

Exploration of Undergraduate Teaching Reform under the Background of New Engineering - Take Digital Image Processing Course as an Example

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Abstract

The education reform under the background of new engineering aims to cultivate engineering and technical talents with comprehensive quality and innovative ability. As an emerging interdisciplinary course in undergraduate colleges, digital image processing has a wide coverage of content and high practical requirements. In order to better adapt to the needs of undergraduate talent cultivation under the background of new engineering, reforms will be carried out on this course. In view of the disconnection between theory and practice and the single assessment method in the digital image processing course, this paper puts forward the curriculum reform under the background of the new engineering. The main reform contents include project-driven practical teaching, online and offline hybrid teaching, and full process assessment method, aiming to improve the teaching quality of digital image processing courses and the comprehensive ability of students.

Keywords

New Engineering; Teaching Reform; Digital Image Processing.

1. Introduction

In order to proactively respond to a new round of scientific and technological revolution and industrial transformation, and support a series of national strategies such as service innovation-driven development and "Made in China 2025", since February 2017, the Ministry of Education has been actively promoting the construction of New Engineering, sparing no effort to explore the model of engineering education and facilitating the building of a strong higher education nation. The construction of new engineering disciplines is a commonality between disciplines and majors, and it is the common progress of discipline construction and higher engineering education reform. The new engineering has the following requirements for undergraduate students: (1) Interdisciplinary integration: The new engineering encourages interdisciplinary integration. Students can not only master professional knowledge, but also understand the basic concepts and skills of other related disciplines; (2) Practical ability: The new engineering major emphasizes the cultivation of practical ability, where students apply theoretical knowledge to solve practical problems through experiments, internships, projects, and other means; (3) Innovation ability: New engineering education focuses on cultivating students' innovation ability and entrepreneurial spirit. Students possess critical thinking, creativity, and teamwork abilities, so that they can propose new solutions in their future work; (4) Lifelong learning: Due to the rapid development of technology, students majoring in new engineering need to possess the ability for lifelong learning. They need to constantly update their knowledge and skills to adapt to the constantly changing professional environment. In summary, the requirements for undergraduate students in the new engineering are multifaceted, including not only the learning of professional knowledge, but also the cultivation

of practical and innovative abilities, as well as a lifelong learning attitude. These requirements aim to help students adapt to technological changes, solve complex problems, and drive industry progress in their future careers.

As an interdisciplinary course, Digital image processing is closely related to social and economic development based on physics, geology, mathematics, computer technology, information theory, etc. The course of digital image processing is a mandatory course for remote sensing science and technology majors. This course is closely integrated with engineering practice and mainly introduces the basic concepts, theories, and commonly used techniques and methods of digital image processing. This course enables students to comprehensively understand the theories and methods of the course and deeply understand and master various methods and their applications in practical image processing through learning. This course is intended to cultivate students' solid theoretical foundation, innovative thinking, and strong engineering practice and hands-on abilities.

In order to better adapt to the needs of talent cultivation in undergraduate colleges under the background of new engineering, digital image processing courses need to undergo comprehensive reforms in teaching methods, experimental practices, and assessment systems, aiming to improve the teaching quality of digital image processing courses and students' comprehensive abilities.

2. Current Situation of Teaching Digital Image Processing Course

As an important course for undergraduate students majoring in computer science and technology, remote sensing science and technology, surveying science and technology, electronic information science and technology, etc., digital image processing currently has the following two problems in the teaching process.

(1) Theory is disconnected from practice. The digital image processing course adopts an indoctrination teaching method during the teaching process, which reduces students' initiative and enthusiasm for learning. In addition, the teaching content focuses on theoretical knowledge and algorithms, without applying theory to practice, thus neglecting practical applications.

(2) The assessment method is single. The traditional assessment method for digital image processing courses consists of regular grades and final grades. The proportion of regular grades is 30%, mainly including homework grades (30%), laboratory grades (40%), and attendance grades (30%), while the proportion of final grades is 70%, which mainly come from the scores of final exams. The traditional assessment method cannot fully reflect students' comprehensive abilities at various learning stages and lacks full process evaluation.

3. Reform Measures for Digital Image Processing Course

To address the existing problems in the teaching process of digital image processing, corresponding reforms should be carried out.

3.1. Project-driven practical teaching

In response to the problems of traditional indoctrination teaching, teachers abandoned the form of separating teachers' "teaching" and students' "learning" in the teaching process and adopted a two-way communication approach during the teaching process. This teaching method enables students to listen to knowledge while also expressing their own opinions, and they can express their opinions through personal reports, group discussions, and other forms. The teaching method of two-way communication can stimulate students' interest in learning and fully tap into their initiative and enthusiasm for learning.

Project-driven teaching places students in real or simulated digital image processing project environments, where students can apply theoretical knowledge to solve practical problems. Based on the background of new engineering, the teaching mode can introduce case-based driven teaching, emphasizing practical application. For example, a case study of crop yield estimation. The estimation of crop yield through remote sensing technology mainly includes the following contents: identification of crops and estimation of planting area, growth monitoring, and establishment of yield estimation models. Firstly, identify crops and estimate the planting area. Distinguish crops from other vegetation based on remote sensing images of phenological periods with the greatest differences in color tone, graphic structure, and specific geographical location features. Combine low-space resolution images (such as China's FY series satellites) and medium-space resolution images (such as Landsat series satellites in the United States) to make a crop distribution map, and use high-space resolution images (such as IKONOS images in the United States) to sample and check the crop distribution map. Modify the crop distribution map, so as to find the sowing area of crops. Secondly, monitor the growth of crops. Use high-resolution satellite images (such as China's FY series satellites) to dynamically observe the entire process of crop growth (sowing, greening, jointing, sealing, heading, and filling stages). Monitoring crop growth levels can be achieved by using vegetation indices (such as RVI, NDVI, DVI, etc.) obtained from the reflectance values of satellite multi-spectral channel images. The final selection of which vegetation index to estimate crop growth requires 2 to 3 years of data fitting and trial yield estimation to determine. Finally, establish a crop yield estimation model. Conduct regression analysis between the vegetation index during the selected plant filling period and the yield of a certain crop to obtain a regression equation, thereby achieving remote sensing yield estimation of crops.

The design of traditional digital image processing experiments focuses on a single knowledge point, such as theoretical knowledge including image stretching, image correction, and information extraction. Thus, the experimental content is designed in close accordance with these theoretical aspects. It is simple and discrete, resulting in students' inability to solve complex engineering problems. The project-driven practical teaching model is used to improve students' ability to solve complex engineering problems. For example, to study the urban expansion of one's hometown, the process will involve remote sensing image download, remote sensing image enhancement, remote sensing image correction and urban information extraction, etc. Students will be guided to carefully analyze the needs of the project, sort out the problems that need to be solved, and decompose them into specific tasks. Students use the specific algorithms in the field of digital image processing to solve the corresponding problems, and analyze and evaluate the results. Through a set of demand-problem-algorithm-evaluation processes, students are trained to solve complex engineering problems.

3.2. Improve the assessment mechanism

The traditional assessment of digital image processing teaching mainly includes student attendance, homework, experimental reports, and final exam content, lacking process evaluation of students, making it difficult to grasp their daily learning situation. To solve this problem, a blended online and offline teaching system is constructed, and the entire process evaluation of students' learning situation is carried out.

3.2.1. Blended online and offline teaching

Before each class, online learning tasks are assigned through Rain Classroom (as shown in Figure 1), mainly consisting of videos related to the course content. Each video is about 30 minutes long, and students are required to watch these videos independently before class. Rain Classroom automatically records the learning process. During each class, corresponding test questions are assigned through the Rain Classroom platform, which mainly include multiple-choice questions, fill-in-the-blank questions, and true/false questions (as shown in Figure 2).

Students can interact with the class through features like bullet screen comments, submission, and screenshots for any points they don't understand or test questions they got wrong. The learning records and test results are used to track students' learning progress in real-time, and during this process, students are encouraged to think actively.

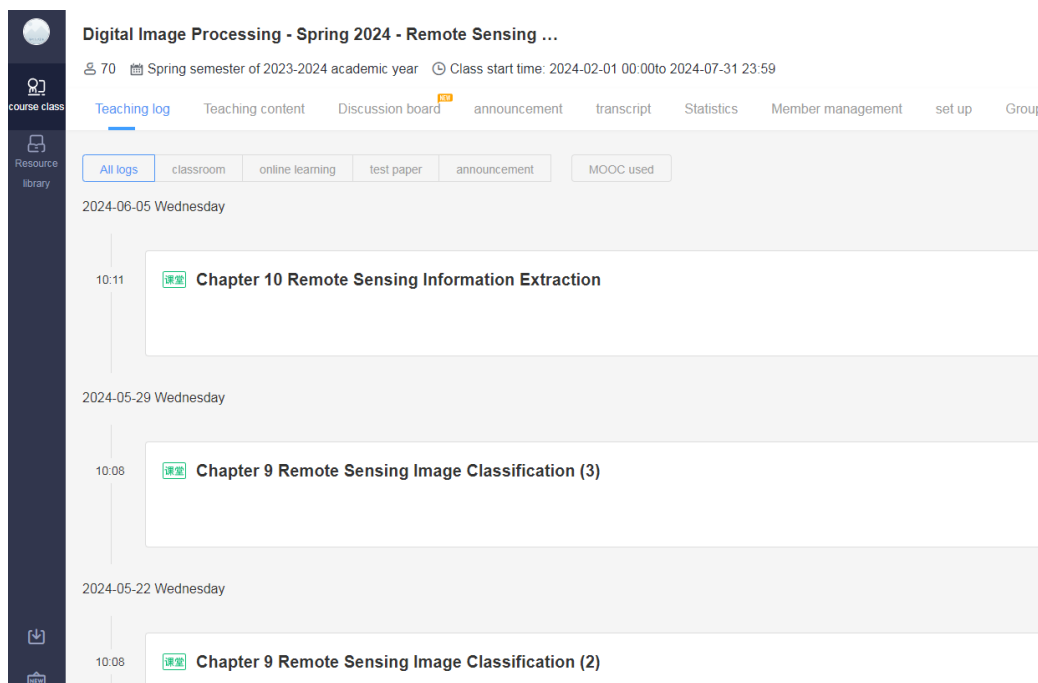


Figure 1. Rain Classroom Teaching Log

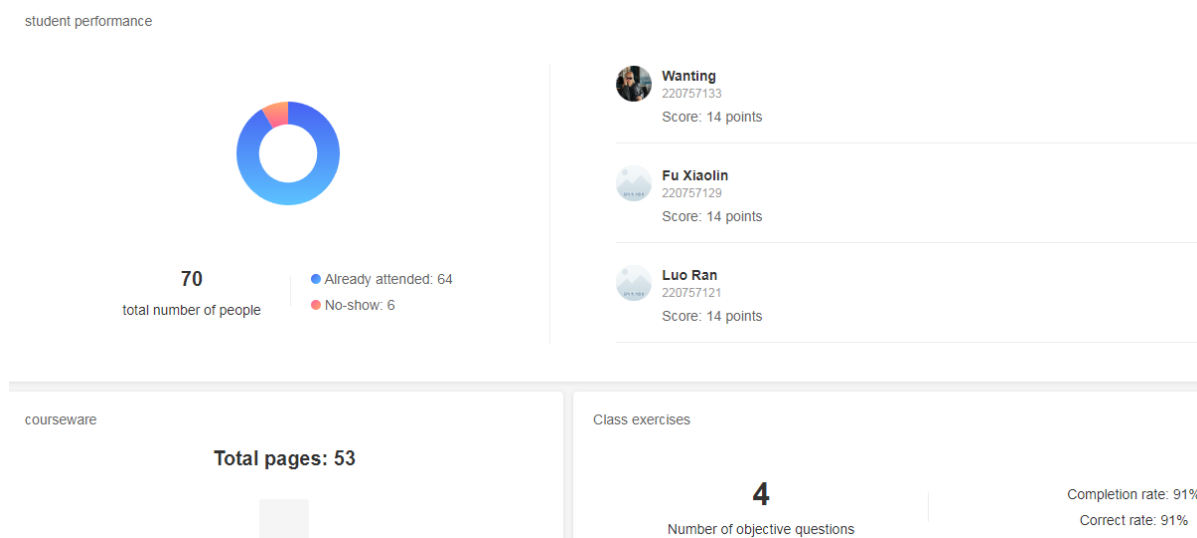


Figure 2. Rain Classroom Report

In addition to the teaching assessment of each class, the teaching content of each stage is also assessed to ensure the continuity of the content for students. The assessment of each stage of teaching content is achieved through the school's online teaching platform. Teachers should set up no less than four online tests on the online teaching platform (as shown in Figure 3), and set up mid-term tests at the halfway point of the course. The test types mainly include multiple-choice questions, fill-in-the-blank questions, and short answer questions. The platform has automatic evaluation and instant feedback functions, and timely tracks students' learning situation at each stage based on their online test results, so as to understand students' mastery

of knowledge points at each stage and communicate with students with lower online test scores in a timely manner.






<input type="checkbox"/>	test title↕	Deadline↕	public↕
<input type="checkbox"/>	 Test 4	2024-06-05	public
<input type="checkbox"/>	 Test 3	2024-05-16	public
<input type="checkbox"/>	 midterm test	2024-04-25	public
<input type="checkbox"/>	 Test 2	2024-04-11	public
<input type="checkbox"/>	 Test 1	2024-03-28	public

Figure 3. Online testing interface of online teaching platform courses

In addition, survey questionnaires for digital image processing courses will be conducted at the beginning and middle of the semester. The content of the initial survey questionnaire mainly includes whether the teaching objectives of the course are clear, whether the current learning resources of the course (such as textbooks, courseware, lecture notes, videos, etc.) meet the learning needs of students, and whether students can keep up with the teaching progress and pace of the course. Taking the initial survey questionnaire for the Remote Sensing Level 22 Digital Image Processing course as an example, the survey results were analyzed: For the clarity of the teaching objectives of this course, 97.37% of students rated it as clear, indicating that the teaching objectives of this course are relatively clear; Regarding whether the learning resources of the current course meet the learning needs of students, 97.36% of students think they meet their learning needs, indicating that the learning resources of this course can meet the learning needs of a large number of students; In terms of whether students can keep up with the teaching progress and pace of the course, 97.11% of students think the teaching progress and pace of the course are suitable, indicating that the teaching progress and pace of the course are relatively appropriate for most student.

The contents of the midterm questionnaire mainly include whether the key and difficult points of the digital image processing course are prominent and easy to understand, whether the teaching content is combined with the needs of the discipline frontier and social development, whether the communication and discussion time, homework time and learning time of the course can meet the students' learning needs, whether students' questions can be answered and guided in a timely manner during the learning process, whether students have the opportunity to participate in the course discussion and express their views during the learning process, and whether students' interest in the course continues to increase with the course. Taking the mid-term questionnaire of remote sensing level 22 digital image processing course as an example, the survey results are analyzed: For the course content, the key and difficult points are prominent and easy to understand. 97.56% of the students think there are clear explanations for the key and difficult points, indicating that there are indeed clear explanations for the key and difficult points of the course. For the teaching content that combines the forefront of disciplines and the needs of social development, 97.68% of students think the teaching content involves the forefront of disciplines and the needs of social development,

indicating that the teaching content does indeed combine the forefront of disciplines and the needs of social development. Regarding whether the communication and discussion time, homework time and study time of the course meet the learning needs of students, 97.56% of students have arrangements that can relatively well meet their learning needs, indicating that the communication and discussion time, homework time and study time of the course can relatively well meet the learning needs of students. Regarding whether students' questions can be answered and guided in a timely manner during the learning process, 97.56% of students gave feedback that it was very helpful, indicating that most students' questions can be answered and guided in a timely manner. During the learning process, in terms of whether students have the opportunity to participate in course discussions and express their views, 97.56% of students often or always participate in course discussions and express their views. As the course progresses, regarding whether students' interest in the course keeps increasing, 97.56% of students think that their interest in the course keeps increasing as the course progresses.

The interactive learning methods mentioned above help broaden students' thinking and enhance their problem-solving abilities. Blended online and offline teaching can not only improve students' learning efficiency, but also cultivate their ability to learn independently and solve problems.

3.2.2. Reform of Assessment Methods

According to the blended learning method of online and offline, the assessment of the entire process mainly includes two parts (as shown in Table 1).

Table 1. Assessment Methods

Process assessment score accounts for 50%				
Classroom performance	Homework after class	Online testing (no less than 4 times)	Mid term testing	Experimental report
15%	20%	20%	20%	25%
The final exam score accounts for 50%				

The process assessment score (accounting for 50%) and the final exam score (accounting for 50%). The process assessment score mainly consists of five parts: the classroom performance score (accounting for a total of 15%), which is automatically evaluated by Rain Classroom; The homework grade after class (accounting for 20%) will be given a corresponding score based on the student's completion status; The online test score (accounting for 20%) is automatically evaluated by the online teaching platform; The mid-term test score (accounting for 20%) is automatically evaluated by the online teaching platform; The experimental report score (accounting for 25%) is awarded based on the quality and completion of the student's experimental report. At the end of the semester, write a quality report on the digital image processing course, summarize students' learning outcomes, analyze the achievement of course objectives, compare the teaching quality with that of previous years, summarize experience, and find out shortcomings, so as to improve the next round of courses.

4. Conclusion

The new engineering is committed to cultivating competitive engineering talents to meet the development needs of the new era. Under the background of new engineering, this paper takes the course of digital image processing as an example, aiming at the problems of disconnection between theory and practice and single assessment method in this course, the main reform contents include project-driven practical teaching, blended online and offline teaching, and the whole process assessment method. At present, as an effective channel to improve the quality

of undergraduate talent training and comprehensively improve the quality and effect of course teaching, how to integrate ideological and political content into the digital image processing course and organically combine ideological and political education with curriculum education will be a future research direction in digital image processing course teaching.

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