torsion, and they are not used to analyzing the
stress of components in space, which is prone to analysis errors. However, Midas software teaching is
adopted to gradually apply various loads and show stress of components respectively according to
load conditions so that students can more easily find the most dangerous sections and the most
dangerous points under various load conditions and total loads. This not only is helpful to improve
students' spatial thinking ability but also can stimulate students' interest in learning and realize the improvement of teaching quality.

Midas software teaching helps students to participate in innovative undergraduate planning projects and postgraduate entrance exams to carry out scientific research and design work. In recent years, more and more students take the postgraduate entrance examination and material mechanics is one of the courses. The learning depth of material mechanics in the undergraduate stage directly influences the results of the postgraduate entrance examination, scientific research and design. Therefore, in the study of material mechanics, students will be exposed to professional software at an early age and conduct software modeling analysis of simple components in groups, which will lay a solid foundation for further study and employment in the future and increase their competitiveness.

**Summary**

As an important basic course of the civil engineering major, the teaching effect of material mechanics is of vital importance, which will directly affect the learning of follow-up professional courses. Therefore, the teaching reform of the material mechanics course is extremely necessary. Based on the teaching experience and the present situation of material mechanics teaching in our school, the author puts forward some Suggestions on teaching reform from the aspects of teaching contents and teaching methods.

With 136 students majoring in civil engineering in 2017 as the practice object and based on the above teaching reform measures, good teaching effects were achieved in the course of materials in the first semester of the 2018-2019 academic year. The passing rate of the exam has improved significantly, from 62% in 2016 to 88.2% in 2017. Compared with the previous students, they make significant progress in the learning enthusiasm and understanding ability and they finish their homework with a better performance. At the same time, Midas modeling and analysis in groups can enhance the ability of teamwork and increase students' confidence in participating in innovation and entrepreneurship.

The construction of new engineering is a long-term process, which cannot be accomplished overnight. The research on the teaching reform of material mechanics under the background of new engineering is also a process of continuous improvement. Teachers are required to constantly explore and summarize experience in teaching so as to effectively meet the curriculum construction requirements of the new engineering major and cultivate new engineering talents with a strong engineering practice ability.

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**References**


