

Research on Practical Teaching Method and Effect Based on the Integration of Online and Offline Patterns: Take the Course, Reliability and Risk Analysis on Electronic Products, as the Case

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Abstract. The traditional teaching pattern in the classroom has no longer adapted to the needs of education and teaching under the current new situation, the utilization of online and offline integration mode is the trend of the future. To improve the teaching quality and learning effect, the teaching method combining theory and practice is adopted and the theoretical method explanation and virtual simulation analysis are combined organically by introducing the online and offline mixed teaching mode. In this paper, the teaching method called "offline theory explanation, online practice simulation, flipped class discussion" and the teaching evaluation method of "whole process and diversification" are constructed. The teaching was carried out from four aspects: preliminary preparation, online theoretical explanation, offline practical operation and online discussion, which effectively alleviated the contradiction of theoretical teaching content, tense practice site, single assessment method and so on, and achieved a good teaching effect.

Keywords: online and offline; hybrid teaching; combination of theory and practice; diversified evaluation.

1. Introduction

The traditional teaching mode in the classroom has many deficiencies in teaching effect, practicality and interest. Online and offline integrated case teaching breaks the limitation of teaching time and space. It can help to make up for the shortcomings of the traditional teaching mode and stimulate the enthusiasm of students to learn effectively. It is not only the need to improve the quality of teaching to explore the new mode of online and offline integrated case teaching, but the inevitable requirement to adapt to the future trend of teaching development as well.

"Reliability and Risk Analysis of Electronic Products" (hereinafter referred to as "E-R&R Course") is an important professional theoretical core course in the teaching of systems engineering. The main content of this course is the theoretical methods of reliability analysis and risk assessment of electronic products under thermal, vibration, electrical, electromagnetic and other environments and loads, which is highly theoretical, systematic and practical. The E-R&R Course guides students to transform from "reliability science theory" to "reliability engineering". Students are required to have a higher learning background of mathematical theory and failure physics. Meanwhile, engineering education mainly cultivates students' ability to solve complex engineering problems. How to realize the high-quality knowledge transfer between teaching and learning, how to realize the transformation of thinking from theory to practice, how to stimulate students' subjective initiative learning, and how to cultivate high-quality reliability talents put forward higher requirements for teaching work.

At present, the traditional classroom teaching mode still occupies the dominant position in the university education. This teaching mode includes three parts: the teacher prepares the lesson before class, the teacher speaks and students listen in class, and the students finish the homework assigned by the teacher after class. This kind of "injection" teaching mode ignores the dominant position of students and lacks the targeted cultivation of students' practical ability.

In the era of "Internet +", the reformation of higher education teaching has ushered in a new opportunity. It has become an important trend to improve education and teaching mode on the Internet. The "online and offline" blended teaching model provides a new direction and a new model for college teaching, which is in sharp contrast with the traditional classroom teaching model [1-4].

Zhao Manping et al. set up micro lessons, PPT courseware, self-test questions and other related teaching resource of the course "Principles of Machinery". Students learn online first, and in the subsequent offline class, knowledge will be consolidated through the mode of questions and answers. This method realizes the mode of "learning before teaching", reflects the principal position of students in teaching activities, stimulates students' interest in inquiry and personalized learning, and improves the teaching effect [2]. The chronological online-offline hybrid instructional design by Wei Wuguo et al. reconstructed the teaching process and expanded the teaching time and space. Online information technology tools, such as MOOC, were fully utilized to achieve case teaching and instruction, while the offline topic discussion is adopted in the interactive teaching method to carry out flipped teaching [5]. Luo Guotao et al. made full use of the online teaching platform and MOOC to realize the blended teaching model of online and offline, in-class and out-of-class, and pre-class, in-class and after-class. Students explore independently and learn collaboratively online, while offline classes mainly adopt a variety of teaching methods, such as lecturing method, group method, flipped classroom and project method. This way livens up the classroom teaching atmosphere and improves the initiative of students in independent learning [6]. Liu Lili et al. set up the MOOC of Engineering Fluid Mechanics online. Students can arrange to watch videos and take tests after class according to their own learning schedules. In the offline class, the teacher mainly summarizes the knowledge points, focuses on the difficult points and key points, and does some targeted exercises to consolidate the basic knowledge [7]. Cheng Huixiang et al. adopted the MOOC+SPOC online and offline hybrid teaching mode, realized the reformation of the course "modern electrical control technology and PLC curriculum", realized the "student-centered" teaching activities, and achieved pretty results [8].

In order to adapt to the new trend of combining mobile Internet technology with education, our teaching team tries to carry out teaching reformation by adopting the way of online and offline integration to realize the teaching method of "offline theory explanation, online practice simulation, flipped classroom discussion" and the teaching evaluation method of "whole process and diversification". This method provides a new idea for the integration of curriculum theory and practice and the realization of case practice teaching.

2. Teaching status and reformation necessity

This section will give a summary of the ER&R curriculum in the past teaching situation and analyze the need for reform.

(1) frequently-theoretical course content and frequently-monotonous teaching mode

At present, the teaching content of university courses usually focuses on theoretical teaching with offline teaching mode, including theoretical formula derivation, method process introduction and example explanation. The teaching content is highly theoretical. In the course of teaching, it is difficult for teachers to have enough time to provide practical opportunities for students, and the lack of connection between theory and practice leads to students' difficulty in understanding. For engineering students, this teaching method often makes it difficult for students to apply what they learn in class to engineering practice directly.

In terms of teaching mode, teaching face to face in the classroom was still the main teaching mode before the reformation. Teachers showed the professional knowledge to students directly through simple injection way. This mode lacks sufficient interaction with students, which hinders students to understand the professional knowledge.

(2) tense experimental site and monotonous assessment method

In the past, the experimental course adopted the form of simulation and calculation for practical part. However, due to the limited capacity and performance of the public computer, the calculating speed after the installation of the simulation software is significantly low. It means the high-precision simulation of the model cannot be realized, which brings great difficulties to the smooth development of the offline practical courses. In addition, the way of course assessment is often requiring students to submit a paper related to the course, which is relatively simple. As a result, the course results cannot reflect the students' participation and completion in the whole course, which is lack of comprehensiveness and systematism.

To solve the above problems, the course introduces an online and offline teaching model, which focuses on theoretical teaching offline and simulates cases online. After that, we will return to the offline class to discuss the problems in the practice. Each part will be scored, and the final score comes from the synthetic judgment of these parts.

The following section will provide more details of the reformation.

3. The practice of online/offline mode in the course

3.1 Overall arrangement of the teaching content

The teaching team extended the present teaching content, which only included theoretical explanation, into the two-stage teaching content that combined theory and simulation practice teaching. The arrangement of such teaching content needs to fully mobilize the information resources and computing capacity of the Internet, and the specific relationship between the two parts is shown in Figure 1 [9].

To provide fixed teaching materials for the repeated learning and practice, the course team wrote monographs, re-made the course ppt, shot a wealth of micro videos, and made experimental instructions and experimental report templates for the online simulation practice part.

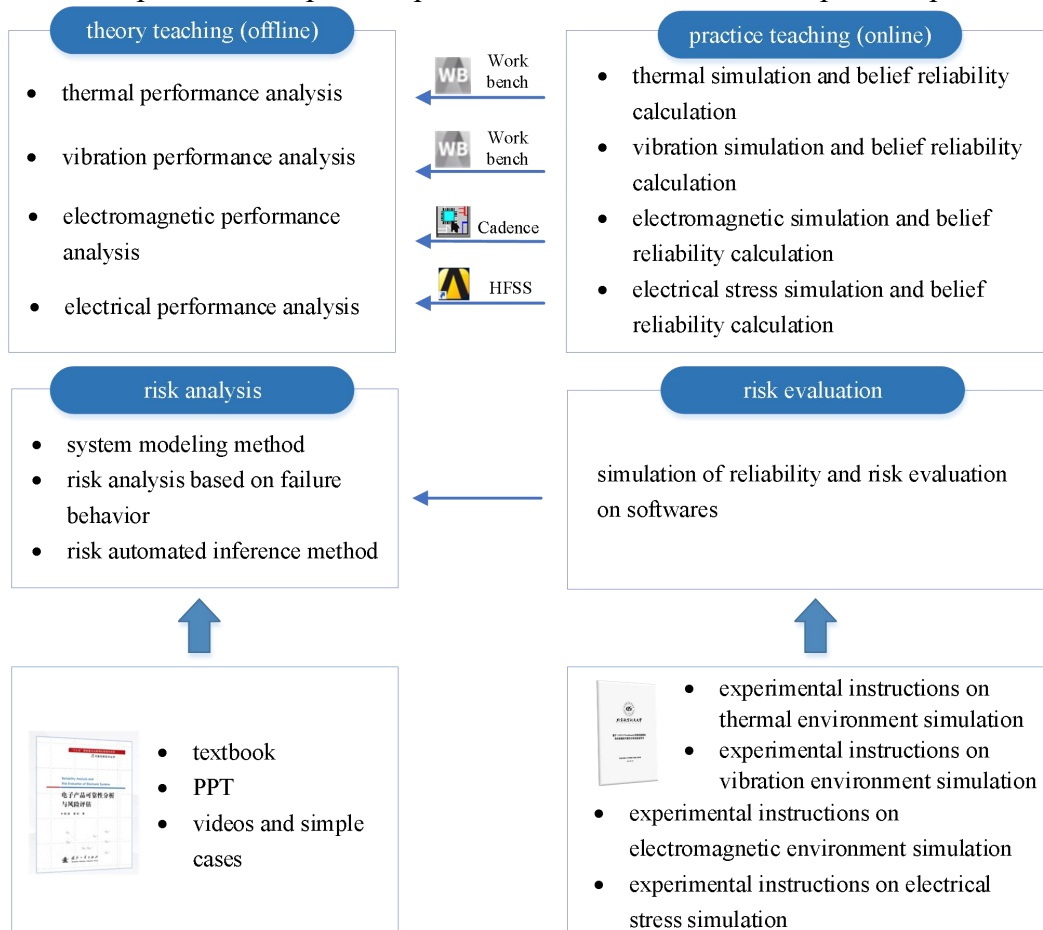


Fig. 1 Two or more references

It should be emphasized that the explanation part of the curriculum theory should not only be combined with the engineering practice, but also need to add ideological and political elements to reflect the humanistic care of the course and increase the interest of the course. For example, when explaining the history of the reliability of electronic products, Robert Lusser, the "father of reliability", is introduced to students to learn more interesting stories about reliability, stimulate students' interest in learning, and help students establish a correct world view, outlook on life and values. In the explanation of electromagnetic interference phenomenon, we add the introduction of the causes and hazards of electromagnetic compatibility accidents occurred in the United States aircraft carrier, so that students can personally experience, naturally improve the understanding of electromagnetic faults related to electronic products.

3.2 The implementation of the practice teaching

The implementation of practical teaching includes three parts: offline theoretical teaching, online simulation practice, and offline discussion and promotion.

(1) offline theoretical teaching

The offline theoretical teaching is the basis of the whole course, and also plays a role in paving the way for the subsequent practical part. During the offline teaching, the teacher combines the belief reliability theory with virtual simulation practice, so that students can understand the importance, relevance and application scope of what they have learned. For example, when explaining the reliability analysis of vibration performance of electronic products, we start with the single freedom undamped system, transition to the multi-freedom damping system, introduce the power spectral density curve and calculation method, and put forward the calculation formula of vibration stress based on strength criterion, natural frequency based on stiffness criterion and crack length based on fracture mechanics and other performance parameters. The process of belief reliability analysis for vibration environment is proposed, including determining the performance threshold, constructing the vibration performance margin equation, analyzing the uncertainty, and finally calculating the belief reliability.

In addition, in order to avoid the abstraction and monotonicity of narrative presentation, the PPT has been designed, in which more animation and video elements have been added to impress students and make it easier for students to understand the related content. For example, in explaining the method of reliability analysis in thermal environments, we scoured many recent thermal design video resources; In explaining the method of belief reliability analysis in electromagnetic environment, we edited several videos to show the harmfulness of electrostatic discharge.

(2) online simulation practice

Industrial simulation software can intuitively show the stress changes of electronic products under different environments and loads, so as to help understand the degradation and failure mechanism of products under environmental loads. The virtual simulation teaching process introduces finite element thermal analysis and vibration analysis software, electromagnetic analysis software, electrical stress analysis software, etc. From the establishment of digital model, grid division, material parameters and boundary conditions to the determination of the final numerical calculation and post-processing, students can use the experimental instructions, operate by themselves, transform the initial conditions and boundary conditions, observe the variation rule of performance parameters of electronic products, analyze and solve problems. In this way, students are guided to gradually develop interest in reliability analysis and develop the good habit of independent thinking.

A flexible online simulation is used to teach the class. Before the beginning of the practical course, students will be given the lab instruction. We will arrange unified practice and organize online courses. During this period, each student used his or her own computer to build a model and used computing resources in the cloud to solve it, avoiding the problem of slow calculation caused

by the low configuration of personal computers. Teaching assistants will also provide answers online in real time to help students complete the required material for the practical course. In addition, the cloud resources will be open to students throughout the semester, so that students can conduct more in-depth simulation learning and analysis at any time.

(3) offline discussion and promotion

Due to the limited time, the unified online practice can not solve all problems that students have. Therefore, we will return to the offline class again at the end of the semester to focus on solving questions throughout the semester.

The specific practice is to divide the students into several groups. At first, each group presents the simulation results, then further discusses the problems they found and shares the harvest, and the teacher makes comments and development at last. This method not only exercises the self-study ability and language expression ability of students, but also enlivens the classroom atmosphere, gives play to the subjective initiative of students, deepens the grasp of the knowledge, and learns how to apply the theoretical methods in engineering practice.

3.3 Examination methods

Before the reformation, the total score of the course examination came from the final exam or the thesis assignment. After the adoption of online and offline mode, the assessment method is more diversified. The total score includes regular score (20%), discussion in class (20%), virtual simulation practice (30%) and the thesis work (30%), which is shown in Table 1.

Table 1. Course grade assessment

project	Scoring criteria	The weight
Sign in	Online and offline class check-in	10%
Class trivia questions	Offline Class Questions	10%
Classroom interaction	Participate in class presentations and discussions, using both self-evaluation and mutual evaluation	20%
Virtual Simulation report	Virtual simulation results accuracy, report integrity, systematic, correct	30%
Thesis work	An analytical paper at the end of the course	30%

In the offline teaching process, activities such as check-in, answer questions, topic discussion and quiz are automatically recorded; In the online class, the class performance, completion of simulation tasks, practical operation and problem-solving ability are assessed, and finally the comprehensive assessment of online and offline results is completed.

4. Summary of teaching practice effect

In order to understand the acceptance and satisfaction degree of students to the hybrid online/offline teaching, we published the course questionnaire. Figure 2 shows students' overall comments on the course: 52% of students chose very good, 37% good, and 11% relatively good. It shows that the students have a good recognition of the new teaching model and course organization form.

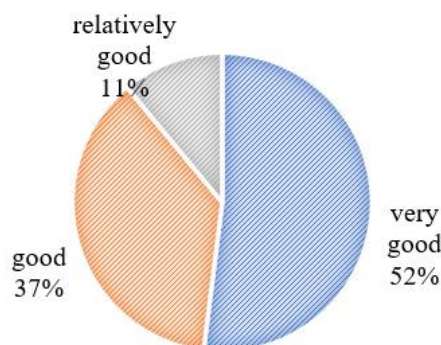


Fig. 2 The overall evaluation of the course

Figure 3 shows how students feel after finishing the course. 18% of the students were very satisfied with the course structure, 35% were satisfied and 47% were relatively satisfied. As for the mastery of the course, 40% of the students said they had completely mastered the course content, 33% said they had mastered the belief reliability evaluation, and 27% said they had mastered the stress simulation content. It can be seen that the difficulty of the course content is moderate and the students can all gain something, which reflects the students' recognition of the new course teaching mode.

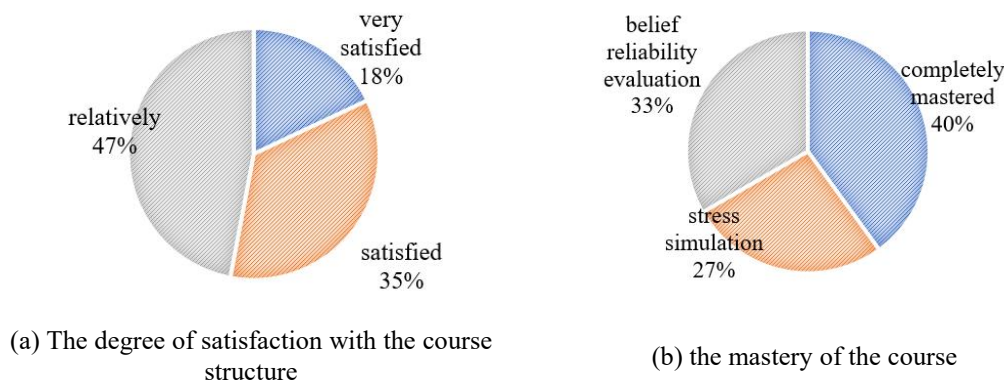


Fig. 3 Questionnaire survey on learning experience

In summary, the introduction of mixed online and offline teaching mode, combined with virtual simulation, engineering examples and other teaching methods, can make the relatively abstract basic theory concrete. Offline, multimedia methods such as video can be used to make up for the deficiency of theoretical explanation. Online virtual simulation cases can be explained and practical operation, deepen the understanding of theoretical knowledge, master the engineering application process. Students can improve their practical ability in the application of knowledge, effectively expand the scope of students' knowledge, and improve the interest of the course. The program was nominated as a university-wide Graduate Program of Excellence in 2022.

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