Problem Based Learning In The Online Environment – Successfully Using Student Diversity and e-Education.

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Abstract

Problem Based Learning (PBL) is a well known and well used teaching methodology. Most current literature points to McMaster University in Canada with the introduction of PBL into its medical schools in the 1960's, but its intellectual history is much older. Thomas Corts of Samford University sees PBL as "a newly recovered style of learning". From these beginnings PBL has been incorporated into a wide range of professional studies including nursing, dentistry, social work, management, engineering and architecture.

In the rush to tap into new markets and to take up new technologies many academics and institutions have turned to online education. However, PBL does not seem to have made the leap fully into online education. The use of discussion boards, chat facilities and web resources are still not being fully utilised to take up the advantages of this paradigm. There are only a limited number of references to PBL in distance education. Of available references to group based cooperative learning nearly all require at least some face-to-face meetings of the team members. This does not make full use of the available technology and means that students need to physically meet.

This paper investigates the literature regarding PBL in the online setting. It demonstrates that by appropriate application of both technology and sound teaching, PBL can be successfully used to deliver the required educational outcomes whilst taking advantage of a diverse student profile. Our Faculty has introduced a fully online PBL course to first year engineering and surveying students. The course relies entirely on internet based communication and resources and requires no face to face meetings. Students are located across Australia and the world, often in different time zones. They successfully communicate and solve a range of contextualised engineering problems, facilitated by an academic staff member. The course successfully integrates student diversity (age, culture, education backgrounds) and appropriate technology (chat, discussion and web) to enable students to participate in team based assessments. In the process, students learn teamwork, communication skills, use of internet based technology as well as discipline specific technical knowledge.

History and Definition of PBL

Most current literature points to McMaster University in Canada with the introduction of PBL into its medical schools in the 1960's, but its intellectual history is much older. Thomas Corts of Samford University sees PBL as "a newly recovered style of learning" (Rhem, 1998).

The educational and philosophical theories underpinning PBL were not explicit in early PBL literature (Rideout, 2000, Newman et al, 2001) and the pioneers of the McMaster program had no background in either education or psychology. They simply thought that learning in small teams using authentic cases and problems would make medical education more interesting and relevant for their students (Barrows, 2000; Newman et al, 2001). This current PBL methodology is now currently used in more than 80% of medical schools in the USA (Vernon & Blake, 1993).

From these beginnings PBL has been incorporated into a wide range of professional studies including nursing, dentistry, social work, management, engineering and architecture (Boud & Feletti, 1997) and spawned a plethora of educational terminologies with an almost unclassifiable array of categories (Barrow, 2000).

For the purpose of this paper PBL will be defined as a constructivist learning paradigm where small groups of students, engage in cooperative learning and collaborative problem solving to solve problems in complex and authentic projects. These projects pursue specified learning outcomes that are in line with academic standards and course objectives with assessment focusing, to a varying degree, on the project outcome versus team process.

Distance Education

Distance education is not a new phenomenon. Since the late 1800's correspondence programs have been used in the United States to deliver educational material to students. Initially materials were print based, but as technology has evolved so to have distance education programs and methodologies. From radio and 'school of the air' through to the Internet and 'online' courses educational institutions have sort to continually enhance courses and attract new students.

Desmond Keegan (Keegan, 1980) identified six key elements of distance education:

- separation of teacher and learner
- influence of an educational organization
- use of media to link teacher and learner
- two way exchange of communication
- learners as individuals rather than grouped
- educators as an industrialized form

Many of these elements can easily be expanded or slightly modified and applied to PBL. If media is used to link teacher and learner, then learner can link with learner and hence a separation not only of the teacher but of other students working in a team environment; the two way exchange of communication could easily be a multiple exchange between many participants; learners as individuals bringing prior skills and knowledge to share in the information exchange and the influence of an education organization becomes a facilitator of learning.

If the media link is the Internet then team based PBL becomes not only possible but a way of overcoming the 'isolation' typically felt by traditional distance students. However despite these linkages and synergies there are only a limited number of references to PBL in distance education. Of available references to group based cooperative learning nearly all require at least some face-to-face meetings of the team members. This does not make full use of the available technology and means that students need to physically meet.

PBL in Engineering Education

Interest in problem-based learning (PBL) arose in engineering higher education in response to criticisms that programs failed to equip graduates with collaborative problem-solving skills required for a life long learning and the reality of the work place

(Wilkerson & Guselaers, 1996; Boud & Feletti, 1997; Brodeur et al, 2002). In many cases educational outcomes have focused on the technical and quality aspects of design and neglected the professional skills necessary for design (Davis et al, 2003). Problem based learning has now become a widespread learning method in disciplines where students must learn to apply knowledge not just acquire it. The need for problem solving skills, teamwork and communication skills, skills and knowledge acquired through problem based learning, have been highly prioritized in recent reports from major engineering accreditation and professional bodies (ABET, 2003; IEAUST, 1999; IEEE 2002; Kjaersdam & Enemark, 1994; Knudsen et al, 2000).

Thoben and Schwesig (2001) expand these attributes, listing working globally in a multicultural environment; working in interdisciplinary, multi-skill teams; sharing of work tasks on a global and around the clock basis; working with digital communication tools; and working in a virtual environment as requirements of engineers and a responsibility of engineering educators.

The last of these attributes, sharing of work tasks on a global and around the clock basis; working with digital communication tools; and working in a virtual environment, are ideally suited to online education. The challenge is incorporating team PBL into the equation.

About USQ

The University of Southern Queensland (USQ) is a regional university located in south-eastern Queensland, Australia. The main campus is in the city of Toowoomba which lies approximately 130 km west of Brisbane, the capital of the state of Queensland. The university incorporates five faculties – Arts, Education, Business, Science and Engineering and Surveying - and has a total enrolment of over 26,000 students

The university has an international reputation for providing distance education with approximately 76% of the total number of students studying via distance education. The university also offers online education as well as the traditional face to face courses and programs.

USQ gives opportunities for tertiary education to a broad range of people by providing many alternate entry paths. This has lead to a very diverse student population. In Australia, student demographics have changed dramatically in the last 10 years. Now only 41 percent of university students are the traditional school leavers while 37 percent of students have attendance patterns other than internal full time modes (DEST, 2004; DEST 2002). This contrasts with USQ where less than 30 percent of students enter university directly from school and only 24 percent are internal full time students (USQ, 2003).

The Faculty of Engineering and Surveying (FoES) is unusual in that it offers 9 majors (agricultural, civil, computing/software, environmental, electrical/electronic, mechanical, mechatronic, surveying (spatial science), GIS) with no departmental subdivisions. Staff have discipline specific knowledge and teach in their discipline areas at higher levels of the course, but the foundational years are taught by all staff, often in multidisciplinary teams.

The faculty has approximately 2,500 students with 76 percent studying via distance education. The diverse background of students in the faculty includes people with

trade backgrounds or other tertiary qualifications and many mature age students. This means that a high proportion of students lack the traditionally expected background of mathematics and physics as prerequisite entry. At the same time some of the students with previous qualifications have gone well beyond the minimum entrance expectations. With all courses offered by distance education, many of our students are already working in the engineering and surveying disciplines. This student population brings a great range of prior knowledge, skills and experience as well as cultural and age differences. In the past, this student diversity has been seen as a disadvantage, but the faculty review suggested that the diversity represented an untapped potential advantage.
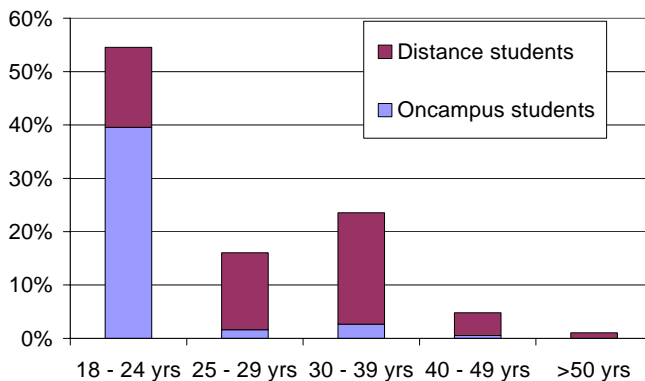
Figure 1 Commencing Student Age Profiles for USQ Engineering Programs.

The challenge of managing the student diversity is complicated by the different expectations of students in the 3 levels of faculty programs. We offer Associate Degree (2 year full time), Bachelor of Technology (3 year), Bachelor of Engineering and Bachelor of Spatial Science (4 year) programs across all majors previous listed and a number of 5 year double degree programs (e.g. engineering/ business, engineering/ science). Economic constraints have led to the development of a large number of common courses for all programs and majors in foundational years, particularly in first year.

Online PBL at USQ

In 2001 after an extensive curriculum review the Faculty of Engineering and Surveying introduced 4 new courses to its programs. These new courses replaced traditionally taught, content based courses. The new courses would utilize team PBL. The academic staff charged with this development could find no reference in the literature to PBL delivered to true distance students. It therefore became a challenge to develop a method to enable the diverse cohort of students to successful engage in team based activities, meet individual and program learning objectives and stimulate students interest for the technical content of the problems.

Our students are dispersed across Australia and the world and would only be able to meet 'virtually'. Asynchronous communication was preferable to enable effective communication across different time zones. After the first semester of offer, the university introduced a Learning Management System (LMS) which then offered significant enhancements for student communication and delivery of the team problems and resource material. This LMS is now an integral part of the delivery of this course.

Initially students must indicate they are active in the course by completing an online 'permission to release email address' form. Once this has been received and acknowledged student teams are formed of up to 8 members and allocated a USQ academic to act as a *facilitator*. Teams are chosen randomly but each contains a

mixture of students from each discipline and program. An email is sent from the course examiner to a team giving information on members email contact details.

Students are directed to USQStudyDesk which is the portal for the Learning Management System (LMS). The LMS used by USQ is WebCt Vista 4.0 and a screen capture is shown in Figure 2. The LMS provides a general discussion board for administration and general enquiries; a team discussion board, only accessible for a specific team; a combined board for interaction between distance and day teams; a chat and whiteboard for each team (if requested); electronic submission for both team and individual assessments and a link to the Course Resource Page. The Course Resource Page is a separate web page where students find assessment details, general information about the course and specific resources for each problem.
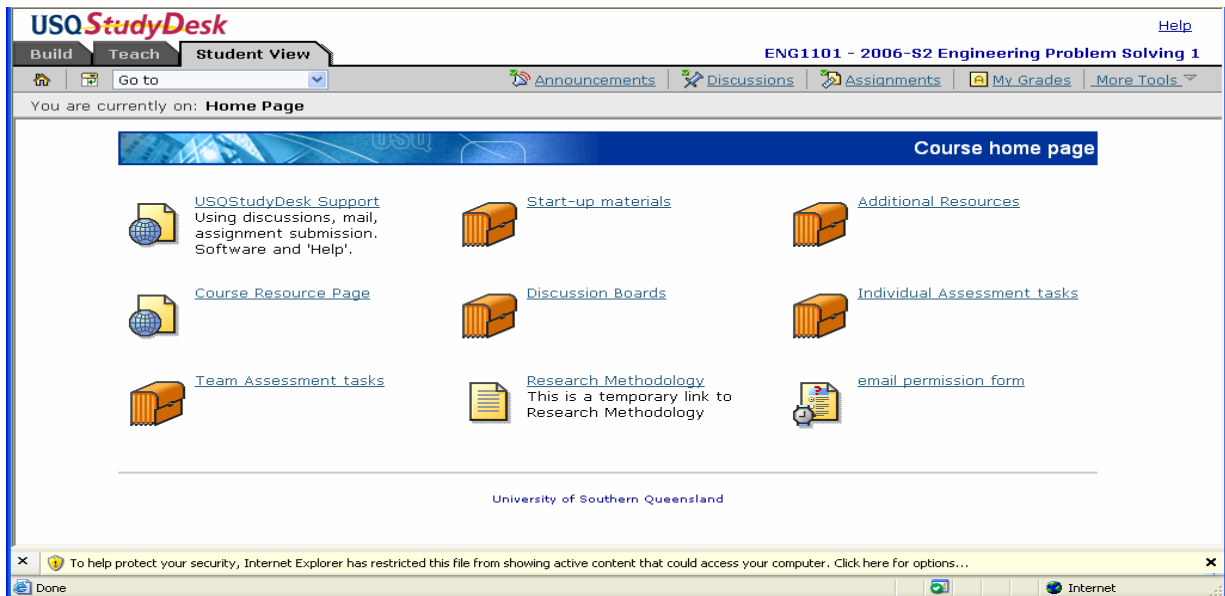
Figure 2: Screen Capture of the LMS

On team discussion boards there are a number of startup threads which students must respond to. These include – Introduce yourself, Team Code of Conduct and Responsibilities, Team Communication Times and Strategies, and Key Concepts of Problem 1.

The team Code of Conduct is an assessable part of the first team submission and teams are guided by their facilitator to investigate and reflect on teamwork and the requirements and characteristics of successful teams. Teams then formulate a list of 'rules' that their team will work by. Over the course of the semester teams will revisit this list and modify it as their team matures and different situations arise. They are also asked to think about individual responsibilities and roles within the team.

Teams are encouraged to find communication strategies which are tailored to individual team requirements. Some teams work entirely on the discussion board, others supplement this with chat sessions on MSN or similar and email. Very few teams work entirely from one technology and such teams tend to struggle with the course requirements.

Teams are encouraged and facilitated to consider not only the method of communication but also a strategy to ensure this method is effective and efficient. As the age distribution of our students is wide, many students have poor keyboard skills and limited knowledge of computers and protocols such as MSN. Many teams mentor members to install and use MSN or other chat facilities. They also list specific 'rules' in their codes of conduct to ensure all members have the ability to contribute during such meetings, especially those with poor keyboard skills. Where teams meet outside the overview of a facilitator, they are encouraged to place a summary of the meeting on the discussion board. This enables not only the facilitator to keep track of team participation and progress but also students who were unable to attend the 'meeting' to keep up with team progress.

Three new threads appear for each problem on each team's discussion board. These are assessed and they are designed to stimulate discussion and student thinking on teamwork, conflict resolution, individual learning goals, mentoring and technical concepts. Students are also able to set up new threads to enable team discussions on the current problem.

Assessment is a mixture of both individual contributions to the team effort, self and peer assessment and team output. The assessment scheme has recently been changed to more effectively monitor and encourage self directed learning by setting and meeting individual learning goals, mentoring with in the team and individual participation and contribution to the team effort.

Results

In Semester 1 2006 there were a total of 309 students enrolled in the course. With 113 enrolled in on campus mode and 196 in distance mode. Students spent a total of almost 10000 hours in 155000 sessions on WebCT. They posted a total of nearly 16000 messages to the discussion boards. This consumed the majority of time on the LMS accounting for 67.5% of student time or 6750 hours. Figure 3 shows the distribution of sessions and percentage of total sessions spent on all the functions offered by the LMS. It should be noted however that the email facility offered by WebCT was not available to students. For administration reasons the examiner uses email addresses provided by students on their enrolment forms.

The chat rooms within WebCT where also poorly utilized with many teams using other mechanisms for chat such as MSN. This is due largely to the instability of the chat rooms.

The URL as shown in the figure is the Course Resource Page. This is heavily utilized by students accounting for over 10 % of all sessions and 1054 hours of student time. This time accounts only for students who visited the Course Resource Page by entering via WebCT. It does not account for students who went to the URL directly without logging into USQStudyDesk.
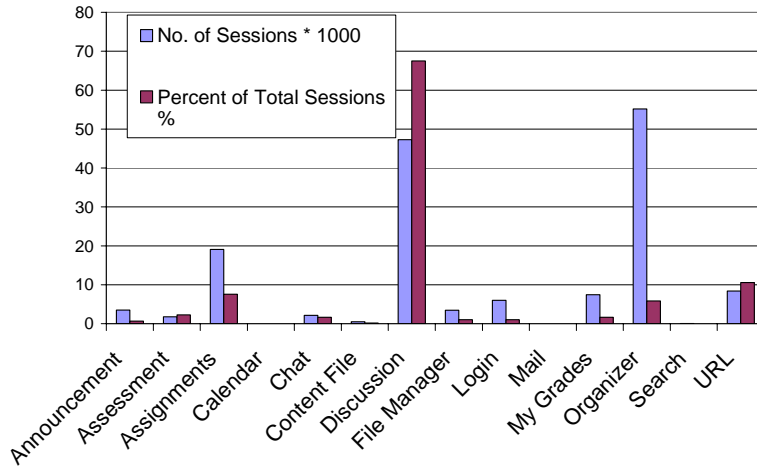
Figure 3: Student usage of features on the LMS

Figure 4 shows the total number of posting on team discussion boards for each of the two student cohorts – distance and on campus teams. At first glance the data shows significantly more postings for distance teams, who have no alternative communications, than for day teams who can meet face to face. However Figure 5 shows that the average number of postings per student was equally shared between on campus and distance students. This is an interesting result as it was assumed that on-campus students would make significantly less use of the 'virtual' communication methods. However they like the flexibility offered by electronic communications and virtual teamwork.
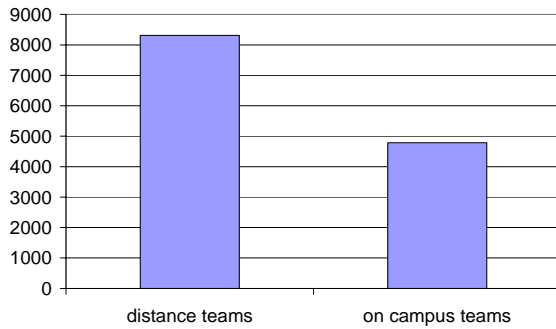
Figure 4: Postings to team discussion boards for each student cohort
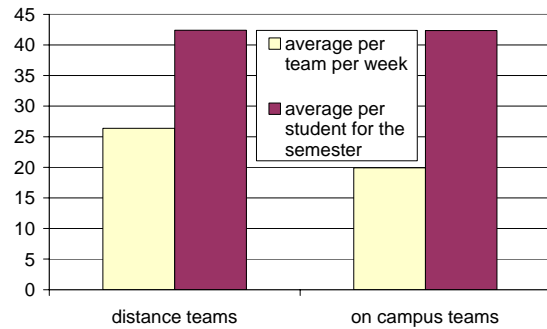
Figure 5: Average postings per team and average postings per student to team discussion boards

The electronic communication methods of this course develop skills engineering graduates of the future will require. Increasingly consultancies are using dispersed multi-disciplinary teams on projects. The ability to effectively communicate electronically and solve problems at a distance is currently missing in many university graduates. This course is ensuring our graduates can meet these requirements. This is reflected by student comments.

"I work in the construction industry and team work is essential. The biggest problem we have with the [qualified] consulting engineers is their inability to communicate with each other, especially at a distance. We have to get them to site and face to face to work through design issues. I believe you should do at least one project [at university] where all the teams work remotely from the other team members." – **(Student comment)**

"… it will become common for an individual engineer to have a working relationship with many companies simultaneously and to receive and present work over a secure Internet connection" – **(Student comment)**

*"……I feel that working externally [distance mode] and communicating solely via the internet, exacerbates the issues that can arise when working in a team. You have to put in extra effort to communicate effectively. i.e. correctly word your statements so that they cannot be misinterpreted. It's from this aspect of the subject that I feel I have learnt the most thus far. **I am surprised at how I am actually using these communication skills in my day-to-day work now with success.**'* – **(Student comment)**

For our distance students, working in a student team is a novel experience. This course provides their first opportunity to actively work with other students. Our students across Australia and the world meet 'asynchronously' because of their different time zones. Virtual team meetings for distance students are as effective as physical meetings for on-campus students and foster the desirable attributes of teamwork, conflict resolution and negotiation of tasks.

"I also found that it was easy to communicate within a group via email and the Internet. I enjoyed this part of the course, as it allowed members to join in discussions at different times of the day and this suited the group as we all work different hours and have a range of internet access times available to us" – **(Student comment)**

"… we all have a lot of fun together even though we have never met face to face. Our team has found common interests and all show a genuine concern for each others welfare". **– (Student comment)**

"I enjoyed working with most members of my team and I was good to be able to talk to other students in the same position as me, I was also able to get help with other subjects from some of my team members" **– (Student comment)**

Conclusions

The education background of our students includes people with trade backgrounds, mature aged people with other degrees who are seeking to change careers, and school leavers. The course with careful design of learning objectives, support mechanisms and communication strategies enables Team PBL to be effectively delivered to students who study in an online mode.

A longitudinal study carried out over the last 5 years of the course indicates that

- 84% of students agree or strongly agree that the course increased their appreciation of how prior knowledge and skills of their colleagues and themselves can be used to effectively solve problems
- 85% of students believe the course improved their problem solving skills
- 81% of students agreed that the course increased their ability to work in a team
- 73% of students agreed that the ability to learn independently increased
- 79% believed their communication skills had increased.

Qualitative data from student portfolios also supported this analysis.

"I now believe a virtual team can work if the right individuals are put together, despite their diverse professions, cultures and geographies. If a virtual team can work I believe a face to face team can not fail. I will use the same negotiating skill, project task identification knowledge, the same focus to a specific goal, strength and weakness identification skills and the same effective communication skills we have used in this project in my everyday team work." **– (Student comment)**

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