Practical OR for Undergraduates in the Swinburne Course

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Much of the debate over OR education over the last ten years has been confined to the relevance of the content and style of programmes at the postgraduate level. This paper focuses on the undergraduate level and discusses the way in which practical elements have been successfully incorporated at this level in Australia. These elements include the use of case study material from the literature, case problem solving groups, industrial projects and 12 months paid employment through a co-operative education programme. The use of each of the above and the context with which they fit into the programme is covered as are the benefits and problems associated with the programme.

Key words: OR education, learning, training

INTRODUCTION

There has been much debate over the relevance of OR education programmes over the last ten or so years. No doubt the most controversial and most quoted papers published during this time were those by Ackoff1,2 who stated that university courses were 'Almost uniformly unimaginative and conventional'. He went on to state that this was a significant contributor to the fact that the large majority of students leaving university had 'Very little understanding of scientific method and the differences between the methods, techniques and tools of science.' Further, he indicated that this was largely due to a tendency for courses to concentrate on the mathematical tools of OR and as a consequence OR was seen as a branch of mathematics by many students.

Rivett3 argued strongly for a general change in attitude. He referred to this inability to differentiate between OR and a branch of mathematics as 'The insidious change in our subject from a practically orientated discipline into an area of applied mathematics'. Both Ackoff and Rivett along with many others pushed for a major shift in emphasis in academic programmes. Scott4 discussed the application of experiential learning techniques as an appropriate way of introducing students to OR. He suggested, 'That there is a strong parallel between any OR methodology and the Kolb/Lewian learning cycle in education theory' and advocated a 'change in the process of learning, to one more in tune with all of the stages of the learning cycle'. The learning cycle consisted of the following four stages—concrete experience, reflective observation, abstract conceptualization and active experimentation. Very few have advocated courses based largely on the mathematical tools of our trade. Greenberg6, who is one of the exceptions, believes that courses have shifted their emphasis too far and are now neglecting the mathematical aspects. This belief is in contrast to the opinion of the Commission on the Future Practice of Operational Research7. In its report the Commission stated that it was encouraging to see a range of courses offering different content and structure. The report went on to say, 'However, the Commission would like to see all courses giving sufficient prominence to the true nature of OR in practice.'

OR courses whether they be undergraduate or postgraduate should be structured in such a manner as to give a feel for the true nature of our profession. Any OR practitioner who hopes to survive purely on the strengths of their knowledge of mathematical tools is likely to fail. Successful OR practitioners need to have other skills including:

investigative;
problem solving;
communication;
human interface;
oral and written presentation.

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Haley\(^8\) provides a more comprehensive list of skill areas. Eilon\(^9\) in arguing that OR is not mathematics began summarizing his position by stating, ‘Mathematical techniques constitute a very small part of the OR activity, hence it is essential for OR workers to have a wider base of knowledge and understanding of the industrial context in which they undertake project work’. An OR course that only covers the mathematical tools of OR must surely fail if its objective is to provide the student with a realistic appreciation and understanding of the life of an OR practitioner. Further, an OR course that covers more can result in a positive feeling towards OR. Erikson and Turban\(^10\) in reference to the use of microcomputers in OR education stated that they had experienced, at both undergraduate and postgraduate levels, a ‘Significant increase in students' interest in OR and in quantitative analysis mainly because of the shift of emphasis from computation to problem formulation and analysis of results and the ability to cover more realistic options, cases and problems.’

The author’s own undergraduate OR studies were undertaken as part of a mathematics degree and the units that were completed covered most of the usual mathematical tools of OR. The studies were undertaken on a part-time basis and hence an interest in OR developed because the application of these tools in certain areas became evident. The enthusiasm for OR that was gained by the time of graduation quickly waned because it was found that most of the mathematical tools that had been supplied did not fit the problem under consideration. The OR education undertaken had neither warned of, nor provided any training in coping with, this situation. Because of this, the author contends that his own undergraduate training was inadequate in preparing him for a position in an OR environment.

It is debatable whether the purpose of undergraduate education is to provide students with a basic level of training in their selected area of study or whether it should provide a broader level of education with the aim of generally developing each student. It is the author's view that educational programmes in OR at the undergraduate level can achieve both of these aims. Undergraduate OR courses which rely purely on mathematical techniques do not, in the author's opinion, adequately achieve either of these aims. However, a course that is structured to include training in the skills listed previously as well as the mathematical tools of OR will meet both of the aims given above.

A large part of the discussion relating to OR education has been restricted to the postgraduate level. One exception to this was the joint meeting of the OR Teaching and the Process of OR Study Groups of the Operational Research Society on the topic, 'How to teach the process of OR'\(^11\). Further, King\(^12\) described a methodology which had been successfully used in teaching mathematical modelling to undergraduates. There is no disputing the fact that OR is taught at the undergraduate level and yet it is interesting to note the lack of discussion on undergraduate programmes. Perhaps it is because many feel that OR education is out of place at the undergraduate level. The question of whether OR can be taught at the undergraduate level is raised (but unfortunately not discussed in any detail) by Beasley and Whitchurch\(^13\).

At Swinburne we have what we believe to be a unique undergraduate OR programme. Aspects of this programme have been discussed elsewhere\(^14,15\). This paper will discuss the practical elements of our degree programme in some detail.

**BACKGROUND**

Swinburne Institute of Technology is situated about 6 km to the east of the centre of Melbourne, which is one of the major cities in Australia. It offers the full range of tertiary programmes up to Doctor of Philosophy level. In general, the programmes offered at Swinburne are more practical in nature than those offered by traditional universities. A student studying Operations Research at Swinburne does so as part of a Bachelor of Applied Science degree with majors in Mathematics and Computer Science. The degree was introduced in 1977 and has been progressively developed since. It takes 8 semesters (4 years) to complete. Six of these are academic semesters lasting 13 weeks which are spent at Swinburne pursuing traditional studies. The remaining two are spent in fully paid employment as part of the industry-based learning programme which operates at Swinburne.