

Optimising the Content and Delivery of Postgraduate Education in Engineering Management for Government and Industry

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Abstract - Optimising the content and delivery of postgraduate education requires a systems approach, and attention to a number of issues, the most important of which is the recognition that the needs (requirements) of postgraduate students employed in the workforce are different to those of traditional full-time students. This paper describes such a systems approach and addresses those issues in the context of a proposed new Master of Engineering Management Degree for implementation at the University of South Australia (UniSA).

Key words – flexible delivery, distance education, engineering management, postgraduate, ALN.

I. INTRODUCTION

This paper describes a systems approach for optimising the content and delivery of postgraduate education in the context of a proposed new Master of Engineering Management Degree for implementation at the University of South Australia (UniSA). This approach crafts the content and delivery in a holistic manner by integrating a number of factors identified in [1] which discussed the content of, customised corporate postgraduate degrees for Government and industry and experiences in crafting them at UniSA and University of Maryland University College (UMUC). The paper briefly summarises:

1. the differences between the needs of the two types of students;
2. a flexible delivery program;
3. the delivery arrangements and how face-to-face and distance mode are to be integrated;
4. pedagogical differences between face-to-face and distance mode classes;
5. the chunking of knowledge into segments smaller than the traditional semester; and
6. the design of assignments to demonstrate that the students have understood the course material and can apply the knowledge.

Each of the above poses requirements that have to be satisfied in the design of both the curriculum and delivery.

II. THE DIFFERENCES BETWEEN THE NEEDS OF THE TWO TYPES OF STUDENTS

Traditional full-time undergraduate students attend classes as scheduled by the university. Students in full-time employment (SIFTE) find this difficult if not impossible. The

traditional solution has been to schedule classes in the evenings, at convenient locations off-campus and the use of distance education techniques. However as long ago as 1998 at UMUC, enrolment patterns showed that this solution was proving less than optimal as more and more SIFTES opted for distance delivery even if they lived within ten miles of a convenient location. Lifestyles were changing; the demands on single parents with young children in the workforce, and increasing traffic congestion in the national capital area played a major part in the choice to take classes from home. In addition, increasing globalisation meant students travelled more on business for longer periods of time. Consequently, the SIFTES wanted the convenience of courses accessible from any location and that meant flexible delivery.

Employers are invariably interested in their staff (SIFTES) acquiring valuable skills that will translate into enhanced workplace performance in the short term. Thus the curriculum and assessment design need to take this into account [1].

III. A FLEXIBLE DELIVERY PROGRAM

Flexible delivery has to be optimised to fit the SIFTE's schedule. The major differences between undergraduate and postgraduate courses for SIFTES are:

1. Undergraduate courses tend to focus on knowledge, while postgraduate courses should (but often don't) focus on the application of the knowledge. Consequently, postgraduate seminars tend to incorporate more group activities and problem based learn.
2. Undergraduate students tend to be full-time students, SIFTES are generally part-time.
3. Delivery of courses for SIFTES has to be flexible.

A. Delivery environments

Classes are delivered in two major environments:

- Face to face (f2f) which the SIFTES and the instructor gather at the same time and place (synchronous) and
- Online over the Internet in a non-real-time (asynchronous) environment. This environment has become known as an Asynchronous Learning Network (ALN).

However, there are a large number of possible environments with various mixes of synchronous and asynchronous delivery and communications techniques. These

environments are spread out along a continuum of possibilities, namely the spectrum of synchronicity shown in Figure 1.

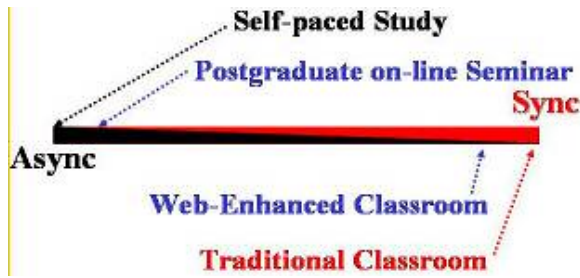


Figure 1 Spectrum of Synchronicity

The traditional f2f delivery environment, a classroom, lies at the synchronous end of the spectrum. The traditional classroom can be augmented with a web page, a List server, and other asynchronous techniques. When web augmentation takes place, the web augmented traditional classroom moves away from the edge of the synchronous end of the spectrum towards the center. The delivery environment is no longer purely synchronous.

At the other end of the spectrum is the totally asynchronous delivery environment. This represents the self-paced studies, correspondence schools and other techniques in which there is no synchronous contact between anyone in the class. The post-graduate school seminar is positioned slightly inwards from the asynchronous end of the spectrum since while being mostly asynchronous it does allow for synchronous student to instructor and student to student communications. Moreover, it has so many of the characteristics of an ALN that it will be considered as an asynchronous environment for the remainder of this paper.

IV. DELIVERY MODES

Delivery modes used at UMUC and UniSA, which will be offered in the new degree, included the following

- **Semester Mode** – in which the class is offered for 14 consecutive weeks. In the f2f version, the class meets once a week for a session lasting three hours or so at the same day and time in the same location. In the online version, the session lasts for the whole week. The final assignment is due on the last day of class.
- **Block mode** – in which the class meets for a week in an f2f environment. The sessions are delivered over the course of the week, and the students have up to 90 days to turn in the final assignment. Post class communications between the students and the instructors take place in several modes including emails, List servers, telephone and even an f2f meeting.
- **Executive weekend mode** – in which the class runs for a number of weekends in the f2f environment in a convenient location. SIFTEs travelled to the location for the weekend. Communications during the weeks between the sessions are synchronous or asynchronous.

A. Does delivery mode make a difference?

In 2003 and 2004 Systems Engineering for Complex Problem Solving (SECPS) was offered as a Corporate Class to the Australian Defence Science and Technology Organisation (DSTO) by UniSA. The course was offered in two delivery modes (Block and Semester), and two environments (f2f and ALN). The course ran four times: there were two Block f2f deliveries, and one each of Semester f2f and ALN. Each offering of the class had:

1. The same content – the class had been created for the DSTO just before it was offered for the first time in 2003 so there was little need for an upgrade¹.
2. The same assignment;
3. The same person marking the assignments;
4. The same class format (learning objects).

Table 1 shows the year, delivery environment and mode, numbers of students, the mean final grade (based on a maximum of 100%) and the standard deviation. Using ‘final grades’ as a measurement it can be seen that there was no significant difference in outcomes between the delivery environments and modes.

Table I
Summary of SECPS Grades

Year	Delivery	Students	Mean	Std. Dev
2003	Block	35	73.28	16.38
2004	ALN	14	73.71	6.3
	Semester			
2004	Block	17	76.29	5.5
2004	F2f Semester	49	73.37	8.4

The same instructor had taught a class on software maintenance (MSWE 648) at UMUC between 1998 and 2000 in the Spring (02), Summer (06) and Fall (09) semesters. The first iteration of the class was in the Fall semester of 1998 (9809). The class content was converted to ALN delivery with a slight change of content for each of the following year iterations. However, the assignments remained the same and were assessed by the same instructor. In the Summer of 2000, two iterations of the class were delivered in Semester ALN format at the same time. The summer necessitated a compressed delivery schedule in which two sessions ran in a week, unlike the ‘normal’ semester mode of one session a week. The results are shown in Table 2.

Table II
Final Grades for MSWE 648

Class	Delivery	Students	Mean	Std Dev
9802	F2f Semester	20	86.84	6.26
9909	ALN Semester	17	76.70	7.65
0002	ALN Semester	17	84.71	5.83
0006-0	ALN Semester	25	85.93	5.08
0006-1	ALN Semester	24	83.30	8.38

¹ The class did undergo an upgrade in early 2005.

Apart from a blip in 9909, when the delivery was converted to ALN Semester format, there seems to be no significant difference in the outcomes.

The same instructor had taught yet a third class, Software Engineering Project Management (MSWE617) in two iterations. The first iteration was an f2f semester class in 9902, and a web-assisted hybrid in the following year (0002) [2]. The web-assisted class was configured with ALN lectures to a f2f class with an f2f teaching assistant. Each ALN lecture was followed by a synchronous audio link. One group of students worked in an ALN environment, the remainder in an f2f environment. The results shown in Table 3 seem to indicate no significant difference in outcomes. Although only two classes were offered, the results are consistent with those of MSWE 648.

Thus for this instructor, in three different subjects in two different institutions with two different student postgraduate populations delivery environment and mode do not seem to affect learning outcomes as measured by final grades. This information allows the delivery environment and mode for the new degree to be set for the convenience of the student and flexibility of delivery.

Table III
Final Grades for MSWE 617

Class	Delivery	Students	Mean	Std Dev
9902	F2f Semester	20	89.59	2.83
0002	Web-assisted Semester	30	88.38	3.44

B. Instructional design

There are two different approaches to instructional design [3, 4, 5] namely the:

- **Objectivist approach**, which is based on the assumption that there is a real, objective, and knowable world and that the instructor's primary duty, is to convey that knowledge to the students.
- **Constructivist approach**, which is based on the assumption that knowledge is constructed by the learner, that learning is active and collaborative and that the instructor's primary duty is to provide a context whereby the student can discover his or her own "constructed" knowledge.

These approaches have been considered as two of the tools in the toolbox of the postgraduate course designer. Thus postgraduate seminars tend to use a mixture of both approaches. The lecture adheres to the objectivist approach in which the instructor "imparts" real, objective, and knowable information about the subject to the students. The students collaborate to construct knowledge by developing a project. In well-designed projects, the project passes through the three sequential stages of confusion, clarification, and completion as the semester progresses. Thus the instructor feeds the students information as the semester progresses and the students build their project in an iterative manner as they receive (and

process the information) in each session. This approach will be offered in the new degree.

V. THE DELIVERY ARRANGEMENTS

Universities tend to place a limit on the number of students that may be enrolled in seminar-style classes. For example, UMUC generally capped f2f classes at 30, and online classes at 25, unless the instructor allowed additional students to attend. Student demand for courses at UMUC was such that in some instances the same class had to be offered in several sections in a single semester. Some classes ran f2f in different locations as well as an ALN, some ran only f2f and some ran only as ALNs. It depended on the semester and availability of instructors. Most instructors were employed in industry or government and taught part-time; hence they were generally not willing to teach a class on more than one evening in a week. Locations were on- and off-campus at a site provided by the State Government, or at sites convenient to Industry. Such distant locations were not offered by UMUC alone, other area universities offered similar delivery services. For example at that time the George Washington University offered f2f classes in Semester Mode in various locations in the National Capitol Area, including Towson, Annapolis, and Reston, Virginia. Online classes can also be offered in several sections if enrolments justify them, and staffing simultaneous online classes is simple. For example, in the Summer Semester of 1999 one software engineering class at UMUC ran in two simultaneous ALN sections with the same instructor². UMUC students could generally enrol via the Internet into any section (f2f or asynchronous) that had vacancies. UMUC degrees were awarded following successful completion of the requisite number of courses irrespective of delivery mode. This mixture of ALN and on-site delivery will be offered in the new degree.

VI. PEDAGOGICAL DIFFERENCES

The course content is the same for each environment however there are a number of other differences between them including

- **Dialog** – unlike the f2f environment, the asynchronous environment tends to use non-visual and non-verbal dialog. Mechanisms such as the requirement for regular task completion, evaluation of frequency and depth of interaction (i.e. making it 'count') and hooks such as regular postings requiring student response can be used effectively in classes where dialogue constitutes a significant learning resource.
- **Attendance** – unlike the f2f environment with its fixed meeting times, the asynchronous environment is available for longer periods of time in which both the student and instructor appear at sporadic or periodic time intervals. This requires specific time management skills.
- **Lecturing and discussions** – unlike the f2f environment where lectures are interspersed with question and answer

² It was advantageous to the instructor, both financially and in terms of workload, to run two small sections of the class instead of one large class of 51 students.

discussions, the asynchronous classroom is multi-threaded not single-threaded. The instructor cannot wait for a few days before continuing the lecture. Asynchronous pauses can, however, be advantageous to the learner who (depending on learning disposition and language proficiency) can benefit from the time available for reflection before responding to or asking questions.

- **Technical limitations** - designing the optimal ALN requires that the entire computer and communications link between the students and the instructor be considered using a systems approach.
- **Team building** - unlike the f2f environment in which a team can begin to form in a few minutes as the prospective team members sit and talk, forming successful teams in the asynchronous on-line environment requires a completely different approach. However, once developed, this approach can also be retrofitted to the f2f environment to facilitate team building in that environment. At UMUC, most first-time online SIFTEs tended to start their team building by setting up a synchronous meeting in the Chat area. They soon found that synchronous meetings were generally unworkable with a geographically distributed team, and graduated to asynchronous dialogues. These factors will be considered in the new degree.

VII. THE CHUNKING OF KNOWLEDGE

Current courses contain a fixed number of credits or points. Students are currently awarded a degree when they complete the prescribed number of courses, i.e. achieve a certain number of credits or points. Traditional courses in a post-graduate information technology or management program contain some degree of overlap of content. While the overlap is often due to the difference in perspective in the treatment of the material, there is some redundancy that could be eliminated. Moreover, the interest and need of the employer funding the tuition or the student might be in a range of subject matter that does not exactly align to the course syllabus. At UMUC students were automatically allowed to take up to two courses at another accredited institution³ and special studies courses were introduced [1]. This was a flexible arrangement which allowed SIFTEs to take whole courses of interest to them or their employers, which were not offered by UMUC. In the new degree, the body of knowledge for the degree has been mapped at a high level into more than the usual number of courses for a degree. The course requirements will begin as a set of core courses and electives made up from modules from an appropriate variety of standard courses. In preparation for this concept, several post-graduate courses at UniSA have already been chunked into modules. Moreover, where the modules can be applied in different programs, they have been incorporated into the other courses. Chunking them will make configuration control easier because course coordinators will no longer have to keep track of which

³ With the pre-approval of their advisors.

courses use their content and distribute the appropriate updates⁴.

Chunking the knowledge in the current syllabus into smaller segments allows for a greater degree of flexibility and reduces some of the redundancy.

VIII. THE DESIGN OF ASSIGNMENTS

Assignments in the postgraduate courses tended to require the students to apply the knowledge to perform a task discussed in the semester. Thus, for example, the focus of the assignment in a class in software maintenance was to produce a maintenance plan. The assignment however did not allow an assessment to be made as to the understanding of the knowledge. It was noticed in some corporate postgraduate courses at UniSA that it was possible for students to gain high grades in a course without demonstrating a grasp of the application of the subject matter. Students could even fail to complete the assignment and still pass the course (albeit with a minimum passing grade). When the assessments were changed from using the knowledge taught in a class to commenting and reflecting on the knowledge taught in the class, an approach adapted from [6] the grades fell into line with the student's in-class demonstrated abilities. Examples of such changes are:

- **Project Development** - instead of being asked to produce a Project Development Plan, students are asked to "describe, compare, and contrast the way project development is performed in Government and Private Industry."
- **Requirements Engineering** - instead of being asked to produce a requirements document students are asked to "discuss the nature of requirements, their use in the acquisition life cycle by the government, and"

Universities tend to teach generic principles; employers tend to want company-specific principles taught. The compromise is to teach generic principles in the classroom and set up assignments in which the SIFTEs compare, contrast, comment and reflect on, the generic principles with the company specific ones.

These types of assignment and assessment will be used in the new degree.

IX. SUMMARY

This paper has described a systems approach for optimising the content and delivery of postgraduate education in the context of a proposed new Master of Engineering Management Degree for implementation at the UniSA.

X. CONCLUSIONS

Optimizing the content and delivery of postgraduate education in Engineering Management for Government and Industry is not simple. It is a task that requires a systems or holistic approach and a combination of

⁴ Due to the rapid turnover of content, several of UniSA's information technology and management courses are updated each time they are offered.

- Subject matter expertise in the fields of systems engineering, project and engineering management.
- Proficiency in education and curriculum design;
- An understanding of the capabilities provided by, successful experience of teaching in, and skills pertaining to the two delivery environments.

XI. REFERENCES

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