Planning And Developing A Problem-Based Learning Environment For Large On-Campus Classes Using The WWW

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This paper reports on the development and implementation of a Web-based learning environment that was designed and developed to support a problem-based learning setting for a university course. In particular the system was designed to support learning with a large on-campus cohort of approximately 250 students and was intended to provide a means to replace a conventional lecture setting with a student-centred learning environment. The paper reports the design and development of a system and describes its use in the on-campus setting. Feedback from an initial implementation is provided and a discussion is given of the ways in which teachers wishing to adopt a similar form of Web-based teaching could set about achieving this.

Keywords: **World Wide Web, collaborative learning, problem-based learning, instructional design, higher education, student-centred learning**

1 Introduction

Many writers have sought to describe ways in which the World Wide Web can be used to support teaching and learning. There are now many guidelines and strategies which have been produced to suggest to teachers ways to create effective Web-based learning environments (eg. [3]). Increasingly educators are looking to learning technologies as a possible solution to the problems associated with delivering quality programs efficiently to large numbers of students [5] . However in the process of adopting technologies, educators have often not looked to fully exploit their potential and most learning technologies in the past have been directed towards the presentation of content rather than the answering of questions or the opportunity for discussion and reflection.

Many writers are now providing ideas and strategies to guide and support learning in universities. It has been suggested that the massification of higher education has increased the need to support individual learners through learning dialogues [10]. Laurillard describes teaching as mediating learning and suggests the importance of a

conversational framework in media-supported learning which provides for discursive, adaptive, interactive and reflective forms of communication in academic dialogues [9]. The WWW and on-line applications offer considerable prospect for the support of these forms of communication and it is this use of technology which forms the focus of this paper.

The instructional design guidelines which we have developed at Edith Cowan University, focus on a view of teaching and learning as comprised of 3 critical elements, the ***content*** to be learned, the student ***activity*** necessary to engage the learners in the learning process and learning ***support***s, the way in which teachers provide support for the learners and their learning. Our previous research has confirmed our views that instructional design for higher education is facilitated by consideration of these 3 elements and that higher order learning is possible when the learning environment is crafted with these in mind (eg. [6]).

In developing Web-based learning environments, there has been a tendency in the past for teachers to let the technology determine and influence the instructional design rather than the intended outcomes. For example, many WBL environments are focused primarily on content which is presented in HTML form and the extent of the instructional design has been the development of electronic forms of conventional teaching materials. Similarly many instructors have found the communicative components of the Web to be attractive to them and have included mainly activities which require learners to communicate in various ways as part of the learning environment. In many instances, Web-based materials are developed for independent student learning and as such contain few forms of instructor support. In all these instances, there can be a tendency on the part of instructors to merely apply Web features in their learning rather than to selectively choose and adapt these Web features to learning activities of their own choosing.

This paper describes the development an implementation of a Web-based learning environment that consciously and intentionally sought to use all 3 constitutuent elements to support student learning in a freshman course of study.

2 Designing the learning setting

The unit in which the students were enrolled was entitled Introduction to Multimedia. It is a unit that aims to provide students with a basic form of information literacy and one which seeks to develop not only students' knowledge of this subject but their abilities to further develop their skills and knowledge after the course has finished.

There were several challenges to designing a learning environment for this course. Since the course aims to develop information literate students who can continue to learn beyond the course, it was decided that the environment needed to involve a student-centred mode of instruction. Our previous research indicated that developing a learning environment based on authentic and relevant learning activities would be a useful strategy if we wanted students to be able to make sense of the available information and to apply it to their own needs ([11]). At the same time, we had to remember that the unit typically enrolled 250 students in an on-campus mode of study involving at least 6 tutors as well as the Course Coordinator and Lecturer. We needed to design a course which could comfortably be coordinated and driven by a single person yet effectively include

the involvement and participation of other tutors with a variety of approaches and views to teaching and learning.

In the past the course had been based around a one hour mass lecture followed by a 2 hour workshop for groups of up to 20 learners. In planning this Web-based course, it was our intention to preclude the need for a mass lecture as a form of information dissemination and transmission. We planned to use the mass-lecture as a forum where the students could discuss and debate aspects of the content for each week. To do this we needed to create learning activities which required the students to prepare for this weekly meeting, to seek information and to read and consider the planned content in meaningful ways.

The approach we chose to adopt included a problem-based format, an approach which would require students having to interact with the course content in response to a weekly problem. We planned the course so that each week, students would work in small collaborative groups to find a solution to a given problem. The problems needed to be designed in a fashion that gave meaning and purpose to the weekly content and reflected in some way how the learners might use this information in a real-life setting. The intention was to contextualise the information in a way that made the learners see the content as a *means to an end* rather than an end in itself.

Problem-based learning is a curriculum approach which helps the learner frame experience as a series of problems to be solved and where the process of learning unfolds through the application of knowledge and skills to the solution of real world problems, often in the contexts of real practice (eg. [2]). It is a form of situated learning, learning through goal-directed activity situated in circumstances which are authentic in terms of the intended application of the learnt knowledge. Situated learning is based on the premise that the nature of the situation and the circumstances in which knowledge is learned are both influential in determining the likely prospect of subsequent redeployment to other situations and settings ([4]).

Situated learning draws on the relationship between construction of knowledge and the circumstances of its acquisition and integrates constructivist and socio-cultural perspectives of learning. Such thinking is drawn from cognitive learning theory which sees learning not so much as a function of behavioural responses but more as a function of what learners know and how they acquired that knowledge. Contemporary learning theories such as constructivism and socio-cultural theory present a view which highlight the social and cultural influences in knowledge acquisition and learning (eg. [1]).

A common problem with much of the instructional design associated with traditional university teaching has been the decontextualising of knowledge and learning. Jonassen argues that “the most effective learning contexts are those which are problem- or case-based and activity oriented, that immerse the learner in the situation requiring him or her to acquire skills or knowledge in order to solve the problem or manipulate the solution” ([8], p. 36). Problem-based learning and the use of authentic tasks have become an alternative to more content-oriented approaches to education. Problem-based learning builds on experiences and empirical findings that students learn more from a problem-oriented task than from a fact-oriented one. At the same time problem-based learning environments are frequently reported to increase student motivation, to develop their critical thinking skills and deepen their understanding of significant content [12].

The Web provides an ideal setting for this form of learning environment. It provides a means to create the collaborative learning space required to support the small group work, it provides a source of information to support the problem solving processes and provides a way for the whole project to be managed through a computerised management process. As well as providing these essential elements, the Web also delivers a number of other useful features including a means for students to work from home and to collaborate without meeting face to face. The Web was an obvious choice of technology for this setting.

3 The problem-based learning environment

The format we chose for our problem-based learning environment was to base each week's work on a problem solving activity. Students in the course are arranged into Workshops of about 20 students. In this course, there are usually about 12 such groups. Within each Workshop, students would be formed into smaller Groups of 4 or 5 for the problem-based activity. Each of these small groups would be required to develop a solution to the weekly problem, an activity that necessitated them to explore the topic, locate relevant information and resources, consider the various options and outcomes and to create a response which was informed and well argued. The solution was then to be posted to a bulletin board and accessible to other students in that Workshop. We decided that each solution would be assessed by both the tutor and other groups in the Workshop, an activity that would require students to read the solutions of about 4 other Groups and to consider the arguments and information presented. From one week to the next, a record would be kept of the marks received by each group for their problem solution and at the end of the course, this cumulative mark would be used in the students' assessment.

The following images show the main features of the learning environment which we developed according to this specification. The screens provide examples of the electronic environment developed for the course and the forms of interaction supported in a typical week for both students and their teachers.

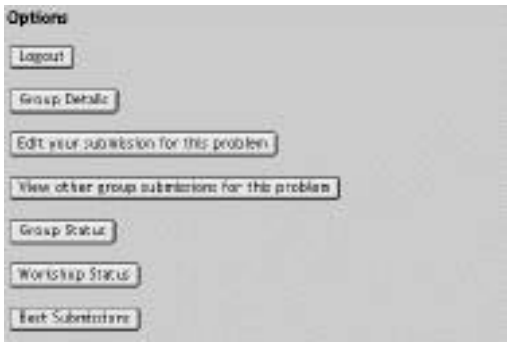

Figure 1. The Student Menu
The menu provides students with access to the various components of the learning system.

1. The weekly problem is given in the on-line course notes along with a number of initial references and information sources, both on-line and in print. Students are expected to read the various sources and consider an appropriate solution. The students can then meet together to plan their problem solving strategies, many however prefer to use email for this purpose. The Web problem-based learning environment is controlled by a menu system which is password protected and provides closed access to students within the various Workshops to the system features (Figure 1).

2. The students work together to solve the problem, some collecting information, others analysing the problem setting and considering the options. A solution is developed with a word limit of 250 words. The students pass this between themselves to polish and refine it. At the end of the week, the solution is posted (Figure 2.).

Figure 2. The Problem
The solution to the problem is submitted using a simple form.

3. Once the solution has been posted, the members of a Group can then see the solutions posted by others in their Workshop. Students are required to read the solutions of others and to choose the best solutions from the other Groups (figure 3.).

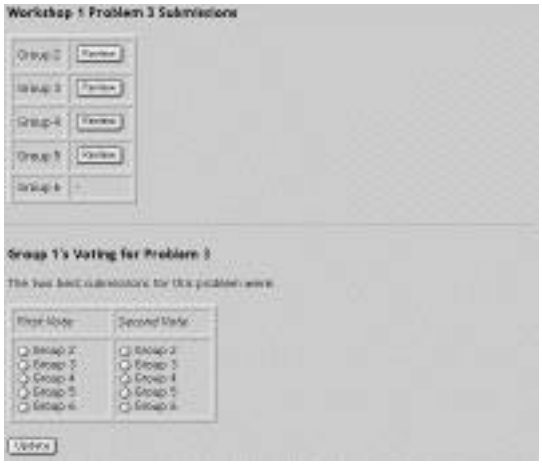

Figure 3. Reviewing and Assessing solutions of other students.
Students are required to review and assess the solutions of other students in their groups.

The learning system offers a simple voting mechanism, the results of which are uploaded into the system database. In each Workshop, the Group which receives the most votes achieves a score of 5, the second Group receives 4 and all other Groups which have submitted a solution receive 3 marks. The tutors of each Workshop can now mark the solutions of their Groups. In this instance, the tutors give marks out of 5. When all Groups have been scored by their peers and their tutors, the marks for the activity can be viewed. The system shows students the results for each problem solution in a graphical form.

The program chooses the best solutions from each Workshop, based on the marks achieved, and creates a page which students can view. In this way, students can see the

solutions of students from other Workshops and consider other alternative to the problem, a useful activity to encourage reflection. The Course Coordinator and tutors use a different menu system to gain access to the data from the learning system. They can view the results for each Group and can see the results across all the Workshops (Figure 4).

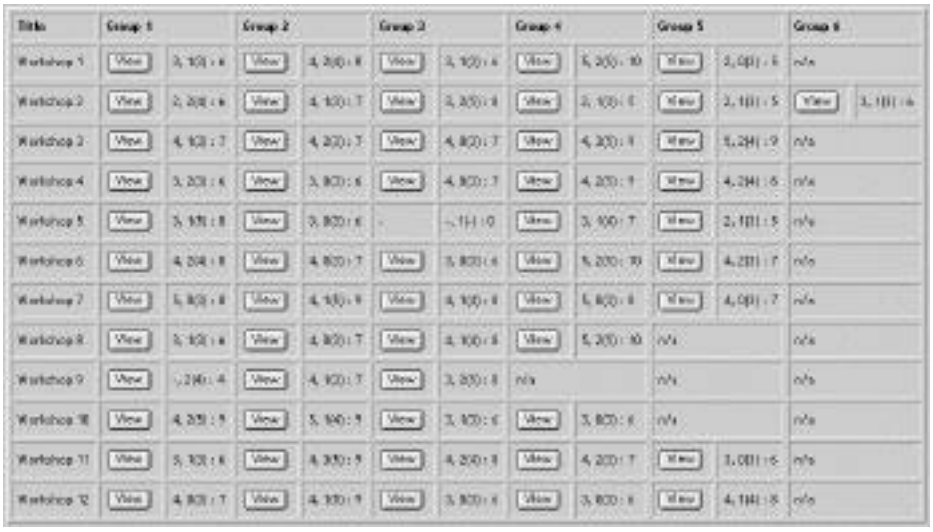

Figure 4. Overall Results
The Coordinator and Tutors can view the overall results for all Groups and Workshops.

4 Initial Feedback

The project was tested in a first year undergraduate class with an enrolment of 240 students. The feedback from our initial implementation has been quite positive. In the first instance we were concerned with the system being able to deal with the large number of server hits and information requests. For example, in the first month alone, this learning system was responsible for over 40,000 hits on the server. The system did stand up to this and proved to be very reliable as an on-line database and learning system.

The learners took some time to fully understand the system and its various components. Like many readers, the system appears complicated when it is first met, but becomes quite simple once an appropriate mental model of the various features has been formed. All students became quite comfortable with the system within 2 weeks. The various tutors took a similar length of time to become familiar with their roles and responsibilities. Within weeks of commencing the course, both students and tutors were very comfortable with the system and its use.

What we have achieved is to develop a Web-based learning environment that encourages and supports on-campus learners into participating in student-centred learning activities. The environment encourages collaborative learning and provides learners with opportunities and reasons to reflect on the course content, to explore beyond the course notes and to analyse and synthesise course content.

We still have many issues to consider and deal with from a learning perspective, however. This form of learning environment is quite different to that which many learners are familiar with. It places the onus of learning onto the students and changes

the role of the teacher from an information provider to a guide and coach. Some of the issues which have arisen and which we are dealing with include:

- Group composition, knowing how best to form learners into collaborative groups;
- Problem choice, choosing problems which are open-ended and require the forms of inquiry and problem-solving students are capable of;
- Peer assessment, many students do not enjoy having their peers stand in judgement of their work;
- Attrition, the system doesn't handle well students dropping out of classes and their groups;
- Workload, the system is causing students to spend considerable more time on these activities than we had expected.
- Motivation, we are always exploring ways to motivate and encourage learners to participate in such learning activities without the need to make the activities assessable.

In terms of positive outcomes, we are able to report a number of highlights, some of which are listed below:

- Students have found the activities extremely motivating and have accessed far more information than we had anticipated;
- The students are developing very good skills in using the web for information access as they seek information for the problems;
- The students are developing strong skills in forming arguments and creating logical answers to the problems;
- The problems are making the content extremely relevant and causing many students to learn how to learn and apply this information.

As we expected when we started this project, we will want to continue using (and modifying) this form of teaching environment. We are very glad now that when we commenced the design of the software that we chose a flexible learning setting in the Web and a flexible approach to the design of our learning system. In future implementations we will be able to build in changes derived from the formative feedback approaches we have used.

5 Summary and Conclusions

This paper has described a project undertaken in an Australian university where a technology-based solution was proposed to create a flexible learning environment capable of providing alternatives to the mass lecture. The solution incorporated a problem-based learning environment supported by a Web-based on-line system. The problem-based learning activity was undertaken in small collaborative groups organised with a larger Workshop cohort in an undergraduate unit of study with a total enrolment of 240.

The project proved to be quite successful in terms of the intended aims. It provided a means to deliver the course content in an alternative way to the mass lecture. The project involved an action research study to investigate the usability of the prototype system and an exploration of learners' views on the usefulness and effectiveness of the new environment. The results indicated a general level of satisfaction and contentment with this student-centred form of learning involving problem-based learning in group settings. But the results also indicate that for many, this is not their preferred form of learning. The results from this project, however, also highlighted areas where the system didn't

work well and in future implementations we intend to refine the application and our delivery strategies.

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