COST-EFFECTIVE DEVELOPMENT AND DELIVERY OF 100% ONLINE I.T. COURSES

CP Zuluaga, EJS Morris & G Fernandez
School of Computer Science and Information Technology,
RMIT University, AUSTRALIA
{cz, ted, george}@cs.rmit.edu.au

Abstract

The pedagogical effectiveness of internet technology for online education is still not well understood (Hartley, 1996). How is learning maximised when teachers and students are connected only by a learning management system (LMS) while separated by distance, and possibly time? Previously, we argued the focus should be on what students do, rather than what teachers do (Fernandez, 2001; Fernandez, John & Netherwood, 2001). Thus, we coordinate subject material and activities around learning objectives, targeted at achieving clearly identified learning levels and stated learning outcomes.

Here we continue this approach while addressing the cost-effective development and delivery of 100% online courses in Information Technology (IT). Our aim is to maximise flexible learning opportunities for off-campus, distance students, cost-effectively. We utilise a palette of WWW tools to provide subject content, self-test questions, interaction, assignments, and assessment feedback.

This project has produced twenty 100% online IT courses in three years, reaching 6000 off-campus students, world-wide, via freely downloadable WWW browser and associated software (Zuluaga, 2002a). Based on these online courses, a complete Bachelor degree in IT is offered through Open Learning Australia (OLA Handbook, 2002). The first graduates were awarded their degrees in 2001.

Keywords
Online, student-centred, objective-based, cost-effective teaching and learning

Introduction

Due to their presentation and penetration possibilities, online and electronic teaching methods — such as multimedia, CD or WWW-based instruction — have been suggested as most appropriate for online education. However, educators and teachers can be easily captivated by the possibilities of the media, and fall into the trap of concentrating on their presentation and dissemination aspects, rather than on the students reaction to them (Romiszowski, 1986). Since the teacher is mostly absent when learning takes place, remote online teaching and learning implies necessarily changing the emphasis from a teacher-centred to a student-centred approach. The main purpose of teaching ceases to be to transmit information in a clear and organised manner and to manage the instruction process properly (see Level 1 and Level 2 in (Prosser, Trigwell, 1998)), to be mostly concerned with what students have to do to learn, and to enhance as much as possible the (remote) staff-student interactions. The challenge is to engage students in appropriate learning activities that foster question, reflection and analysis, with teachers acting mostly as learning mediators (Laurillard, 1993), designing tasks to induce consideration and inquiry in the students, and supporting their learning process.

One of the main difficulties with student-centred learning is coordination, required to get all the components of the teaching system to assist each other to induce learning. In this way fundamental concepts can be ‘cross taught’, reinforcing the message in different ways to achieve the desired level of

learning. Student activities must be carefully structured and planned, so teaching, learning and assessment are coordinated within an overall aligned instruction strategy (Biggs, 1986; Biggs, 1999). This is particularly relevant in the case of Internet-based distance education, where the interactions between teaching staff and students are reduced to electronic messages, where necessarily there is at least some time lag between request and response.

To be able to present a highly structured framework of learning activities without reducing flexibility, our first step in the online learning strategy is to define the subject objectives, that is, what it is that the students are to learn. We specify the desired outcomes, and we state the level of student learning required of each outcome. We argue that designing the learning experiences to address the stated objectives and making sure that the outcomes are at the centre of the assessment tasks will ensure that students have the best opportunities for learning at the required level. To base learning on what students do, we make sure that their activities and experiences take pre-eminence in the teaching model. The effort should focus on providing an instructional environment with which students can successfully interact to learn, and the tools for teachers and students to be able to control the process (Chalmers, Fuller, 1995).

Online courses structure

Our objectives-based, online learning strategy has been implemented by presenting each of our online courses with 3 levels of content (see Fig. 1), each at a different level of abstraction and detail. We argue that this course structure provides our online course developers with a template that simplifies the development process.

The top level or Contents Layer (Layer 1) lists the course topics using keywords, short phrases and bullet points. This layer contains pointers to the concepts discussed on the lower layers. The Contents can be viewed as a brief or as a detailed index. A brief index lists the classes in the course and their major objectives and topics. A detailed index divides classes and topics into a structured study guide. Each index is a list of HTML links that allows student to navigate through the topics in the next level (Layer 2). The middle level (Layer 2) is divided into classes, each with a set of learning objectives. There are typically two (2) classes per week over a 13-week course. The first class in each week usually introduces new material, as an on-campus lecture would do. A student is assumed to spend between 1 and 2 hours online on their first class each week. The second class usually reinforces the learning with tutorial examples, exercises and references addressing the same objectives. Again, a student is assumed to spend between 1 and 2 hours online on their second class each week. A similar amount of time would also be spent offline working on these class materials. To close the learning cycle, assignments are set every few weeks, on which students are expected to spend 6 or more hours per week working offline.

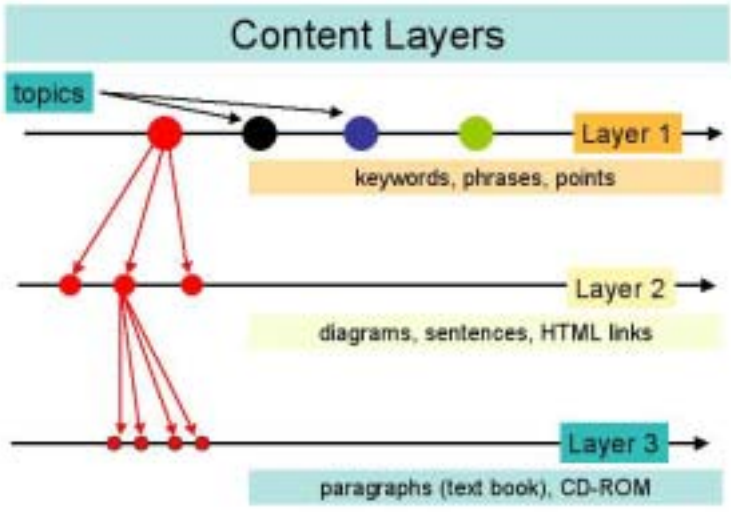

Figure 1: Content layers

The middle layer is comprised of a sequence of small “bites” or “chunks” containing course material text (HTML) and associated diagrams (e.g. gif, jpg, pdf). Each individual bite is designed to take a student 2 to 5 minutes to assimilate. To provide students with context as they study, ideally the previous, current and next bites are all visible on the student’s screen at once.

Each time students login to their course, the default screen shows the current class, based on the calendar date, not the point where the student logged out last time. This provides a guideline reminding students where they should be, rather than where they currently are. Students can progress at their own pace, however, by freely moving to earlier or later classes. Some students progress at up to twice the default rate (4 classes per week). Others may progress at half the default rate (1 class per week).

Frequently the middle layer bites link to items in the bottom level (Layer 3). These items provide supporting material at the highest level of detail, such as text similar to printed lecture notes (doc, ppt, pdf, html, cd-rom). Sometimes this layer also includes video clips, voice overs and animations. To wrap up the cycle, this layer often includes sample answers, additional online resources such as self-test quizzes, and downloadable reference materials (websites) for offline study.

Online courses life cycle

Development phase

The life cycle of our online courses comprises two major stages - development and delivery. The development phase generally converts the on-campus teaching resources into a format appropriate for online learning by breaking down the material into segments (the “bites” or "chunks”) that are appropriate to be delivered online. To exploit the multi-media capabilities of the WWW, generally HTML is used, interspersed with jpeg, pdf, doc, animated gif, wav, flash, etc. The online teaching materials are placed within an online Learning Management System (LMS), such as SERF, CourseInfo (Blackboard), Webmentor or WebCT.

Developing at a lower level than the native format of a LMS reduces conversion costs from one LMS to another. This allows us to deliver courses through multiple channels that support different LMSs. We note that SCORM compliant learning objects could be expected to also facilitate portability, but the main aim is reusability of learning objects through their re-combination. So far, the meta tagging of learning objects is too coarse to readily assist portability across LMSs.

The development phase repeats in the form of upkeep / re-development after one or two delivery periods. To this end, we contract a dedicated online technical / educational expert who consults with academic authors and manages other online developers. This expert is knowledgeable in the specific academic area, and possesses the skills to convert it to online format. This hands-on and management role is frequently contracted out because university academics often do not have sufficient online development skills, nor full-time availability. The contracted position description provides the necessary technical skills, and supports the typically intensive online development process.

Dedicated online developers also meet the university objective that online courses should be developed faster and cheaper than existing on-campus courses. On average, one or two online developers can convert, including proofing and peer review, an existing on-campus course to 100% online for USD13,000 over a period of 2 to 4 weeks. The necessary processes to satisfy quality assurance requirements, can be completed in parallel, and are therefore included in this period. This distinguishes our approach from others that require outsourcing: these generally involve more personnel, highly structured project management, and therefore more bureaucracy and administration. Our experience indicates that academic staff are frustrated by the overheads that distance them from their content and its timely upkeep. Our strategy is to keep the academics closely involved with the development of the online version of their materials, but without requiring them to “get their hands dirty”. As a result, our development approach is less costly and time consuming, without sacrificing quality.

Our approach even allows a bare-bones online course to be developed Just-In-Time (JIT). For instance, the development each week of a properly designed course could be completed one week ahead of delivery to students. Although this is not a recommended academic practice in general, external pressures and constraints sometimes leave no better options. The inherent immediacy and spontaneity can even be an

advantage, which can be capitalised on during a future upkeep / re-development cycle. For example, student feedback from a JIT course development can inform its refinement without losing the original informal expression and vigour. This, for example, occurred with a project based course that was intended to allow students to demonstrate their integration of skills learnt in other courses. Student feedback on the first 2 weeks of the course informed the development of the next few weeks. By student request, the JIT developed course included more links to material from other courses than staff anticipated. Some links were repeated more than staff thought desirable, and in unforeseen combinations. This student-centered JIT development process requires further research to compare the evaluations from a fresh cohort of students who find the course fully developed when they begin it.

Delivery phase

The delivery phase comprises the day-by-day access by students to online teaching materials, and the interaction between staff and students during the learning process (eg. via email, asynchronous and synchronous discussions, etc). Our 100% online courses have no staff-student face-to-face contact at all; teaching and learning materials are online, supplemented by text books or lecture notes. Assignments are submitted online, and feedback on them is via email. Final examinations are also online under the eye of an invigilator who signs a declaration, which staff authorise in advance (Zuluaga, 2002b).

Online courses are created first on a development server, and then delivered on a production server, where uptime and student throughput are paramount. Our experience indicates that an effective flexible online learning environment should be inherently adaptive, and that improvements and enhancements should be readily incorporated. Thus, our approach to online course development and delivery facilitates online course evolution, and we consider minor corrections upkeep to be ongoing, even when the material is on the live production server. In contrast, approaches based on outsourcing or third parties cannot provide this immediacy, since updates to content need to pass along a bureaucratic chain before becoming live. This delays and complicates fixing ambiguities or errors in the material. In the meantime, student queries flow in and require more work to remedy. Our evolutionary approach to development and delivery maximises the flexible learning potential inherent in online course development and delivery.

We do not believe quality assurance is compromised by our evolutionary development / delivery approach. QA is incorporated during development, just as it would be if delivery was completely separate. In our approach QA also informs progressive updates immediately.

Our production servers display a customer service policy (Morris, 2002a) so staff and students know what to expect. A flexible deadline policy allows students to submit assignments late without penalty, provided they recover lost ground before the course ends. This does not devalue the purpose of deadlines, because the final one is non-negotiable. However, this policy does allow students to better manage their studies around events that are not always in their control. Where students still fall behind, they may defer their course at any time without academic or financial penalty. A second deferment in a given course is only granted in extenuating circumstances.

We also support a continuous course delivery cycle, that is, a course starts again every quarter, subject to demand. Students can defer and resume at any time in the delivery cycle. Our experience shows this to be a successful strategy to rescue students that have to defer for any reason, and re-start in a later cycle. Table 1 summarises some of the statistics with respect to deferring students, most being part-timers

Deferring students	In some courses up to 50%	Approximately 50% resume	Close to 75% of resuming students pass
Non deferring students	Pass rate close to 75%	Most results in the top quartile	

Table 1: Some data about deferring students

These statistics contrast sharply with the general distribution of student results in a typical on-campus IT course. Not more than 1% of students defer, but substantial numbers withdraw before the census date, around 3-4 weeks into a course. (Precise figures are only available after the census. In any case, on-campus students often withdraw / enrol in various courses while “shopping-around” until the census.) Once the results of a typical on-campus IT course are finalised, 10-15% often “did not sit”, meaning they

dropped out. Presumably many of these would have deferred if allowed. On average, 20% of students fail each on-campus course. We believe most of these would defer if they could. The same may be true for a number who just pass. We conjecture that the freer deferment available online is more pedagogically sound, in that students either do well, or (ultimately) drop out. Admittedly, international students' visa obligations and other government imposed constraints make freer deferment on-campus difficult. It may be another matter if deferment incurred a fee.

A central plank of our teaching strategy is the provision of continuous, timely feedback. In this way, remote students feel in constant contact with their teaching staff, and the learning is kept cycling over thoughout the duration of the course. The delivery team use WebLearn (Fernandez, 2001), a quizzing software package that provides immediate auto-marked responses, and email to provide feedback to student queries. During local business hours, email turnaround averages 15 minutes. In general terms, email turnaround averages 4 hours, all day, every day. Assignment assessment feedback averages 3 days, often using partially automated computer program assessment. Generally, essays take longer, up to a week. Feedback to students is via individual email, in many instances generated by marking scripts. We believe this level of online delivery service constitutes best practice among our online courses competitors.

These turnaround statistics are achieved in courses with 50 to 300 enrolments. A course instructor is assisted by one (1) tutor per 50 to 100 students. Student email reaches these staff via an email alias, since we have found this to be more effective than individual email for each staff member. It allows students one point of contact. The response will come from the most appropriate staff member, depending on the student query and who is on duty at the time. To ensure consistency and allow responses to be re-used where appropriate, all responses are broadcast to all staff by CC'ing the email alias. In this way, typically instructors answer only new queries, while tutors monitor the instructors' responses and re-use them. Tutors also provide more detailed follow-ups and formulate broadcasts for an online discussion forum. The class discussion forum not only reduces the need for individual emails, but it also provides material for a Frequently Asked Questions (FAQ) bulletin board. FAQs are carried over between delivery cycles whereas discussion forums are emptied at the start of each delivery cycle.

As assignments are submitted online, anti-plagiarism software can be routinely used. Final examinations are also online, under the local supervision of an invigilator. Each invigilator is nominated by their examinee in advance, and authorised by staff, based on their credentials and signed declaration (Zuluaga, 2002b). Our central exam supervisor responds to exam related email within 5-10 minutes. This remote supervisor is also contactable via a mobile phone hotline. Students and / or their invigilators can be contacted at random during an exam. We are confident that all these checks adequately secure our assessment processes, especially when additional technical tools such as cookies allow us to detect unusual IP addresses, internet routes, ISP connections, etc.

Servers

Each of the servers supporting our online courses is an IBM Netfinity 5000, with Pentium 3, 500MHz processor and 256Mb RAM. The production server supports 600 students on average each quarter, 24/7/365. This system has three (3) 4Gb raid discs, one of which is a 'hot spare'. The cost of the total configuration is about USD 5,000. This production server is backed up by two (2) identical servers. One is used for course development, to house courses before they are exported to the production server to be delivered live. The third server is used for development and delivery of special projects, and online corporate courses.

We use the SERF LMS (Hofstetter, 2002) under Windows NT to develop and deliver online materials. Our SERF license is USD 2 per student per course. SERF is written in Java, using a MS SQL back-end database. Apart from regular administrative database maintenance SERF requires little technical support, thanks to an auto-reboot facility when it 'hangs'. (Another computer pings the SERF server and reboots it if there is no response.) We have found that SERF provides an efficient, cost-effective online learning environment that suits distance learning over narrow bandwidth. Some other LMSs for developing and delivering online courses better facilitate high-end production value material like animations and streaming, but reliable and timely delivery of this kind requires wider bandwidth than our average student can access.

Cost –Effectiveness

External constraints significantly limit the expenditure allowed for development and delivery of our online courses. Our School's target is to teach two online students for the price of one on-campus student. The data below assumes this price point. However, we deliver our online courses through several channels to different markets, and our online course fees actually range from the same as for our face-to-face on-campus students (AUD 1100 -1600) to AUD 450 for our online Open Learning Australia students. Nevertheless, the following analysis of the data below (Table 2) suggests we are on target. We compare the costing of a face-to-face (F2F) course with a subsequently developed online version of the same course (Morris, 2002b). The major facts for 250 and then 500 students per course are:

F2F	**Online**	
$1589	$500	average fee per student, 250 students per course
$862-978	$141	total cost per student
$727-611	$359	total profit per student

F2F	**Online**	
$1589	$500	average fee per student, 500 students per course
$688-745	$112	total cost per student
$902-844	$388	total profit per student

Table 2: F2F vs. Online costing

For each student paying (say) $500 per online course, the services provided over the duration of the course include:

- 1 to 1.5 hours email interaction ,
- 1 to 1.5 hours assignment marking,
- 10 minutes exam marking per 1 hour exam (eg. 30 minutes per 3 hour exam)

Since some students require more attention than others, these figures are averages. For a given online course, one student cohort may be less profitable than another. Careful cost management for the duration of each online course is essential to maintain profitability. This is still true where our fee per online course is higher, because the amount of service rises accordingly.

Our online staff submit fortnightly time sheets online. Each sheet is matched against the incoming and outgoing activities recorded in the email traffic through the email alias for the online course in question.

Nevertheless, Table 2 suggests F2F looks far more profitable. However, F2F is not as scalable as online for the following reasons:

Firstly, our figures make the assumption that a permanent academic develops the initial F2F course at the same pay rate as a contracted sessional develops the subsequent online version. The permanent academic could develop 2 or 3 such F2F courses per year. Therefore, in effect s/he is paid one half or one third of their salary per F2F course, not $2000 in total for 3 hours preparation per online lecture. Profit per student drops to the lower figure, as shown above.

Secondly, although our figures include governance, space utilisation and equipment leasing costs, explicit capital expenditure / building costs are excluded. F2F enrolments do not scale up without investing in additional space, infrastructure and equipment. Online enrolments can scale up without additional equipment costs, currently at least to twice the above enrolments per course in our case. An online course could also run 4 times per year. A F2F course could run at most 3 times per year in our case. So the projected increase in profit from 500 on-campus students, compared to 250 on campus students, is quite unrealistic. On the other hand, the relatively fixed profit from 250 or 500 online students suggests it is sustainable while scaleable.

A third consideration is the costing of institutional services and governance. For our F2F courses, the School takes 6% of total income, the Faculty that includes our School takes 5%, and the University takes 21%. Although the rates applicable to online courses are arguable, our figures assume 10%, 0% and 5% respectively. We argue that in order to teach two online students for the price of one on-campus student, the University should expect no more than half the income from an online student (compared to an on-campus student).

In summary, online course enrolments and numbers of courses both scale up more readily than for F2F courses, so the profitability of online courses should ultimately exceed our conservative estimates above.

Conclusion

Near the end of each online course cycle, the students are asked to complete an online course evaluation survey (Zuluaga, Fernandez, 2002). The return rate is typical. The results for questions that are common to all our online courses are remarkably similar. Some of these general questions are also asked in our F2F on-campus courses. The average results for these questions on-campus and online are similar. Indeed, the results of additional surveys, and further analysis, are needed to determine if there are any statistically significant differences. Hence, we find these preliminary results very encouraging.

We believe our model for the development and delivery of 100% online courses is based on sound pedagogy. Utilising narrow bandwidth 'production' oriented courseware, rather than a wider bandwidth 'prototype' and showcase tool set, our team-oriented approach to online course development and delivery is proving to be cost-effective and scalable. Student evaluation feedback vindicates our emphasis on flexible learning principles, quality materials, and an up-front service agreement, including quick 24/7/365 response.

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