

# Exploration on Teaching Reform and Practice of Mechanics of Material in the Era of MOOCs

Shanqin Hou

School of science, Shandong Jiaotong University, Jinan 25037, China

Email: housq@sdjtu.edu.cn

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**Abstract.** This paper has discussed the teaching reform and practice of “mechanics of material” under the background of Massive open online courses (MOOCs). Comparison with traditional teaching model, “blended teaching” model has its advantages. The reform of teaching content, teaching methods and means, and evaluation methods has been proposed based on teaching situation and curriculum characteristics. After the teaching reform, the results indicate that it’s conducive to stimulate students’ learning interest, to master the basic concepts and theory, and to improve the ability of solving practical engineering problem.

## 1. Introduction

“Mechanics of material” is one of the important basic courses for students of mechanical design manufacturing, automobile application engineering, and civil engineering in college. It’s an important foundation of the subsequent courses, such as the mechanical design and structural mechanics. And it can solve the practical engineering problems, hence, the teaching objectives of “mechanics of material” are not only to master the basic knowledge and theory, but also to cultivate students’ learning methods, innovation consciousness, and the formation of engineering concepts.

With the rapid development of science and technology and the popularity of internet, a large number of courses teaching spring up on internet. Recently, MOOCs become world university curriculum innovation and development trend of the times [1], the teachers and students of higher education faced both the challenge and development opportunities. Shang [2] has proposed the “blended teaching” mode of traditional teaching and course teaching on internet. “Blended teaching” combines the advantages of face to face teaching and network e-learning, and it becomes a new trend in the development of international educational technology. Moreover, “life scenes approach” have been developed to carry out equal dialogue and discussion between the teachers and students [3]. The reform of teaching content and methods based on teaching situation [4, 5] have been discussed. However, the traditional teaching content, methods and means, and experimental skills are difficult to meet the requirements of innovative talents training objectives, and how to use MOOCs technology devoted to traditional teaching reform is very important.

The teaching reform of mechanics of material under the background of MOOCs is necessary. To make full use of the advantage of network online teaching and strengthen the face to face interaction, overall goal of teaching reform based on teaching situation of mechanical design manufacturing is proposed, which includes changing teaching ideas, improving teaching quality and level, reforming teaching methods and means, optimizing teaching contents and evaluation method.

## 2. The reform of course content

### 2.1 Optimization of teaching contents according to specialty and curriculum characteristic

With the deepening reform of higher education, teaching hours of “mechanics of material” shrunk dramatically, but the teaching content decrease not too much. Some new knowledge (composite materials and the application of numerical analysis software) have been introduced to inspire the students’ creative thinking, and widen the range of knowledge. Hence, the teaching content in unit time greatly increase. To solve this problem, a series of short videos and interactive exercises are

established to encourage students to learn online using odd time. For example, the derivation process of shear stress acting on a cross section in a circular bar in torsion which combine deformation of the bar, stress-strain relation and statics, is difficult to understand. Hence, the students can learn it in advance using online course. Through group discussion and difficult point analysis in class, the learning enthusiasm of students is extremely high, and the theory derivation process can be fully understood.

Some famous persons as Leonardo da Vinci, Galileo Galilei and Leonhard Euler are introduced on network teaching platform to stimulate students' learning interest. And, the teaching content should be determined by specialty characteristic. The component of structure in the civil engineering is subjected to compression or bending or the combination of them, such as beam and pillar, while seldom subjected to torsion. However, circular shafts in torsion are widely used in the mechanical engineering, compression, bending, and torsion are the same important in these majors.

## 2.2 Design open experiment

Experimental courses of "mechanics of material" are conducive to cultivate students' innovation and practical ability. Hence, the opening mechanics laboratory is necessary. Some opening experimental items, such as the design of eccentric tension, the equal-strength beam and buckling of columns with fixed at the base and free at the top, have been performed.

## 3. Comprehensive application of various teaching methods and means

### 3.1 The combination of traditional teaching and online learning

The purpose of traditional teaching is not only to impart knowledge but also to educate student. Hence, traditional teaching cannot be displaced by e-learning as assisted teaching method. "Blended teaching", which combines the face to face teaching and network e-learning, is very popular these years. The advantage of "blended teaching" is to stimulate the students' learning passion, and to encourage teachers to interact with students.

The resource database of "mechanics of material" based on network teaching platform should be set up at first, it includes teaching outline and plan, courseware, practical engineering case, the finite element model, online test and forum system, etc. A complete "blended teaching" process which includes pre-class preparation, classroom teaching, after class expansion and teaching evaluation, is shown in Fig.1. Some teaching contents will be accomplished in advance based on network, and the learning effect of students can be mastered by teacher in advance.

### 3.2 Stimulate students' learning interest by optimizing teaching methods and means

Interest is the best teacher. Dong *et. al* [6] have proposed the research of how to improve students' learning interest. Hence, it is very important to stimulate students' learning interest in classroom teaching. It was proved that taking practical case as a core [4] in classroom teaching was an effective teaching model. Using multiple teaching methods in classroom teaching can improve students' innovation thinking and engineering quality [7].

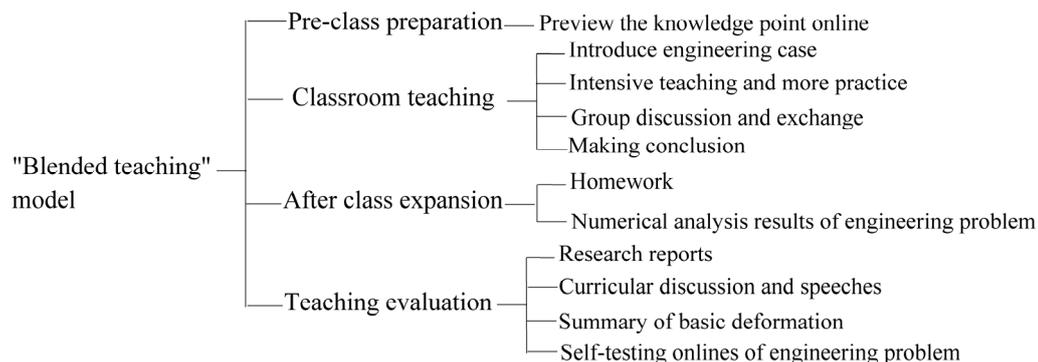


Fig. 1. The process of "blended teaching"

Making full use of teaching case in life scene is necessary. The behavior of bending and buckling can be demonstrated by loading a book. To understand the bending of beam, the book is fixed at the left and free at the right, and subjected to a load at the free end. It is simplified as a cantilever beam with rectangular cross section, as shown in Fig. 2. The effect of different placement methods on bending deformation is discussed in class, and how to improve the bearing capacity of structure? To understand the buckling of column, the direction of load on the book become compressive load along the axis at the free end. Some questions are discussed, what does the lateral displacement of book at free end depend on, and how to determine the critical load?

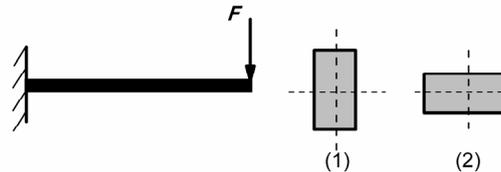


Fig. 2. Cantilever beam with rectangular cross section

Stress increase abruptly near the cross section with a sudden change in dimension. Moreover, the stress concentration of engineering component with V-shaped notch, crack, or a sharp point, is more serious. Some questions should be discussed in class: why is there a V-shaped notch on food packing bag, and why do we cut a small notch with a scissor on the cloth before tearing it open? We usually use stress elements to represent the state of stress at a point in a body, but it's hard to understand, the chalk box is conducive to understand how to take out the stress elements at a point. So teaching case in life scene is conducive to stimulate student curiosity and learning interest.

FEA software (ANSYS, ABAQUS, etc.) is used to solve practical engineering problem. The powerful post-processing module and dynamic display of FEA software can be used to display the structure from loading to deformation until the destruction of the whole process. Hence, the students can also repeat experiment process of basic deformation, and can understand Saint-Venant's Principle. The students' creative thinking can be inspired by solving practical engineering problem.

#### 4. The reform of evaluation methods and forms

The evaluation system of "mechanics of material" which includes four parts, has been rebuilt. The first part is written exam at the end of term, which accounts for 60% of the grade. Calculation problems of engineering components subjected to basic or combined loading are chosen to check the application of basic theory and formulas, and the simplified model of engineering problem. The second part is online test on network teaching platform, which accounts for 10% of the grade. The online test questions are randomly selected from test database on network teaching platform. The third part which accounts for 20% of the grade, is to prepare a report about shear problem of connecting members, the main contents include the role of connecting member and the strength calculation of shear and bearing. The report is finished by a team which consist of 4-5 students, everyone on the team has specific work. The fourth part is experiment, which results account for 20%. Hence, the overall scores of the test is equal to written exam (60%) plus the online exam (10%) plus report (20%) plus experiment (10%).

#### 5. Conclusion

The teaching reform of "mechanics of material" under the background of MOOCs has been proposed. The teaching effect combined the advantages of face to face teaching and network learning is obvious. Using resource on network teaching platform and online forum system, the students can preview and review the teaching content. After reform, the basic concept and theory are relatively clear. The students' learning enthusiasm is very high. The ability to solve practical engineering problems is improved by using the numerical analysis software. After the reform of evaluation methods, the pass rate of the exam is higher than before. It is found that it is important to combine the reform of the teaching content, teaching methods and means, and evaluation system.

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