

Survey and Reform of Data Structure Courses Based on SPOC Mixed Mode

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Abstract: A questionnaire survey was conducted among undergraduates from the School of Computer Science of Zhuhai College of Jilin University to analyze the current status of data structure courses to know about the difficulties students encountered during the learning process and the help they expect to get, and to explore the design and implementation of the face-to-face teaching and online network self-learning platform of the data structure courses reform based on SPOC online and offline mixed mode, so as to meet the purpose of allocating teaching resources reasonably, improving students' self-learning ability, strengthening the cultivation of students' computational thinking and hands-on ability, and in the end, the students' evaluation and feedback of the course are collected and the experience of this teaching reform is summarized.

1. Introduction

International Engineering Education Certification is a new trend of modern engineering education. The education certification promoted by IEET is a non-governmental, peer-review mechanism. Its main purpose is to change as students' outcomes-based, and to maintain the quality of education and pursue continuous improvement through the certification mechanism. In 2019, our school actively promotes the IEET certification of computer majors, enhances the understanding of the education standards of the major, completes various teaching tasks in accordance with the requirements of the certification specifications, and guarantees the quality and quantity of the teaching effectiveness of each course in the teaching process. Curriculum, as the sum of educational content and process selected to achieve the training goal in the talent training mode of colleges and universities, contains a wealth of educational activities [1]. The design and arrangement of the curriculum should closely focus on the objectives of talent training and the needs of regional social and economic development.

Data structure, as an important professional basic course generally offered by computer-related majors, is a focus of IEET certification. This course has the characteristics of wide coverage, high teaching difficulty, strong teaching interaction, and great impact on subsequent courses. At the same time, the data structure course is also one of the difficult courses for students to learn. The traditional mode, mainly lectured by teachers, has not been able to follow the changing academic situation, and in face of many algorithms and many data structures, the students often feel confused, "What to learn? How to learn?" However, the effect of data structure course learning is directly related to the improvement of software design level and the cultivation of professional quality. It plays a very important role in the education of computer disciplines. Data structure teaching is closely related to the success or failure of computer professional training plan.

2. Survey and Statistics

In order to fully understand the difficulties encountered by students in studying this course and solve them, we conducted a questionnaire survey for computer science and technology majored students in September 2019, and received a total of 144 valid questionnaires. According to the survey results of "the main difficulties encountered in the process of studying data structure

courses": (A) 81.94% of students think they lack programming skills; (B) 65.97% of students think that theoretical knowledge is difficult to understand; (C) 16.67% of students think that the study time is not enough; (D) 28.47% of students think that they could not adapt to the learning style; (E) 21.53% of students think that they lack of learning peers; (F) 27.78% of students think that there is a lack of learning environment; (G) 11.81% of students think there are other difficulties. As shown in Figure 1.

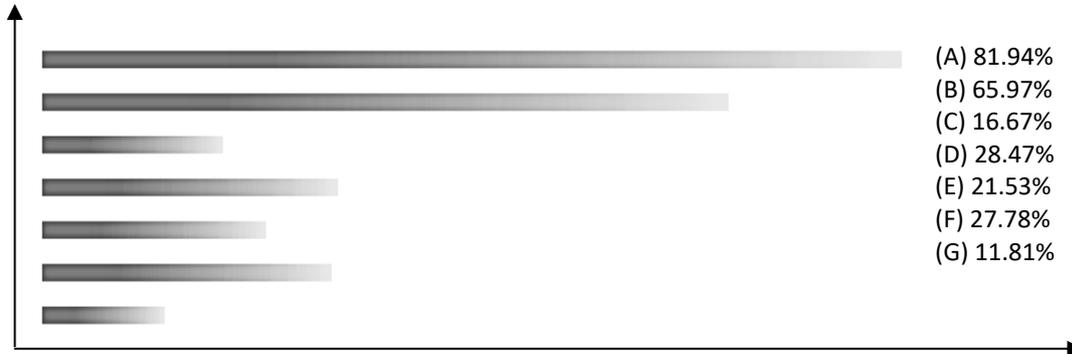


Fig. 1. Major Difficulties Encountered by Students in the Learning Process

The survey results on "what kind of help do you need in the process of learning data structure courses" show that: (A) 13.79% of students need emotional encouragement from teachers, (B) 73.1% of students need effective learning guidance from teachers, (C) 71.03% of students hope that the teacher can provide rich learning materials, (D) 61.38% of students hope that the teacher can use their spare time to counsel and answer questions, (E) 58.62% of students need teachers to provide professional technical support, (F) 57.93% of students need teachers to provide scientific learning methods, (G) 6.21% of students need other help, as shown in Figure 2.

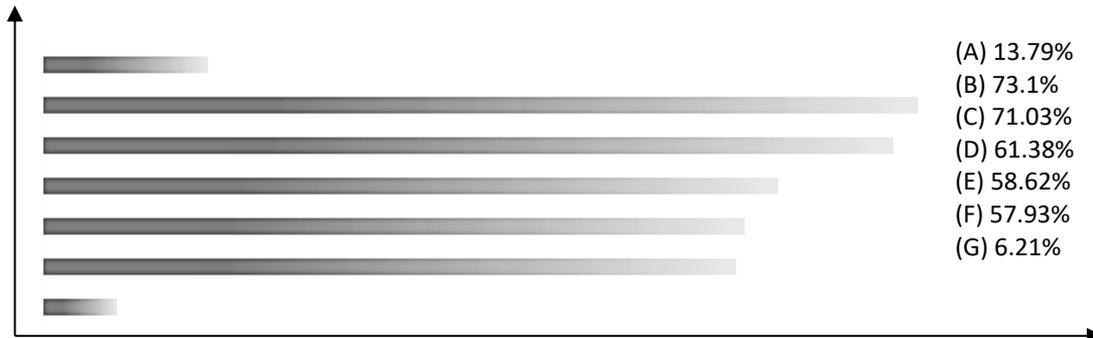


Fig. 2. The kind of Help Students Need

The survey results on the "college students' ownership rate of personal computers and intelligent communication equipment" show that all students have their own personal computers and intelligent communication equipment, and the equipment can access the internet. The popularization of student personal computers and intelligent communication equipment has provided a strong guarantee for the teaching reform of SPOC online and offline mixed mode.

3. Design of SPOC Mixed Mode

Data structure course is an engineering education course combined of theory, practice and design. Its teaching method should not be just the conventional teaching or demonstration method, etc., but should follow the rapid development of information technology, combine with modern educational technology means to carry out the reform of new compound teaching methods. Therefore, we designed the SPOC mixed teaching mode of the data structure course shown in Table 1 based on the questionnaire feedback. SPOC is a small-scale, restricted course open to school students or specific personnel [2]. Compared with the large, open, and online learning characteristics of MOOC [3], the

SPOC mixed mode has the characteristics of small, private, online and offline mixed learning, which not only overcome the shortcomings of single and one-sided traditional teaching methods, but also make up for the large and open MOOC's shortcomings of difficult to manage and not good for interaction [4] [5].

Table 1. SPOC Mixed Teaching Mode Design for Data Structure Course

Content Teaching	Face-to face Teaching	Online Learning
	Classroom Teaching	Micro-Lecture
	Lecture	Podcasting
	Experiment Teaching	Virtual Classroom
	Curriculum Design	
Curriculum Resource	Textbook	Online Resource
	Reference Book	Questionnaire
	Laboratory Manual	Question bank
	Electronic Courseware	Algorithm Demonstration System
Teacher-student Interaction	Notice and Announcement	Course Survey
	Face-to-face Coaching	Online Q&A Discussion
	Experiment Guidance	
	Seminar	
Assignment and Test	In-class Exam	Online Test
		Electronic Task
		Electronic Laboratory Report
Assessment	Attendance Rate	Electronic Task Completion Rate
	In-class Performance	Submission of Electronic Laboratory Report
	In-class Test Score	Micro-lecture Viewing Rate
		Online Test Score

4. Implementation of SPOC Mixed Mode

The data structure course based on the SPOC mixed mode combines online learning and face-to-face teaching, and comprehensively applies the organic combination of new technologies such as NTP (Network Teaching Platform), micro-lectures and online program evaluation systems, examination systems, with traditional classroom teaching, experiment teaching and practical teaching. The teaching strategy of "based on theory, guided by examples, targeted by applications, and promoted by self-test" is established, and the content is arranged in accordance with the four major modules of "linear structure, tree structure, graphic structure, and set structure". The selected content is classic and rich, and as simple as possible and step by step. Each knowledge point is designed with the following process: narrating concept-> raising question -> describing instance -> designing data structure-> designing algorithm-> programming realization-> self-testing and strengthening training. We hope that the SPOC mixed mode course can bring as many benefits to the students as possible, helping them to master the inherent learning rules of the data structure course, and add some auxiliary binding forces through self-assessment exercises to help students overcome obstacles and enhance their self-learning ability. The implementation plan of each step is as follows:

(1) Selection of teaching materials: Referring to the Comprehensive Basic Examination Outline for Computer Science Majors of the National Postgraduate Entrance Examination, the selected teaching materials has covered all the knowledge points specified in the outline, and the relevant national knowledge examination questions, reference answers and problem analysis are attached to the relevant knowledge points.

(2) Case design: Fully consider the needs of application-oriented undergraduate talent training, and focus more on the implementation of algorithms. The algorithms taught in the course are realized by elegant and complete C ++ programs, and all programs are compiled and passed under the Visual Studio environment. This will help students master the program implementation of the algorithm and the design, analysis and comparison of the algorithm.

(3) Experimental teaching: It includes two modules. The first is the basic experimental teaching module: focusing on training the students' basic data structure and algorithm design ability. The second is the curriculum design module: focusing on cultivating students' ability to analyze and solve practical problems using basic data structures, algorithms, basic experimental techniques and methods.

(4) Video Recording: Psychological research results show that the most effective concentration time period for human attention is 6-10 minutes. After this time period, it will drop, and the ability to receive information will also decline [6], so the trend of information acquisition must be fragmental. Following this principle, the micro-lectures of this course divide the video according to knowledge points and control the length of the video. The systematic knowledge is transformed into fragmented information. The curriculum team has recorded more than 80 micro-lectures.

(5) Network teaching platform design: Organize learning resources according to the tree structure divided by modules, chapters, and knowledge points, including 4 modules, 12 chapters, and 102 knowledge points. Course resources include syllabus, teaching schedule, electronic courseware, podcasting, algorithm demonstration system, experimental answers, after-course exercise answers, assignment answers, etc.

(6) Construction of the question bank: Taking into account the selection of graduate students, all exercises are from exam questions of the local colleges and universities and the national uniform examination. While completing the corresponding questions, students can not only consolidate knowledge points, but also selectively improve their ability. At present, more than 450 questions are contained in the examination system. All knowledge point tests can be automatically graded, and feedback can be given in time. Students can repeat the test until they reach the required score to pass the knowledge point test [4].

(7) Self-learning of students: Students can complete experimental assignments and knowledge training tasks independently in the experimental class or after class. When encountering difficulties, students can consult the teacher in the experimental class or online forum. They can discuss with classmates, or search for related knowledge on the Internet, and they can also watch the micro-lectures on knowledge points.

(8) The assessment and evaluation mechanism: The data structure course is theoretical, designing, and practical. In the past, we mainly tested the theoretical knowledge learning effects of students through paper tests, which did not fully reflect the students' usual performance and analytical design capabilities. The reformed curriculum assessment and evaluation mechanism is shown in Table 2. The process assessment phase mainly examines students' independent learning ability, practical ability and classroom performance. The knowledge point test, mid-term exam, and final exam are conducted through the examination system provided by a third-party company, and the self-built computer professional graduate entrance examination question bank is used for assessment.

Table 2. Assessment and Evaluation Mechanism

Assessment Mode	Proportion	Implementation Mode
Process Assessment (50%)	Attendance and In-class Performance (10%)	Finish During the Class Teaching Process
	Micro-lecture Viewing Rate (10%)	Finish by Logging in the Online Learning Platform After Class
	Completion of Laboratory Assignment (10%)	Finish by Logging in the Online Learning Platform in or after Laboratory Class
	Completion of Knowledge Points Test (10%)	Finish by Logging in the Exam System in Laboratory Class
	Mid-term Test (10%)	Finish by Logging in the Exam System in Laboratory Class
Final Assessment (50%)	Final Exam (50%)	Finish by Logging in the Exam System in Laboratory Class

The results of the latest questionnaire survey on curriculum recognition after the implementation of the SPOC mixed mode show that: (A) 57.93% of students believe that studying this course will help them improve their ability to analyze problems and solve some practical problems; (B) 35.86% of students think that studying this course will help improve their ability to analyze problems and solve some practical problems; (C) 1.38% of students think that studying this course is not helpful to improve their ability to analyze problems and solve some practical problems; (D) 4.83% of students do not know if the course have helped them.

5. Summary

The fragmentation of SPOC knowledge points is conducive to students' pre-review and review of the course, which makes up for the lack of classroom teaching and provides strong supplement and support for classroom teaching. Preview the micro-lectures before class and listen to the teacher's lectures with focus on the key points and doubts in class, there would be high efficiency. After the class, review the micro-lectures and algorithm demonstration system and complete the experimental assignments, unit tests, and module tests. It provides students with a more systematic and comprehensive opportunity to consolidate exercises, which is conducive to the formation of a complete knowledge system and promotes the cultivation of students' self-learning and lifelong learning ability. At the same time, teachers can effectively monitor the student's learning progress and completion degree through the statistical analysis function provided by the network teaching platform, so that teachers can timely know the changes of academic situation, and then adjust the teaching focus and teaching strategies flexibly. After the teaching reform, the assessment and evaluation mechanism of the curriculum is more focused on process evaluation, which not only retains the advantages of simple and intuitive operation of the final evaluation, but also strengthens the management of the learning process, emphasizes the cultivation of students' learning ability, and the evaluation mechanism is more scientific and reasonable.

The data structure course based on the SPOC mixed mode organically combines the advantages of the two teaching modes, that is, it has the advantages of easy interaction and management in face-to-face teaching, and also has the characteristics of intensive and niche SPOC online learning, so as to achieve the goal of reasonable allocation of teaching resources, expand of the depth and breadth of courses, optimization of learning efficiency, improvement of self-learning ability, and optimization of teaching effect.

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