

Chapter 9

Realizing Desired Learning Outcomes in Undergraduate Mathematics

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ABSTRACT

STEM education at UTM uses the OBE model in its effort to ensure its students are qualified and able to compete in a climate of global development and technological advancement. In line with this, the authors embarked in transforming their teaching and learning approaches to meet these demands. In this chapter, they share some of their experiences in coping with the challenges of changing teaching practices to accommodate OBE. In redesigning the Engineering Mathematics course, the authors started by looking at meaningful mathematical learning and identifying skills that could be integrated with teaching. They used this information in helping to determine the desired learning outcomes. Then, they examined the relationship between the content, assessment, and teaching and learning approaches. For successful mathematical learning, they believed that students should participate actively in the knowledge construction, develop flexible thinking skills, be able to communicate their knowledge, and become independent learners. The authors discussed the strategies they designed and employed in engaging students with the subject matter as well as to initiate and support students' thinking and communication in the language of mathematics. Indications of students struggle, progress, and growth that were taking place and the difficulties encountered in the research implementation are highlighted.

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INTRODUCTION

The context of engineering education has changed. Engineers now need a new set of skills that not only encompass basic mathematics and science skills, but should include skills such as communication, teamwork and problem solving. In addition, issues such as sustainability and innovative practices have to be considered in the engineering education curriculum. Incorporating Outcomes Based Education (OBE) was part of an overall change in higher education policies of the Ministry of Higher Education to ensure more students to be competent to perform better in the work place. In UTM, adopting OBE generated changes to the curriculum and the courses. Our institution identified eight essential graduate attributes which are similar to those identified by the national agencies such as, Engineering Accreditation Council of Malaysia (Engineering Programme Accreditation Manual, EACM/BEM; 2003 & 2007), Malaysia Quality Frameworks Assurance (Malaysia Quality Assurance Manual, 2004, MOHE) and international accreditation bodies such as American Board for Engineering and Technology (ABET). These attributes guided the formulation of desirable program outcomes which were then translated into courses' learning outcomes based on the OBE framework. Other changes were the use of English as the medium of instruction and that there should be an emphasis on soft skills development for the students. Soft skills were skills that could be applied across a variety of jobs and life contexts which consist of skills, attitudes and values that would facilitate employability. The following soft skills were identified:

- **Communication Skills:** The ability to communicate effectively in Bahasa Melayu (Malay Language) or English across a range of contexts and audiences.
- **Critical Thinking and Problem Solving Skills:** The ability to think critically, logically, creatively and analytically.
- **Teamworking Skills:** The ability to work with other people with different background to achieve a common goal.
- **Information Management and Lifelong Learning Skills:** The ability to continue learning independently in the acquisition of new knowledge and skills.
- **Entrepreneurship Skills:** The ability to analyse situations and recognise opportunities to use one's knowledge and skills for business opportunities.
- **Leadership Skills and Proactiveness:** The acquired knowledge of basic principles of leadership and application of the traits of leadership in one's interaction with others.
- **Ethics and Integrity:** The ability to apply high ethical standards in professional practice and social interactions.

A review of all courses learning outcomes was carried out to ensure compatibility with the Engineering program objectives and outcomes. This included our course, Engineering Mathematics, as it is one of the core mathematics courses in the engineering education curriculum at UTM. In addition, some soft skills appropriate for the course had to be selected and included in the course outcomes. An important consideration for us was: how mathematics learning can support outcomes based education in engineering? Our experience had shown that we needed to address how to enhance students' understanding and problem solving skills. Some students were not adequately competent in using appropriate mathematical techniques and some were not able to choose suitable techniques for problem solving. Thus, we believed that the new outcomes should support the program outcomes and the

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