Exploration and Consideration on Teaching Reform of Data Structure Course for the Engineering Education Professional Certification

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Keywords: Data structure course; Engineering education certification; Teaching reform.

Abstract. As a core curriculum of computer science, data structure plays a key role in connecting the preceding with the following in the professional curriculum system. This paper analyses the problems existing in the traditional teaching method of data structure course. Based on the results-oriented concept of engineering education for professional certification, the student-centered and continuous improvement concept of teaching, some ideas and measures for the reform of data structure course are presented, including adjusting teaching aims and improving teaching methods and reforming assessment methods, etc. Through the reform, we can effectively improve the teaching effect of data structure course, learning interest and initiative of the student and improve engineering practice ability for them.

Introduction

Engineering education certification is a special certification for engineering specialties offered by higher education institutions, which is the basis of realizing international mutual recognition of engineering education and engineer qualification. China started the pilot project of engineering education professional certification from 2006 and became the 18th formal member of the Washington Agreement in June 2016, which indicates that the quality certification system of engineering education has achieved international level and been recognized and appreciated in the world. In recent years, more and more scholars engaged in computer teaching have studied and discussed the training mode of computer professionals based on engineering education certification [1]. Zhang Xu [2] has made a useful exploration on the teaching reform of operating system for engineering education certification, and put forward a teaching method based on the combination of various modes of network learning platform. Liu Yongbin et al. [3] discussed the training mode of Applied Software Talents for engineering education certification. Luo Weilian et al. [4] deeply studied the curriculum system reform of computer specialty. Zhao shu et al. [5] focused on the construction of computer composition and architecture courses for engineering education professional certification. Chen Shuhong and others [6] have studied the computer network teaching driven by the professional certification of Engineering education. As the core course of computer science and technology, data structure course is a compulsory subject for postgraduate entrance examination of computer specialty. It discusses the knowledge content and advocates technical methods, whether for further study of other follow-up courses in computer field or for large-scale software development. They are all important and necessary foundations. Therefore, it is particularly urgent to reform the course of data structure with the professional certification of engineering education to improve ability of student to analyze and solve practical engineering problems.

Teaching Problems in Data Structure Course

Teaching Method is Single and Lacking of Learning Enthusiasm

At present, most of the theoretical courses of data structure courses in schools are explained by teachers with the help of PPT and blackboard writing. The teaching mode is single. Teachers can better complete the "teaching" link in the teaching process. Students listen passively below, which
cannot guarantee the quality of "learning," and it is difficult to mobilize students' enthusiasm. Especially, it is particularly prominent under the background of engineering education professional certification.

**Less Experiments and Lack of Innovation**

At present, there is a widespread phenomenon in the teaching of data structure in the colleges that the theory is be emphasized excessively more than experiment. Most of the experiments focused on verification, rather than to improve professional quality and innovation ability of students and the ability to solve practical engineering problems is not trained.

**The Method of Course Assessment is Single and the Evaluation System Need to Improve**

As an examination course, data structure is mostly graded by the examination method at the end of term and supplemented by experiments and assignments. The final examination results account for a large proportion of the total scores. If the final examination result is good and the students can get the credits of this course successfully, which is not conducive to train practical ability of student.

**Teaching Reform of Data Structure Course Based on Engineering Education Professional Certification**

**Formulating the Teaching Objectives of Engineering Education Based on the Outcome-oriented Concept**

Professional certification is mainly based on the quality of graduate. After analyzing the relationship between data structure course and graduation requirements, the teaching objectives of this course are found and described as follows. (1) the students should master the characteristics and implementation methods and application scope of commonly used data structures, master the design and analysis methods of commonly used algorithms, understand the concept and analysis methods of space-time complexity of algorithms. (2) Training the ability to analyze and solve value problems, read widely, analyze and design algorithms, develop awareness of evaluation of algorithms and data structures, accumulate and improve programming and practical application abilities for complex problems. (3) Training the ability with the knowledge learned synthetically to analyze practical problems, select appropriate data structures, design algorithm, code comprehensive program and have good programming style, teamwork, innovative professional qualities. The corresponding relationship between curriculum objectives and graduation requirements is shown as Table 1.

| Graduation requirements | Graduation Requirements Indicator Point | Curriculum objectives |
|------------------------|----------------------------------------|-----------------------|
| 1. Engineering knowledge: Able to apply some theories and methods to grasp the basic knowledge of Computer Science Specialty | 1.3 Ability to master basic computer knowledge and to analyze and design complex computer engineering problems | ✓ ✓ |
| 2. Question analysis: It can apply basic principles, identify and express, and analyze complex computer engineering problems through literature research, so as to obtain effective conclusions. | 2.2 Identification and judgment of key links and parameters of complex computer engineering problems | ✓ ✓ |
| 4. Research: It can study complex computer engineering problems and get reasonable and effective conclusions through information synthesis. | 4.2 Can understand the design ideas and basic principles of computer systems, and can use the corresponding principles to solve specific problems. | ✓ ✓ |

Table 1. The Corresponding Relation between Teaching Objectives and Graduation Requirements Indicators.
From Table, we can see that professional certification pays more attention to the cultivation of engineering practice ability and the improvement of analysis and problem solving ability.

**Combination of Multi-teaching Mode Based on Student-centered**

Because the theory and practice of data structure course are very strong, many teaching methods such as inquiry teaching, multimedia teaching, case teaching and flipping classroom are used during teaching to achieve the objectives of the course and ensure the teaching effect. The important algorithm adopts animation demonstration to make learning become more effective, vivid and interesting. In the process of teaching, several examples are discussed according to the content of the course. With the interesting examples discussed, learning enthusiasm of students is enhanced greatly and teaching effect is improved. Emphasis is laid on introducing new examples and related technologies as a starting point to organize students to find problems in the process of discussion, raise questions, so that students can realize the practical application scenario of data structure. It not only increases the interaction between teachers and students, but also enables students to change from passive to active learning of curriculum content, mobilizes subjective initiative in learning, and improves ability of analyzing and solving problems. Combining with network teaching resources, students adopt problem-driven way to conduct online live learning and online on-demand learning, so as to improve initiative in learning of the students. The limitation of time and space in traditional teaching is broken, and students can learn independently at any time. The development of online and offline hybrid teaching mode stimulates learning initiative of student and makes up for the shortcomings of classroom teaching.

**Reforming the Examination Method and Content of the Course Based on the Outcome-oriented Engineering Education Idea**

According to the result-oriented concept of engineering education, the assessment mode of data structure course is reformed. The new curriculum assessment standard pays more attention to the process evaluation and the engineering practice application assessment center on the curriculum knowledge points. Usual performance accounts for 40% of the total and usual performance is divided into classroom performance, small assignments, and experimental results are emphasized. By subdividing large and small assignments, the weight of procedural assessment is increased, and the way of attendance is changed to classroom discussion, case analysis and thematic report. The content of the final exam has changed from focusing on mastery of basic data structure and algorithm to focusing on practical application ability of basic data structure algorithm. Through the reform of course assessment methods and contents, the results-oriented concept of engineering education is enhanced, and the requirements of professional certification of engineering education are met.

**Summary**

This paper analyses the problems existing in the teaching of traditional data structure course. Combining with the engineering education professional certification, the teaching reform of data structure course is discussed. With these methods and measures, we can effectively implement the "student-centered" and "result-oriented" engineering education concept to improve the teaching effect of data results course, and the quality of computer professionals.

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