

Strengthening Engineering Application, Simplifying Theoretical Derivation and Reflecting Humanistic Spirit --- Discussion on the Compilation of Teaching Material of “Engineering Mechanics”

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Abstract. Spring Admission is for the secondary vocational school graduates and ordinary high school graduates. Most students just received junior high school or high school education. The foundation of mathematics for engineering mechanics is generally not good. Engineering mechanics is the first course college students studied which connects to practical engineering problem. There are too many concepts, theorem, and formula. Those theories are abstract and lack of contact with the practical production. The goal of spring Admission is to cultivate senior professionals who get innovation spirit and practical abilities. So this paper analyzed the characteristics of students from spring Admission and the problem of current teaching material of engineering mechanics. Through dozens of years of teaching experience, the suitable content and aim for engineering mechanics teaching were discussed. Finally it brought up the spirit that the new teaching material should have: strengthening engineering application, simplifying theoretical derivation, reflecting humanistic spirit.

Introduction

Engineering mechanics is the first course college students studied which connects to practical engineering problem. There are too many concepts, theorem, and formula. Those theories are abstract and lack of contact with the practical production [1-4]. But with the popularity of higher education, students have easier access to universities. The level of students' intelligence is quite different especially for the students from spring Admission [5-9]. It is a serious problem for teachers, because if they consider the problem from the integrity of the discipline system it will focus on theoretical knowledge which could weaken the ability for students to analysis and solve practical problem. So according to dozens of years of teaching experience, the author will do an initial exploration on the innovation of "Engineering Mechanics" for spring Admission.

Characteristics of the Student from Spring Admission

Spring Admission is for the secondary vocational school graduates and ordinary high school graduates, but mainly for technical school students. Most students just received junior high school or high school education. The foundation of mathematics for engineering mechanics is generally not good, so they do not have the ability to analyzing and solving problems. The goal of spring Admission is to cultivate senior professionals who get innovation spirit and practical abilities. The spring Admission students should have strong hands-on ability and could use theoretical knowledge to analyze and solve problems in the first line of the practical production [10-12].

Characteristics of the Current Teaching Material

The Content of “Engineering Mechanics”. Usually, “Engineering Mechanics” of teaching material for university consists of two parts: theoretical mechanics and material mechanics. Among them, theoretical mechanics is a subject studying the general rule of objects' mechanical movement

which is built on Galileo and Newton's law belonging to the category of classical mechanics, and its theory is classic. As for the material mechanics, it mainly studies the component's bearing capacity about strength, stiffness and stability under loading. Compared with theoretical mechanics, materials mechanics is more closely related to engineering practice and application, and its theory and method are also classical and universal. So the theory and method of engineering mechanics are of classic, integrity and relative stability.

Technicality and Systemic of “Engineering Mechanics”. Due to the classicality of the content of engineering mechanics, the logical inference and demonstrating method are too complicated in current teaching materials. It is too specialized emphasizing on its systematic and integrity and the connection with engineering application is weak. It is hard for students to get the necessary engineering education and training. Because of the fussy mathematical derivation, it is difficult for students to study by themselves and, what is more, in the process of teaching, the ability training of students thinking and analyzing practical problem is weakened.

Lack of Humane Spirit Education. Current engineering mechanics of teaching material is lack of cultural education. Avoiding overspecialization on theory and combining mechanics science education with humanities education organically, penetrating humanistic spirit into the course education and improving students' comprehensive qualities are the important problems that must be solved in the reformation of engineering mechanics teaching material.

Innovation and Improvement in Engineering Mechanics of Material

Aiming at those problems mentioned above, the author believes that the spring Admission “engineering mechanics” of teaching materials should “strengthen engineering application, simplify theoretical derivation and reflect the humanistic spirit”. The system should be “small” but “essential”. “Small” refers that the content should take the necessary concept and theory as the base and take the basic knowledge and skills mastered as the purpose. “Essential” refers to the material system so that the students can acquire the mechanics knowledge the method of analyzing and resolving problems in less time. Next, the innovation and improvement of the new “Engineering Mechanics” of teaching material will be discussed by the following several aspects.

Content of the Textbook. “Necessary” and “sufficient” are the basic principles of the teaching material. By “cutting the branches” and “strengthening the rod”, the key point can be stressed in the content. The whole textbook is divided into two parts: “rigid body statics” and “material mechanics” emphasizing on weighted rigid body and deformation member. “Rigid body statics” contains “basic principles”, “horizontal force system” and “space force system”, especially emphasizes on learning how to draw the force diagram and establish the balance equations, and the friction part existing in the current textbook is deleted. The section of “material mechanics” contains a total of ten chapters: The Basic Concept, The Four Types of Basic Deformation (in four chapters), The Stress State and Strength Theory, Combined Deformation, Compression Rod Stability, Fatigue Failure and Engineering Mechanics Experiments. Through merging Bending Internal Force, Bending Stress and Bending Deformation, the three chapters into one, the content of the textbook has been refined and cut for the length. According to this principle, each chapter has been simplified for good.

Development of Students' Mechanical Modeling Ability. Innovation is the soul of the nation. Cultivating students' innovation ability is an urgent demand this era bestows to education. Engineering mechanics should pay more attention to raise students' creative thinking ability which should be showed on the formation of written and the arrangement of content. Engineering mechanics studies the force and movement, deformation and damage regularity of the component, but the objects in textbook are not real engineering components but the mechanical model. That is to say, the analysis and calculation in teaching process are performed around mechanical diagrams. Then, how to transform engineering components to mechanical diagrams in order to analysis and calculate is a key problem. The current textbooks are inadequate for demonstrate of simplification and lack of a clear clarification so that students often cannot simplify components, the load and the constraint in the subsequent curriculum design and graduation project. In a word, they cannot

abstract mechanical model. Some of the students master the ability after working through a few engineering cases. For this reason, each chapter is brought forward by engineering examples and begins with establishing mechanical model. About basic mechanical model and how to establish a mechanical model it has been fully described. The modeling of mechanics as the main line has run through the whole book; it make up the weakness of current textbooks in mechanical modeling.

Cultivation of Students' Divergent Thinking Ability. Divergent thinking is the thought process of exploring different answers from the same source material. It has the characteristics of fluency, flexibility and creativity. Strengthening divergent thinking ability is an important part in training students' creative thinking. The textbook can achieve the aim through the following two aspects:

(1) Training by examples. Carefully choose the examples. It should not be too many but be sufficient for teacher to choose. Not only should it guarantees the coverage of the knowledge, but also typical and clear. The example also should be able to inspire student's divergent thinking such as associate several conclusions from the same condition, multiple solutions.

(2) Setting Questions and Exercises for each chapter. Questions sticks to the textbook content but also expand students' thought. Exercises are arranged from simple to complex, from easy to difficult containing enough knowledge. Mainly on basic knowledge, supplemented by composite application students are able to summarize regularity and remember easily.

Humanistic Spirit in the Textbook

Philosophical Thinking. During the process of narrating concept and elaborating theory, if put philosophical views in it timely, guiding students to look at things and solve problems through philosophical thinking, it could benefit students for a life time. For example, when referring to "rigid body" concept, it should be emphasized that when study the external effect of an object, also named static, the shape change is the secondary contradiction which could be omitted to simplify the problem without effecting the nature of the thing. But when it relates to material mechanics, the shape change of the object is the main contradiction which cannot be regarded as rigid body but a deformation body.

Infiltration of Humanistic Spirit. The discoveries of important laws in engineering mechanics all present scientists' extraordinary creative thought; by reviewing those masters' glorious past, their innovation quality shall be appreciated. For example, normal stress in bending beam was studied earliest by Galileo more than three hundred years ago and the conclusion that the distribution of normal stress on a cross section was not so accurate. Later Coulomb corrected it as linear pure pulling (pushing) stress. Until 1705, Venant got the correct conclusion of the bending beam stress. As another example, the founder of formula of slender rod's critical force-Euler who dedicated his life to science, created world-famous Euler's formula at 67 years old. Through the reading part after each chapter, the history of mechanical science, the innovative spirit and biographies of those scientists are introduced to students, and it could stimulate students' enthusiasm for learning and innovation.

The Layout of Experimental Section

Mechanics experiment is important part of the course engineering mechanics. Some of the theories and formulas are based on experiment and observation and hypothesis and reasoning, and their correctness could only be certified by experiment. The mechanical properties of new material also need to be determined through experiment. Mastering the methodologies and tools of experiment is the essential basic skills for engineering students. Therefore, the experimental section is arranged in the textbook.

The experiment section aiming to cultivate students' ability to observe, analyze and solve problems, are mainly designed around experimental method and process which mainly considers the following seven aspects: (1) experimental purposes; (2) experimental equipment and samples; (3) samples' preparation; (4) experimental principles and methods; (5) experimental steps; (6)

experimental data processing; (7) questions to think about.

Summary

The teaching material of engineering mechanics for spring Admission has highly ideological and rigorous scientific content; it is good for the development of students' scientific literacy and thinking ability, cultivating exploring and creative spirit and improving the skills of solving practical problems. In conclusion, it is not enough to just restructure the original knowledge; “strengthening the engineering application” and “simplifying theoretical derivation” and “reflecting humanistic spirit” should be the goal and aim for the construction of the teaching material of engineering mechanics for spring Admission.

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