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E-learning Strategies on Science and Engineering Education in the SIM University

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Abstract *:* The SIM University started a massive e-learning implementation in its four academic schools towards the end of 2010. By now we have more than two years of experience in the use of e-learning in our teaching and learning environment. Initially, many of our course materials were converted to the digital format. These include the course guides, study guides, discussions, lesson presentations, formative and summative assessments. Most of the online materials are delivered using the Blackboard learning management system (LMS). However, how has the School of Science and Technology managed to balance the need for e-learning and at the same time ensure that our students in the 13 undergraduate programs maintain the human touch so essential in learning interactions?

The purpose of this paper is to explain the eight e-learning strategies that the School of Science and Technology has adopted to ensure that our students receive a value-added education that is engaging, educational and experiential. We also propose a simple model to assess the effectiveness of the e-learning strategies.

Key words : strategies, engaging, educational, experiential.

INTRODUCTION

The SIM University (also known as UniSIM) is Singapore's first and only privately-funded university recognized by the Ministry of Education (MOE) to issue its own degrees. It was gazetted as a university on 14 April 2005 [1].

UniSIM is part of the Singapore Institute of Management (SIM). SIM is the largest and most comprehensive provider of private tertiary and professional training in Singapore. It was formed on 28 November 1964 as a not-for-profit membership institution, under the Economic Development Board (EDB) [2].

UniSIM's mandate is to provide higher education opportunities to adult learners. Since July 2011, all eligible adult learners at UniSIM enjoy government subsidies of up to 55% for their degree programs [3].

Since its setup in 1964, the SIM has been offering management development focused courses to its members. SIM soon partnered with foreign universities to offer degree courses in several disciplines. In 1992, the MOE appointed SIM to run the Open University Degree Program (OUDP) in partnership with The Open University of the United Kingdom (OUUK). The objective then was to provide university education for the adult working population.

SIM began registering the students in 1994 and subsequently had a contract with the OUUK to manage and deliver certain courses from its undergraduate degree programs. These programs led to degrees in many disciplines, namely, English, Computing, Mathematics, Psychology, Business and Technology.

From February 2003 onwards, OUDP achieved OUVS (Open University Validation Services) institutional accreditation. It was renamed the SIM Open University Centre (SIM-OUC). Since then the SIM-OUC began to develop its own course materials for the presentation of new undergraduate programs.

SIM-OUC became a university in January 2005 when MOE granted SIM the approval. On 14 April 2005 the SIM University (UniSIM) was fully gazetted by the Singapore Government.

UniSIM has four Schools: Arts and Social Sciences (SASS), Business (SBIZ), Human Development and Social Services (HDSS) and Science and Technology (SST). The organization chart of UniSIM is presented in Figure 1.

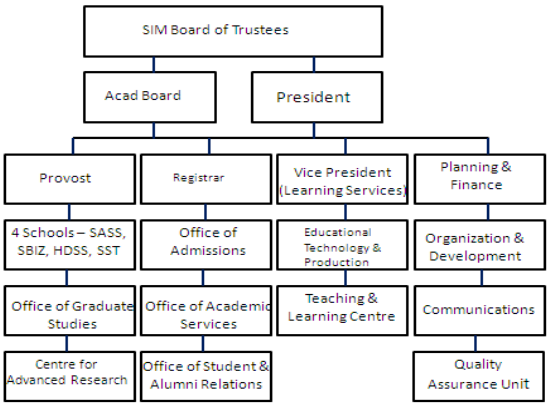

Fig 1: Organization Chart of the UniSIM [4]

SST has a total of 13 undergraduate degree programs [5]. These are:

- BEng Aerospace Systems(EAS)

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- BEng Aviation Business Administration (BSABA)
- BEng Aviation Maintenance (BSAM)
- BSc Biomedical Engineering (BME)
- BEng Electronics (ELN)
- BSc Human Factors in Safety (HFS)
- BSc Information and Communication Technology (ICT)
- BSc Information Technology and Business (ERP)
- BSc Info-Comm Technology with Security Studies
- BSc Mathematics (MTH)
- BSc Multimedia Technology and Design (MTD)
- BSc Facilities and Events Management (FEM)
- Bachelor of Building and Project Management (BPM)

Each degree program is headed by a Head of Program (HoP). Each program is made up of many courses. Many of these courses are of 5 credit units (CUs). This means that the 5-CU course will be taught over 6 weeks with 3 hours of lecture / tutorial every week. For courses with lab components, there is an additional 6 lab sessions. Each course is usually taught by a part-time Associate Faculty (AF).

Our students are working adults who come in for their studies after work, i.e. from 7 pm to 10 pm on weekdays from Monday to Friday. Where necessary, lab work and other practical sessions are conducted on Saturdays and occasionally on Sundays.

We work on a half-yearly semestral program presentation system. We thus have a January intake followed by a July intake. Lessons are conducted over the first 4.5 months of the semester before the students take their examinations in the 5th month.

Our system is a flexible system which allows students to complete their part-time studies up to a maximum duration of 8 years (students take on average 3 to 4 years to complete). This is another reason why we have decided to embrace e-learning in a big way in UniSIM. With e-learning, we are able to provide flexible learning such that our students can obtain their course materials and interact collaboratively with their instructors and study mates online.

E-LEARNING IN UNISIM

E-learning was started on a university-wide scale in early 2010 when the Chancellor of UniSIM mandated that all undergraduate degree programs must have at least 50% of the course materials developed in e-learning format by 2015. These include course guides, study guides, discussions, lesson presentations, formative and summative assessments. Most of the online materials are delivered using the Blackboard (LMS) [6].

Year	2011	2012	2013	2014	2015
No. of e-learning courses developed	13	50	113	159	189
Overall total no. of courses	308	308	308	308	308
Percentage	4.2%	16.2%	36.7%	51.6%	61.4%

Table 1: 5-year E-learning progressing targets for UniSIM's SST

Table 1 gives a breakdown of the 5-year e-learning targets for the four schools in UniSIM. Taking charge of the entire development of all the e-learning courses is the Learning Services Cluster of UniSIM. This cluster comprises the Educational Technology and Production (ETP) Department and the Teaching & Learning Center (TLC):

In this paper, we have chosen to use the e-learning definition from Littlejohn and Pegler [7] as "the process of learning and teaching with computers and other associated technologies, particularly through use of the Internet". As such, many of our course materials are converted to the digital format. We use two modes for course delivery to the students, viz., the asynchronous mode and synchronous mode. In asynchronous course delivery mode each student can adopt his convenient pace to go through the course materials (study guide) provided in the digital format. In synchronous course delivery mode the students and the AF come together simultaneously either on an online platform or physical seminar room to collaborate. As for the online platform in synchronous mode, we used the WebEx web conferencing system [8] initially before moving to the Collaborate web conferencing system. The switch to the Collaborate system came about when Blackboard integrated Collaborate into the LMS. The SST is the University's largest user of the Collaborate web conferencing system. In addition, we used the Classroom Replay System [9] to capture the synchronous course delivery and collaboration taking place inside the seminar room.

Fig 2: Screen shot of Classroom Replay System

DEVELOPING E-LEARNING IN UNISIM

For the purpose of developing and implementing e-learning courses, we have expanded the definition of e-learning to the following:

- **Collaborative Learning.** Much learning must take place collaboratively via mechanisms like discussion forums and Collaborate sessions among students.
- **Online Contents.** Course materials must be accessible to all students from anywhere on a 24/7 basis.
- **Limited face-to-face.** A 5-CU e-course will have only 3 face-to-face seminar sessions for collaborative learning instead of the 6 sessions in a normal course.
- **Submissions Online.** Submission of any assignment must take place via online uploading facility of the LMS. This also activates the Turnitin [10] plagiarism checker program installed on the LMS.
- **Administrative Help**. Online help must be provided for the proper administration of any online course.

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The process of developing e-learning courses is rather a long and tedious process. It starts with the identification of the suitable e-course developer by the HoP and submission of a Job Request Form to the ETP Department by the HoP. The ETP Department will then assign a Learning Development Specialist (LDS) to work with the HoP and the e-course developer for the particular course. A typical e-learning courseware may take as long as 8 to 10 months to develop. An example of this is to embed voice recordings within the PowerPoint presentations using the Articulate software [11]. For the purpose of develop e-learning courseware, the ETP Department uses the ADDIE Model for the instructional design framework [12].

In addition, the e-course developer and the AF teaching the e-course need to undergo some mandatory training [13]. The following is the list of the mandatory training courses:

- AD101: Teaching@UniSIM
- AD102: MyUniSIM Blackboard Basics
- AD103: Academic Integrity: How to Advise Students on Plagiarism
- AD104: Providing Constructive Feedback to Students via Assignments
- AD105: Peer Mentoring
- AD106: How to be an Effective Online Instructor
- AD107: Designing Effective Assessments

Altogether, we believe that UniSIM has a good infrastructure to deliver e-learning.

MAINTAINING THE QUALITY IN E-LEARNING

Maintaining quality in e-learning is just as important as having a comprehensive infrastructure and building the e-learning capability amongst our AFs and staff members. This is where we have the following initiatives to ensure quality:

- Regular course audits including those of e-learning courses
- Having some of our e-learning courseware evaluated by Quality Matters (QM) [14].
- Mandatory webinar tests before our AFs conduct webinars
- Monitoring feedback from students
- Promoting use of Active Learning in all SST's courses
- Promoting the effective use of e-learning by students

CHALLENGES FOR THE SST

Although the e-learning infrastructure has been set up properly in UniSIM, we do have several challenges in the SST. Firstly, unlike the other schools, we have many courses in the 13 undergraduate degree programs that cannot be shared in other SST programs. For example, courses in the Electronics program cannot be used by students in the other degree programs that are not related to Electronics. This means that many unique e-learning courses have to be developed for the SST programs. The SST actually has 308 different courses in all the 13 different undergraduate programs.

The second challenge is that most of the teaching is done by our AFs who are engaged on a part-time basis. Being part-timers, they will not have much time to develop the e-learning courses.

The third challenge is that almost all the e-learning courses have to be developed from scratch. Consequently, the development and delivery of e-learning courses take a long time. We have only recently started to consider using book publishers' e-Textbooks as another alternative.

The fourth challenge is that there is a lack of e-learning culture in the SST and UniSIM in general. Almost everyone prefers learning face-to-face.

E-LEARNING STRATEGIES

Recognizing that the SST has many challenging e-learning tasks ahead, we decided to adopt the eight strategies as illustrated in Figure 3.

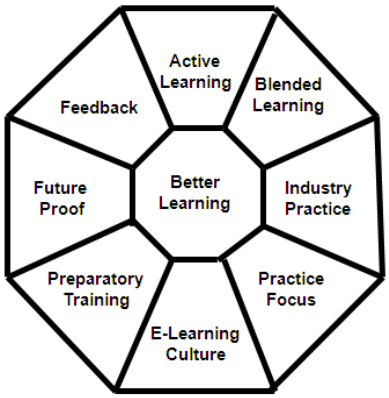

Fig 3: E-learning Strategies adopted in the SST

Strategy 1 – Active Learning. We adopt Active Learning for better learning by our students. Active learning is a teaching method that involves students in the learning process rather than seeing them as passive recipients. "Students learn best by doing" [15]. "Active learning asks that students use content knowledge, not just acquire it" [16]. The purpose of active learning is to improve students' comprehension, retention and overall learning.

Active learning can be applied in both e-learning courses as well as in classroom, face-to-face setup. For example, during a webinar on Michael Porter's Competitive Forces Model, students are asked to form virtual groups to discuss some reasons for the huge success of Samsung's smartphone over that of Apple's iPhone even though Apple is the company which first introduced the smartphone.

In the SST, we required our AFs to practice Active Learning whenever they conducted any lesson with the students. Our AFs can make use of lesson plans in order to plan the learning activities. Eventually, we hope to reduce the quantum of didactic teaching.

Strategy 2 – Blended learning. Blended learning, which is a combination of various pedagogical approaches to

produce an optimal learning outcome, has often been touted to be better than just "pure" e-learning. In the SST, we have been using the blended learning approach in the teaching and learning of Mathematics, Project Management, Electronics and SAP (an Enterprise Resource Planning system) [17].

An e-learning course was developed by our colleague Dr Andrew Toon and administered to students enrolled on the Mathematics course entitled, "Further Mathematical Methods and Mechanics". About 350 students went through the totally online course for 6 weeks, starting in July 2008. The software called "Geometer's Sketchpad" was used to represent differential equations as Java applets. Students could then use these Java applets to help them visualize and come out with possible solutions. The students also made use of the MathCAD software when they wrote their assignments [18]. The Java applets and associated course learning contents were delivered from the Blackboard LMS. Altogether there were 5 online tutors enlisted with each tutor overseeing 2 or 3 online tutorial groups. Each online tutorial group comprised 25 students.

Strategy 3 – Industry Practice. This is where we work with industry partners to use their e-learning systems in our courses provided they meet the academic criteria. In this area we have, for example, collaborated with the Institute of International Learning (IIL) to offer the Project Management Basics course (PM) [19].

The PM course was conducted using the Centra virtual classroom software system. This virtual classroom system comprised three modules: (1) Project Management Basics, (2) Project Management Fundamentals for IT Professionals (PMIT) and (3) Managing Multiple IT Projects (MMITP).

The Project Management Basics course is a 12-hour self-paced online learning module. The students take an online test at the end of the module. They are required to pass this module before they can proceed to the next module.

We have also collaborated with the SAP eAcademy in India to offer SAP e-courses since August 2008 [20].

Strategy 4 – Practice Focus. Science and Engineering courses require much more practice than other disciplines. Whether it is writing a computer program or working on a circuit board in electronics, students need to work with their hands and brains on a hardware system or computer laboratory.

In Electronics workshops, it is very difficult to completely replace the face-to-face student-to-student and student-to-tutor interactions. Nonetheless, e-learning presents an excellent supplement to the usual face-to-face classroom lectures and tutorials.

In 2008, we introduced virtual laboratory, wiki sessions, modeling and simulation and recorded laboratory sessions to students doing the Electronics course.

Although Virtual laboratories are difficult to set up they are valuable as they can give students a simulated environment for them to learn electronics [21]. The challenging issue is in setting up the assignments and assessing the student's competency.

Strategy 5 – E-learning Culture. All the expensive e-learning software, hardware and courseware would have gone to waste if there is no e-learning culture in the SST. E-learning culture is not easy to implement and be embraced readily by staff, AFs and students. However, if it is introduced in a subtle way, we believe everybody will eventually accept it and its practice will become a "culture". One example is the automated submission of assignments by our students. Every course usually has a Tutor-Marked Assignment (TMA) to be done by students and submitted within a specified time, e.g. one month after it has been given out to the students. Before the automated submission, we have many cases of late submissions and students giving many excuses for late submissions.

We then introduced automated TMA submission. Once the deadline is over, e.g. by 11:59 pm on a certain pre-announced cut-off date, the student will not be able to upload their TMAs at all. By now we have implemented this system for about 4 years and our students have accepted the system.

Another example is that we have started to slowly replace many didactic lectures with webinars. There are a few advantages in doing this. Firstly, by resorting to webinars, we do not require our students to rush to our campus to attend the face-to-face seminars. With webinars, our students can view the lectures, listen to the lecturers and interact with the AFs all from the comfort of his home, office or anywhere he fancies. The second advantage is that if the student misses the webinar, he can view its recording at a later date and time that he chooses. All our webinars are archived for students to go through the lessons.

Strategy 6 – Preparatory Training. Right from day one, we have recognized the importance of having constant technology training for both our Associates and students. For example, before we embarked on using webinars to deliver our lectures, we organized familiarization training courses for both our AFs and students. Next, when the university changed the web conferencing system from WebEx to Collaborate on the Blackboard LMS, we conducted another round of familiarization training classes for both our AFs and students on the new Collaborate web conferencing system.

All our AFs are also required to attend the mandatory e-learning courses conducted by our ETP Department. These courses have been listed in the third paragraph under the section on "E-learning in UniSIM".

Strategy 7 – Future Proof. There is no doubt that there will be changes in the future. Previously, the iPad, iPhone and other smartphones are not in the vocabulary describing technological e-learning tools. Suddenly, everyone seems to own a smartphone or an iPad. However, whatever new technology will appear, we believe that as long as our strategies are based on the best practices in the teaching and learning area, our students, AFs and staff members will definitely benefit.

A good example is that of the eBook strategy which was recently launched in our SIM University. The eBook is based on the ePUB specification [22]. This is a good move to get our staff, AFs and students familiarized with mobile learning. The plan is to convert the study guides of the courses offered by SST to the ePUB format. Figure 4 shows a

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snapshot of ePUB based eBook. The ePUB format is the latest eBook specification that is developed by the International Digital Publication Forum (IDPF).

ePUB (short for electronic publication) is a free and open e-book standard by the International Digital Publishing Forum. Files have the extension ".epub".

ePUB is designed for reflowable content. This means that an ePUB reader can optimize text for a particular display device, e.g. an iPhone, an Android smartphone or a Samsung Galaxy tablet. ePUB also supports fixed-layout content. The format is intended as a single format that publishers and conversion houses can use in-house, as well as for distribution and sale.

There are currently two ePUB versions – 2.0.1 and 3.0. Although we will be using the newer version 3.0, we found that it does not handle mathematical symbols, equations and other scientific notations very well. The usual approach is to create graphical images of the mathematical symbols, equations and other scientific notations and then insert these graphical images into the XHTML-based ePUB pages. Such an approach is very laborious. What we did was to find a workaround solution for this problem. Fortunately, we were able to find a slightly better solution.

There will be more of such changes but we believe we have the framework to allow us to cope not only with the changes but also to innovate and find better solutions.

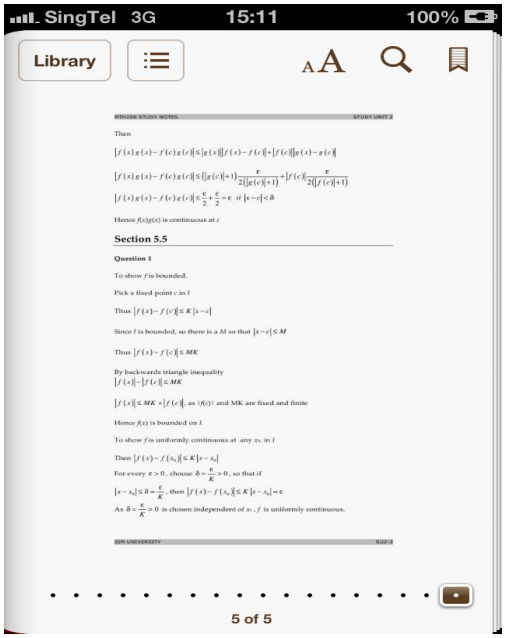

Fig 4: iPhone screen shot of an ePUB-based eBook (using PDFMate Professional) [23]

Strategy 8 – Feedback. Feedback is necessary for us to know whether our strategies are working or not. For us, we have both formal and informal feedback mechanisms. The formal feedback mechanism is from two sources. The first source is obtained when the e-learning course is undergoing a pilot test with some selected students. The feedback obtained is used to improve the design of the e-learning course. The second feedback is obtained after the students have taken the actual e-learning course and they provide us their feedback.

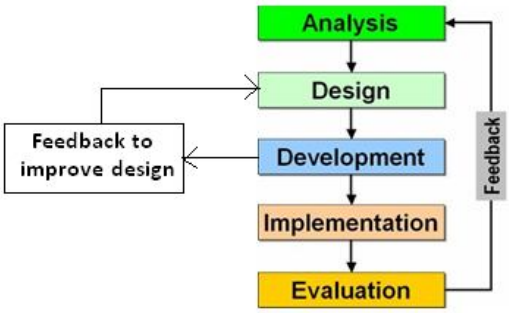

Fig 5: Formal feedback mechanisms with iterative improvements of the end-point results

Informal feedback takes place all the time. Such feedback from students and AF can be communicated to SST in many ways. It does provide us with insights into how our e-learning courses have been received by both our Associates and students. For example, we received many feedback comments about the webinar presentations when we first started using webinars to deliver our lectures. Remedial actions were then taken to rectify any shortcomings. Figure 5 illustrates this feedback mechanism adopted in SST.

EFFECTIVENESS OF E-LEARNING STRATEGIES

So, where do all these strategies lead us to? How can we be sure that the e-learning strategies that we have adopted are effective in making our students learn better? This is where it is necessary for us to have a model which allows us to assess the effectiveness of our e-learning strategies. In this paper, we propose a model which we think can provide a successful and flexible assessment of the e-learning strategies.

This model is based on an assessment matrix which Ron Miller and Barbara M. Olds [24] adapted and expanded from a similar matrix included in the National Science Foundation's *User Friendly Handbook for Project Evaluation* [25]. The assessment matrix comprises the following items:

1) Objectives and Outcomes: It is important to develop clear objectives and outcomes to ensure the success of an assessment plan. Faculty need to begin by defining broad objectives and then ask questions like "What should students know and be able to do when they complete the course or program?" Here, a broad statement of the desired results such as "students who complete the program should be able to develop electronic applications." An outcome is a "detailed statement which describes under what circumstances the goal will be achieved" [26].

2) Performance Criteria: A performance criterion "defines the level of performance required to meet the objective" [24]. It also indicates the types of data that will be collected to provide supportive evidence. There are two questions to be answered here. The first one is on how the outcomes are to be achieved. The second one is the performance level that is required to meet each outcome.

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3) Implementation Strategy: It is important to ensure that learning outcomes, performance criteria, and implementation strategies mesh.

4) Assessment Methods: For this item, we define assessment as "collecting and analyzing data on student academic performance". Evaluation, on the other hand, is defined as "interpreting assessment data to draw conclusions about how well program goals and objectives are being met." [27]. In the SST, our assessment is divided into two categories: Overall Continuous Assessment Score (OCAS) and Overall Examination Score (OES):

OCAS covers the following:

a. Research project preliminary / interim reports
b. TMA (Tutor-Marked Assignment)
c. Case Study analyses
d. Lab reports
e. Project proposals / progress reports

OES can take different forms, such as:

a. 2-hour written exam (either open book or closed book)
b. ECA (End of Course Assessment)
c. Capstone project final report (may include poster and oral presentations) [28]

CONCLUDING COMMENTS

There is still some skepticism regarding the effectiveness of e-learning in teaching. In addition, research work on determining the effectiveness of e-learning is still ongoing. Therefore, it is important to carefully and professionally assess e-learning.

In our opinion, the keys to a successful assessment of the e-learning strategies are:

a. Identifying the appropriate objectives and measurable outcomes;
b. Selecting appropriate assessment methodologies; and
c. Using the assessment results to improve the e-learning courses continuously.

In this paper, we have laid out the eight carefully thought-out e-learning strategies that can help our students to improve their learning in the Science and Engineering domains. The following diagram illustrates how we propose to go about assessing the e-learning strategies:

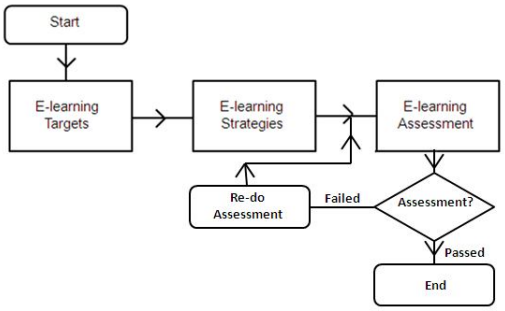

Fig 6: E-learning strategies and how we intend to assess them

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