

Discussion On the Application -Oriented Teaching Reform of Optimization Method

Saihua Liu

Department of Mathematics, Wuyi University, Jiangmen 529020, China

lsh1808@163.com

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Abstract: The course of optimization method is a mathematics course with strong application. This paper discusses the reforms on the teaching content, teaching methods and method of examination of this course under the application-oriented destination. We also consider the way of ideological and political education of this course.

1. Introduction

The course of optimization method is a mathematics course with strong applicability in engineering, which is mainly for undergraduates majoring in mathematics and some postgraduates majoring in engineering [1]. The study of this course plays a positive role in promoting students' thinking ability, problem-solving ability, application skills of mathematical software and the development of creative ability. With the progress of science and technology and the development of modern production, optimization theory has been widely used in public management, economic management, national defense, engineering and other fields. Spady [2] put forward the application-oriented education model in 1994 based on the logic of OBE education concept. This idea and educational model provide a direction for "what kind of people should be trained" and "how to train people" in university education. Based on the strong application of optimization method in various disciplines, it is necessary to carry out the application-oriented reform for this course [3].

2. Problems Existing in the course optimization method

Mathematics curriculums are of vital importance for the study of engineering courses. Especially, the course optimization method is of strong application. However, the current teaching mode of optimization method is far from the educational idea for "application-oriented" and the aim of "serving engineering majors" [4]. The problems are mainly showed in the following aspects:

Firstly, the teaching process of optimization method cannot achieve the objective of the course for application, and students cannot effectively apply the basic theory and basic method in their own fields. It is not conducive to the cultivation of students' innovative ability. One of the reasons is that the content of the course is too theoretical. Another is that traditional mathematical reasoning takes a main role in the class. Also, Curriculum design does not consider fully the knowledge backgrounds in their fields. At last, the assessment method is still based on theoretical examination.

Secondly, students' computing ability with mathematical software can't keep up with the development of new technology. The development and wide application of optimization methods are closely related to the application of computational software. In fact, the skillful application of computational software is the key to solve optimization problems. At present, the assessment content of optimization method is mainly on proves of conclusions and manual calculations, which is difficult to reveal the application ability of the students. This is contrary to the idea of application-oriented education.

Thirdly, the ideological and political education in the course is weak or even missing. We lack index to measuring the effect of ideological and political education. Many teachers ignore the importance of ideological and political education. And the ways and means of integrating ideological

and political education into the curriculum need to be enriched and advanced with the times.

3. Exploration of the Innovation

3.1 Problem-driven case-based teaching

The theoretical study of optimization method needs a strong foundation of calculus and linear algebra. For many science and engineering students, pure theoretical teaching method of mathematics courses will be undoubtedly difficulty. They will even lose learning interests. Even if students master the theoretical part well, it is difficult to connect theoretical knowledge with practical problems. Mathematics is a powerful tool. It is very important for students gaining application skills besides mastering basic principles. Driven by practical problems, theoretical teaching and method demonstration through cases can not only enable students to master the application skills of optimization theory, but also enable students to have a deeper understanding of the basic principles of optimization methods [5]. With the rapid development of various disciplines, especially the rapid development of data science and artificial intelligence, new optimization problems continue to emerge. The application function of optimization method, a multidisciplinary interdisciplinary course, is far from being efficiently utilized and fully explored. Collecting the latest and suitable problems and teaching in the form of case introduction is an important thing for us to do at present.

3.2 Make full use of modern computing software and optimize computing methods

The goal of the course of optimization method is to make students master the basic theory of optimization problems, understand the design ideas of various algorithms, establish mathematical models and design algorithms, and skillfully use MATLAB or other software to solve them [6,7]. With the more and more extensive and deep application of programming models, in addition to classical optimization algorithms, stochastic programming, fuzzy programming, simulated annealing, genetic algorithm and other optimization algorithms are also widely concerned. The teaching mode that pays too much attention to theoretical learning is difficult to match the mathematics knowledge background of engineering students. So, it is important to train the scientific computing ability of the students. Then it can truly achieve the application-oriented aim of this course. We strengthen the cultivation of application ability through the following two aspects:

- First, in the course, we not only pay attention to the systematic narration of typical mathematical ideas and methods, but also pay attention to practical training after class, and encourage students to collect new problems and new cases in their own professional fields. Driven by the problems, students discuss, model and solve in groups.

- Second, we will choose appropriate textbook with widely used algorithms at present. Also, we will strengthen software introduction and bring algorithms and software calculation into the category of process assessment and the final examination of the course.

3.3 Mathematical Modeling assists in the course of Optimization Method

With the continuous progress of mathematical methods, computer technology and data science, mathematical modeling is widely used in various scientific fields. Optimization method combines optimization theory, mathematical modeling and scientific calculation closely. It solves optimization problems in military, economic, engineering, information science and other fields. Obviously, mathematical modeling is the key link to connect the theoretical methods of mathematics with practical problems [8]. In the course of optimization method, it is necessary to introduce abundant modeling examples. On the other hand, the theory of optimization method and classical methods are available in mathematical modeling.

- Taking mathematical models as examples in case teaching is a practicable way to realize the application function of optimization method.

- We should encourage students to participate in undergraduate or postgraduate mathematical modeling competitions in order to stimulate students' interest in learning and promote their practical skills.

3.4 Integrate ideological and political education into the course

Under the guiding ideology of General Secretary Xi Jinping that "all kinds of courses go in the same direction with ideological and political theory courses, form synergistic effect, and regard moral education as the fundamental task of education", practice and exploration of integrating ideological and political education have been carried out into professional courses in colleges and universities [9]. As a course with profound application in many fields, the ideological and political education of optimization method is worthy of deep discussion. The content of the discussion includes two parts, one is the excavation of ideological and political elements in the curriculum, and the other is the way of integrating ideological and political elements into the course. An important ideological and political education point of this course is to encourage students to make scientific analysis for the optimal distribution of various resources of the country and society by using their knowledge.

For example, in economic activities, people no longer blindly pursue economic benefits, but also focus on the impact of economic growth on the environment. A good environment is not only the material basis for our survival, but also the premise of economic development. General Secretary Xi Jinping emphasized that "lucid waters and lush mountains are invaluable assets, which makes economic development and environmental protection harmonious, unified and complementary". Therefore, cost saving and environmental protection have become equally important goals in economic activities and the pursuit of economic benefits. Multi-objective programming problems can comprehensively consider all objectives in economic activities. Among them, energy saving and environmental protection are important goals in economic activities. They can be introduced as indexes in objective functions, and expected values (expected goals) are introduced for each objective function. Due to the limitation of various conditions, all expected values cannot be achieved at the same time. So positive and negative deviation variables are introduced to describe the degree that the target value exceeds or falls below the expected value. Furthermore, due to the different importance of each goal, priority and weight coefficient are assigned to each goal. Finally, the mathematical model is established with each goal as a constraint condition.

3.5 Reform the assessment form

At present, many mathematics courses generally adopt traditional examination methods: theoretical derivation, manual calculation and proves. This assessment method is seriously out of touch with the modern information society. For students majoring in applied disciplines, it is necessary to highlight their ability to analyze and solve problems, and weaken mathematical calculation, formula derivation and theorem proves. We carry out the reform of curriculum assessment oriented by practical ability for this course. Curriculum assessment consists of two parts: process assessment and final examination, which are combined to meet the requirements of theoretical assessment and practical assessment.

- The assessment of the practical part is achieved by the process assessment. According to the contents of the course, several open questions are designed in stages. Students complete them, through searching materials, discussing and analyzing, modeling and solving, in groups. Then their papers are submitted.

- In addition to the basic theory, algorithm design processes and the establishment of models for some given problems are required in the final examination.

4. Summary

The teaching reform of optimization method course can not only meet the requirement of students' professional fields, but also effectively improve students' learning effect, practical ability and innovation ability. Then we can finally achieve the application-oriented educational purposes of mathematics curriculums.

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