IMPROVING TEACHING STRATEGIES IN OPERATIONS RESEARCH

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ABSTRACT

Operations research is the systematic application of scientific methods analysis and solution of various problems involving the operation of systems. In this paper, we consider how to enhance operations research teaching. It is different to traditional teaching approaches which emphasized information transmission/teacher-focused. "Student-centered teaching" and "problem-base learning" teaching strategies are considered in operations research course. These teaching strategies are expected to improve the quality of operations research teaching.

Keywords: Operations Research; Student-Centered Teaching; Problem-Based Learning; Assessment

I INTRODUCTION

In the mid-1970s, the Operations Research Society of America defined the subject matter as follows:

"Operations Research (OR) is concerned with scientifically deciding how to best design and operate man-machine systems usually under conditions requiring the allocation of scarce resources."

The phases that a typical OR project might go through are:

1) Problem identification,

2) Formulation as a mathematical model,

3) Model validation,

4) Solution of the model,

5) Implementation

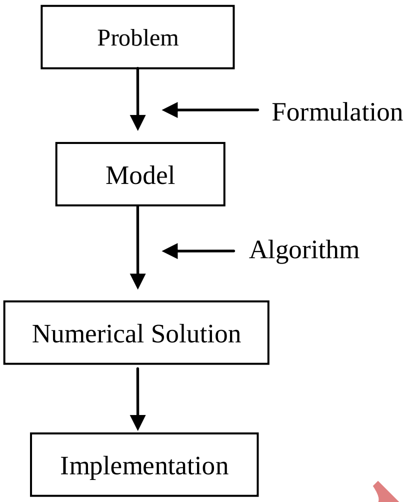

Figure 1

In our university, OR is usually taught as a one-semester optional course in the fourth year for students majoring in applied mathematics, business management or engineering. We will mainly concern the teaching of OR to applied mathematics students. The total number of hours allocated to the course is 54, including 36 hours lectures and 18 hours laboratories.

After two or three years' study, students feel they understand some mathematical tools used in OR, they think it is simple to learn OR. Because they already known a lot about mathematical analysis, algebra and probability and statistics. The problem is that different sorts of problems in OR require different mathematical tools, and so students get confused about which mathematical tool to apply in different situations. In order to rigorously describe and analyze these algorithms, many concepts have been introduced. Students often find it hard to remember the definitions of these concepts and to understand the underlying reason for introducing them. On the other hand, most lecturers are still using the traditional information transmission/teacher-focused approach in teaching OR, via lectures and tutorials. Research has shown that teacher-centered teaching does not provide an active learning environment for students. It diminishes students' interest and leads in most cases to students adopting a surface learning approach (focusing on rote memory and reproduction). While there is some debate on whether or not it is the universities' responsibility to give students these abilities, most people think teachers should not only transmit knowledge but also cultivate some lifelong learning skills in their students.

Considering the above problems, it is imperative for us to reform the OR teaching method, which will encourage students to think creatively about each problem. According to contemporary education theory, what we essentially need to do is to convert the traditional teacher-focused method to the student-centered approach, along with suitable assessment schemes.

II IMPROVEMENTS STRATEGIES

2.1 Student-Centered Teaching

A psychological report (Lagowski 1990)[1] shows that students retain 10% of what they read, 26% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say, 90% of what they say and do. This suggests that students should be involved in teaching and learning as much as possible. In other words, we should move from teacher-centered teaching to student-centered teaching. "Student-centered teaching" [2] focuses on the student and, in particular, on the cognitive development of the student. The teacher's goal is to help students grasp the development of knowledge as a process rather than a product. The focus of classroom activities and assignments is on the student-centered process of inquiry itself, not on the products of inquiry. Students create their own conceptual or cognitive models. Content, teaching style, and methods are adapted to aid the cognitive and intellectual growth of students. Student-centered teaching combines an understanding of the way that humans process information with other factors that affect learning such as attitudes, values, beliefs, and motivation.

How to motivate students? How to develop deep learning? How can student-centered teaching strategies be used in lectures? Some methods, such as presenting interesting problems, asking questions, giving student's time to think, and so on, will be used to make students active and interactive in my lectures. Much attention will be paid to students since they are indicators of learning. For example, after we have taught an OR method, such as mathematical programming, or after students have learnt several algorithms students will be asked to discuss those OR techniques and answer questions such as:

1) What are the assumptions and new concepts under each model or algorithm?
2) What are the basic ideas underlying its design?
3) What kind of mathematical tools are used and how?
4) What is the strength and weakness of each algorithm?
5) What are the differences between these algorithms and what do they have in common?
6) What kinds of real life problems a specific algorithm can solve?
7) How many different algorithms can be used to solve a given practical problem?

8) Is it possible to improve an existing algorithm or to find a new algorithm to solve some real problem? How?

The 1)-3) questions will help students fully understand different OR methods, while the next two questions would force students to compare different OR methods and thus get a clear picture about those algorithms. The 6)-7) questions can lead students to think about possible applications of each OR method. The 8) question is the most difficult questions, not only demanding extensive enquiry and discussion, but also encouraging creative thinking. We are pretty sure that students will adopt the deep learning approaches to accomplish these tasks and, hopefully, this will help them to learn how to devise new algorithms or OR techniques.

"Studies have shown that student-centered teaching leads to a strong tendency for students to adopt a deep learning approach (focusing on meaning and understanding) which then results in good teaching and learning outcomes. Through student-centered learning we can also teach our science students lifelong learning skills" (King 2004). [3]

2.2 Problem-Based Learning

"Problem-based learning(PBL) is a curriculum design and a teaching and learning strategy which simultaneously develops higher order thinking, disciplinary knowledge bases and practical skills by placing students in the active role of practitioners (or problem-solvers) confronted with a situation (ill-structured problem) which reflects the real world." [4]

PBL promotes the students motivation and makes students more engaged in learning because they feel they are empowered to have an impact on the outcome of the investigation i.e., assume more responsibility for their learning. PBL offers students an obvious answer to the questions, "Why do we need to learn this?" and "What does what I am doing in school have to do with anything in the real world?" The methods of PBL may train the students in higher-order thinking skills. The ill-structured problem scenario calls forth critical and creative thinking by suspending the guessing game of "What's the right answer the teacher wants me to find?"

Compared with other disciplines, the teaching of operations research is more suitable for using the PBL method [5]. Through any textbook about operations research, we would become increasingly aware of the fact that the complexities of reality call for great flexibility in how operations research projects are tackled. There exists no one absolutely correct approach. The 'best' approach to be followed not only depends on the nature of the problem and the amount of time and funds available, but also on the training and personality of the operations researcher. We have to make some simplification or omit some details when the operations research model for the related problem is derived, so that the resultant mathematical model can be handled by existing operations research algorithms. Depending on how the model is established and how the obtained theoretical solution is adjusted, different decisions can be proposed for one specific management problem. Therefore, most operations research projects are very complex, open-ended problems, which demand not only objective decision ability, corresponding to the theoretical part of operations research, but also subjective decision ability, corresponding to the decision-maker's practical experience and personality.

In the process of teaching operations research, teachers will organize students to watch the video about some large company (or actually visit it) to find out how productions are planned and different departments are organized. After this, students are formed into groups of size around four, and are asked to do a series of independent investigations, which typically involve the following steps:

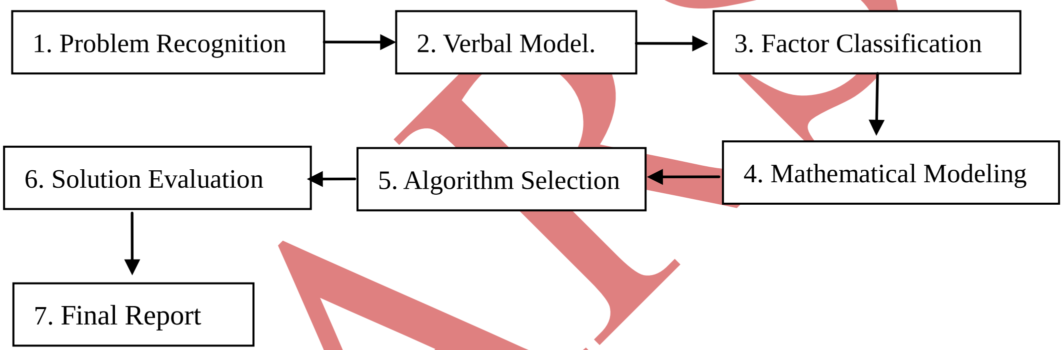

Figure 2

Students will be asked to discuss those questions such as:

1. What is (are) the management problem(s) for this factory?
2. Can you describe the problem in the usual nonmathematical way?
3. How many factors are there for the problem to be solved and what are their relationships?
4. Can you establish a proper mathematical model based on previous steps' analysis?
5. How can you solve the identified OR problem? Can you directly use some existing algorithm in OR or do you have to modify a specific algorithm?
6. Is the solution acceptable?
7. Can you explain your results verbally to managers using common, non-mathematical terms so that they can fully understand what you mean?

During the above process, the lecturer should provide sufficient support and monitor students properly. The benefits from this kind of teaching and learning will be a very rewarding experience for students to practice the whole process relating to the application of OR techniques in solving practical management problems. It will allow them to find their possible weakness in some aspects and rectify that as soon as possible. At the same time, students' generic skills will be improved, since the process involves higher order thinking, problem solving ability, collaborative ability, and communication ability.

2.3 Modification of Assessment

As we know, assessment influences students' learning. In the past, monotonous assessment of students was employed, which is mainly determined by the final closed-book examination at the end of each semester. The traditional assessment of this course is out of 100, 80% for the examination and 20% from the student's record. The traditional assessment will be modified because this assessment does not evaluate students properly. We will adjust current assessment to take account of the student-centered teaching and problem-based skill components. The new assessment will consist of: final examination (50%), laboratory report (20%), small quiz and homework (20%), problem project (10%).

III CONCLUSIONS

OR is a professional foundation course which has strongly theoretical and practical. If we want to achieve good teaching effect, it is necessary for us to implement teaching reform and improve teaching methods. All teaching and learning methodologies aim at improving the quality of education. Our plan is to change strategies and aim for a more student-centered approach to teaching and learning. The purpose of the change is to improve the outcomes of teaching and learning in the course

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