

Issues in making the transition from traditional teaching to project based learning

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***Abstract:** Project based learning (PBL) is a complex topic that has become a contentious issue in recent years. Amongst its supporters, PBL is seen as a great step forward in higher education. Through the eyes of its detractors, PBL is an unwarranted burden that presents no value. The latter point of view originates from those who have not experienced a PBL environment. There are challenges in implementing PBL as a means of delivering a programme in tertiary education. The teacher's role is changed from that of knowledge giver to one of facilitator. Teachers need to be taught and assisted with new practices, and a PBL programme has to be designed for each institution proposing its uptake. It is claimed that the transition from traditional to PBL-based teaching is worth the effort as graduates are said to be "industry ready" to a greater extent than under the traditional system.*

Introduction

PBL: Project-based or problem-based learning?

A common answer to the question "Does PBL mean project-based or problem-based learning?" is "nobody really knows". Perhaps a part of the real answer lies in the process of executing a project. Often the first step is to define the problem, after which the project is planned and executed in order to solve the problem. Hence it may fair to say that project-based learning includes problem based learning, as solving a problem does not necessarily include executing a project in the formal sense. In this paper PBL is taken to mean learning based on project work *and* on finding solutions to real problems.

PBL is becoming widely accepted as a means of adding value to the learning experience in tertiary teaching institutions, and to producing "industry ready" graduates. There is a growing demand for graduates with, in addition to core engineering abilities, skills in team work, project management, negotiation, communication, computer literacy, problem solving, information literacy and a commitment to lifelong learning (Krishnan, Vale, & Gabb, 2007). The foregoing are often referred to as "soft" or "transferrable" skills. It is claimed that PBL is instrumental in equipping graduates with these skills (Kolmos, 2002, Spronken-Smith, 2009 and Krishnan et al., 2007).

The School of Engineering at AUT University (Auckland, New Zealand) has made a commitment to introduce PBL to two of its degree programmes in 2011. The process of preparing for the transition to PBL is a complex one. There is no single prescription for PBL that can be applied to any teaching institution (Kolmos, 2002). Rather, a model must be developed for each application. Decisions about when (e.g. in first or subsequent years of the study programme) to implement PBL, and how much of the course content (a single paper, 50% or 100% of the curriculum) should be taught by PBL methods have to be made.

Implications for teachers

Teacher preparation and supervisory considerations are of vital importance in making the transition to PBL. Spronken-Smith and Harland (2009) report establishment of a "community of practice" (COP) for supporting teachers during the transition. It was considered necessary to develop a collective vision

about the desired learning outcomes of the PBL programme, ensure the necessary skills, incentives and resources are available for teachers, and develop an action plan for implementation. Implementers of PBL may need to overcome an “implementation hurdle”. When teachers relinquish control over curriculum content knowledge they are no longer required to be “knowledge-givers” and this can challenge their values, resulting in a reluctance to accept the new practice.

Whilst a fundamental change to teaching practice may provoke resistance among teachers, experience at Aalborg University (Denmark) suggests that the change to PBL has resulted in a 70% reduction in lecturer contact hours (Kolmos, 2002). Much of this reduction is attributed to students dividing their time equally between lectures and project work, and a change in assessment practice. After two years working with PBL at the University of Otago (New Zealand) it was stated that most teachers enjoyed teaching with PBL and found it rewarding. Some reported anxiety and stress due to a perceived lack of structure, while others found it wonderfully relaxing (Sponken-Smith & Harland, 2009).

Kolmos (2002) reported that trust was an issue among staff in the early stages of the transition. Some staff stated that they would not trust the PBL model until they had been able to observe progress of a student cohort from the first year to completion of a master’s programme. Now that PBL has existed in one form or another for about three decades, there should be sufficient evidence that PBL is (if executed correctly) a teaching method that is worthy of trust.

A number of PBL models exist. The Aalborg and Maastricht models have been established over several decades and are seen to be successful in providing well rounded graduates equipped with a good range of transferrable skills. Yet the two models have distinct differences. Students at Maastricht University (Netherlands) carry out small, well-defined projects and sit individual exams. At Aalborg, students undertake larger, loosely-defined projects and take a group, oral exam at the end of the process. At Aalborg, first-year students undertake a paper titled “Collaboration, learning and project management”. Other universities offer similar papers in the first year.

It has been reported anecdotally that sceptics of PBL become “converts” once they have experienced it. PBL appears to have become a philosophy, and perhaps, in the eyes of some, a religion. As such it must be subject to intense scrutiny and question. Nevertheless there is evidence to suggest that introducing PBL changes the culture of an organization from one where teachers are somewhat remote and autocratic to one in which there is continuous interaction between staff and students.

Implications for students

The student experience of PBL is important. Third-year students at the University of Otago (New Zealand) undertaking a PBL-based course concurrently with three traditional, one-semester papers reported that they spent more time on the PBL paper than on the others. However student satisfaction scores for that paper increased from 2.9 (on a 1 to 5 scale, 5 being the best) under the traditional system, to 4.3 under the PBL format (Sponken-Smith, 2009). Students felt that knowledge gained through PBL would be more likely to be retained than would knowledge gained through cramming for an exam. Maori students, accustomed to being part of hui and other communal aspects of Maori life, saw group work as a way of life, and felt the lecture scenario was a foreign, uneasy way of learning.

One of the soft skills said to be developed in the course of PBL is that of being able work across a range of disciplines. That being the case an interdisciplinary approach could be taken from the lowest level at which PBL is to be introduced. Thus the PBL implementation plan must define whether the PBL content is to be applied to a single course comprising single-subject material, or to a composite project module comprising subject material from a number of courses, taught either previously or concurrently. In the AUT context, where mechanical and electrotechnology disciplines are taught, it may mean that students from the two streams should form joint teams to undertake interdisciplinary projects.

Engineers need to maintain lifelong learning and skill enhancement in order to preserve their value and maintain competitive advantage. Graduate engineers may never practice as engineers, but may become involved in business, management, law or even medicine.

Discussion

The Accreditation Board for Engineering and Technology (ABET) is an organization for evaluating and accrediting, and providing quality assurance for engineering programmes in American universities and colleges (Shuman, Besterfield-Sacre, & McGourty, 2005). ABET is a signatory to the Washington Accord. It has described a set of “hard” engineering skills and a set of “professional” engineering skills. The latter includes teamwork, communication ethics, professionalism and lifelong learning. Changes were made from the traditional concepts of engineering disciplines in 2000, to encompass the need to work in the new environment of globalization, advancing technology, and outsourcing of engineering.

With globalization, bright young engineers in third world and developing countries are now available at (say) a third of the cost of engineers of five years ago, and the engineer is now treated as a commodity rather than a professional. Major trends include changes forced by the fragile world economy, student and professional mobility, communications and IT, and social imperative. Hence the need for what were once referred to as “soft” skills. Development of soft, transferrable skills is a recurring theme throughout tertiary teaching institutes, whether aligned to PBL or not. It is suggested that PBL goes further toward developing the soft skills than does the traditional approach.

PBL in operation

In the PBL environment teachers do not teach students. Rather they enable students to acquire knowledge through their own endeavours. Although the word “teacher” appears contradictory in light of the previous statement, the word has been retained in this paper as a substitute for “academic staff member”. Facilitation of knowledge acquisition rather than teaching is an essential part of group learning and teaching. Savin-Baden (2003) defines three modes for facilitation:

Hierarchical mode. Facilitators direct the learning process and exercise their power over it. Facilitators take responsibility for learning.

Cooperative mode. Facilitators share power over learning with the project team and enable team members to become more self-directed by conferring with them.

Autonomous mode. Facilitators respect total autonomy of team. The team evolves its own learning and structure (Savin-Baden, 2003).

Perhaps the mode of facilitation should evolve from hierarchical to autonomous during the course of study. Barrows (1996) reported that first year students rely more on lecturers and reference lists than do students in second and subsequent years, when they tend to become more self-directed and seek information for themselves (Barrows, 1996). Hence the hierarchical facilitation mode is appropriate in the first year, the co-operative mode may be adopted in the second year and in the third and subsequent years the autonomous mode should be applied. In some instances it may be appropriate to progress through the facilitation modes during a single course of study.

The traditional method of teaching is not always successful in stimulating students to become lifelong learners or to learn for the sake of acquiring knowledge and developing skills. Hadgraft (1998) described four modes of learning applicable to PBL:

Active learning through posing questions and seeking answers

Integrated learning by tackling problems for which knowledge of several sub-disciplines is necessary

Cumulative learning by a succession of increasingly complex problems, working up to those which would typically be handled by a young professional, and

Learning for understanding, rather than for the retention of facts (Hadgraft, 1998).

As a result of undertaking the PBL course at the University of Otago many students reported a new sense of learning (Spronken-Smith, 2009). Increased motivation and desire to know what was “going on” were reported, as was an understanding of the difference between learning for the sake of passing an exam, and learning for the sake of developing a true understanding of the subject matter. Students felt that knowledge gained through PBL would be more likely to be retained than would knowledge

gained through cramming for an exam, supporting a belief that deep learning is more likely to occur in the PBL environment than in the traditional one.

Fundamental to PBL is supervision of small groups of students. A system is proposed in which project groups each have two supervisors (Hansen & Jensen, 2004). It is suggested that one supervisor is responsible for matters such group dynamics and social the impact, whilst the other takes responsibility for technical, subject-related matters. This concept is likely to be highly desirable during the first year or two of PBL, when teachers are becoming accustomed to their new roles.

Assessment is entirely different under PBL, and some proponents claim that teacher work load is reduced as a result. Perhaps the most important aspect is the peer assessment that takes place, whether overtly or covertly, at regular group meetings. Formal assessment strategies need to be developed, however, and that development must be initiated during the planning phase.

The issues for AUT

Present staff engaged in traditional teaching practice raise a number of concerns about PBL, and some feel that PBL is already taking place. It is true that many of the papers taught include significant project content. However the projects almost invariably comprise teams of one or two participants. In a developed PBL environment project teams generally comprise six to eight members during the first two or three years, often diminishing to two or three members during the final year or two.

When and how to implement PBL is a matter for careful consideration. At the University of Otago PBL was introduced in a third-year research course, concurrently with three other courses. There is evidence that the outcomes were desirable for staff and for students. However students observed that they spent more time on the PBL course than they did on the other three. All of the courses carried equal points value. Hence there is a need to manage time so that students allocate the appropriate amount of effort to each course of study.

PBL was applied to a number of fourth-year courses and students found loading too great, so PBL was applied to one paper per semester. PBL has not, and probably will not be applied across the entire programme at the University of Otago.

Resources, in terms of staff and facilities, are to be considered. At AUT the typical number of first-time, first year students in Bachelor of Engineering (BE) and Bachelor of Engineering Technology (BET) programmes is expected to be 200 in 2011. Students take four papers in each semester. In order to allocate resources, it is first necessary to determine which (if not all) papers will be taught by PBL. First year papers in the diploma course include Manufacturing Processes, Engineering Drawing, Engineering Practice, Electrical Theory, Engineering Mechanics I (statics), Engineering Mechanics II (dynamics), Material Science 1, and Mathematics 1. As Engineering Practice and Engineering Drawing are assessed on work done during class time, it is not proposed to teach those papers as PBL. As Mathematics 1 is a core paper delivering theory to be applied elsewhere, it is considered appropriate to continue to teach the paper in the traditional manner.

Hence the five remaining papers may be considered, at least in terms of resources, for PBL. Assuming only four were selected, the students may undertake two PBL papers per semester. Taking an average group size of four, then the cohort would comprise 50 groups. If each group were to receive two hours supervision per week, 100 hours per week of lecturer time would have to be found in each semester. Each paper would require 30 hours per week of lecturer time, so two lecturers would be required per paper. This is the inverse of the current situation, where one lecturer currently delivers two papers. Further, there is some value making an expert facilitator available in the early stages.

The issue of project facilities arises. The project team should meet in a room capable of comfortably accommodating six (minimum) members plus facilitator(s). There needs to be desk space, at least one computer (networked, with internet connection), a whiteboard and a notice board. It is desirable to provide power and network (wireless) connections for members' lap tops. Some space for making simple models is recommended. If 3m² floor space is allowed per person, then a room size of 25m², with the foregoing equipment, is suggested for each team.

In order to reduce the risk of failure a new position, that of Project Manager: Problem Based Learning Introduction, is to be created. The manager's task will be to coordinate staff training and curriculum preparation activities, coordinate changes to facilities, facilitate internal and external quality assurance procedures, and networking with organizations where PBL is established.

It is recommended that the appointment will be of three years' duration. During the first year (2010) the intention is to provide training to staff in PBL methodology and to make the necessary adjustments to the curriculum and associated material. PBL is to be introduced across the first-year of the BE and BET programmes in 2011, and substantial support from professional development sources will be provided to teaching staff during that year. It is anticipated that a review process will take place at the end of 2011, and some fine tuning will be necessary during 2012, concurrent with introducing PBL to second year of the programmes.

Conclusion

The first stage in introducing PBL is to gather information on what PBL is and how it has been applied elsewhere. Secondly a comprehensive plan is required for its implementation, taking into account teacher preparation, resource requirements, curriculum modifications, costs and benefits, and a need to bring about a change of culture. Finally the practice is introduced and should be constantly monitored and revised as necessary.

Staff and students who have experienced PBL almost universally extol its virtues. Some students report that they work harder and longer in PBL courses than they do in others, and the result is that they tend to retain knowledge rather than forget it after an exam. The PBL style appears to benefit all participants, especially members of cultures for whom communal living is the norm.

The transition to PBL will be a large and complex task, making considerable demands on staff involved, but there is plenty of evidence to suggest that the effort will be well rewarded.

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