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Exploring the Process Evaluation System and Practice of Modern Control Theory Course

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Abstract: *Modern control theory is a theoretical and practical professional foundation course for automation. This paper addresses the drawbacks of the current transmission course assessment and evaluation, combines the characteristics of the modern control theory course, and explores the process assessment and evaluation system based on results orientation from classroom interactions, stage quizzes, course assignments, and project experiments, aiming at comprehensively and dynamically reflecting students' learning progress and knowledge mastery. Finally, through the analysis and comparison of course assessment data, it is found that students' learning outcomes are improved, and the expected effects of measures are realized.*

Keywords: *Modern Control Theory, Course Assessment, Outcome Orientation, Evaluation System*

1. Introduction

Modern control theory is one of the core courses in automation and related engineering majors, and it is highly theoretical and practical. However, the traditional teaching mode is often teacher-centred, focusing on the transmission of theoretical knowledge and the evaluation method of summative examination, ignoring students' initiative and continuous participation in the learning process. This model makes it difficult to fully reflect students' learning effect and practical application ability, leading to more significant difficulties in understanding and applying complex theoretical knowledge [1]. In October 2019, the Opinions on Deepening the Reform of Undergraduate Education and Teaching and Comprehensively Improving the Quality of Talent Cultivation released by the MOE emphasized the need to improve the academic assessment system that organically combines process assessment and outcome assessment. In November 2022, the General Office of the Ministry of Education and other four departments released the Opinions on Accelerating the Construction of New Agricultural Science and Promoting the Innovative Development of Higher Agricultural and Forestry Education issued by the General Office of the Ministry of Education and other four departments in November 2022 also proposed to improve the course assessment and evaluation system, establish a diversified assessment and evaluation system, and pay attention to the organic combination of process assessment and result-based assessment [2]. The process evaluation system is an evaluation method that emphasizes continuous observation and feedback on student's performance in the learning process, focusing on students' comprehensive quality and ability cultivation.

2. Disadvantages of traditional course assessment and evaluation methods

In the traditional education model, the course assessment and evaluation method is mainly based on the final examination, supplemented by a small amount of homework or experimental results. Although this mode has had its rationality throughout history, its drawbacks have gradually appeared with the progress of educational concepts [3]. In this paper, the disadvantages of the traditional course assessment and evaluation methods are divided into the following four parts to be discussed.

2.1. The assessment method is single and it is difficult to evaluate students' abilities

The traditional course assessment and evaluation method mainly focuses on the final examination, and students' final grades are usually determined by the results of one or several examinations. Although this way can test students' mastery of theoretical knowledge, it cannot fully reflect students'

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comprehensive ability due to its single assessment method. Modern control theory courses not only require students to master complex mathematical theories and control algorithms but also require practical, solid application ability. The final examination usually focuses on memorising and understanding the knowledge points while ignoring the students' practical ability, innovation ability, and ability to solve practical problems. This single assessment model makes it difficult to evaluate students' overall performance and learning progress accurately.

2.2. Emphasis on outcome orientation and neglect of process learning

Traditional assessment and evaluation methods tend to be result-oriented, focusing on performance in the final examination and ignoring students' efforts and progress in the learning process. This model leads to the fact that students tend to focus only on the review at the end of the semester in the learning process, ignoring the usual learning and accumulation. Especially in a course like Modern Control Theory, the knowledge points are complex and abstract, and understanding and mastery must be achieved through continuous practice and practice. Suppose the evaluation method only focuses on the final grade. In that case, students' learning behaviours and efforts throughout the semester often cannot be effectively evaluated and encouraged, which affects students' motivation and initiative in learning.

2.3. Lack of timely feedback affects learning outcomes

Traditional methods of course assessment often lack timely feedback mechanisms. Students receive their grades only after final exams, which prevents them from promptly identifying their deficiencies during the learning process. Modern educational theories emphasize the importance of timely feedback for improving learning outcomes. Without timely feedback during the learning process, issues cannot be promptly addressed, negatively impacting learning effectiveness. This is particularly crucial in complex subjects like modern control theory, where students should constantly refine their learning methods and strategies to address different concepts and difficulties. The absence of timely feedback affects students' learning outcomes and limits teachers' ability to optimize their teaching methods and content.

2.4. Focusing on memorization and comprehension and neglecting thinking skills development

Traditional examination methods often rely primarily on written tests, focusing on memorizing knowledge points and understanding basic concepts, which easily overlooks the cultivation of higher-order thinking skills. Students must possess strong analytical and problem-solving abilities in modern control theory courses. However, a single form of written examination is inadequate in effectively assessing students' higher-order thinking skills, especially when the exam questions emphasize fixed answers and formula application. In such cases, students often resort to rote memorization rather than genuine understanding and flexible application. This assessment model is not conducive to cultivating students' comprehensive abilities and fails to meet the requirements of modern engineering education for innovation and practical application skills.

Analyzing the four main drawbacks of traditional course assessment methods reveals significant deficiencies in the current assessment model regarding the comprehensive evaluation of students' abilities, promoting process-oriented learning, providing timely feedback, and fostering higher-order thinking skills. Addressing these issues requires exploring and implementing a process-oriented assessment system based on the OBE (Outcome-Based Education) philosophy to improve teaching effectiveness and enhance students' overall quality [4, 5].

3. Design of Process Assessment System Based on OBE Philosophy

To improve teaching effectiveness and students' comprehensive quality, this section will discuss how to construct a process assessment system based on the OBE concept. The system not only emphasizes the achievement of learning outcomes but also the feedback and improvement in the learning process, aiming to promote the overall development of students.

3.1. Setting clear learning outcomes

OBE (Outcome-Based Education) emphasizes specific learning outcomes that students should achieve, including the skills, knowledge, and literacy necessary for real-life challenges and careers. Therefore, teaching modern control theory courses should adhere to a student-centred development

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approach. This involves: firstly, focusing on the formulation of clear course objectives and ensuring effective knowledge transfer while also considering students' learning outcomes; secondly, cultivating students' independent learning abilities, problem-solving skills, and capacity for collaboration and teamwork; and finally, emphasizing both process-oriented and summative assessments to provide a more comprehensive evaluation of teaching. In this approach, the teacher shifts from being a mere transmitter and assessor of knowledge to acting as a guide and companion. This shift aims to stimulate students' interest in learning better and, in turn, foster a positive learning attitude and good study habits.

3.2. Designing diverse evaluation methods

Based on the concept of OBE and according to the nature and characteristics of modern control theory, a learning outcome-oriented assessment and evaluation system can be constructed by improving the assessment method and content, adding evaluation indexes and other measures.

Design of assessment indexes: The modern control theory course is highly theoretical and needs practical application. Therefore, the design of the assessment index needs to comprehensively reflect the student's mastery of theoretical knowledge, practical ability enhancement, and the cultivation of innovative thinking. Through the course, students can not only learn solid theoretical knowledge but also apply theoretical knowledge to practice and develop the ability to have practical operation and problem-solving. Teachers should focus on stimulating students' active learning in the teaching process to help them master theoretical knowledge, improve practical ability, and stimulate innovative potential. Therefore, the assessment indicators of students' learning effect should cover four aspects: learning initiative, theoretical knowledge, practical ability, and innovation potential.

Design of Assessment Methods: Assessing students' learning outcomes should seamlessly integrate into the teaching process, with evaluations occurring before, during, and after class. Initially, students' engagement is assessed through their participation in classroom interactions. Students' grasp of fundamental knowledge is then measured via periodic tests and final exams. Practical abilities are evaluated through group projects, teamwork, and MATLAB applications. Finally, students' innovative thinking is assessed through project case discussions and post-course activities that promote further knowledge expansion.

Design of Assessment Weights: The science course can adopt a “process assessment + summative assessment” model. First, teachers provide teaching resources through an online platform before class, allowing students to review them repeatedly and prepare the experimental environment and related content in advance. Second, 10% of the total assessment weight is allocated to mid-course evaluations, which include students' performance, attendance, and participation in problem discussions to enhance their learning enthusiasm and classroom initiative. Additionally, 20% of the assessment weight is assigned to post-course evaluations, which cover the quality of exercise completion, course experiments, and extension of thinking. Of this, course experiments account for 10%, and the remaining 10% is allocated to other activities. Finally, the summative assessment accounts for 70% of the total weight, divided into midterm and final assessments. The midterm assessment evaluates students' understanding of basic theoretical knowledge and concepts covered in the first half of the course, while the final evaluation focuses on their mastery of the entire course content and their ability to apply it comprehensively.

Assessment Time Design: Process assessment should be integrated throughout the semester. Pre-course materials should be provided one week before each class. Teachers will regularly assess students' attendance and facilitate ongoing course discussions. Tests should be administered approximately 3 to 4 times. The midterm examination should occur in the 8th week. Assignments should be submitted at the end of each chapter. Experimental practice, which generally includes MATLAB, stability analysis, and optimal control applications, should be conducted in the machine room during the tenth week. Based on assessment results and students' performance, teachers should adjust their strategies and methods to meet students' learning needs at different stages and ensure the continuous improvement of teaching effectiveness.

4. Practical Effect Verification

To grasp students' learning outcomes in each course, it is necessary to sample the course grades randomly as sample observation data. In this paper, we take the course "Modern Control Theory" as an example, sampling the grades of 9 classes of automation majors in the class of 2021 and selecting the

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grades of one class (29 students) as a sample.

4.1. Analysis of usual results

The regular grade consists of scores from multiple sub-items, where diversifying evaluation methods and content avoids the singularity problem of traditional course assessments. The assessment system for regular grades is shown in Table 1.

Table 1: This caption has one line so it is centered.

	Evaluation content	**Evaluation subject**	**Type of Evaluation**
Ordinary grades	Classroom interaction	Teachers and students	Formative evaluation
	Stage process assessment	Teachers	
	Weekday homework	Teachers	
	Experimental grade	Teachers	

Using this teaching assessment system, we can analyze the distribution of students' regular grades, as shown in Figure 1. The data indicate that the average grades of the class exceed 80 points. This suggests that the optimized assessment system effectively evaluates students from multiple perspectives, enhances grading objectivity, and boosts students' motivation to study regularly.

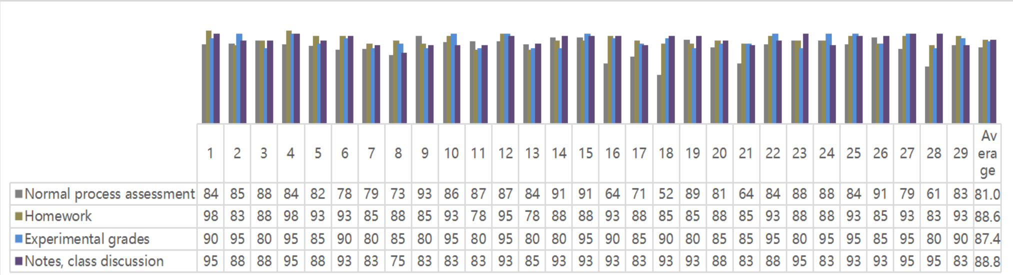

Figure 1: This caption has one line so it is centered.

4.2. Analysis of course grades

The course grade is a summative assessment, which means that the student completes the course evaluation after completing a semester of coursework and applying the knowledge and skills learned comprehensively. The assessment course grade system is shown in Figure 2.

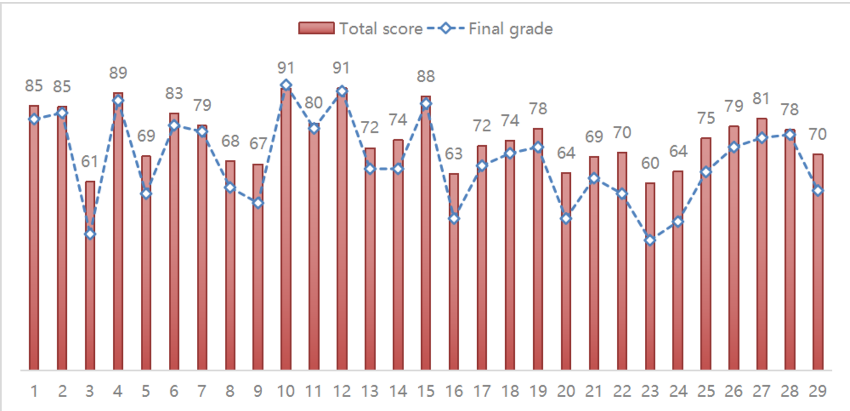

Figure 2: This caption has more than one line so it has to be set to justify.

The final grade in the figure is the final examination grade, and the student's grades are qualified in 4/5. The total grade represents the final grades of the usual and final grades, of which between (70,100) accounts for 20/29. All these can indicate to a certain extent that the optimized assessment system can evaluate the students in multiple ways and improve the objectivity of the grading.

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5. Conclusions

In the study “Exploring the Process Evaluation System and Practice of Modern Control Theory Course”, we designed and implemented a scientific and practical process evaluation system. This system assessed students' learning outcomes through a multi-dimensional approach, including regular grades, course design grades, and final course grades. The results indicate that applying this evaluation system significantly enhances students' enthusiasm and participation and deepens their understanding of the course content. Additionally, the system effectively identifies students with lower scores and provides targeted counselling to address their specific needs, optimizing overall teaching effectiveness. Consequently, this study provides valuable insights into the reform and practice of modern control theory courses.

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