A Multi-Modal Approach to Teaching and Learning: A Case Study of Teaching Materials and Process Engineering

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Abstract: *How we effectively plan, coordinate, resource and promote change is of ongoing concern to those who work in Higher Education. Increased pressure from diminishing resources, intensified competition and changing obligations towards quality assurance and accountability has placed enormous strain on teaching academics. This paper seeks to examine an initiative where the delivery and assessment of a first year materials engineering subject was integrated with an online Learning Management System know as Blackboard©, to reduced correction time and increased student participation and satisfaction. Examples are given of how the technology available within the learning management system can be used to support laboratory work, whilst still engaging the student and staff in hands-on experimental work. Associated online learning aspects such as timely feedback, online assessment management, collaboration, group work and group communications are discussed in relation to current teaching and learning methodology.*

Keywords: *collaborative, learning, assessment, multi-modal*

Introduction

During the latter half of 2001 Swinburne University of Technology implemented a policy of online support for all subjects delivered throughout the University. This was achieved through the adoption of a Leaning Management System called Blackboard©. In the early days of Blackboard©, support from the School of Engineering and Science was lackluster. Many academics felt the move online would increase their workload and require them to undertake extensive up-skilling in the technology. A view widely held by many academics throughout Australia (Coaldrake, 2000; Fox, 1999) at the time.

To promote flexible delivery in Engineering and Science, a number of lighthouse projects were identified in an attempt to demonstrate how new technologies could lower academic workload while stimulating learner participation and satisfaction. It was hoped that while going some way to relieving the pressure on academics who were 'time poor" it would also contribute to identifying strategies for enriching the learners experience (Bell, Bush, Nichollson, O'Brien and Tran, 2002). It was decided that a subject where a large cohort of students, who were required to participated in multiple lectures, laboratories and tutorials

requiring extensive marking, would be assessed using the online testing facility in Blackboard©. They would also receive online support for the lectures and tutorials. The first year Mechanical Engineering subject "Materials and Processes" (HES1230) was ideal candidate subject for this project as it had 200 students enrolled, required students to undertake a number of lectures, tutorials and laboratories within a tight time schedule and was delivered by academic staff that had demonstrated a prior commitment to technology.

A project team of academics, teaching and learning advisors, and development staff was formed to look at a number of key issues: the technical skills of the staff; students computer literacy; technology limitations of the delivery platform; accessibility; and the educational relationship between the content, teaching methodology, assessment methodology and course outcomes. A project scope was developed, management support was sought and institute resources were allocated. The University was looking for ways in which the use of technology could be mainstreamed across the university, linking it to external clients to optimise convenience and accessible for students (Coaldrake and Steedman, 1999). In addition they suggested that " the impact of technology is felt more widely throughout Higher Education, and as increasing numbers of part-time and mature age students attend university, the boundaries between distance education and on-campus delivery will blur, and the distinctions in staff work underpinning the two modes will become harder to sustain."

From the outset, the project team was committed to establishing some fundamental principles to maintain the integrity of teaching process while ensuring online delivery did not jeopardise the learning experience for participants. This was achieved through the adoption of Swinburne's Flexible Learning and Teaching Development Plan (Table 1 and Table 2) which provides baseline expectations for all online subjects throughout the university. From this baseline, which specifically outlines minimum standards for resources, communications, assessment, evaluation and management (Table 1) it was easy to move to developing enhanced features (Table 2) where more innovative practices in HES 1230 could be trialed and evaluated.

The innovations undertaken by the academics and project team involved, correlated well with educational expectations put forward by Swinburne University in their plan (Table 1 and Table 2) as the enhanced features for HES 1230 were based on the five innovations outlined in Table 1. These innovations correlated with the educational expectations as follows:

> The design and development of educational materials provided comprehensive access to **subject resources** as all print based resources were available online in compressed format and ready to print. Other online resources such as journal articles, online reserve items; URLs, online activities, email, announcements and chats were imbedded into the delivery model.
>
> The curriculum design of the subject involved many examples of **flexible communication**, **timely assessment**, **subject evaluation** and **flexible subject management**, often allowing students the opportunity to select their time, place and pace of study. Built into the materials was a sensitivity to learning styles. Participants were given the opportunity to access and select a variety of online resources and activities, which all addressed the learning outcomes.
>
> Learning activities and interactions were implemented using a **flexible means of communication** for example; email forums and electronic discussion boards were widely

used to facilitate whole group and small group communication; **evaluation**, publication of results, formal assessment and marking of laboratories and tutorials was online and available 24 hours a day, 7 days a week.

Currently all subject and program evaluations at Swinburne are carried electronically through anon online surveys via Blackboard enhancing a flexible approach to **subject and program management**.

Subject Trial and Delivery

Students enrolled in first year engineering at Swinburne University of Technology must undertake the first year subject "Materials and Processes" (HES1230). This subject is taught at the mainland campus in Hawthorn and at the recently established Malaysian campus in Sarawak. Because of staff number minimization, and re-allocation of teaching resources, a novel approach was developed for the teaching of this subject

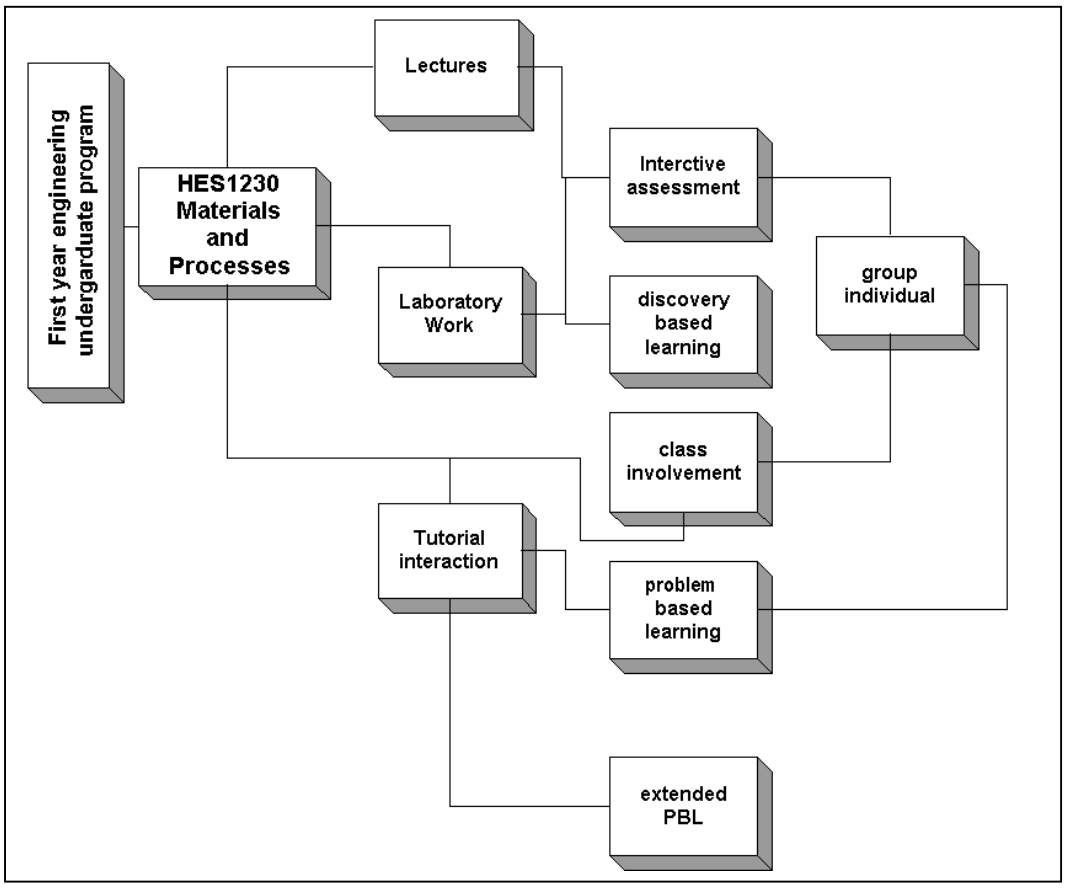

Figure 1: A schematic illustration of the subject delivery and teaching and learning process

It involved the use of new technologies in the delivery of learning material (Foertsch, Moses, Strikwerda. and Litzkow, 2002), the conduct of online tutorials (Tutoring Materials, 2003) and laboratory classes (Ogot, 2003). A schematic illustration of the delivery process is given in Figure 1 and is further explained in the text below.

The main cohort of students numbered approximately 200. The lecture theatre resources only accommodated half that number. In addition, only one lecturer was available for the delivery of lectures. The large number of students and a single lecturer, resulted in a large workload for the delivery of classes, tutorials and laboratories compounded by the need for timely and pedagogically sound assessment for all these activities. To address these issues a new e-learning approach for delivery of material and associated assessment was developed and trialed.

Baseline expectations for flexibility of all current subjects

Educational expectations	Subject sites online
☐ Student access to subject **resources** at time, place, pace of their choosing (e.g. through provision of subject learning guides, lecture notes, readings and references electronically or in print; electronic resource links; Powerpoint slides online; lectures on video-on-demand, streaming video and streamed audio).	☐ Subject code and title correct
☐ Enhancement of student to student and student to lecturer interaction through flexible means of **communications** (e.g. electronic discussion boards, email, electronic chat, video-conferencing).	☐ Unused navigation components, communications and electronic tools not visible
☐ Provision of timely **assessment** of student progress (e.g. negotiated assessment tasks, using electronic pool/assessment manager, quizzes, online submission of assignments).	☐ Consistency in the structure of presentation of information and activities
☐ Provision for subject **evaluation** using flexible means (e.g. electronic surveys, discussion boards, other informal feedback).	☐ Availability online of subject outlines including objectives and assessment requirements
☐ Flexible approaches to subject **management** (e.g. using announcement facilities on subject web pages, electronic bulletin boards, email).	☐ Availability of learning resources such as lecture notes and slides prior to lectures
	☐ An online announcement including a welcome and basic information such as attendance requirements and session details
	☐ Subject open to allow student access

Table 1: Swinburne's Flexible Learning and Teaching Development Plan, 1 detailing baseline expectations for all online subjects throughout the university.

The Lecture Series

Due to the large enrolment cohort, and staff redeployment, two lecture streams were conducted in parallel, but disjointed in time. However, the students benefited from such a delivery mode, with the enhanced features for learning (and teaching) being shown in Table

2. The delivery of lecture material was coordinated through Blackboard© and audio-visual presentations employing Microsoft PowerPoint©. Student notes were distributed via the Blackboard© environment in pdf (Adobe Acrobat©) format. Students were expected to download the notes before the class, consult appropriate references and come to class ready to engage the lecturer and their peers in appropriate discourse.

Enhanced features for selected subjects

Innovations undertaken by individual academics and course teams	Some possibilities supported by LTS
☐ Innovations in the design and development of educational materials	☐ Student to student and student to lecturer educational interaction using a variety of flexible electronic communication tools (e.g. threaded discussions, virtual chat, video conferencing, email).
☐ Innovations in curriculum design	☐ Adoption of innovative approaches to student centered learning and teaching (e.g. problem based learning, action learning) incorporating graduate attributes and Swinburne themes.
☐ Innovations in learning activities and interactions	☐ Provision of evidence of coherence between subject outline and curriculum development.
☐ Innovations in educational communications	☐ Efficient and effective use of technology to improve access to learning and teaching resources for international, on/off campus, fleximode students (e.g. metadata tagging).
☐ Innovations in assessment	☐ Adoption of a variety of forms of assessment (e.g. formative and summative assessment using quizzes, electronic submission, negotiated learning contracts, group projects).
☐ Innovations in subject and program evaluation	☐ Ongoing subject improvement.
	☐ Effective and efficient use of technology to manage student administration (e.g. regular use of announcements/bulletin boards, results via online gradebook, group management).

Table 2: Swinburne's Flexible Learning and Teaching Development Plan for developing enhanced features and innovative practices in HES 1230.

To ensure that lecture materials were reviewed by students, each set of notes had sections missing, which could only be obtained by attending the appropriate class. These were not merely skeleton or fill in the gap notes, but were a substantive set of notes in there own right. Main points were emphasized and analyzed in class and operated as an addendum to the written materials. The pre-identified main points were the central focus or theme for the particular class. Although a whole semester of notes could be downloaded, the main focus of each class could only be obtained by physical attendance at the class. Communication with

such a large cohort of students was achieved initially through face–to-face contact, but the amount of time consumed communicating this way severely limited the academics opportunity to undertake other academic pursuits. To try and overcome this issue, an online question and answer forum was established using Blackboard©. For the majority of situations this worked well, as a peer tutoring environment was established amongst students along with the traditional lecturer/student form of tutoring. Students were given the opportunity to undertake group projects in an attempt to improve teamwork skills.

When lecturing to large classes it is sometimes difficult to answer all the questions put forward by students. Often students will approach a lecturer after the class seeking to ask clarifying questions. Unfortunately given this scenario the rest of the class does not have the opportunity to listen to the answers provided. In some cases students can often be reluctant to ask questions in person. For these reasons a Frequently Asked Question (FAQ) "e-mail forum" was set up through Blackboard© giving students the opportunity to ask each other (e.g. peer group learning) as well as staff, various focused questions. This form of WWW e-mail is often not regarded as a medium for electronic learning, despite most undergraduates, and all staff, having access to the technology.

Ongoing Assessment of Lecture Material

With a limited semester of 12 weeks, ongoing assessment using the online Blackboard© system gradebook was initiated. This allowed assessment results to be immediately available through auto correction, as well as providing timely textural feedback to the students. All results were displayed through the online gradebook© in Blackboard©. The assessment procedures and feedback were developed with student needs in mind, and provided students with a current percentage grading of their total semester result. At the commencement of the semester the students were given full details of the timing and topics to be assessed. At the conclusion of each major lecturing theme (approximately 4 and 8 weeks) a class test was conducted online. Students were given one week and one attempt to complete the assessment.

The assessment was quiz based and was composed of a random block of 15 questions from a question pool of 45. Each student was required to logon on to the subject via the Blackboard© system, with a unique username and password. The system was set to allow only one attempt at the assessment item. Prior to undertaking the assessment students had been encouraged to work in groups to promote team-work and research skills. Once logged on each student was presented with a different set (15) of questions. Because of the time constraint, small groups of students worked collaboratively on one student's questions, and when finished, would move on to the next student's unique set of questions which were similar but not necessarily the same. Once a group of four students had completed all 4 question sets then they had intensively discussed each of the problems and had a deeper understanding of the topic. The relatively high score achieved by the students working in this manner evidenced this. Of the students who did not work in a group environment considerably lower scores were recorded although there were of course outliers i.e. those students who worked alone and achieved high scores.

The Laboratory Learning Structure

Laboratory work, an integral part of the subject, was organized so that students participated in experimental work individually. However, the number of laboratory reports were overwhelming for one lecturer to mark and return to students in the time frame allowed. The

cohort of approximately 100 students were divided into groups of four students, for each laboratory session, necessitating 25 sessions spread over 4 weeks i.e. approximately 6 laboratory sessions were held in one week. These sessions had to fit into the timetable of the demonstrator as well as laboratory availability. Working in groups of 4, the students would conduct the experiment, take measurements, and record results.

The materials tested were different for the varied groups so that results amongst groups were not always the same. The submission of laboratory results were achieved through a computer based interactive laboratory administered through Blackboard© a program similar to a quiz. Only the students who had participated in the laboratory group could satisfactorily answer all the questions. As part of the laboratory work, the individual participants had to perform calculations, consult their textbook and class notes for appropriate descriptions, and in some instances, use alternate references to understand the concepts requires of them which were associated with the laboratory work. This style of delivery is considered to be a form of Discovery Based Learning (SES Student Manual, 2003; Engineered Materials Website, 2003). Examples of the concepts and applications of this mode of learning are given in Table 3. The laboratory-based exercises varied and comprised several examples where extensive laboratory equipment was utilized. This allowed students to gain exposure to equipment and techniques such as tensile testers, hardness testers, and operation of heat treatment furnaces, whilst participating in more student-centered learning.

Materials are everywhere around you, from the computer mouse under your hand to the wooden computer desk. Materials selected for different uses are chosen because their properties fit the need. But no matter where the material originated, it's properties, processing and performance are all interdependent and interrelated. These material properties, such as strength, can be measured and analysed using tensile testing equipment.

Key concepts:

People have exploited materials for useful purposes.
Find out that the structure, properties, processing, and performances of materials are all interdependent and interrelated.
Learn about the different types of engineered solid materials.
Learn the useful engineering properties of materials.
Hardness is an important property of materials. Learn how to measure and choose the correct hardness test

Learning Objectives:

After completing this module, you will be able to:

- State how structure, properties, processing and performance are all interdependent and interrelated for a given material
- Identify useful properties of a given an engineered solid material (i.e. composite, ceramic, metal, polymer)
- Choose the correct test to measure strength
- Discovery based learning via 'hand-on' experimental.

Table 3: Concepts of Discovery based learning applied to engineering materials

Ongoing Laboratory Work Assessment

The students worked as groups to research the topic but were required to submit individual results, thus promoting peer group tutoring to arrive at appropriate answers. The students were given different sets of conditions to answer as individuals, thus providing another form of learning many aspect of the laboratory work, both theoretical and experimental. In all

instances, the submission of experimental outcomes was of a high standard. It appeared that the group work had succeeded in the student's learning process.

The Tutorial System

The most difficult aspect of applying the e-learning process was the implementation of the tutorial. The subject, Materials and Processes, HES1230, was assigned a one-hour tutorial each week as well as a laboratory class every alternate week.

The tutorials were conducted in a face-to-face environment to classes of approximately 24 students. The tutorial sessions were used to explain, in depth, concepts from the lecture sessions that were considered important. However, not all students had the same difficulty with the same sections of the lecture material and needed support in varied and diverse areas of the curriculum.

To overcome this phenomenon various online practice exercises were developed in Blackboard© to enhance student understanding. Problems were set for solution for each tutorial; these problems covered lecture content as well as extension activities. Students reported a high satisfaction rate with the concept and staff reported increased understanding of the topic as well as heightened problem solving skills. The worked solutions to all the problems were available to the students as part of the feedback in the Blackboard© Learning System.

Students were given the opportunity to gain content knowledge through a variety of online and face-to-face mechanisms. Some students took part in class discussions of a particular aspect of their work, others attempted problems in class with tutor support, whilst another group of students enhanced their understanding by discussing problems amongst themselves and working collaboratively to solve them. Adopting this style of delivery allowed for multifaceted learning to take place. The tutors (in many instances the same person as the lecturer) were able to be more efficient in their teaching. This efficiency came, not from employing a totally new online teaching methodology but rather through timely presentation of material, use of peer support and utilization of self paced activities as extension exercises via Blackboard©. New technologies were not necessarily driving the process but rather supporting it.

Concluding Remarks

New Technologies are just another set of tools to be used in the practical implementation of good teaching principles, and as such, must be trialed and evaluated as they become available. Many will enhance the learning process while others will become redundant. What is of importance is the commitment by academics to undertaking reflection and continuous improvement in their teaching practice.

Certainly, time will need to be spent on acquiring new technology skills and expertise within the medium, but the increased diversity of resources, flexibility and timeliness of communication along with the responsiveness of formal assessment are likely to increase student engagement and promote self directed learning. One of the most pleasing aspects of the trial was increased cooperative and collaborative learning amongst students. A skill not easy to enhance in large first year subject deliveries.

It has been demonstrated that successful and effective flexible delivery is underpinned by the same principles as successful and effective face-to-face delivery. The learning-teaching process requires:

- The establishment of clear goals and expectations,
- The alignment of objectives, learning activities and assessment,
- The use of active learning methods,
- The creation of a supportive environments that are inclusive of the diversity of students,
- The enhancement of generic skills and autonomy, and;
- The focus on continuous improvement through evaluation and review.

(McAlpine, Koppi, McLean, Hodgson, Fardouly and Kinch (2001)

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