Research on computer algorithm experimental teaching method based on engineering education accreditation

Quan OuYang, Hongyun Xu*

School of Mathematics & Computer Science, JiangHan University, Wuhan 430056, China

*Corresponding author: xhy1978@163.com

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Abstract. This paper analyzes the current experimental teaching methods and elaborates the existing problems in the current experimental teaching. An experimental teach method of computer algorithm related courses for engineering education accreditation is proposed, which includes selecting relevant knowledge points from scientific research or engineering projects as experiment items, implementing experimental teaching, and evaluating the students' experimental results. Finally, an example is given to illustrate how to use the experimental teaching method proposed in this paper for engineering education accreditation to design a group of experiment items related to computer algorithm.

1. Introduction

In engineering education accreditation, there needs to be open, school oriented, and socio-economic development oriented training objectives. Generally speaking, what kind of professional skills and level can students reach five years after graduation? In the major of science and engineering, the advantages and disadvantages of experimental teaching methods play an important role in achieving the training objectives. As we all know, in the process of the experiment, students are trained in various abilities, including practical ability, observation skills, analytical skill, application ability of theoretical knowledge, innovation ability, and so on. Therefore, in order to achieve the training objectives more accurately, we must establish a reasonable experimental scheme for each course related to this major.

2. Analysis of the current situation of experimental teaching

2.1. Less proportion of experimental teaching.

For some applied courses, the teacher's teaching method is mainly to explain a large number of basic knowledge first, and then arrange several experiments. In the process of experiment, theoretical knowledge and practice are separated, which cannot promote each other and stimulate students' interest in learning.

2.2. Too many replication experiments and few designing experiments.

The experiments of specialized foundation courses are mainly replication experiments. For example, in the course of object-oriented programming, there are quite a number of experiments just to verify various grammar rules, and there is no use of examples to practice how to apply knowledge points. Thus, the content of the experiment is empty, which cannot guide the students to think actively and leads to the lack of initiative for the students, so that the experiments do not do what it was supposed to do.

2.3. Separation of theory and experiment.

The theoretical knowledge taught in the specialized course is the knowledge after abstracting the practical problems and solutions. How to use this theoretical knowledge to solve the practical problems is completed through the experimental course. In the current teaching process, there is more

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or less separation between theoretical teaching and experimental teaching, which leads to the failure of timely combination of theoretical learning and practice. Such a teaching process is not conducive to students' timely absorption and digestion of knowledge.

2.4. Summary of experimental teaching methods.

At present, all colleges and universities are preparing for passing the engineering education accreditation. The purpose of engineering education accreditation is to cultivate qualified undergraduate graduates. As an important evaluation link in engineering education accreditation, experimental teaching must be guided by the principle of combining theory with practice and learning with application. At present, the more practical experimental teaching methods include research projects based experimental teaching method, achievement based experimental teaching method, and engineering based experimental teaching method, and so on.

3. Engineering education accreditation based experimental teaching method

Through the study and summary of the current experimental teaching methods, this paper puts forward an experimental teaching method based on engineering education accreditation, which aims to pass the engineering education accreditation, designs the experimental teaching items to meet the requirements of undergraduate education, and completes the experimental teaching process by effective assessment and evaluation means. The reasonable experimental items can simultaneously cultivate students' various abilities, including practical ability, observation, analytical ability, application ability of theoretical knowledge, innovation ability, and so on. Therefore, the experimental teaching method based on engineering education accreditation is to establish a set of experimental teaching items system meet with engineering education accreditation, the process of which is presented in Figure 1.

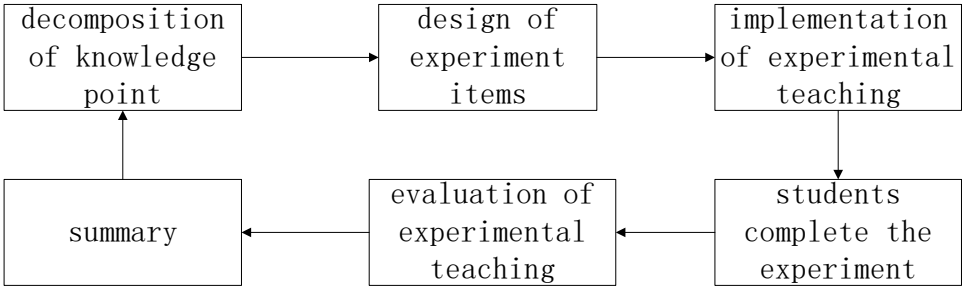

Fig. 1 Process of the experimental teaching method based on engineering education accreditation

3.1. Knowledge point decomposition.

By screening some scientific research or engineering projects, some of them which are closely combined with the major are selected to be experiment items. In particular, it is to decompose scientific research or engineering projects, analyze them from the perspective of experiment courses, find knowledge points related to courses, and set up relevant experiment items. Take my project "Research on job scheduling in computer numerical control (CNC) equipment cluster control system" as an example. It is a project related to optimization, which is closely related to the courses of object-oriented programming, data structure and algorithm, algorithm design and analysis, discrete mathematics, and combinatorial mathematics in the computer science and technology major. From the project “Research on job scheduling in CNC equipment cluster control system", we can sort out several knowledge points related to computer professional courses, and then design them into the experiment items required by the above professional courses. These experiment items provide strong support for the practical application of the professional courses, improve students' recognition of professional courses and make use of what they have learned.

3.2. Design of experiment items.

Based on the technical data of scientific research or engineering projects, we modify them appropriately and design them as experiment items. In the process of design, students' existing theoretical knowledge and acceptance of the problem should be taken into account. Relevant literature should be provided for students to consult, which help students to obtain corresponding information and design their own experiment scheme. In the process of experiment, relevant background, application scope, and other knowledge should be supplemented to help students to understand the experiment items. In the design of experiment tasks, the whole item can be divided into several sub tasks with low difficulty, which is convenient for students to choose tasks freely according to their own interests and hobbies.

For example, the project "Research on job scheduling in CNC equipment cluster control system" involves the knowledge of multiple courses, which can be divided into small projects according to different courses. The experiment items could be designed according to the knowledge points of relevant courses.

3.3. Implementation of experimental teaching.

Choose an experiment course for small scale test. Modify the experimental design scheme further according to the experimental results and increase the integration degree of experiment items and professional courses, and so on. For example, the optimization algorithm of project "Research on job scheduling in CNC equipment cluster control system" can be completed step by step, from simple to complex. Start with the implementation of local search algorithm, then the implementation of evolutionary algorithm, and then the implementation of hybrid algorithm.

3.4. Assessment and evaluation of experimental teaching.

At the end of experiment, the students report in the form of essays, which mainly explains the parts they have completed in the experiment items, such as algorithm design, program implementation, debugging, data analysis, parameter adjustment, and so on. The teacher gives the corresponding scores according to the students' answers.

4. Summarize the experiment items from project "Research on job scheduling in CNC equipment cluster control system"

4.1. Background of the experiment design.

Scheduling problem is a kind of important combinatorial optimization problem. It uses some processors, machines, or resources to optimally complete a batch of given tasks or jobs. During the execution of these tasks or jobs, some restrictions need to be met, such as the tasks or jobs' arrival time, completion time, processing sequence, and the influence of resources on the processing time, and so on. The optimal completion is to minimize the objective function, which is usually a description of the processing time or the utilization rate of the processor [2001-introduction to sequencing]. In the computer science and technology major, the courses involved in scheduling problem mainly include data structure and algorithm, algorithm design and analysis, discrete mathematics, combinatorial mathematics, and so on. Next, we will design relevant experiment items according to the teaching requirements of algorithm design and analysis.

4.2. Experiment objective.

Three evolutionary algorithms for single machine scheduling problem are designed, which adopt three crossover operators PMX, OBX, and aERX respectively. The widely used benchmark instances in the literature for single machine scheduling problem are used to test the three evolutionary algorithms.

These three crossover operators, PMX, OBX, and aERX, are the common methods in evolutionary algorithm, the details of which can be referred to [1,2,3]. The implementation of three crossover operators can help students to establish more intuitive concepts for evolutionary algorithm.

4.3. Algorithm principle and crossover operator.

Evolutionary algorithm is generated by simulating biological evolution laws, which is a kind of algorithm with strong robustness and wide adaptability. Its main implementation processes include coding, population initialization, selection strategy, crossover operators, and other parts. The evolutionary algorithm's description is as follows [4,5]:

Step 1: Generate *n* initial work sequences $P = \{x^1, \cdots, x^n\}$

Step 2: repeat

Step 3: x^* =min{ $f(x^i)|i$=1 to n} /* $f(x^i)$ is the objective function value of x^i */

Step 4: Use roulette strategy to select two working sequences x^j and x^k from *P*

Step 5: $x^0 \leftarrow$crossover operator (x^j , x^k)

Step 6: if $f(x^0) < f(x^*)$ then

Step 7: $\{x^1, \cdots, x^n\} \leftarrow$Updating $(x^0, \cdots, x^n)$

Step 8: end if

Step 9: until the stop criterion is met

4.4. Algorithm test scheme and performance analysis.

Evolutionary algorithm is a heuristic algorithm, which is characterized by relatively high efficiency but poor stability. Therefore, we can take the method of short time for one run and run many times to test the algorithm when developing the test plan. For example, we solved each problem instance with the proposed evolutionary algorithm independently for 50 times, subject to a time limit of 100 CPU seconds. Under the same framework of evolutionary algorithm, the initial population is generated randomly and the roulette selection method is adopted. Combined with three different crossover operators (PMX, OBX, aERx), three evolutionary algorithms (denoted by PMX, OBX, aERX respectively) are produced respectively.

Compared the computational results of the three evolutionary algorithms (PMX, OBX, aERx) with the optimal solution, the numbers of equal and worse solutions are presented in Table 1, respectively. From Table 1, we observe that the algorithm PMX reaches the optimal solutions for 23 out of the 32 instances, while aERX and OBX can only reach the optimal solutions for 17 and 13 ones, respectively. This shows that the crossover operator PMX is effective than the other two crossover operators aERX and OBX when using evolutionary algorithm to solve large scale $1|s_{ij}|\sum T_j$ problem.

Table.1. Summary of comparing the computational results of three evolutionary algorithms with the optimal solutions

	aERX	OBX	PMX
Number of equal solutions	17	13	23
Number of inferio solutions	15	19	9
Number of all solutions	32	32	32

5. Conclusion

In the engineering education accreditation, it is particularly emphasized to cultivate graduates' ability to solve complex engineering problems, and whether there are courses to support it or not is an important basis for judging whether the ability training is really implemented. The experiment items with engineering and research project background is added to the course to meet this requirements. Starting from the actual engineering project, let students study with problems, help students to establish the relationship between theoretical knowledge and practical application, improve students'

ability to analyze and solve problems, and cultivate students' creative ability. The experimental teaching method for engineering education accreditation proposed in this paper can be used as a reference method for making experimental teaching plans for science and engineering courses.

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