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Blended Teaching Based on "Learning-Centered" in "Mechanical Equipment Structural Design"

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Abstract: Addressing the challenges in the core course "Mechanical Equipment Structural Design" of mechanical major, such as the difficulty of teaching content, insufficient student engagement and follow-through during class, and the contradiction between the timeliness of textbook content and the cultivation of student innovation capability, the implementation of a "PAD Class" model based on an online-offline blended teaching approach was proposed, and a corresponding comprehensive assessment system was also established to enhance the "Advancement, Challenge, and Innovation" of the course teaching and ensure teaching quality.

1. Introduction

Under the impetus of the Emerging Engineering Education initiative, engineering education is undergoing significant transformations from philosophy to practice. With the continuous deepening of engineering accreditation, the requirement for course content to support course objectives has been refined into every aspect of the teaching process. Traditional teaching models and methods can no longer comprehensively and effectively cover all course objectives required for graduation attributes, making the exploration and establishment of new teaching models imperative[1,2].

"Mechanical Equipment Structural Design" is a core professional course for mechanical engineering students, primarily aimed at cultivating students' ability to utilize advanced design methods and concepts for the design and analysis of complex mechanical equipment. While improvements have been made across various teaching aspects of this course[3], several issues persist: the teaching content is highly challenging; due to time constraints in class, some knowledge points are not fully digested before moving on to the next, leading to discontinuous foundational knowledge and hindering effective absorption and mastery by students. Furthermore, the rapid development of current technology outpaces the timeliness of textbooks, making it difficult to incorporate the latest achievements and design methods promptly. Sole reliance on in-class textbook instruction thus restricts the development of students' innovation capabilities.

In summary, targeting the aforementioned issues and based on the Emerging Engineering Education philosophy of "Student-Centered, Outcome-Oriented, Continuous Improvement," this project intends to shift the traditional "Teaching-Centered" approach gradually towards a

"Learning-Centered" one. This involves adding an online self-study session before class to preview knowledge points and broaden students' horizons; introducing the "PAD Class" teaching model in offline classes, utilizing student presentations and case discussions to stimulate learning initiative and deepen understanding of knowledge points; and constructing a comprehensive assessment and evaluation system covering the entire online and offline learning process of the course.

2. Online-Offline Multi-Link Teaching Based on "Two Platforms, Multiple Terminals"

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Utilizing the university-recommended "Chaoxing Learning Platform" and "Yi Wang Chang Xue" platform as carriers, course chapter content is synchronized and arranged. Students choose their preferred platform for online learning before class. The resources developed for this teaching reform include the following:

1) Extracurricular Extension

For the knowledge points of each class, high-quality Massive Open Online Course video links are provided as extension materials, appropriately incorporating elements of value cultivation to broaden students' knowledge scope. This content is included in the final examination scope.

2) Knowledge Point Recorded Lectures

Key course knowledge points are recorded as micro-lecture videos and published on the learning platforms, breaking the constraints of time and space for learning. This enables students to engage in self-directed learning anytime, anywhere, enhancing learning convenience and facilitating a deeper understanding of the knowledge points.

3) Reflection and Discussion

Open-ended questions are posted on the learning platforms. Through free-form student replies and discussions, online interaction between teachers and students, as well as among students themselves, is achieved, thereby enhancing learning outcomes and facilitating the exchange of learning experiences.

4) Multi-Terminal Collaboration

Mobile social software such as WeChat and QQ are used as auxiliary tools for teacher-student communication. This facilitates convenient questioning by students while allowing teachers to simultaneously gauge student understanding of knowledge points, promptly adjust teaching content, and effectively implement differentiated instruction.

3. Innovative Teaching Model of "PAD Class"

Building upon students' self-study of online resources before class, the "PAD Class" teaching model is adopted. This four-step process – "Student Presentation – Teacher Commentary and Interaction – Online Quiz – Case Study Deepening" – aims to stimulate learning initiative and promote in-depth understanding and mastery of knowledge points. The specific contents of the PAD Class are as follows:

(1) Student Serial Presentation and Teacher Commentary Model

Based on pre-class learning via online platform resources, specific knowledge points are assigned for serial presentation. Methods include voluntary sign-up or teacher assignment. In class, students give 5-10 minute explanations, followed by teacher commentary, questions, or discussion to enhance understanding. A photo of a student presenting in class is shown in Figure 1.

(2) Group Learning and Discussion Model

For knowledge points that are difficult to understand or particularly important, the teacher first provides a basic introduction in class. The content is then broken down, and students are required to

discuss it in groups. Each group subsequently reports and explains their discussion results. The teacher interacts with students through questioning and commentary, fully engaging their concentration and inspiring active thinking to improve learning outcomes. Figure 2 shows the classroom discussion results for overspeed phenomenon analysis. A recorded class session is available via the smart classroom recording.

Figure 1: Photo of a student giving a serial presentation in class.

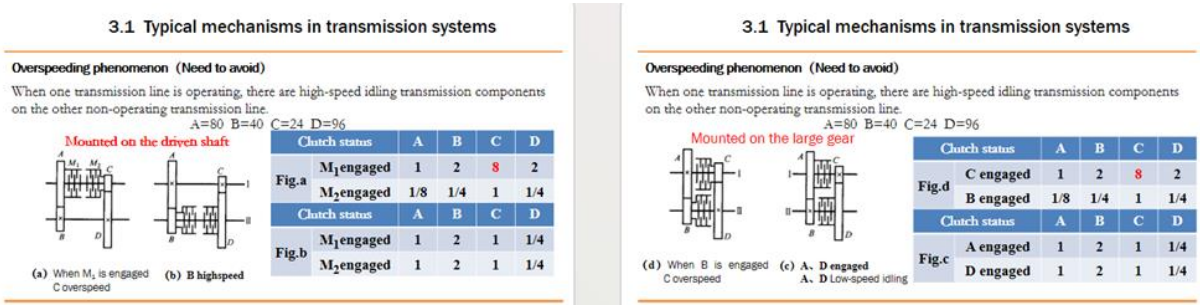

Figure 2: Classroom discussion case and results on overspeed phenomenon.

(3) Extended Classroom and Case Deepening Model

Following the understanding and mastery of knowledge points, advanced discussion topics are released both online and offline. A major course project spanning the entire teaching process is assigned. Additionally, extracurricular visits and internships are provided. This allows students to stay informed about cutting-edge developments in equipment design while offering opportunities to integrate classroom knowledge with practical engineering applications, thereby deepening their understanding and mastery of knowledge points from multiple perspectives. Figure 3 shows photos of students visiting the 13th China CNC Machine Tool Exhibition. Figure 4 -Figure 6 show some screenshots of a PPT from a student's completed major project.

Figure 3: Photos from the extended classroom.

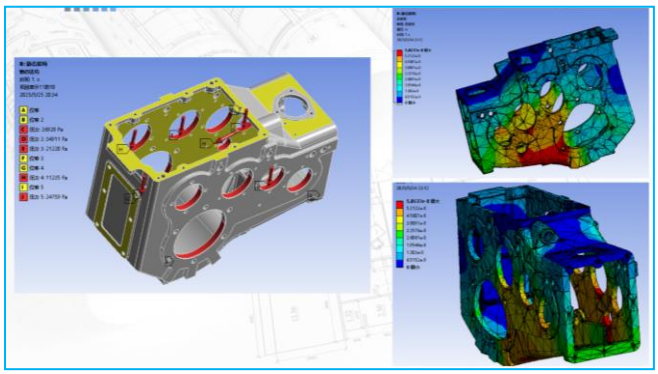

Figure 4: Screenshot of simulation from case.

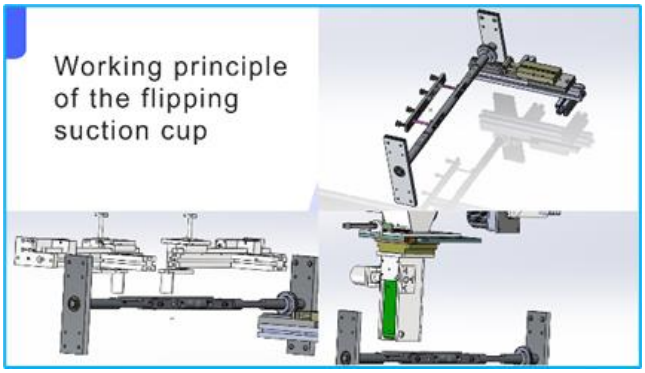

Figure 5: 3D model of the suction cup.

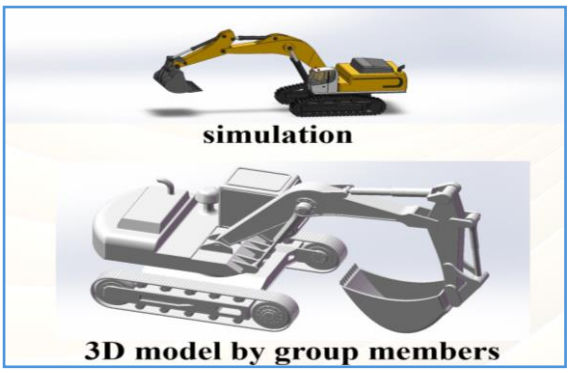

Figure 6: motion simulation of excavator.

4. Constructing a New Comprehensive Assessment System for the Entire Learning Process

The weight of the usual process-oriented assessment scores is increased to 50%. Concurrently, a minimum score threshold for the final exam is stipulated to prevent students from artificially inflating their usual grades through opportunistic means and thereby raising their final overall grade. This encourages students to maintain a diligent and serious learning attitude throughout the semester, ensuring that learning is consistently pursued both online and offline, and effectively guaranteeing the learning outcomes of the course knowledge points. The components of the assessment system are shown in Figure 7.

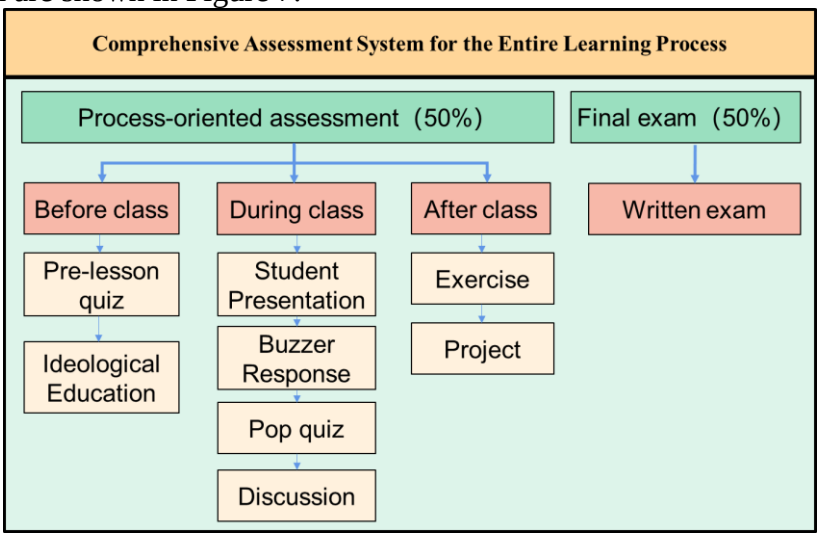

Figure 7: Composition structure diagram of the comprehensive assessment system.

While implementing the teaching reform project, student feedback on teaching effectiveness has also been consistently monitored during the course. A teaching questionnaire is distributed every semester to survey students on various reform measures. Results from two semesters of implementation show that students have responded positively to all reform initiatives and have given high evaluations of the post-reform teaching outcomes. Moreover, based on the reform measures, the average final exam scores have demonstrated steady improvement over these two semesters.

5. Conclusion

1) By organically integrating student learning and discussion during and after class with teacher guidance, ample space is provided for student reflection and digestion. Students' self-understanding

replaces some of the rigid instruction from teachers. The combination of the PAD Class model with online-offline blended teaching improves teaching quality.

2) Aligning with engineering accreditation standards, a comprehensive online-offline evaluation system for the entire learning process, adapted to the "PAD Class" model, is constructed. This system quantitatively evaluates student learning from pre-class, in-class, to post-class stages, providing a scientific and reasonable assessment of the learning effectiveness throughout the entire process.

Acknowledgement

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