Virtual Communication for Lab-based Science Teaching: A Case Study

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This paper is a slightly modified version of a paper presented at the Computer Based Learning in Science, CBLIS'99 conference. It is reprinted here with permission from CBLIS'99.

Introduction

"Effective university teaching is about making learning possible. There can be no excellence without changes in understanding. Changing understanding ... can only be done by shaping experiences for students that encourage them to learn"[14].

In recent years students around the world have been demanding greater input into their tertiary studies, including more involvement in setting learning contracts, a greater say in deciding what assessment tasks are suitable for them and in particular they are demanding greater flexibility in the way they receive their instruction. As academics we, in Australia, are being pushed willingly or unwillingly along new routes to investigate and experiment with course delivery strategies that fulfil our students' expectations. For many of us the new route has been to look at on-line delivery of learning materials, which is neither new nor the panacea for all problems, but it does offer teachers and students a more flexible mode that may suit certain teaching activities but more importantly may suit the learning style and commitments of some students. A mix of face-to-face activities and on-line activities together form the basis of many university courses today. Candy, Crebert and O'Leary[3] suggest that courses which enhance lifelong learning must offer some flexibility in structure and provide for development of self-directed learning. They state that teaching in such courses must make use of open learning delivery mechanisms, where appropriate, and should make use of peer-assisted and self-directed learning. Open Learning is defined by Paine[11] as "a process which focuses on access to educational opportunities and a philosophy which makes learning more client and student centred". This means that not only is access to education made more equitable but also that the experience is more flexible. Fraser and Deane[7] suggest that flexibility in teaching and learning can be provided in a number of ways, which include the resources made available for learning, the interaction between learners, and the support provided for learners. Lewis[9] suggests that changes that would allow a more flexible approach include: improved access to learning resources; provision of flexible student support systems which should include counselling services, bridging, catch-up, remedial and study skills courses; and the development of learning resources and experiences that cater for different learning styles. Lewis[9] also suggests that the educational aim of 'student-centred learning' should also be included under the umbrella of flexible learning with the aim of helping individuals take responsibility for their own learning.

In Australia in the 1990s the modern university student has many commitments that impinge on an otherwise full campus life. It is the norm in Australia for students to travel long distances on a daily basis to the campus, and many live on relatively low incomes and have to undertake paid

employment in parallel with their studies[10]. There is little Government assistance (AusStudy) available for university students and that is slowly being eroded with increases in the cost of living and decreases in the overall assistance available. In the current economic climate, many students have to juggle university commitments with employment, potentially missing some of the structured teaching and learning sessions and, more importantly, not being able to take advantage of campus-based course materials and face-to-face assistance from staff. A small shift away from courses comprising all face-to-face teaching to courses with more flexible access to teachers and learning materials has the potential to help those very students who may otherwise give up when the pressure of time and other commitments seems too difficult to cope with. McInnis et al.[10] found the pressures of part-time work made it extremely difficult for some students to fulfil course expectations. A 1998 survey of first year science students at The University of Sydney showed that 54% of full-time students are undertaking some form of employment, with 31% of all students working 10 hours or more per week during semester, and 14% working over 15 hours per week[13].

Currently student retention and progression is one of the most pressing concerns for higher education in Australia. McInnis et al.[10], in their Australian benchmark survey of the first year experience, found that over one third of students had seriously considered deferring in the first semester. Their survey showed that the causes for students leaving are many and diverse, including change of intentions, uncertainty of future, other commitments, lack of adjustment, academic difficulty, academic boredom, financial difficulty, and isolation. These are compounded for students who are unable, for various reasons, to take full advantage of what is being offered on campus. Annual national Australian surveys of graduates show that nearly half of those graduating for the first time report that feedback was mostly in terms of marks[8]. Opportunities for helpful feedback on student progress are often limited, and are becoming more limited, as the system becomes more strained, with classes becoming larger, and dollars for teaching becoming more scarce. One way to help solve some of these problems is the judicious use of the Web. On-line materials on the Web: allow for the delivery of course materials in both 'book' mode and interactive mode; allow for a means of doing formative and summative assessment; and provide a means of offering asynchronous communication channels for student-student and student-staff interactions. The latter can make a powerful contribution to the student satisfaction equation.

Since the early 1990s, we in First Year Biology at The University of Sydney, along with the rest of the 'innovators'[1]1, have utilised computers in educational settings and this has led to an explosion of material and delivery modes. A discussion of the development and use in First Year Biology of both CAL materials and delivery modes (from stand-alone to Internet-based) can be found in Franklin and Peat[4] and Franklin, Peat, Mackay-Wood and Chambers[6].

Whilst First Year Biology has for 20 years provided a supervised room for students to access teaching and learning resources, it is only since the rapidly increasing use of the Web that these resources have been moved on-line, and mainly in response to a need to keep the resources room 'open' longer. Moving the resources room 'on-line' subsequently led to a new focus on communication, offering both a novel email link from students to staff and a mechanism for student-student interaction. In addition this allows the students a flexibility of use that the supervised resources room could never offer.

The web-based communications now available for over 1300 first year students, along with the virtual resources available, can all be accessed via a user-friendly 'Virtual Resources Room'. These resources are helping to enhance the student experience by providing both an asynchronous communciation mechanism for those unable to visit the staff and flexible learning opportunities that help to train students to be independent learners.

Virtual Resources Room

The Virtual Resources Room (VRR) was a web site accessible to all students from anywhere. A new virtual resource centre has recently replaced and enhanced the VRR, to create a better service for the students and to accommodate more courses. The new address is http://fybio.bio.usyd.edu.au/vle/L1/ResourceCentre/. When students enter the VRR (Figure 1) they see a virtual room with all the conventional resource room facilities. It has typical learning equipment such as desks, computers, blackboards, bookshelves and so on, and contains many of the resources that are available from the 'actual' resources room. It is an ever evolving web site with new materials being linked in as they become available. The students may see a new 'shelf' or other visual aid that will inform them of additional material, along with a flashing announcement as they enter the site, but the look of the VRR stays the same.

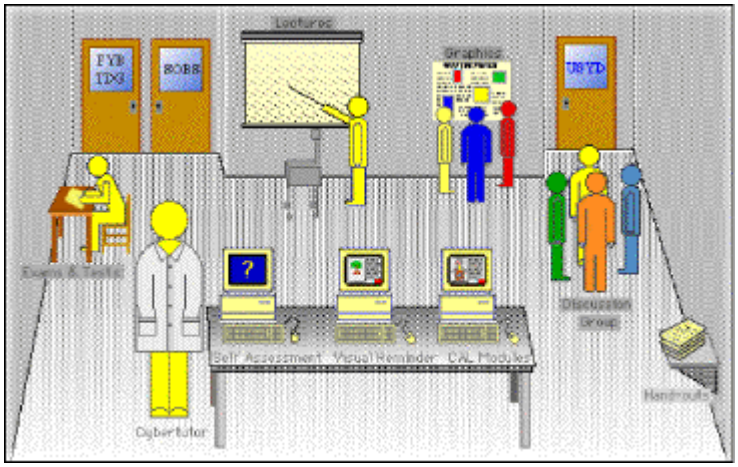

Figure 1. The Virtual Resources Room

The VRR is available to all users, however students must log in with a User ID and Password to access the lecture note resources.

In the actual resources room materials are located and lent to students by the room attendant, much like in a library. In order to mimic this situation the virtual resources room has been provided with a search engine to enable students to locate materials. The provision of this search engine has also allowed students to locate information more quickly than the actual resources room allows. For example students can search for a particular topic within a lecture, within a first year biology course.

Some general perceptions of the VRR from students via email and open ended questionnaire are: "It's an awesome idea";

"This site is very impressive and better than I could have expected";
"It's the best assistance program on the campus"; and
"... can be accessed at any time from home, night or day".

Communication via the Virtual Resources Room

Communication between students and staff has traditionally relied on face-to-face meetings. Electronic asynchronous modes of communication are, of necessity, becoming more popular. The two modes we have introduced so far are an email link to staff and a means for students to talk to one another.

CyberTutor

CyberTutor offers students a means of communicating with staff. Students who have an email account can send messages to staff to ask questions about the course content and organisation. Staff check the CyberTutor email inbox and reply to any questions, usually within a day or two. Students are advised that questions need to be specific and not require long detailed answers. If the question is too broad or will require a long answer they may not get the answer they want or the CyberTutor will recommend they come in for a face-to-face consultation. If CyberTutor cannot answer student questions on the lecture material then the email is sent on to the relevant lecturer with a 'cc' to the student so that they know where their question has gone. The staff remain anonymous in this process, allowing for the involvement of several staff acting as CyberTutor during the course of the semester.

Discussion group

A discussion forum is set up for student use. This encourages students to access each other in real or virtual time, and allows students to post questions or discuss any topic with their peers. Students can either join a topic currently under discussion or start a new topic for discussion. Each topic under discussion, highlighted in blue, is followed by the date and time of the last posting. Students can click on a topic to check out what has been discussed and follow-up with comments of their own. The discussion area is not routinely monitored by First Year Biology staff.

On-line teaching and learning materials

The development of a web site for student use has enabled students to access resources, including copies of traditional paper-based materials, CAL modules, formative 'examinations' and remedial materials linked to the formative examinations, at any time of the day and from anywhere.

Paper-based materials

Course timetables, handouts associated with both the lectures and laboratory sessions, and lecture notes are all available in the VRR. Handouts include electronic versions of all the paper-based materials available in the actual resources room, such as answers to homework and self

test quiz questions, copies of the sample examination papers for the various courses and materials required for assignments. Lecture notes (Figure 2) are posted on the Web after the lecture has been given. The format varies from lecturer to lecturer: some are full transcripts; some are in point form only; and some are interspersed with questions. Lecture notes on the Web are not intended to be used as a substitute for attending the lectures as not all the details or visual aids (slides, transparencies) are included, but they are an adjunct for revision. The lecturers' email addresses are included so the students can contact them directly if they wish. The most frequent, positive perceptions of students, concerning the most useful/worthwhile aspects of the VRR relate to the availability of the lecture notes, allowing them to catch up on missed work.

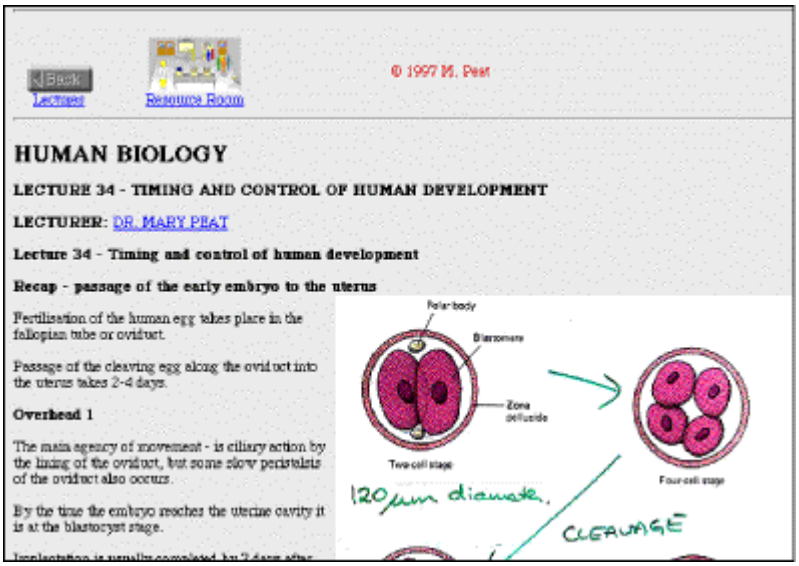

Figure 2. Example of lecture notes available from the Virtual Resources Room

Computer based learning material

Since 1992 three styles of computer based learning modules have been created and evaluated4,6. They are: tutorials, which are designed to be resources for students to use in conjunction with paper-based materials; pre-lab modules, which are introductions to the use of laboratory equipment or procedures allowing students to practise using the equipment on the computer prior to using the laboratory-based equipment; and revision modules, which review practical material (in particular prepared microscope slides) previously seen in the laboratory.

A special form of revision module is called a SAM (Self-Assessment Module) and these SAMs enable students to take a series of formative tests and exercises aimed at helping them monitor their level of understanding of major biological concepts[12].

Formative mid-semester examination

The aim of the formative examination (Figure 3) is to familiarise students with examination format and typical content, give them feedback on their understanding of the course concepts, allow them to take appropriate remedial action if necessary, help them feel less stressed about the

end of course examination, and, hopefully, allow them to achieve at a high level in the final course assessment.

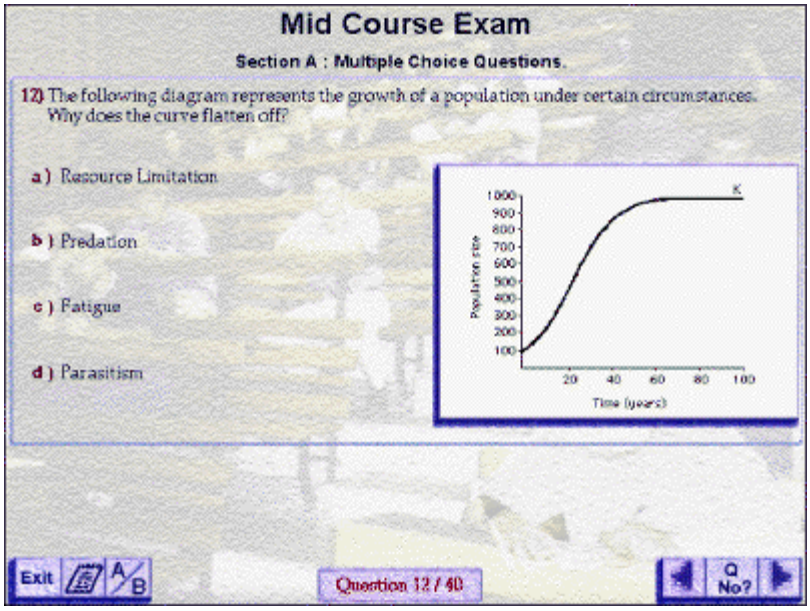

Figure 3. Part of the formative mid-semester examination on the Web

Remedial materials

Students, who believe their performance in the formative mid-semester examination to be less than desired, are encouraged to use web-based remedial materials which are aimed at enhancing understanding of major topic areas covered in the first semester course. The remedial materials comprise: a tutorial; a glossary of terms used for the particular section of the course; and questions (with hints and answers provided). These remedial materials do not cover all the material in the course but have been selected to include the topics considered by staff to be amongst those that students find the most difficult. They can be used by any student but they have been designed specifically for those in greatest need.

Student perceptions of the formative mid-semester examination and remedial materials were generally positive but a number of students experienced difficulties in making the materials run on their computers. In order to run the mid-semester examination it is necessary to download the *Shockwave* browser plug-in which is available free from the Web. This issue was resolved by placing instructions on the VRR on how to download the *Shockwave* browser plug-in.

Student usage and perceptions

The effectiveness of the VRR and the materials available within it has been investigated using survey instruments, focus groups and on-line feedback forms. From the formal surveys over 70% of students (n=240) indicated they had used the VRR and 77% of those students rated it as 'good' to 'very good' for their learning. Of the students who visited the VRR, 6% used the email facility to communicate with staff, 12% used the discussion group to communicate with their colleagues,

47% used the self-assessment modules and 86% used the lecture notes. Students who visited the lecture notes used them for a variety of purposes including reading them only; printing them out; and for catching up on missed materials.

Students are required to mark the formative mid-course examination themselves from either paper-based resources or web-based resources. In 1998 37% of students used the web-based materials, and 34% of students used the web-based remedial tutorial materials to help increase their understanding.

Students also sent unsolicited comments by email on their perceptions of the Virtual Resources Room such as:
"Biology web site extremely useful and well organised";
"You have done an absolutely fantastic job ... I appreciate it very much and so no doubt do many other 'silent' students";
"Overall this message is mainly to compliment the staff on an excellent set of resources and to encourage you to continue developing them";
"In response to the idea for putting the CAL modules on-line. I think it's a wonderful idea. I can't express how great I think that idea is ..."; and
"Just a note to say thanks. FYB definitely makes more (use) of the on-line resources than most other subjects".

The positive responses and free-form comments from students indicate that we are making a strategic contribution towards their learning. In time the 'newness' of our intervention may reduce the eagerness of their responses but we will still have addressed an access and equity issue.

Discussion

University teaching and student learning are moving through transition processes, driven by many factors including changing student requirements and economic forces. In First Year Biology we have tried to encourage students to develop collaborative learning strategies and we have offered a more flexible delivery for some of our materials, such that our students can choose when they want to be engaged in these activities. To this end we have introduced strategies for setting up learning communities in large classes which include creating small peer working groups; group laboratory experiments, field work and poster presentation; specially designed card and board games; and computer-aided learning materials designed for use in peer groups[5]. It is clear from the student response to surveys that we are using the technology as an adjunct to their learning process, allowing them to learn in a way that suits their lifestyle and which we hope will enhance opportunities for participation in higher education. Moving part of the total course materials to the Web stimulated us to design web-based communication capabilities, as an adjunct to face-to-face contact with students. It is felt that some students may feel more comfortable communicating electronically with staff while others may never use the facility.

In First Year Biology we aim to mix virtual learning on the Internet with real life, face-to-face learning in practicals and lectures, but with an emphasis on accessing virtual learning resources.

Using the Web for the delivery of teaching and learning materials has already led to an increase in flexibility for students using the materials. Students now have greater access to the materials than previously as our on-line facility is open 168 hours a week. Depending on their preference, students can now access all our teaching and learning resources either in person by visiting the actual resources room or electronically via the Virtual Resources Room. Thus students without Internet access are not disadvantaged. In time the traditional three lectures a week and three hours of laboratory work will diffuse into a mix of these styles with small group activities and independent activities associated with computer-aided materials, with a greater emphasis on student autonomy within the learning process.

Moving the materials onto the Web is in line with The University of Sydney, Faculty of Science policy on equity of access and availability of teaching materials. Access has been greatly enhanced by the opening of student computer laboratories (one with 24 hour a day access) across the University campus. This has enabled students without home-based computers, who previously may have been disadvantaged, to have 24 hour access to the Web. In 1998, a survey of first year biology students at The University of Sydney showed that 89% of students have computers at home, but only 54% of students with computers at home are linked to the Internet. However, 62% of those students without the Internet at home use networked computers provided on campus to access the Virtual Resources Room. Another 10% of students access the Internet in the resources room. It is assumed that the number of students with Internet access at home will increase each year. Australian Bureau of Statistics[2] data show that the number of Australians with the Internet at home has quadrupled in the past two years. These data show that 250,000 homes were connected to the Internet in 1996, with this number increasing at a steady rate to 1.038 million in 1998. It is assumed that this will be reflected in increasing numbers of first year biology students with Internet access at home.

Presenting materials in this non-confrontational, user-friendly way offers students the benefits of different learning modes, depending on their preferences. They can test themselves using self-assessment packages; they can read lectures they may have missed; and if they want to interact with other students or staff, they can use the discussion group or CyberTutor. All of these activities puts the onus on the students to take responsibility for their own learning, but in a way which caters for all learning styles. The students have indicated their appreciation of our efforts and have, through the use of CyberTutor, given us many ideas for further improvements. Thus we are moving towards a closer partnership with our students in these endeavours.

"To produce graduates equipped for the workplace, it is essential that educators teach in ways that encourage the learner to engage in deep or meaningful learning, which may be built on in the later years of their course, and also be transferred to the workplace."[7]

In the next few years we will need to develop a more powerful measure, or sets of measures, to evaluate the strengths and weaknesses of both the mix of on-line and face-to-face teaching experiences. The next few years will show us the ways in which students will want to learn and communicate with staff and with other students and we need to be flexible in accommodating their preferred learning strategies.

Acknowledgements

The author would like to thank Sue Franklin for being committed to improving student learning; Rob Mackay-Wood for his continued enthusiastic programming of the student materials; and Professor Robert G. Hewitt who, as Dean of Science 1988-1999, has been pivotal in the support of teaching development within the Faculty of Science at The University of Sydney.

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