

Research on Teaching and Learning of Operations Research in the Engineering Costing Program Based on MATLAB Technology

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Abstract: With the rapid development of the engineering costing industry, the demand and skill requirements for engineering costing professionals are also increasing. However, at present, the teaching of operations research focuses on the theory but neglects the application, which results in the relatively weak ability of engineering costing students to solve practical problems by using the knowledge of operations research. Therefore, the purpose of this paper is to explore the application of MATLAB-based operations research teaching method in engineering costing majors, in order to improve students' learning interest and practical ability, and enhance their competitiveness in the industry.

Keywords: MATLAB, Operations Research, Engineering Costing Program, Teaching Research

1. Introduction

The engineering cost profession is currently in the limelight and in increasing demand in society. With the increase of construction and infrastructure projects^[1], the demand for knowledge of cost control and optimisation, resource allocation, schedule management, and risk analysis and decision making in operations research has also increased^[2]. However, the current approach to teaching operations research is more theoretical than practical, and the course content is highly theoretical, involving a large number of mathematical models and calculations with complicated and interrelated steps^[3]. This requires students to be careful and patient, but if students are not interested in mathematics or have weak calculation ability, they may be disinterested and intimidated, resulting in poor teaching results and unable to meet the social demand for engineering cost talents in decision making, process selection and other aspects. Therefore, it is particularly important to reform

the operations research teaching model to enhance students' interest in learning operations research knowledge and practical ability.

In order to improve students' ability to use operations research to solve problems in engineering costing, it is necessary to strengthen the cultivation of related knowledge in course teaching. One of the approaches worth exploring is the study of teaching operations research using MATLAB technology^[4]. MATLAB, as an efficient, flexible and widely used mathematical software in engineering, provides an excellent tool for students to understand and apply the concepts and techniques of operations research.

The purpose of this paper is to discuss the necessity and feasibility of using MATLAB technology for teaching and researching operations research in engineering costing programme. Through this teaching method, we can effectively improve students' learning interest and competitiveness, and enable them to flexibly use operations research to solve practical problems in their future work. In this paper, we will provide theoretical analysis and practical cases to verify the effectiveness of this teaching method, and call on education departments and schools to include it in the curriculum system of engineering costing majors, so as to better cultivate excellent engineering costing professionals who can adapt to the needs of social development.

2. The Need to Teach Operations Research with MATLAB

Operations Research is a discipline that broadly includes linear programming, integer programming, dynamic programming, queuing theory, simulation methods, network optimisation and multi-objective decision making^[5]. Operations Research provides a clear set of steps in the problem solving process. First, the problem formulation must be clarified, i.e. the dilemma or objective to be solved is

identified. Then an appropriate mathematical model is developed to abstract the actual problem into a mathematical problem so that it can be solved using mathematical methods. Next, the model is solved to find the optimal solution or decision for the problem. Finally, the validity of the results is interpreted, the feasibility of the identified solution is verified, and a specific implementation plan is developed to ensure that the problem is effectively solved.

An Operations Research course typically requires approximately 68 hours of classroom study. This is because the course covers a wide range of knowledge and methods, and students need to be flexible in mastering and applying them. However, the solution process of some methods can be complex and require multiple iterations of calculations, which can be challenging for students. Traditional operations research teaching tends to focus on the algorithmic principles of the solution process, resulting in large and time-consuming computations. This tends to undermine students' motivation and leads to their relative weakness in practical skills. Therefore, it is necessary to optimise and improve the teaching methods of operations research in order to enhance the learning effect and practical skills of students. MATLAB, as a powerful mathematical computing software, has the characteristics of easy programming, efficient calculation, strong visualisation, etc., which provide a powerful tool to support the teaching of operations research. The introduction of MATLAB technology in the teaching of operations research can help students understand the basic principles and methods of operations research more intuitively, and improve their ability to analyse and solve practical problems.

3. Research on Teaching Operations Research using MATLAB Technology

3.1 Design of Teaching Content

To take full advantage of MATLAB technology in teaching operations research, the content of the course needs to be carefully designed. First, it should focus on the explanation of theoretical knowledge to ensure that students have a deep understanding of the basic concepts, principles and methods of operations research. Second, it should be combined with the actual needs of the engineering costing profession by selecting typical problems for case analysis, so that

students can understand the application scenarios and practical effects of operations research in engineering costing. At the same time, it should pay attention to the design of practical links, guide students to use MATLAB technology to solve actual engineering costing problems, and improve their practical ability and innovation ability.

There are four main steps to solving the problem using MATLAB software: first, formulate the relevant real columns according to the learning objectives; second, establish the relevant mathematical model; again, write the MATLAB program; and finally, solve the process and analyse the results using MATLAB. An example of an application problem for integer programming is shown below:

A construction unit works from 9:00 to 17:00 every day, and the number of workers needed at different times of the day is shown in Table 1 below:

Table 1. Number of Workers Required by Time Period

| Time period | Number of workers needed |
|-------------|--------------------------|
| 9-10 | 4 |
| 10-11 | 3 |
| 11-12 | 4 |
| 12-13 | 6 |
| 13-14 | 5 |
| 14-15 | 6 |
| 15-16 | 8 |
| 16-17 | 8 |

A construction unit can hire both full-time and half-time temporary workers; full-time workers are paid \$100 per day and work from 9:00 a.m. to 5:00 p.m., but have a one-hour lunch break between 12:00 p.m. and 2:00 p.m. The construction unit cannot hire more than three half-time workers at the same time each day, and each half-time worker must work four consecutive hours at a rate of \$40. Q: How should workers be hired to minimise total expenditure?

Set up a linear programming model:

Let the number of full-time workers employed by the construction organisation who will eat lunch each day during periods 12-13 and 13-14 be x_1 and x_2 . The number of half-time workers who start work on 9, 10, 11, 12 and 13 is y_1 , y_2 , y_3 , y_4 and y_5 respectively.

The constraints are satisfied:

$$\text{Min}Z=100x_1+100x_2+40y_1+40y_2+40y_3+40y_4+40y_5$$

$$\begin{cases} x_1 + x_2 + y_1 \geq 4 \\ x_1 + x_2 + y_1 + y_2 \geq 3 \\ x_1 + x_2 + y_1 + y_2 + y_3 \geq 4 \\ x_2 + y_1 + y_2 + y_3 + y_4 \geq 6 \\ x_1 + y_2 + y_3 + y_4 + y_5 \geq 5 \\ x_1 + x_2 + y_3 + y_4 + y_5 \geq 6 \\ x_1 + x_2 + y_4 + y_5 \geq 8 \\ x_1 + x_2 + y_5 \geq 8 \\ y_1 + y_2 + y_3 + y_4 + y_5 \leq 3 \end{cases}$$

Where $x_1, x_2, y_1, y_2, y_3, y_4, y_5 \geq 0$ and are integers
MATLAB is utilized for programming to complete the code conversion of the integer planning model:

(1) Matrix input:

```
f=[100,100,40,40,40,40,40]; % Objective function coefficient matrix
```

```
intcon=[1,2,3,4,5,6,7];
```

```
A=[-1,-1,-1,0,0,0,0;
```

```
-1,-1,-1,-1,0,0,0;
```

```
-1,-1,-1,-1,-1,0,0;
```

```
0,-1,-1,-1,-1,-1,0;
```

```
-1,0,0,-1,-1,-1,-1;
```

```
-1,-1,0,0,-1,-1,-1;
```

```
-1,-1,0,0,0,-1,-1;
```

```
-1,-1,0,0,0,0,-1;
```

```
0,0,1,1,1,1,1];
```

```
b=[-4,-3,-4,-6,-5,-6,-8,-8,3];
```

```
Aeq=[];
```

```
beq=[];
```

```
lb=zeros(7,1);
```

```
ub=[];
```

(2) Function use:

```
[x, fval] =
```

```
intlinprog(f,intcon,A,b,Aeq,beq,lb,ub);
```

```
disp("Optimal integer solution:")
```

```
x
```

```
disp("Minimum objective function value:")
```

```
fval
```

(3) The experimental results are shown in Figure1.

3.2 Innovation in Teaching Methods

In teaching methods, innovation and practice should be emphasised. Firstly, the case teaching method can be adopted by introducing real engineering cost cases so that students can learn and apply operations research knowledge to real

problems. Secondly, a project-oriented teaching method can be adopted to encourage students to form a team and work together to solve a challenging engineering cost problem. In this way, students can gain a deeper understanding of the practical application process of operations research and improve their teamwork and problem-solving skills.

In addition, the advantages of MATLAB technology can be used to carry out some innovative teaching activities. For example, we can organise a MATLAB programming competition for students and encourage them to use MATLAB technology to solve some challenging operations research problems. Or we can offer some elective courses related to MATLAB technology to provide students with more learning opportunities and practical platforms.

```
1 最优整数解:
2
3  x =
4
5      3
6      4
7      0
8      0
9      2
10     0
11     1
12
13 最小目标函数值:
14
15  fval =
16
17     820
```

Figure 1. Experimental Results

3.3 Teaching Evaluation and Optimisation

In order to ensure the effectiveness and quality of teaching, a scientific teaching evaluation system must be established. First, it should use a variety of evaluation methods, including homework assignments, experiments, project reports, etc., to comprehensively evaluate students' learning achievements and practical skills. Secondly, it should pay attention to students' feedback and opinions, and adjust the teaching content and methods in time to meet students' learning needs and expectations. At the same time, industry experts and enterprise representatives can be invited to participate in teaching evaluation to provide guidance and suggestions on teaching from the industry perspective.

In order to optimize the teaching effect, the following measures can be taken: first, to strengthen the interaction and communication

between teachers and students, and encourage students to actively participate in class discussions and questions; second, to provide more practice opportunities and resource support to help students better master and apply the knowledge of operations research; third, to strengthen cooperation and communication with other majors, and learn from the successful experiences and methods of other majors to continuously improve the level and quality.

4. Conclusion and Prospect

The research on teaching operations research based on MATLAB technology is of great significance to improve the practical ability and industrial competitiveness of engineering costing students. Through the discussion in this paper, we can see the necessity and feasibility of adopting MATLAB technology for teaching operations research. In the future, we will continue to study and practice the operations research teaching method based on MATLAB technology in depth, so as to contribute to the teaching reform and talent cultivation of engineering costing majors. Looking to the future, with the continuous development of science and technology and the continuous progress of the industry, the application of operations research in the field of engineering costing will be more extensive and in-depth. Therefore, we need to constantly update the teaching contents and methods to keep up with the development trend of the industry and technological changes. At the same time, we also need to strengthen cooperation and communication with industrial enterprises and research institutions to jointly promote the application and development of operations research in the field of engineering costing.

In addition, we need to pay attention to students' personal development and career planning, and provide them with more practical opportunities and career guidance. By cultivating students'

practical ability and innovative spirit, we can help them better adapt to industry demand and market changes, and provide a strong talent guarantee for the sustainable development of the operations research industry. In conclusion, the research on the teaching of operations research based on MATLAB technology will provide new ideas and methods for the teaching reform and talent cultivation of the field of engineering costing, which will help promote the sustainable development and progress of the engineering costing industry.

Acknowledgement

This work was supported by Fund projects: Chengdu Technological University Laboratory Open Fund (2023LOF022).

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