PROVISION OF ONLINE MATERIALS TO SUPPORT STUDENT LEARNING: HAVE WE FOUND THE RIGHT MIX?

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ABSTRACT
The teaching of science subjects to very large numbers of first year students (up to 1800) is a characteristic of the larger Australian universities. During the last decade, to improve the learning environment in first year biology at the University of Sydney, we have moved from teacher-centred instruction to student-centred learning. To support our students we have developed and implemented a number of strategies to help them to enhance their learning outcomes. Since establishing a Virtual Resources Room, which was reported at CBLIS'99 (Peat, 1999), we have since developed a Virtual Learning Environment that incorporates learning and self-assessment resources and extensive communication opportunities (Peat, 2000a; Franklin and Peat, 2001). Over the last decade the evolution of the resources and the delivery mechanism have been subjected to rigorous iterative development cycles and more recently the resources have been investigated to determine whether they are still supporting student learning. This paper will report on several recent research projects and suggest broad guidelines as to how online materials can be used to support learning.

KEYWORDS
Online learning; offline learning

INTRODUCTION

In the Australian context, recent longitudinal studies are indicating that current students may need more support than their predecessors due in part to the increasing heterogeneity of the student cohort (McInnis, James and McNaught. 1995; McInnis, James and Hartley, 2000). In the scientific academic community, especially when we are faced with increasing student numbers and reduced staffing resources, many of us have been struggling to provide alternative learning experiences to support students. Over the last decade many of us have turned to the use of the computer to help us bridge the gap between acceptable and unacceptable (but all we can afford) provision of support. As teachers many of us have introduced new and varied offline and online materials to support student learning, knowing that the educational research literature indicates that students who make use of every learning opportunity have better learning outcomes (e.g. De Vita, 2002; Heffler, 2001). Online materials also have the capacity to enhance the learning experience due to their inherent flexibility of anywhere/any time access for students. Much of these materials have targeted the provision of assessment opportunities that allow for relevant feedback. In particular, the provision of feedback on continuous assessment activities is acknowledged as a motivator of student learning (Clariana, 1993; Macdonald, Mason and Heap, 1999; Zakrzewski and Bull, 1999). However feedback needs to be provided early in the learning process to be effective (Brown and Knight, 1994) and have some degree of prescription about how to improve performance (William and Black, 1996). Computer-based assessment is one of the key elements used in the sciences for both formative activities and summative purposes, helping to provide immediate feedback to students while reducing load on over-stretched staff (Bull, 1993; Lyell and MacNamara, 2000). A number of products are currently available for the delivery of computer-based assessment, either as stand alone packages (e.g. QuestionMark, WebMCQ) or as part of a web management tool (e.g. WebCT, Blackboard).

The teaching of science subjects to very large numbers of first year students is a characteristic of the on-campus learning environment at the larger Australian universities. For almost a decade at The University of Sydney we have been providing large groups of up to 1300 first year, undergraduate biology students with computer-based resources to support them in their learning. In 1996 we moved these resources online (Peat, 1999) to provide students with the flexibility to work with them any time/any place. This accommodates the requirements of many of our students who, although enrolled as full-time on-campus students, are increasingly in paid employment and thus have limited time to attend classes (Peat and Franklin, 2002b). Since 2000, the materials have been presented via a virtual learning environment that allows easy access for students to all available learning resources (http://FYBio.bio.usyd.edu.au/VLE/L1/) and this is described elsewhere (Peat, 2000a). Our online resources include tutorial modules to help support learning and understanding, self-assessment modules to enable students to test themselves and gain a perspective on their own learning requirements, lecture notes, links to useful web sites, and links to in-house help desks (academic, administrative and technical).

In 1999 we indicated (Peat, 1999) that we would develop more powerful measures of the strengths and weaknesses of the mix of online and face-to-face teaching experiences. In answering the question "Have we found the right mix?", this paper discusses several of our recent research projects that have explored the use of our resources and student perceptions of their usefulness in supporting learning. We will report on a holistic study which looked at student use of a range of resources, both online and offline, and how students perceive they support their learning (Peat, Franklin, Lewis and Sims, 2002); and show how the use of online and offline assessment affected student learning outcomes (Peat and Franklin, 2002b). Whilst each of these research projects has been documented individually elsewhere, this paper will review our position and suggest some broad guidelines for ways in which online materials can be used to support student learning in large first year science classes.

The purpose of this paper is to provide a reflective and analytical assessment of a broad range of learning resources, some of which are integrated through web-based technology, provided for our first year biology students. There are three important factors that have influenced taking this approach. First, the students in first year biology form a heterogeneous group with varying interests and backgrounds in the discipline as well as constituting a large cohort of learners at different stages in their own cognitive development. Second, the online modules used within our nine first year biology courses have been demonstrated as effective (Peat, 1999; Peat, Franklin and Mackay-Wood, 1997), having been developed over a number of years with ongoing formative evaluation enabling each resource to be enhanced as it was developed and integrated into the curriculum. Third, the research agenda within instructional design has moved on from comparing resources to making them work better (Reeves, 1993).

RECENT STUDIES

Over the last three years, we have continued to develop additional resources accessed via our virtual learning environment, but our focus has been on investigating how students use these materials and how useful they find them. For us the "big" questions are: "Do online materials enhance students' learning outcomes?"; and "Have we found the right mix of online and offline resources?" Several projects have now been completed on the use and usefulness of online and offline learning resources, including some longitudinal studies on online learning and the use of assessment resources (formative and summative; online and offline), and students' perceptions of the usefulness of these resources to their learning. It is of concern that our data indicate that 15-20% of our first year biology students are choosing not to use online resources (Peat, *et al.,* 2002), and of these students a significant proportion are performing badly (unpublished).

The research model that we have adopted for our various studies is based on the arguments of Reeves (1993) and Alexander and Hedberg (1994) which have led to a model involving a mixed approach to

data production and analysis, with both quantitative and qualitative information obtained in the process. This model is described as the Eclectic Mixed Methods Pragmatic Paradigm (Phillips, Bain, McNaught, Rice and Tripp, 2001) and is considered more capable of handling the complexity of modern society and technology with a focus on practical problems rather than on issues. Quantitative and qualitative data were collected using surveys and structured focus group interviews. Many questions were asked using Likert response formats (strongly agree, agree, undecided, disagree and strongly disagree) and these responses were computed into Likert means. Survey questions using open-ended response format enabled students to indicate their own perceptions and these were thematically analysed and categorised, as suggested by Denzin and Lincoln (1994). For some of the data collection student success was measured by final mark, and these studies complied with the University of Sydney's Ethics Committee Guidelines for research with humans.

Note on computer and Internet access at home. In Australia today approximately 33% of households (an increase since 1999) have an Internet connection. An estimated 6.5 million people accessed the Internet in 2000, which included 75% of 18-24 year olds (Australian Bureau of Statistics, 2002). At the University of Sydney 100% of biology students have access to a computer, 84% of them have access to the Internet from home and 100% access to the Internet from the University Student Computer Access Centres (Peat, *et al.*, 2002). In comparison, in the UK 40% of households have Internet access (but with signs of this percentage beginning to decline) (ZDNet UK, 2002).

Use of online versus offline resources

Data gathered so far indicate that 5-25% of first year biology students do not use *all* online and offline resources (Peat, *et al.*, 2002; and unpublished). There is some evidence from these data that indicate students who fail the course may be less likely to have used the resources compared to students who pass the course.

Use and usefulness of online communication

Since providing students with a virtual learning environment we have monitored and evaluated its use by students with respect to communications - both chat discussion groups and email were provided. In our study on the use and perceived usefulness of web-based communication resources, students did not initially consider chat groups to be a resource that they would use to support learning (only 16%did) and even fewer (5%) used chat groups during the semester to support their learning (Table 1). This supports the large, Australia-wide study by McInnis *et al.,* (2000) who report that first year science students infrequently use online discussion groups.

Table 1 reports on expectations of use of email and actual use to support learning in this course, by asking students at the beginning and at the end of the course. In contrast to chat groups, email, as a form of asynchronous communication, was considered to be a more useful resource to support learning. At the commencement of the course 59% of students expected to use email at least weekly (22% initially expected to be in daily email contact) in order to participate in and successfully complete the course (Table 1). In actual fact only 29% actually used email weekly, with 5% actually using email daily. This is similar to the data in the McInnis *et al.* (2000) study which found that only 20% of first year students had used electronic access to tutoring support. Of our students who did use email, 57% found it useful/extremely useful in supporting their learning, which means that only about 10% of our entire cohort found email useful in supporting student learning (Table 1).

Table 1. Student use of and perceptions of the usefulness of communication technologies in support of their learning

		Expectation	**Actual**	
Access to email	- Never/rarely - Weekly - Daily	41% 37% 22%	71% 24% 5%	
			Use	**Did not use**
Use of email to support learning		41%	22%	78%
Usefulness of email in supporting learning – Not useful – Useful – Extremely useful		 41% 48% 11%	 43% 47% 10%	
Use of chat groups to support learning		16%	5%	95%

Whilst we know most students (97%) use email for social communication (Peat, *et al.*, 2002), neither lack of access not lack of IT/computer competence can be considered as reasons for the relatively low level of use of email to support learning in the course. Use was further investigated within focus group discussions where students indicated that they appreciated and expected course information to be sent to them via email but that they would rather talk face-to-face with staff as this gives immediate feedback and allows for follow-up questions.

The student expectation for using email to support their learning was much higher than the reality of using it and this needs to be viewed in the light of the other stakeholders' perceptions, in particular the teachers' perceptions. Nearly half the teaching staff (45%) considered that students should be accessing/using email on a weekly basis to help support learning in the course. It may be that as teachers we have unrealistic expectations and that there is a mismatch between what we expect as providers and how the students perceive the provisions. It may be that the students, whilst expecting to use the technology, find they do not like using it, do not know how to use it to support learning or that they do not see the purpose in using it for course-related matters. Students need a purpose for using a resource and this needs to be made clearer to them.

Use and usefulness of computer based online tutorials

From a study that looked at how all available online and offline learning resources provided to our first year biology students were used, we can identify student use and perceived usefulness of computer-based online tutorials (Peat, *et al.*, 2002). Students were asked questions at the beginning of the course, about what they thought might be their anticipated use of computer-based online tutorials, and at the end of the course about their actual use and their perceptions of usefulness of the online tutorial resources. Table 2 shows student use of computer-based online tutorials (CBT) and the perceptions of those student who used them of their usefulness to learning.

Table 2. Student use of and perceptions of usefulness of computer-based online tutorials (CBT)

		Expectation	Actual use at end of course	
			Use	Did not use
Use of CBT to support learning		73%	75%	25%
Usefulness of CBT in supporting learning	▪ Not useful ▪ Useful ▪ Extremely useful	9% 60% 31%	9% 53% 38%	

At the start of the course 73% of students expected to use computer-based online tutorial resources to support their learning in biology, and students had a high (91%) expectation that they would be useful or

extremely useful. Actual use of computer-based online tutorials provided was high (75%) and those students who used them found them useful in supporting their learning in biology (Peat, *et al.*, 2002). However, it should be noted that 25% of our students did not use these materials to support their learning, and this similar to the data for use/non-use of online materials from Oliver and Omari's (2001) study. For our cohort 25% in fact represents a large number of students (325) who did not use the online tutorials.

Use and usefulness of online and offline assessment

We consider that it is important within our large first year biology group that the students are able to measure their own level of knowledge and understanding. This has led us to develop a mix of online and offline (paper-based) assessment activities that are designed to enhance student learning. These activities include both formative and summative items, some with the provision of extensive feedback. The online assessment materials and the students' perceptions of their usefulness in student learning have previously been described in Peat and Franklin (2002a).

We are interested in how our students have used the mix of assessment opportunities we have provided and whether they have helped them in their learning. This is of concern to us as some of our data (currently unpublished) indicate that some students are not using the learning resources (both offline and online) and that non-use of resources may be linked to poor learning outcomes as measured by final grade in course. Previously we have reported (Table 2) that 25% of our first year biology students are choosing not to use online resources (Peat, *et al.*, 2002), which may be an issue as some of our formative assessment items are online.

The use and perceived usefulness of summative and formative assessment items during a first semester course was investigated. The formative assessment activities include weekly self-test quizzes, marking a mid-course practice exam from web-based materials (taking it was "compulsory") and using self-assessment modules designed to help students identify their level of cognitive achievement. Here we are reporting on whether the use of formative assessment activities have made a contribution towards final grades. Interestingly the usage of the formative assessment materials showed an 80/20 split similar to that for the use/non-use of the computer-based online tutorials (Table 2). Again those students who used the materials reported them to be very useful to their learning. Asked to indicate for what purpose they used the formative assessment items, students mainly suggested that they were used for revision and consolidating new knowledge rather than learning new knowledge (Figure 1).

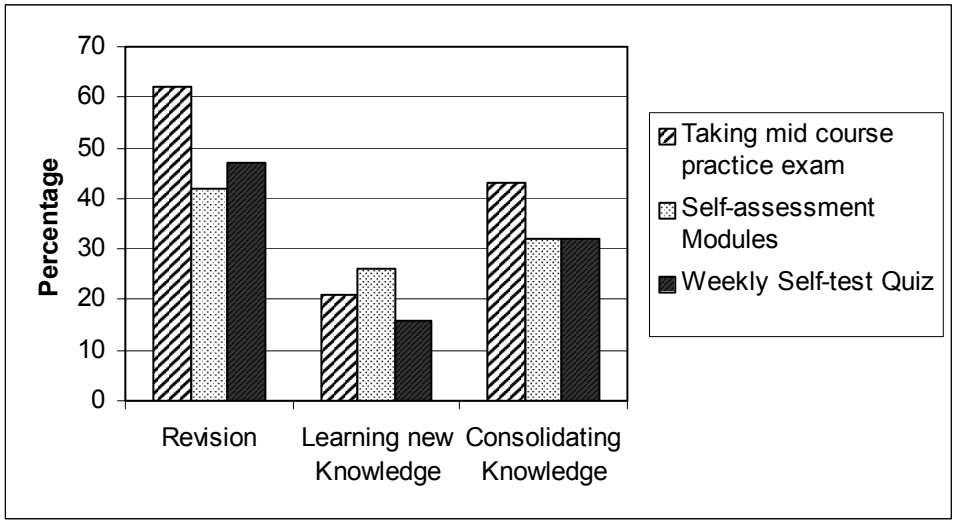

Figure 1. Reported reasons for using formative assessment resources

Open-ended questions investigated students' perceptions on the usefulness of the formative assessment resources, and the responses were thematically categorised. Students reported that marking the practice

examination made them aware of their own understanding (54% of responses for the resource) and gave them insights into the structure of the final examination (27%). Using the self-assessment modules allowed for revision (30%) and for consolidating/enhancing understanding (28%). The weekly self-test quiz was seen to be useful for both consolidating/enhancing understanding (41%) and revision (32%). These data, collected from open-ended questioning, support the information presented in Figure 1.

From the data it would appear that the students are finding the formative assessment resources useful for revision and consolidating knowledge/enhancing understanding. *"But are they helping them do better?"* To answer this question we looked at any relationship between student use and perceptions of usefulness of the various resources and final performance.

Pearson's correlation (reported elsewhere, Peat and Franklin, 2002a) showed that whilst there is a relationship between final course mark and university entry score (normally expected in Australia with large first year science cohorts), there is no significant correlation between the final mark and student use of either our summative or formative assessment resources. This was further investigated by clustering student performance into three groups – excelling students (credit or above), passing students (pass scores) and failing students (below pass scores) and relating these groups to their use of resources. Interestingly a greater proportion of the students who failed the course had taken advantage of the formative assessment resources - more than the students who passed (Figure 2).

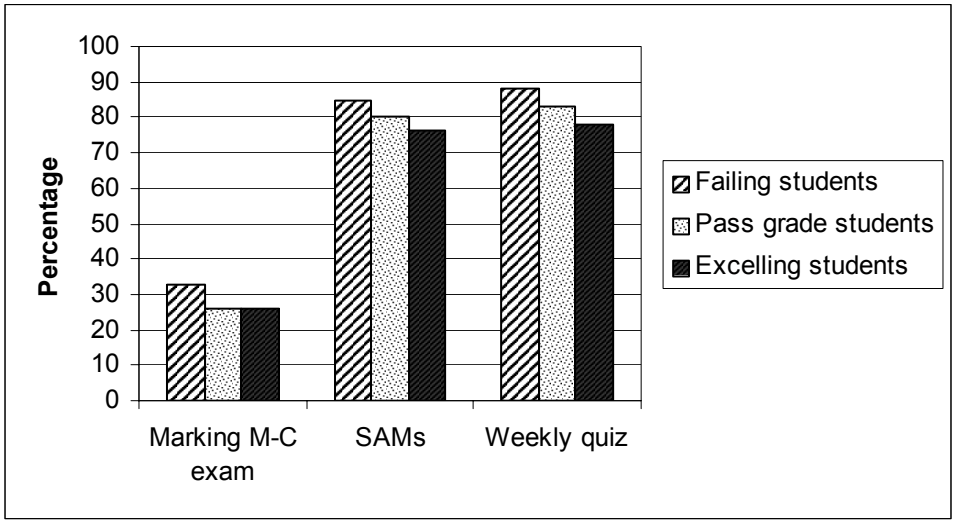

Figure 2: Relationship of use of resources to learning outcome

Table 3 summarises student use/non-use of formative assessment resources relative to final outcome (ie grade in course). The results suggest that using the formative assessment resources and finding them useful is not a predictor of learning outcomes for any of the students in the three performance groups.

Table 3. Use and non-use of formative assessment resources – effect on final mark

	Mean mark and range (%)		
	Failing students	**Pass grade students**	**Excelling students**
Used resource	**45** (23-49)	**58** (50-64)	**74** (65-91)
Not used resource	**44** (37-49)	**58** (50-64)	**73** (65-87)

As we are currently providing a variety of assessment resources, with what we believe to be relevant feedback, we are concerned that these resources are not having the desired impact on student learning.

Thus the worrying aspect of our results is that, although the poorer students are trying very hard and more of them (compared with the more successful students) are using the formative assessment resources provided, these resources do not appear to be helping them. This is in contrast to some of the current literature in which the use of formative tests before summative examinations has been shown to increase the final grade of students (Buchanan, 2000; Zakrzewski and Bull, 1999). We, as teachers, need to demonstrate to our students how to use our resources to their advantage, and for this some degree of prescription might be useful as suggested by William and Black (1996). In addition, especially for students who are in transition from secondary school to university, we need to consider if our feedback is early enough to be effective as suggested by Brown and Knight (1994). Perhaps to do these we may need to review how we introduce our resources to students as well as how we provide feedback and whether it is good enough.

EDUCATIONAL IMPLICATIONS

Our investigations over the last three years have helped to paint a broad profile of our students' use of both online and offline resources, and whether these resources are helping them in their learning. From those students who use the online learning resources we are receiving a consistent message that these resources are perceived to be of value and of help in student learning. Students appreciate the development of supplementary resources that may help them sort and process both content and understanding. They value having a range of assessment items to work with, both online and offline. In contrast the majority appear to use electronic communications primarily for social activities rather than to enhance their learning, however they like to receive online course information (in a one-way mode). However, we currently have no evidence that any of these facilities and resources have made any significant effect on learning outcomes. We need to continually ask ourselves how we can help students to gain greater value from using our offline and online resources. We are continuing to investigate use, perceived usefulness and performance effect of these resources. We can provide the technology but we need to be careful that we match the mix of technology with non-technology based resources to suit the needs of students.

Our experience tells us that we must consider the following when introducing/using online resources to support students in their learning:

- not all students will use online resources for a variety of reasons;
- students may need better instruction in how to get the greatest benefit from online resources; and
- we need to continue to provide a variety of assessment resources – online, offline, formative and summative with as much timely feedback as possible.

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