

As a conclusion, in many education concepts, the learning involves the curriculum of a particular course, the pedagogy involves delivery of the curriculum and finally, the evaluation of the course is the comprehensive measurement to indicate the achievement of students as well as for the lecturer. As discussed above, this study is focused on the pedagogy or activities in delivery of the curriculum. **The innovative idea presented is the integration of problem based learning and flipped classroom approaches to repeat students. This approach appears to give significant impact of their achievement compared to conventional practices.** The commitment, passion and motivation among the students and led by the lecturer are the mandatory elements to ensure successful implementation.

The study also has been implemented for 25 diploma program students in Semester I 2014/2015. The result shows high similarity with the first implementation of bachelor degree students.

**Keywords:** student engagement, flipped classroom, Problem based learning, class of repeat student

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### 41. DEVELOPING EFFECTIVE STUDENTS COMMUNICATION IN ENGINEERING MATHEMATICS

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#### Background

The Malaysian workplace needs graduates with employability skills such as critical thinking, problem solving and ability to communicate. In 2006, Universiti Teknologi Malaysia (UTM) has integrated these goals in undergraduate education but studies at UTM have indicated that the goals have not been translated into successful implementation. In this presentation, we will share how we had implemented an integrated approach which addressed students' knowledge, thinking, problem solving and generic skills, in particular, communication. We had developed a framework which was used to guide our instructions in Engineering Mathematics I since 2009/2010 session, in Engineering Mathematics II since 2010/2011, and in Differential Equations since 2012/2013 session. The same strategies were implemented in Malaysia Japan International Institute of Technology (MJIT, UTM KL) in Engineering Mathematics III for the 2011/2012 and 2013/2014 sessions.

#### Development of the Teaching and Learning Strategy

We had referred to various theoretical perspectives in mathematics education which described understanding, thinking, learning, and teaching (Skemp, 1987 & 1993; Gray & Tall, 1994 & 2001; Schoenfeld,

1985 & 1989; Engineering Council, 2000 & 2012; SEFI, 2011) of mathematics at the tertiary level. These findings also gave explanations on aspects of cognition as well as reports on the viability and consequences of various kinds of instruction. Based on these works, we developed a pedagogical approach that supported meaningful mathematical learning and devised strategies to achieve given learning outcomes. However, in designing classroom instruction and activities, we refer mainly to the theory on mathematical thinking expounded by Mason and his colleagues (Mason, 2002, Mason et al, 1982 & 2010, Mason & Watson, 1998; Mason & Johnston-Wilder, 2006). The integrated framework also connected students' psyche, cognitive, affective and psychomotor development (Gattegno, 1977).

Two models were used to add clarity to the teaching situation namely, Focus of Mathematical Learning (Figure 1) and Cooperative Learning (Figure 2). The teaching and learning situation needed to contribute to the various concerns such as to enhance students' ability to take charge of their own learning, increase their understanding, communicate their mathematical learning, and to increase their awareness of their own mathematical thinking. The focus of learning identified elements that we thought were important and consistent with the University's philosophy of teaching. These were: Thinking, Knowledge Development, Soft Skills Development, in particular, communication, independent learning and teamwork and supporting Self-Regulated Learning.

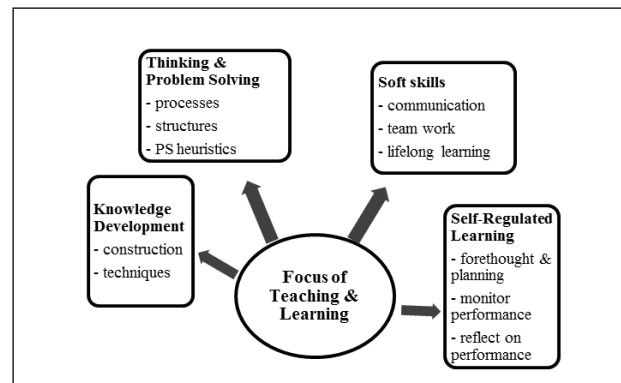


Figure 1: Focus of Mathematical Learning

The following strategies were used to support and encourage students to engage in communication:

(i) **Using classroom tasks** – the tasks require the use of various mathematical thinking powers and to initiate discussion which allows students to verbalize their mathematical ideas. Thus, structured questions with “prompts and questions” were used in addressing mathematical concepts and their problem solution in verbal and written modes. Thus, the need to communicate their knowledge was made explicit and help to provide context for the importance of communication.

We adopted cooperative learning (Meyers & Jones, 1993; Keyser, 2000; Felder & Brent 2008) to promote a learning culture in which students could think, talk and write. The sequence, “read – write report – present – correct report & submit – test” was implemented to ensure students undertake both oral and written communication.

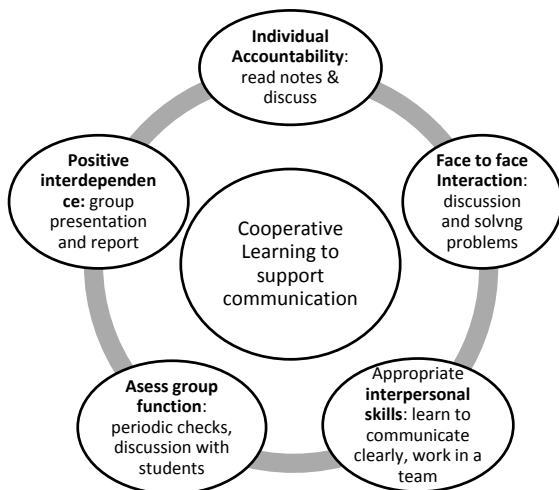


Figure 2: Model of Cooperative Learning

**The Teaching and Learning Approach**

Our model put forward an integrated approach that addresses knowledge and skills development, emphasising on mathematical communication in verbal and written mode. We found that encouraging students to talk, to read, to write and to reflect on their mathematical learning and problem solving, they are able to improve their understanding, gain insights into problem solving and became more able to communicate their ideas in a mathematical manner (Roselainy et. al, 2012). Students worked in small groups, in pairs and independently. They used the “prompts and questions” to learn how to talk about mathematics. In this way, they are responsible for their learning, gain insights into their own thinking and express their mathematical ideas and strategies in a precise and coherent manner using the correct symbols, notations and vocabulary. Conversely, we know about what they are thinking through their writing and oral communication.

In our recent class for Engineering Mathematics III, we modified the delivery and assessment methods. For the delivery, an adapted flipped classroom was used whereby students have to read and discuss each new topic individually and within their group and to solve the given problems. They were given learning guides specifying the topic learning outcomes and the duration of time for each topic. The assessment methods provided a balance between individual and group work. For group work, the students are required to prepare a written report and present the report to the class. During presentation, their peers could participate by indicating they had understood the explanation, offer corrections or provide different explanations. The lecturer will intervene to address mathematical misconceptions or misuse of the mathematical language. Then, they are given time to improve their report. At the end of every major chapter or section, a short test was given a week after the presentation was made and this is the individual assessment, thus compelling them to engage as a team to ensure understanding of the materials and to prepare for the test.

**Significance and Impact**

A typical partial report guide to be presented orally and in written form is included here (Table 1).

<p><b>REPORT 3</b>  <b>DOUBLE INTEGRALS</b>  <b>SMJM 2033 ENGINEERING MATHEMATICS 3</b></p> <ol style="list-style-type: none"> <li>1. How do you evaluate double integrals?</li> <li>2. How do you choose the preferable order of integration?</li> <li>3. How are the limits of integration determined?</li> <li>4. What do you do to evaluate double integrals by reversing the order of integration?</li> </ol>
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	Prompts/Questions
<p><b>Question 1 (5 marks)</b>                      Write the integral  <math display="block">\int_0^4 \int_0^{-(y-4)/2} f(x, y) dx dy</math>                      with the order of integration reversed.</p>	<ul style="list-style-type: none"> <li>• Which part of the integral informs you about the region of integration?                             <ul style="list-style-type: none"> <li>○ Find and sketch the region</li> </ul> </li> <li>• How do you determine the limits of integration for the reversed order?</li> </ul>

Table 1: Questions for presentation and report

For the presentations, students were able to articulate the mathematical concepts and solutions as they were guided by the “prompts and questions”. We found that their facility with the mathematical language became better although there were examples of misconceptions and mistakes in the use of terminologies. In terms of assessing their written responses, a simple criteria was used to categorise the responses, which is, “ability to display correct mathematics, clear explanations and the correct use of symbols and notations. A rubric in a range of 1 to 4 was used with 4 referring to ‘Very Good’ and 1 referring to ‘Poor’. Most of the students’ responses were in the range of 3 and 4, although there were responses in 1 and 2. At the beginning, students were uncomfortable with the activities as they were different from their usual learning experiences. However, after a few sessions, they adapted to the new environment showing particular enthusiasm working in groups, sharing of ideas and working out the mathematics for themselves. Thus, the environment had facilitated thinking and communication skills among the students, and made the class livelier (Roselainy et.al, 2014). The teaching acts implemented also shifted students’ awareness from rote learning towards understanding the facts and procedures, recognizing their mathematical powers, and enhancing the students’ generic skills particularly the mathematical communication.

This framework was a supportive structure that enables a learning environment that requires students to communicate and sharpen their inter-personal and intra-personal skills. As the underlying characteristics remain the same, the framework can be used in any other mathematics courses. The lessons, tasks, and activities designed must be fundamental in providing a conducive environment where students felt unthreatened to express their thinking, take responsibility for listening, summarising, questioning, and interpreting one another’s ideas mathematically in small-group and in whole-class discussions.

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#### **42. BLENDED STUDENT LEARNING EXPERIENCE: COMBINING VIRTUAL LEARNING ENVIRONMENT, 3D DESIGN AND ACTIVE COMMUNITY ENGAGEMENT WITHIN A FRAMEWORK OF KNOWLEDGE TRANSFER PROGRAM**

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##### **Extended Abstract**

Many of the problems that academics face during the teaching and learning exercise include lack of motivation in learning by the students which could be derived from the lack of understanding for a particular topic or concept being taught in the class or (to be fair with the students) could also be due to monotonous teaching practices given by the

academics. In this extended abstract, the author will briefly describe the implementation of 'Blended and Active' student-centred learning tool as one of the teaching innovations or methods which could be used to minimize the problems described here. According to the "Multiple Intelligences" educational theories by Howard Gardner (1983), the 'visual-spatial' intelligence, 'body-kinesthetic' and 'interpersonal' intelligence could be used to develop *Blended and Active Student Learning* experience. In addition, the innovative teaching practice described in this paper is in similar idea with the *Partnership for the 21st Century Skills* - US Department of Education and MacArthur Foundation as well as individuals such as Henry Jenkins, Mimi Ito and John Seely Brown. The partnership group proposed a new learning theory that in this increasingly digital and connected age, skills necessary for students to master and experience success in school and life include digital literacy, traditional literacy, media literacy, content knowledge, and learning / innovation skills. The *Blended and Active* students learning experience proposed in this paper refers to the use of multimedia (such as 3D design and video animation) and interactivity using online 'open learning platform and assessment tools (VLE)' such as Moodle, as well as active hands-on participation of the students in an outdoor teaching and learning activity.

In practice, we have proposed that students taking the engineering and science courses that involve technical devices (such as biosensor, biomedical or biotechnological devices) could be expected to obtain a full or better understanding of the working principle and concept of the device if the teaching facilitators (teachers, lecturers or presenters) use a 3D design and animation tools to illustrate the concept and the system. In particular, this teaching tool helps increase students spatial understanding of the object or the device in accordance with the 'visual-spatial' learning intelligence theory put forward by Howard Gardner (1983). One of the easiest, free and widely-used 3D design software is *Google Sketch Up*. It comes with full and comprehensive online video tutorials for the novice users to build any 3D objects from scratch or from an existing 3D model library. Therefore, busy academic professionals like teachers and lecturers do not have to build the object from scratch. The free software comes with an online community-based collection or warehouse of 3D objects which the users can download and use freely (for modification, adjustments, etc.) for non-commercial or educational purposes. As an example, we have built a 3D design of an indoor orchid-growing kit utilizing aquaponics as the core technology. Following a classroom-based teaching and learning exercise, students were expected to familiarize the models and subsequently build or construct the device (aquaponics system) in a team work environment and develop their hands-on skills. This window of opportunity could also be used by academics for the assessment of the student's affective and psychomotor domains through direct observation and assessment using a suitable rubric system.

The second component of *Blended Learning System* is the use of internet-based *Virtual Learning Environment* (VLE) and online assessment tool. The campus-wide implementation of VLE via Moodle-based application in Universiti Malaysia Pahang (UMP) for teaching, learning and assessment in addition to classroom-based teaching exercise allows academics in UMP (and other universities) to provide relevant teaching materials online for the student to learn and expand their knowledge anytime. It also allows academics to set the mode of quiz to be closed-book or open book. The open book quiz or tutorial could be conducted anywhere and anytime by the students within the time and duration specified by the academics. However, the closed book assessment using internet-based (Moodle) application, must be conducted in a computer room where the academic staff can invigilate the progress of the assessment. Overall, the use of internet-based VLE for teaching and learning purposes has increased students' academic performance and satisfaction in learning and could contribute to *Blended Learning* experience for the students. The method is also in line with the educational theories put forward by the *Partnership for the 21st Century Skills* (US Department of Education and MacArthur Foundation). The use of internet-based (virtual) learning environment (Moodle-based