

# Chapter 29

## Self-Regulated Learning as the Enabling Environment to Enhance Outcome-Based Education of Undergraduate Engineering Mathematics

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### ABSTRACT

*The paper discusses the results of an action research to improve teaching practice which applied the philosophy of Knowledge – Experiential – Self-regulated (KES) at the Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia. The teaching and learning strategies were implemented to achieve the following objectives; (i) to enhance students' mathematical competencies; (ii) to support self-regulated learning; and (iii) to improve the teaching practice of Engineering Mathematics 3 i.e. Advanced Calculus. A modification to a previously developed framework by Roselainy et al. (2012a) was performed to encourage students to adopt self-regulated learning behaviour in an active learning environment. The teaching, learning and assessment activities were aligned constructively based on the theory of Biggs & Tang (2010). Data was collected, analysed and later employed to modify the teaching and learning activities. The findings found that it is imperative for teachers to design an appropriate learning environment and apply suitable strategies in encouraging and supporting students to embrace and take charge of their own learning.*

### INTRODUCTION

An important outcome in mathematical learning for Malaysian engineering undergraduates is the ability to apply the mathematical knowledge

learnt in order to solve complex problems (EAC, 2012). However, previous research and the authors' experience have shown that some students faced difficulties in manipulating concepts, coordinating multiple procedures, manipulating symbols in a

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flexible way and in answering non-routine questions (Tall & Razali, 1993; Anthony, 2000; Croft & Ward, 2001; Hoch & Dreyfus, 2005; Roselainy, 2009; Roselainy, Yudariah & Sabariah, 2012a). Thus, in an effort to promote holistic students' achievement, Malaysia-Japan International Institute of Technology (MJIIT), has adopted a teaching and learning culture by focusing on Knowledge, Experiential and Self-regulated learning (KES). MJIIT is a government to government initiative that aims to provide Japanese style education in a Malaysian setting. This paper will discuss the strategies that were developed to support Outcome-Based Education in the Engineering Mathematics 3 course by promoting self-regulated learning and focusing on the development of mathematical competencies (SEFI, 2011). To ensure the achievement of the course learning outcomes, the constructive alignment theory (Biggs & Tang, 2010) was employed. This was performed to assess whether the outcomes, teaching and learning activities, as well as the assessment of students' learning were aligned and contributed effectively to learning.

In the authors' earlier work, a framework was developed to support and enhance students' awareness of their own mathematical thinking powers as well as to highlight independent learning, communication and team working skills. The framework is also described in greater detail in the works of the following authors: Roselainy et al. (2007); Baharun et al. (2008); Roselainy (2009) and Roselainy et al. (2012a). Various theoretical inputs were considered (Mason et al., 1982, 2010; Watson & Mason, 1998; Tall, 1991, 1995) and strategies were developed and applied to make the thinking processes, structures of mathematics explicit as well as increased students' awareness on the use of their thinking powers. Appropriate teaching tasks were designed to support, develop and extend students' abilities in working on mathematical problem solving. For this study, a new model was designed to further extend the framework and included strategies to support students'

awareness of their Self-Regulated Learning (SRL). There were three main objectives of the research;

1. To enhance students' mathematical competencies;
2. To support self-regulated learning; and
3. To improve the teaching practice of Engineering Mathematics 3 (i.e. Advanced Calculus).

This article discusses the implementation of the research as well as the strategies that were used in the classroom.

## **THE TEACHING AND LEARNING SITUATION MODEL**

The new model proposed in this paper was refined from an earlier model by Roselainy et al. (2012a). The teaching and learning situation was categorized in three components,

1. The learning outcomes of the course,
2. The focus of the teaching, learning and assessment (TLA) activities and tasks, and
3. The environment which supports the SRL processes.

First, in designing the course, the outcomes were identified and these were determined by considering the programme outcomes of the engineering programmes. The outcomes were made up of selected mathematical competencies and undergraduate attributes. Mathematical competencies were defined following Niss (2003, 2011). The eight mathematical competencies which he proposed was later adopted by the European Society for Engineering Education (SEFI, 2011) in their recommendations of mathematics education of engineers. The competencies were, *Thinking Mathematically*, *Reasoning Mathematically*, *Mathematical Solving and Posing Problems*, *Modeling Mathematically*, *Representing Mathe-*

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