

Exploration of Learning-Centred Teaching Mode for “Structural Design for Mechanical Equipment”

Han Wang^{1,a,*}, Yongliang Zhang^{1,b}, Qian Li^{1,c}

¹*School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai, 200093, China*

^awangh9@usst.edu.cn, ^byongliangz7377@163.com, ^cmeql@usst.edu.cn

*Corresponding author

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Abstract: Aiming to address the issue of the failure to comprehend complex course content due to insufficient time for thinking in class and the conflict between the timeliness of teaching content and the development of students' innovative skills, a learning-centred teaching mode is implemented in the education reform of the professional core course “Structural Design for Mechanical Equipment”. Two teaching platforms, “Chaoxing” and “Yiwangchangxue”, with multi-terminal access are introduced in the online-offline mixed teaching process. Based on these teaching platforms, an initiative-inspired teaching mode of Presentation-Assimilation-Discussion class could be implemented. Activities such as preview, discussion, classroom testing, etc. are assigned to students at different stages of the course, and all the activities are linked together with the presentation made by the students themselves. In addition, through the outcome-oriented achievement evaluation system, teachers can comprehensively and fairly evaluate students' learning progress using activity data from the platforms. This data helps teachers make timely adjustments, tailor teaching to individual aptitudes, and guide students in understanding course content correctly. It also fosters strong innovation skills.

1. Introduction

As a professional core course for students majoring in mechanical engineering, the course “Structural Design for Mechanical Equipment” aims to cultivate students' ability to design and analyze complex mechanical equipment using advanced design methods and concepts. However, there are currently two main teaching issues that need to be addressed. One is the failure to comprehend complex course content due to insufficient time for thinking in class. At present, classroom teaching still relies on the traditional method of teachers speaking and students listening. The difficulty and complexity of the course content leaves students with little time for thinking and discussion, leading them to passively accept new knowledge even when they haven't fully grasped previous concepts. This disjointed approach impedes students' ability to absorb and master the knowledge points of the course effectively. The other is the conflict between the timeliness of teaching content and the development of students' innovative skills. The current teaching is mainly based on explaining textbook content. However, the limitations of classroom teaching time and the

timeliness of textbooks make it difficult to impart and update the latest results and design methods on time. Therefore, relying solely on textbook-based teaching in class may restrict the development of students' innovative ability. Aiming to address the above issues, in this paper, a teaching mode based on the learning-centred principal is implemented in the education reform of the professional core course “Structural Design for Mechanical Equipment”^[1]. Two teaching platforms with multi-terminal access are introduced in the online-offline mixed teaching process. Based on the teaching platforms, an initiative-inspired teaching mode of Presentation-Assimilation-Discussion class could be implemented^[2].

2. Implementation of the learning-centred teaching mode for professional courses

With a focus on addressing the above issues, the proposed teaching mode is centred around a new approach to emerging engineering talent training and education that emphasizes “student-centered, output-oriented, and continuous improvement”. The objective is to shift from the traditional “teaching first” to “learning first”. Specific actions include increasing online self-study before classes to broaden students' perspectives while covering key concepts. In offline classes, a teaching mode of Presentation-Assimilation-Discussion class, i.e., PAD-class, is implemented, using student explanations and case discussions to encourage active learning and deepen comprehension^[3]. Additionally, an online and offline assessment and evaluation system is established covering the entire course learning process. The details of the teaching mode are shown in Figure 1.

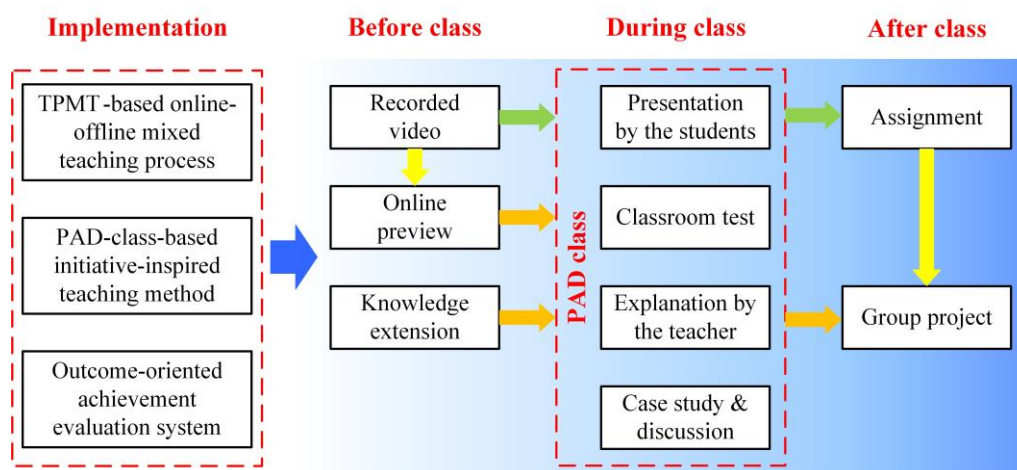


Figure 1: The learning-centred teaching mode for professional courses.

2.1. Two-platform-multi-terminal (TPMT) -based online-offline mixed teaching process

The TPMT-based online-offline mixed teaching process is based on two teaching platforms with multi-terminal access. The chapter teaching content of the course is synchronously arranged and updated on the two platforms – “Chaoxing” and “Yiwangchangxue”. Students can choose either platform depending on their preferences and preview the course by online learning before class. The online resources available include the following:

Recorded video Knowledge points are conveyed through videos and slides, overcoming the constraints of time and space, enabling students to learn independently at any time and place, thereby enhancing their comprehension of the study material.

Online preview Open questions allow students to freely post and answer, enabling online teacher-student and student-student interaction, improving learning and sharing experiences.

Knowledge extension Expand knowledge background and cultivate innovative thinking for students through excellent teaching videos from university MOOCs, with appropriate content on value shaping. The corresponding extension knowledge will be tested in the final exam.

Multi-terminal collaboration Using WeChat, QQ, and other mobile social applications as a platform facilitates communication between teachers and students. It provides students with a convenient way to ask questions, enabling teachers to gauge students’ understanding of key concepts and knowledge points in real-time. This allows for timely adjustments to teaching content and the ability to tailor teaching to individual student needs effectively.

2.2. PAD-class-based initiative-inspired teaching method

Based on students’ self-study results on online resources before class, the PAD-class-based teaching mode^[2] is adopted to inspire learning initiative and promote in-depth understanding and mastery of knowledge points through four steps of “student presentation and explanation - teacher comments and interaction - classroom test and teaching quality feedback – case study and discussion”. The specific implementation of sub-classes is planned as follows:

Student presentation & explanation The teacher divides the students into groups before they present to the class. The teachers choose groups according to the topics to be explained. Using the learning resources from the online platform, each group is required to prepare a 5~10-minute presentation with supporting slides that includes videos and other materials.

Teacher comments and interaction The teacher make comments based on the students’ presentation, correct any inaccuracies, emphasize key points again, interact with students to discuss and answer questions.

Classroom test and teaching quality feedback Two teaching platforms with multi-terminal access are used to issue tests or questionnaires to evaluate students’ understanding of the knowledge points of this course, helping teachers make timely adjustment of the subsequent teaching content.

Case study and discussion On the premise of understanding and mastering the knowledge points, high-level discussion questions or group project assignments published online are explained to improve and deepen students’ understanding and mastering of the knowledge points and expand their knowledge backgrounds.

2.3. Outcome-oriented achievement evaluation system

Table 1: The whole-process evaluation system of the course.

Evaluation item	Stage	Item	Percentage of the total score
Usual performance evaluation	Before class	Preview test	50%
		Value shaping	
	During class	Presentation & explanation	
		Q&A	
		Classroom test	
		Discussion	
	After class	Assignment	
Group project			
Final testing evaluation	The end of semester	Final exam	50%

The scores of usual performances from the usage of platforms, learning quality of offline classroom, etc. are incorporated into the student’s final evaluation, and the weight of these scores is

gradually increased.

At present, 50% of the overall grade is based on scores from usual performances, while the other 50% comes from final exam scores. Different weights are assigned to online and offline learning activities to evaluate students' progress effectively. The specific components of the whole-process evaluation system of the "Structural Design for Mechanical Equipment" are shown in Table 1.

3. Effect of the learning-centred teaching mode

An application case is presented in this section to show the effect of the learning-centred teaching mode. The implementation visualization of the learning-centred teaching mode is shown in Figure 2. Thanks to the platform, all the data including assignments, discussions, materials, lesson activities, etc. could be recorded automatically. Teachers can use the data and activity statistics to analyze whether the students are properly taught the course contents or not. This helps teachers to improve their teaching quality.

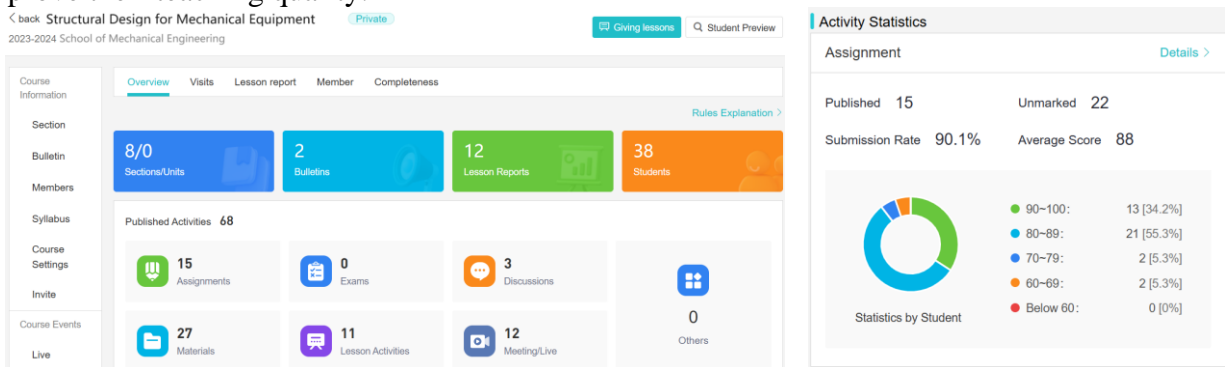
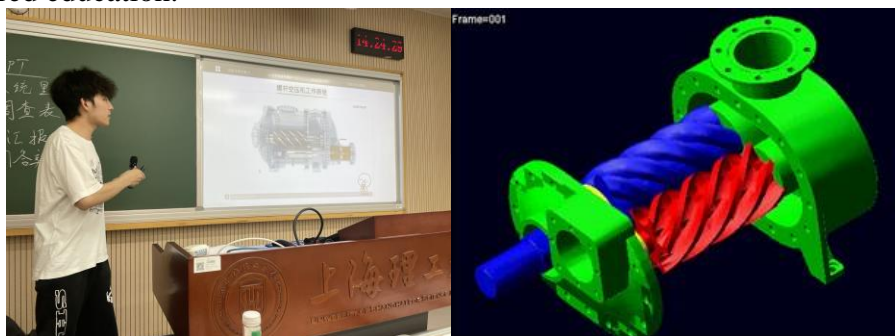


Figure 2: Activity records and statistics on Platform "Yiwangchangxue".

The group project is the key item of the usual performance in the whole-process evaluation system of the course based on the PAD-class teaching mode. The group project requires students to introduce the working principle, structure, and composition of a specific mechanical equipment by using the course knowledge they have mastered, and carry out corresponding performance analysis. Figure 3 shows a typical case of group project presentation given by the students. The topic of the group project is "Thermodynamic performance analysis and motion simulation of twin-screw air compressor". The basic working principle and structure of the twin-screw air compressor are clearly described in class. Moreover, different software, such as SolidWorks, ADAMS and ANSYS, are used to model the twin-screw air compressor, simulate the basic motion and solve the pressure distribution of gas particles under the normal working condition. Through this group project, students can transform their knowledge of mechanical equipment structural design into the ability to analyze actual mechanical equipment structures, reflecting the course's achievement objective of learning-centered education.



(a) Group presentation

(b) Motion simulation by ADAMS

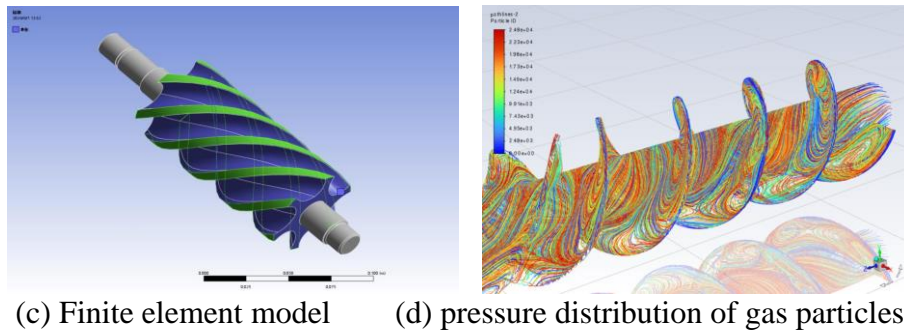


Figure 3: PAD-class-based usual performance evaluation of group project.

4. Conclusions

A learning-centred teaching mode is implemented in the education reform of the professional core course “Structural Design for Mechanical Equipment”. By applying the TPMT-based online-offline mixed teaching process and PAD-class-based initiative-inspired teaching method, students can master not only the knowledge points of structural design in the textbook, but also the practical application ability for structural analysis. The introduction of the whole-process outcome-oriented achievement evaluation system increases the proportion of usual performance with multiple items, and makes the score evaluation diversified. Through the group project which is the key item of the usual performance in the whole-process evaluation system of the course based on the PAD-class teaching mode, students can transform their knowledge of mechanical equipment structural design into the ability to analyze actual mechanical equipment structures, reflecting the course's achievement objective of learning-centered education.

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