

# Problem-based learning and the use of ICT: a tale of two units

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**Abstract:** *A Problem Based Learning (PBL) approach to unit design can address the issue of poor participation and engagement with subject matter by students, as was successfully demonstrated by an existing unit in the Master of Information Systems at the University of Tasmania (Ellis et al., 2009). However, the less-structured content and process involved in group work required through the use of a PBL approach generates the further issue of how to monitor and assess individual contributions in collaborative learning processes. Offering two PBL units within the one semester to the same cohort normally would impact student workload by having two problems to solve while working in different groups in each of the units. In this context, a new Masters unit introduced to the Masters of Information Management in 2010 was designed to complement and integrate with an existing unit that was already developed using a PBL approach. Both units utilised Information Communication Technology (ICT) to support group work and to more adequately assess individual contributions. This case study provides insight into the development, delivery and evaluation of these two units.*

*The delivery method for both units was to provide nine three hour workshops supported by the institutional education platform (MyLO). The first seven workshops delivered the theory for each unit. The theory was delivered using group work learning supported by the instructor. The remaining two workshops combined units in which class members were formed into new groups with members from both units. Both classes were presented with the same problem situation that acted as context for the delivery of the theoretical material. Assessment items across both units were structurally aligned to support the learning process. Four of the five pieces of assessment took the same form, of which the final and major item of assessment required students to submit a single “solution” that was independently marked for each unit against the same criteria while addressing unit specific learning outcomes.*

*Critical reflection and assessment of individual contribution was supported by PebblePad technology. Students were required to create individual assets on a weekly basis that provided evidence of research and participation in both the initial seven workshops and then the development of the final “solution”. Additionally group work interactions were supported by wiki technology in the new unit. Feedback from Student Evaluation of Teaching and Learning (SETL) indicated a positive response to embedding technology in assessment.*

**Keywords:** *Problem Based Learning (PBL), learning technologies, integrated assessment*

## **Problem Based Learning**

PBL originated in a medical school in the United States in 1969 and has been seen in many forms over the years at various educational levels. It was known as the “McMasters philosophy” that evolved into an education strategy we now know as Problem Based Learning (Bayard, 1994). There are three strategies for PBL: initiate learning with a problem; make exclusive use of real world problems; and use the lecturer as a facilitator (Gallagher & Stepien, 1995). The development of the problem and how to resolve it is more critical than the solution (Ward & Lee, 2002).

PBL has spread to other disciplines such as engineering, mathematics, business and architecture. In Australia the School of Electrical Engineering at Victoria University converted to a PBL approach in 2006. The conversion required an integrated approach to the teaching of the program across a number of different faculties and the internal Information Technology Group (Stojcevski, 2007). The embedding of technology into the program supported the students in achieving the learning outcomes (Stojcevski, 2007). This change helped the School of Electrical Engineering at Victoria University to re-position itself and attract students who would have previously chosen to study elsewhere.

### **First PBL Unit**

In 2009 a PBL approach was adopted for one unit (KXI753) in a Masters program at UTAS in order to address the issue of poor participation and engagement by students (Ellis et al., 2009). The Masters unit was taught for three hours over a nine week period. In the first week the students were provided with an overview of the unit and introduced to the real world problem that they would work on during the nine weeks. Students were also given material relating to activities such as working in groups, lateral thinking and critical thinking to provide tools and skills to support their learning journey. The next six weeks were devoted to introducing the theory of the unit to the students which was then used to further analyse the problem. In the last two weeks of the unit the focus shifted from theory to solving the problem.

Students worked in self-managed groups of six for the duration of the unit. Each week one student from the self-managed group would act as leader and facilitate group discussion to complete the workshop tasks allocated. The leader was also responsible for preparing the group’s report presenting their findings for that workshop’s material. Leaders were evaluated on the quality and depth of the report. This report constituted 20% of the final mark. Other individual assessment pieces were a case study analysis weighted at 30% and active participation weighted at 10%. The final assessment piece was a group based solution to the problem weighted at 40%. Students were not presented with guidelines relating to the problem solution. The aim of the assessment was to provide the students with a strong self-managed group experience while ensuring the majority of the assessment was at an individual level. When reflecting on this unit it became apparent that the assessment was strongly weighted towards the solution rather than evaluating the students’ learning journey.

### **Design of two complementary and integrated units**

In 2010 a new Masters unit (KXI721) was to be developed by a new casual staff member who was keen to use a PBL approach and work collaboratively with an experienced member of staff. It was decided to use the PBL model from KXI753 in 2009 as a base for the design of the new unit (KXI721) but revise the assessment. The majority of enrolments in both units

were international students mainly from China, India, Malaysia and Saudi Arabia. Both staff were keen to increase the level of engagement and participation of students in both units. Other units in the program had reverted to more traditional teaching patterns of lectures and tutorials as a way of overcoming the lack of engagement and participation. Those changes had been unsuccessful in achieving the desired outcomes.

Both units were delivered over a period of nine weeks using three hour intensive workshops. The structure from KXI753 presented students with the real world problem in workshop one along with the normal introductory material covered in a unit. In addition the students were provided with an overview of PBL and a lecture on lateral thinking and group work in preparation for the tasks they were about to undertake. The problem presented was relevant to both units. The next six workshops were devoted to the delivery of the theoretical content of each of the units. Each unit adopted a slightly different approach to these six workshops. KXI753 required students to pre-read a chapter of the prescribed text and then work in groups of six to complete workshop tasks, one of which was to reflect on how the chapter might help the group to solve the problem. In addition one group of students was required to deliver a presentation on an allocated topic each week. The instructor facilitated discussion of the information presented and related back to the problem. KXI721 required the students to work in groups and research the workshop topic prior to attending. The group members communicated with each other through a wiki. Both units required each student to act as the group leader once in the six weeks and to produce a report on behalf of the group. This report was a component of the assessment.

The final two workshops were devoted to finding a solution to the problem. Adopting a PBL approach to one unit can easily be done without unduly affecting the student workload. However, when adopting a PBL approach to two units within the same program student workload needs to be taken into consideration. By treating each unit separately students would be working in the last two workshops to solve two different problems and working in two different groups. For the two Masters units it was decided to join both units in the last two workshops and reassign the students to new groups to solve the real world problem. The problem focused on issues of strategy and business intelligence. The problem presented to the students was:

This organisation has issues with their data and information. Data is not easily transferred from one system to another and some of the data is collected manually. The large quantity of data collected by this organisation is not readily available to managers in a form that facilitates and informs decision-making and reporting.

The revised assessment framework was based on feedback from a paper presented at the 2<sup>nd</sup> Symposium on PBL (Ellis, Cummings & Turner, 2009). This feedback identified the need to realign the assessment task used in the 2009 delivery of KXI753 to focus on the student learning journey rather than the solution to the problem. In 2009 students were required to work in groups and the assessment weighting (60%) was focused on the individual. In 2010 the assessment was changed to consist of:

KXI753	KXI721
Participation 10%	
Presentation 10%	Exam 20%
Leaders Report 20%	Leaders Report 20%
Peer/Self Review 10%	Peer/Self Review 10%
Workshop ePortfolio 10%	Workshop ePortfolio 10%
Combined	
*Solution ePortfolio 10%	
*Solution to problem 30%	

\* Group mark

Assessment pieces were not stand alone but integrated to measure both individual learning and individual contribution to group learning. The leader's report was an individual assignment but required the leader to document the contributions of each of the group members. Each leader's report was accompanied by a peer and self review (PSR) assessment. Additionally in KXI721, these two assessments were supported by the instructor's evaluation of individual contributions on a wiki group page. Assessment of active and effective participation was not reliant only on attendance and lecturer observation but was supported by the integration of different pieces of assessment. The portfolios provided evidence of student learning and student contribution to their group; they were also linked to the PSR. The practical exercise was the solution to the problem and this was supported by the portfolio and PSR. KXI721 as a new unit was required by the Head of School to have an exam that specifically focused on and examined the theoretical knowledge in the unit. KXI753 as an existing unit (created while in a different faculty) has assessment that is 100% continuous assessment.

The PSR was designed to provide the students with an opportunity to comment and reflect on their contribution to the group but to also comment and reflect on their group members' contribution to the group. One issue with PSR is that students, especially international students, tend to rank themselves and each other quite high. Lin et al. (2009) experimented with a web based peer evaluation system for problem based collaborative learning. Lin and his colleagues had the students rank themselves and their group peers using a 5 point Likert scale rating. Students, however, could only use a ranking once. For example, if a student ranked themselves as a 4 then no other student in the group could be ranked 4. This approach resolved the issue of students ranking themselves and their group too highly but limited the level of interpretation that could be made on group performance and individual contribution.

Therefore when designing the PSR instrument for the two units a three pronged approach was used. The PSR assessment required students to evaluate the quality of individual contribution to the group effort on a scale of 1 to 5. Students could evaluate their own and group members' contribution as equal quality. However, students had to then rank each person in the group from most effective to least effective contribution. Finally students had to support the second ranking with qualitative comments.

### **Using technology to support the learning journey**

Having aligned the assessment to the student learning journey, the instructors considered technologies to support student learning and its assessment. Within higher education institutions the importance of retaining students, widening participation, and increasingly, reflective learning have also contributed to widening interest in e-portfolio tools and

technologies (Joyes et al., 2010). The first piece of technology adopted was PebblePad to create an ePortfolio. For students the PebblePad technology provides a tool for them to document their individual learning journey by creating 'assets' that can be drawn upon as evidence of engagement and participation in the learning journey. Assets are best described as digital items: ideas, evidence, reflections, feedback, data which 'present' a selected audience with information about the subject of that ePortfolio (PebblePad, 2010).

Students were required to create a variety of assets such as action plans, meetings or thoughts over several weeks that they then incorporated in a 'webfolio' asset, or ePortfolio. Students documented their learning journey by creating assets on a weekly basis. The assets represented personal thoughts, research, contributions and individual performance.

An introduction to PebblePad was provided to both units in workshop one. Both staff demonstrated the software, supported by comprehensive information sheets. In addition students were provided with the URL to the United Kingdom PebblePad web site. This site offers online tutorials for the development of assets and ePortfolios. KXI753 left the exploration of PebblePad to the students and only offered a reminder relating to the first ePortfolio two weeks before the due date. KXI721 use of PebblePad was scaffolded with regular in-class demonstrations of creating different assets that included class discussion and question-time on different levels of thinking and how PebblePad tools provided a structured introduction to different thinking processes.

Two ePortfolios were assessed with the first ePortfolio focusing on workshops two to seven and the theoretical content. The technology offered the opportunity for the students to not only capture but also reflect on their learning journey both as individuals and as a part of a group. The second ePortfolio required the students to comment and reflect on the new group they had been assigned to for the problem solution. The solution was a group mark and the creation of the ePortfolio allowed students to demonstrate their individual contribution to the development of the solution. Students were free to use assets that they perceived as supporting their demonstration of involvement.

Wiki technology was adopted in KXI721 to support the students' learning journey. Students were allocated groups of five to work together over five weeks, each member organising the research effort for one workshop and writing a leader report that drew on the efforts of their group members. Each group member was required to research the topic and post information on the private wiki page provided to each group. Students were informed that the instructor would be monitoring their contributions for quality along the dimensions of Bloom's taxonomy (Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation).

The instructor regularly posted commented on individual contributions from within each group wiki, reminding students to demonstrate use of higher order thinking skills. The instructor also constructed and updated a "Groups and Instructor Communications" wiki page accessible to all class members and regularly sent all students email links to new pages with information, advice, resources, generic critiques of common approaches and highlighted examples of excellence by individual group members.

## **Evaluation of the units**

The University evaluates teaching and learning through Student Evaluation of Teaching and Learning surveys (SETL). The survey consists of ten standard questions and instructors can

add additional questions for feedback. SETL are conducted separately for teaching practices and unit related activities. Teaching and Unit SETL were conducted in both the units. Additional questions focussed on PBL outcomes and the use of technology to support learning.

KXI753 Unit SETL achieved an average of 4.28 over the 10 standard questions. Ten additional questions were also asked with the most notable results aligning to:

*I learned to feel responsible for my own learning (4.45)*

*Tutorials helped me to increase my ability to see another person's perspective (4.35)*

*I have learned to discuss (4.29)*

KXI753 Teaching SETL achieved an average of 4.21 over the 10 standard questions. Ten additional questions were also asked with the most notable results aligning to:

*I learned to discuss (4.51)*

*Interaction with other students was encouraged (4.45)*

*I had an opportunity to demonstrate what I had learned in the unit (4.38)*

KXI721 Unit SETL achieved an average of 4.16 over the 10 standard questions. Ten additional questions were also asked with the most notable results aligning to:

*I have learned to discuss (4.37)*

*I have learned to feel responsible for my own learning (4.12)*

*Tutorials helped me to increase my ability to see another person's perspective (3.93)*

KXI721 Teaching SETL achieved an average of 4.21 over the 10 standard questions. Ten additional questions were also asked with the most notable results aligning to:

*Interaction with other students was encouraged (4.33)*

*I have learned to discuss (4.16)*

*The technology allowed me to demonstrate my individual contribution to the group (4.09)*

The PBL approach with the use of technology and integrated assessment adopted by these units provided a meaningful learning experience for the international Master's students. Students commented positively on the technology providing the opportunity to demonstrate their skills while motivating everyone to contribute.

*At first I found it so hard knowing that we have to do group assignments. I have already experienced the problems of group assignments. It is very hard to manage time to come together. and same thing happened for this unit as well at first when we were very confused about what to do and how to manage. Once we managed to meet but thank god there was wiki which had made it possible to do group assignments. Once I started using wiki all the confusion and problems were gone. [Student Asset, KXI721]*

Students' answers to the question, "What were the best aspects of this unit?" focused on the experience of working in a group, using the PebblePad and wiki technology and learning as a process.

*The concept of learning process, the new technology used: pebble pad and wiki. The way of delivering teaching: more discussion and interaction.*

*Group work and developing a report every week and being a leader once.*

Student suggestions for improvement focused on being allowed to choose group members and reducing the number of assessments.

## **Reflections**

The introduction to PebblePad was the same for both the units. However, KXI721 also provided the students with ongoing support. The first ePortfolios assessed had limited numbers of assets and few students used the tools to engage in critical or reflective thinking. Students had been unclear as to what assets to generate and how they could be used to provide evidence of their learning journey in the first ePortfolio; many students did not start creating assets until several weeks into the course and used them superficially.

For KXI721 the wiki was the primary interface for interaction between student group members and also the communication tool used by the instructor (the 'Group and Instructor Communication' page could be updated and an email sent to the students to alert them to new information). Constant interaction with students by the instructor was labour intensive but had the advantages of: students understanding that their learning journey was supported by the instructor; students relying on the wiki postings as evidence of quality, quantity and timeliness of individual contributions (or failure); and establishing the wiki as an effective communication and collaboration tool for asynchronous group work. Students would have liked a chat function for synchronous collaboration.

In both units the PSR was administered at the end of every workshop. This assessment piece also requires instructors' support. Students took some time to understand what was required of them. A number of the PSRs produced at the end of the first workshop had to be returned to students for correction. On reflection, a role play of group work and a demonstration of the PSR process would reduce confusion. There is also an opportunity to reduce the number of PSRs from nine to two: one PSR to be completed at the end of workshop seven, to reflect on the contribution and participation of the group formed for workshops two to seven. The second PSR to be completed at the end of workshop nine, to reflect on contribution and participation of the group formed to solve the problem. While there were benefits in having reviews each week the workload involved for the staff to carefully evaluate the PSRs was unsustainable.

The insistence that KXI721 have an exam that tested domain knowledge of the unit was an issue for the PBL approach. The KXI721 assessment was originally planned to align with the 100% internally assessed KXI753 unit and designed to encourage the students to become independent and self directed learners while addressing a real world problem. Ward and Lee (2002) identified that students taught using a PBL approach did not do as well on multiple choice tests as those who were taught using lecture based delivery. To support a formative approach to students acquiring domain knowledge, the exam was designed to use MyLO. Students had access to the test bank so they could practise and gauge the level of their comprehension of the text book. In the exam, students answered 80 randomly allocated multiple-choice questions. The majority of students achieved HD and DN grades, a testimony to their ability to memorise.

## **Conclusion**

The overall outcomes of the delivery of the two units were positive. Students participated and were engaged and, more importantly, the newly designed assessment provided opportunities for the students to demonstrate their learning journey. The assessment design also supported a group learning focus while providing the students with individual grades (Duch et al., 2001).

In planning the PBL approach for the two units it was recognised that the students had only a short timeframe for developing group work and communication skills. This concern was intensified by creating new groups for the last two workshops when the students focused on the solution to the problem. However, in reality the students recognised the short timeframes involved and quickly raised themselves to the 'performing' stage of group development (Dwyer, 2002).

There were a number of benefits in having the same assessment for both units. Students were able to integrate knowledge from two topic domains and apply that knowledge to a single context. Moderation of marking was inbuilt for all criteria except subject knowledge for a specific unit. Student workload was more efficient as they were able to focus on a single context to apply two knowledge areas.

In reflecting on the units it is clear that a scaffolding approach is needed, especially relating to new technology, for example the generation of assets. Students value the support of instructors (Oliver & Omari, 1999). In future iterations of using PebblePad the instructors intend that the weighting of the first ePortfolio should be reduced and the assessment be formative, with scaffolding provided each week to demonstrate different types of assets and require students to use them as tools for structuring thinking about their learning journey. Then, students could reasonably be expected to create a second ePortfolio without requiring instructor support. The second ePortfolio would have significant weighting to reflect student effort and learning outcomes expected.

PBL that includes student self assessment results in increased active student participation and motivation (Popham, 2002). The PSR assessment was evaluated against actual contribution demonstrated by wiki postings. Students quickly understood that their PSR grade was for the quality and reasonableness of their *evaluation* of self and peers, not the mark or ranking they allocated. Thus, while monitoring the wiki was time consuming, it also provided a reliable method of monitoring actual student contributions to group effort; evaluating quality of contributions against PSR ratings from group members; and identifying problem group-members and mentoring groups on how to resolve issues.

This case study presents a collaborative effort between two instructors to develop and deliver two Masters units using a PBL approach. The aims for the units were to address the particular problems of international students engaging and participating particularly in collaborative learning contexts such as group work. The use of ICT was integrated with the assessment design to support group work and to more adequately assess individual contributions. This case study has provided the insight that integrating two units with PBL has the positive effect of reducing student workload and allowing them to apply two knowledge domains to one problem. Technologies such as wiki and PebblePad support students to develop critical thinking and reflective skills. The technologies also support the instructors to monitor student progress and provide feedback as well as to assure students that individual contributions to group work were visible.

## References

- Bayard, B. (1994). *Problem Based Learning in dietetic education: A descriptive and evaluative case study and an analytical comparison with a lecture based method*. University of Wisconsin.
- Duch, B., Groh, S., & Allen, D. (2001). *The power of problem-based learning: a practical "how to" for teaching undergraduate courses in any discipline*. Sterling, Virginia USA: Stylus Publishing.
- Dwyer, J. (2002). *Communication in Business* (2nd ed.). French Forest, NSW: Pearson Education.
- Ellis, L., Cummings, E., & Turner, P. (2009). *Engaging International Students through PBL*. Paper presented at the 2nd International Symposium on PBL.
- Gallagher, S. A., & Stepien, W. J. (1995). Implementing Problem-Based Learning in Science Classrooms. *School Science and Mathematics*, 95(3), 136-146.
- Joyes, G., Gray, L., & Hartnell-Young, E. (2010). Effective practice with e-portfolios: How can the UK experience inform implementation? *Australasian Journal of Educational Technology*, 26(1), 15-27.
- Lin, C.-C., Huang, S.-M., Hung, C.-C., & Chen, C.-C. (2009). *A Web-based Peer Evaluation System Development for Problem-based Collaborative Learning*. Paper presented at the 2nd International Research Symposium on PBL.
- Oliver, R., & Omari, A. (1999). Using online technologies to support problem based learning: Learners' responses and perceptions. *Australian Journal of Educational Technology*, 15(1), 58-79.
- PebblePad. (2010). [www.pebblepad.com.uk](http://www.pebblepad.com.uk). 2010
- Popham, W. J. (2002). *Classroom assessment: What teachers need to know*. Boston, MA: Allyn and Bacon.
- Stojcevski, A. (2007). *Technology integration in Problem Based Learning at Victoria University*. Paper presented at the International Conference on Engineering Education & Research, Melbourne.
- Ward, J. D., & Lee, C. L. (2002). A review of Problem Based Learning. *Journal of Family and Consumer Sciences Education*, 20(1), 16-26.

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