An investigation of the use of problem based learning in Professional Degrees.

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Leaders in the field of professional education recognise that in the late twentieth century professional practice requires skills that cannot be developed in a traditional style of university course. It is generally advocated in the field of construction management that today's professionals need to be equipped with self-directed learning strategies to help them cope with the knowledge explosion of the last twenty years. Problem based learning is seen as one method of achieving this. The first section of this paper outlines a major investigation being undertaken into the area of problem based learning. The purpose of the study is to investigate the integrated problem based learning curriculum of the Bachelor of Construction Management (Building) course at the University of Newcastle (the first integrated program in the construction management area worldwide). The study will explore the philosophy, implementation and evolution of the program and position it in relation to current problem based learning theory and wider trends in higher education. The main thrust in this paper, however, is the critical analysis of contemporary developments in the area of problem based learning, its theoretical basis and the relationship to other educational theories.


Individual Paper
Code: TOO98077
This paper arises from a study of the integrated problem based learning program currently in operation within the Construction Management Degree in the Building Department at the University of Newcastle. The program is unique in the field of Construction Management. The study takes the form of an examination of the philosophy, implementation and evolution of the program, with the particular intention of providing strategic information to guide future planning. A further aim is to 'position' the program in relation to other programs in professional fields and within developments in problem based learning theory in higher education. This major investigation being undertaken into the area of problem based learning will be outlined in the second section of the paper.

The first section of the paper focuses on the problem based learning (PBL) literature in terms of a critical analysis of contemporary developments in the area of PBL, its theoretical basis and the relationship to other educational theories. In exploring theoretical aspects of problem based learning, especially in the study of an Australian Professional Degree program, there is also a need to track current trends in Australian higher education and professional education. These areas have an impact on the future directions of higher education, consequently they are pivotal in the study of an approach to education such as problem based learning.

THE LITERATURE ON PROBLEM BASED LEARNING

Problem based learning has not only developed as a product of practice and theory, but its development has also been influenced by trends and policies in higher education and in the field of professional education.

Developments in Problem Based Learning

The principles of PBL can be traced back to the early teachings of Socrates (Whittaker & Scheiman, 1996). Pioneers of the PBL approach as it is known today were the medical schools of Case Western Reserve University (USA) in the 1950s (Boud & Feletti, 1991) and the McMaster University (Canada) in the 1960s (Albanese & Mitchell, 1993). The learning approach adopted by the McMaster medical school was used as a model for other PBL programs, and is still used today as a benchmark for PBL (Barrows, 1996). Features of the McMaster model of PBL are shown in the figure below.
Barrows and Tamblyn (1980) responded to the need for a 'basic text' in the area of problem based learning at a time when the learning approach was emerging in medical education. Their book provided a rationale for PBL, an orientation for both students and faculty, and a structure for applying PBL in a medical course. They defined PBL as:

> the learning which results from the process of working towards the understanding of, or resolution of, a problem. The problem is encountered first in the learning process. (pp. 1-2)

PBL is therefore an approach to learning that uses a problem to drive the learning rather than a lecture with subject matter which is taught (Woods, 1994). All approaches to PBL represent such a wide variety of methods that the term has much less precision than might be assumed (Barrows, 1986).

As different institutions adopted the PBL approach in existing or new programs what emerged were variations, thus there became a need to distinguish between the differing approaches to PBL. Barrows (1986) developed a comprehensive taxonomy of learning approaches to PBL to help teachers and students appreciate the comparative value of
different PBL methods. Particular PBL methods are often chosen for ease of use, perceived feasibility or low cost without realising educational sacrifices made when compared to other methods. Depending on the educational design of the PBL approach, there are a number of objectives addressed in medical education which are not addressed in more traditional educational courses. The more important objectives are outlined in Figure 2.

<table>
<thead>
<tr>
<th>(SCC)</th>
<th>Structuring knowledge for use in clinical contexts</th>
<th>Education is most effective when undertaken in context of future tasks (Glaser, 1982).</th>
</tr>
</thead>
<tbody>
<tr>
<td>(CRP)</td>
<td>Developing of an effective clinical reasoning process</td>
<td>Problem solving skills including hypothesis generation, inquiry, data analysis, problem synthesis and decision making must be developed in association with acquisition of knowledge.</td>
</tr>
<tr>
<td>(SDL)</td>
<td>Development of effective self-directed learning skills</td>
<td>Allows student to locate and use properly appropriate information sources and to be sensitive to personal learning needs</td>
</tr>
<tr>
<td>(MOT)</td>
<td>Increased motivation for learning</td>
<td>Perceived relevance of work and challenge of solving problems provides strong motivation for learning</td>
</tr>
</tbody>
</table>

**Figure 2: Educational Objectives possible with PBL**

Source: Barrows, 1986.

The intent of Barrows’ proposed taxonomy is to identify the degree to which these objectives are addressed, if at all, in the design or execution of various methods referred to as PBL. Figure 4 summarises these methods in relation to this and also identifies specific variables in each method as outlined in Figure 3. Variables identified are either in relation to the design and format of problems in PBL (m) or the degree to which learning is teacher-directed or learning-centred (o). The possible combinations and permutations of design variables in PBL are endless. The methods in the taxonomy were chosen as they represent varieties which are commonly in use (Barrows, 1986).
<table>
<thead>
<tr>
<th></th>
<th>Complete case or vignette</th>
<th>Partial problem simulation</th>
<th>Full problem simulation (free inquiry)</th>
<th>Teacher directed learning</th>
<th>Student directed learning</th>
<th>Partially student and teacher directed learning</th>
</tr>
</thead>
</table>

**Figure 3**: Variables in problem-based learning methods.

Source: Barrows, 1986.

<table>
<thead>
<tr>
<th></th>
<th>SCC</th>
<th>CRP</th>
<th>SDL</th>
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**Figure 4**: Problem-based learning method varieties - PBL taxonomy.

The degree to which each of the four objectives are addressed by the educational design is estimated by a score of 0 - 5. The scores are used only to indicate the comparative power of each method in relation to the particular objective.

Schmidt (1983) identified seven steps learners involved in the process of PBL need to progress through in order to analyse a problem. Walton & Matthews (1989) have added terms such as 'challenge' and 'encouragement' to the steps (Figure 5) as they feel the steps outlined by Schmidt do not encompass those elements of PBL. The four key objectives or types of learning as identified by Barrows (1986) are used to demonstrate how the steps outlined by both Schmidt and Walton & Matthews can help to facilitate problem based learning. Thomas (1997) uses these steps aligned with Barrows four key learning objectives to define PBL, whilst also analysing literature on problem solving in groups as a component of PBL.

<table>
<thead>
<tr>
<th>Schmidt</th>
<th>Walton &amp; Matthews</th>
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<tbody>
<tr>
<td><strong>Motivating learning</strong></td>
<td>1. Stimulation to attempt to tackle realistic problems in chosen fields.</td>
</tr>
<tr>
<td><strong>Developing effective clinical reasoning</strong></td>
<td>2. Challenge to begin by applying prior knowledge and experience.</td>
</tr>
<tr>
<td>1. Clarify terms and concepts not readily comprehensible.</td>
<td>3. Constant practice of a logical, analytic, scientific approach to problems.</td>
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<tr>
<td>2. Define the problem.</td>
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<td>3. Analyse the problem.</td>
<td></td>
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<tr>
<td>4. Draw a systematic inventory of the explanations inferred from step 3.</td>
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<tr>
<td><strong>Developing self-learning skills</strong></td>
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<tr>
<td>5. Formulate learning objectives</td>
<td>4. Encouragement to identify what is not yet understood or known and to see ignorance as a challenge to further learning rather than as a cause for shame.</td>
</tr>
<tr>
<td>5. Enabling the recognition that nothing is ever learned to finality, that learning in a variety of subjects runs in parallel for application in a mixed, interrelated way, that there exists too much for any one person to learn, that tasks need to be shared between students.</td>
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**Structuring knowledge in clinical contexts**

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<tr>
<td>6. Collect additional information outside the group</td>
<td>6. Development of a practice of exchanging information on the relative value of various sources of information; new learning is shared by presenting it to others, and by interrogating others.</td>
</tr>
<tr>
<td>7. Synthesis and test the newly acquired information.</td>
<td>7. The practice of the application of new knowledge to the original or new problems.</td>
</tr>
</tbody>
</table>

**Figure 5: Steps in Problem Based Learning.**

The four types of learning are those identified by Barrows, 1986.


As PBL became more widespread, contention in the area of PBL arose. One issue was whether problem-based learning would be more appropriately termed problem-focused learning (Margetson, 1993). Other learning methods which are considered variations on the theme of PBL are termed integrated learning, pathway models, project-based learning and case-based learning (Chen, Cowdroy, Kingsland & Ostwald, 1994). Synonyms to the term are 'learning in a functional context', task-dependent learning and problem-generated learning, but the 'term PBL is now so widely used that it would be pedantic, and no doubt unsuccessful, to press for an alternative' (Walton & Matthews, 1989, p. 543).

By the late 1970s PBL had been implemented in tertiary programs all over the world, initially in medicine and health related fields but later in other professional fields. A key work in pulling together the elements of PBL programs and research in areas other than medicine...
and health related science was that of Boud (1985) and Boud & Feletti (1991). These other fields include architecture; psychology; nursing; engineering; business & management; construction management; and optometry. A second edition of the edited book by Boud & Feletti was published in 1997 with updated information regarding PBL programs and directions for PBL. This is an important step in the area of problem based learning as the second edition addresses issues that have developed in the six years between editions.

In comparison to conventional teaching methods PBL is a relatively new educational approach. Sufficient time has not yet passed since the introduction of different PBL models to study the effects of using PBL in higher education in relation to conventional approaches to learning. This is especially true in non-medical professional based programs that have only been operational over the past few decades. There are so many permeations of the PBL approach that it is difficult to know whether those professing to implement PBL are actually doing so. It is also interesting to consider whether the programs are still PBL or whether the program has evolved into some other form or educational model. A suggested alternative may be inquiry based learning (Feletti, 1993).

Problem-based learning in Australian tertiary institutions, or more specifically professional degree courses, has been influenced not only through developments in the problem-based learning area but also by developments in national higher education policy and through trends in professional education.

Current Trends in Australian Higher Education

From the late 1980s market principles and concepts such as privatisation, 'user-pays', client service and competition in relation to Australian higher education institutions were clearly articulated in federal government policy (Meek & Wood, 1998). Clients, or students, expect a quality education in return for the money they invest either upfront or through the Higher Education Contribution Scheme (HECS), which is in effect a form of graduate tax. This involves institutions being more accountable for the courses offered. A focus towards teaching in addition to research is required. Students and the community are demanding quality assurance; outcome and competency based learning and fair assessment procedures.

This emphasis on quality assurance is not only a trend in Australian Higher Education but is characterised by universities worldwide (Higher Education Council, 1992). Reasons include providing a return for the communities which support them and also international competition in attracting overseas students. The question of how quality is measured is difficult to answer. Quality is essentially based on judgements by an individual, and one person's view will differ from another's according to their perspective and values. The Higher Education Council (1992) defined the basic set of characteristics of a quality program as: it is internationally recognised; is competitive in attracting participants to it; and it satisfies
learners' needs. The Council argues that both community and peer assessments and judgements must be involved in the determination of quality. University pedagogy is veering away from the traditional lecture-based, didactic teaching methods in favour of supporting and developing the student's learning.

As the knowledge explosion of the last few decades continues, students need to develop the skills required to find information for themselves and then to apply this knowledge to everyday situations. The focus is not only on learning knowledge to pass a test but also on learning for life. Following the release of the West Report, "Learning for Life", there has been even more interest in the promotion and development of self-directed and lifelong learning skills in tertiary education. The West Review is the fifth major review of Australian Higher Education to be completed over the past 50 years. The four previous reports preceded major growth in the industry and underestimated the extent of growth in enrolments (Coadrake, 1998). The report indicates that the government supports the view that university is no longer about being taught. It is about developing lifelong learning skills that will sustain the student throughout their professional life.

Personal and professional success is increasingly seen to depend upon self-directed lifelong learning, as expanding technology renders knowledge which is taught today obsolete tomorrow. Self-directed Learning is seen as an important skill for students to possess and is becoming a trend in higher education (Kreber, 1998). Promoting the ability of lifelong learning in higher education institutions has been seen as important by administrators and faculty, but according to Kreber (1998) changes have not resulted in the process of higher education to facilitate progression towards this goal.

It is interesting that there is little exploration of problem based learning as an aspect of this trend in higher education in current literature. When searching through journals such as Higher Education and The Higher Education Journal papers on problem based learning are few and far between. It seems, as Kreber (1998) pointed out above, that although there is much discussion about the necessity of tertiary students developing lifelong learning skills there is less action about how this will happen. Indeed with the rapid expansion of the higher education industry it is hard to imagine there being a change from mass lecturing to a learning approach such as PBL which relies on small classes of students. Problem based learning is however being utilised by an increasing number of areas in professional education.

Professional Education

Professional Education can be defined as representing the first step towards entry to a 'profession' (Higher Education Council, 1996). In order to become a professional an individual requires specialist skills gained only by extensive education and training (Curry and Wergin, 1993). There is usually restricted access to professional degree courses, with closely controlled entrance and exit requirements.
Professional education became the province of universities following the turn of the century. After World War II, strong annual growth in the Australian economy resulted in an expansion of the university sector. A criticism of the university sector at this time was that courses needed greater vocational content and that higher education should be more readily available. The Martin Report was commissioned by the government to deal with these issues and its key recommendations were implemented. The result was the emergence of the binary system in the mid-sixties, where separate colleges of advanced education were established to be vocational in orientation whilst the universities concentrated on their traditional role of teaching, research and postgraduate training (Maling & Keepes, 1998).

The colleges of advanced education grew rapidly in number incorporating both the former institutes of technology and many teachers colleges. By the mid-eighties the colleges were offering a wide variety of courses at undergraduate level and also a variety of postgraduate diplomas and degrees. The emphasis on professional courses led to the development of part time courses, evening lectures, work experience and the development of professional practice in professional settings. As the colleges expanded and developed successful courses, universities also diversified their curriculum. As the years of the binary sector progressed the differences between courses offered in universities and colleges of advanced education decreased. In 1988 Dawkins' White Paper, *Higher Education: A Policy Statement* ended the binary divide characterising Australian tertiary education for twenty years and introduced the Unified National System. This paper directed that Australia would be better served by fewer and larger institutions and initiated the amalgamation of the forty seven colleges of advanced education with the nineteen universities, resulting in the higher education system we are familiar with today.

Universities are now a key aspect of entry into the professions. As universities have changed over the years so have the professions themselves. The quantity of knowledge required for professional practice has led to the undergraduate curriculum being viewed from an increasingly instrumentalist perspective and has reduced the capacity for critical thought amongst graduates (Aldred, Aldred, Walsh & Dick, 1997). There is growing recognition that contemporary professional life requires skills that cannot be developed in a traditional style of university course. The Aulich Report (June 1990) was very critical of universities claiming they produced graduates in the profession who all too often were 'not analytical, creative thinkers, whose education does not provide the basis for adequate flexibility, who are not sufficiently attuned for the need for "lifelong learning", and who are not good communicators' (p.viii). There is evidence from the Discipline Reviews (also quoted in the Aulich Report) that employers are not just looking for subject competence, but for transferable skills and sensitivity to social contexts (Moses & Trigwell, 1993). One response to these concerns has been the introduction of problem based learning (PBL) into professional education.

Professional education is partly regulated from outside the university (Marginson, 1997). Accreditation bodies of professions such as the Australian Institute of Builders (AIB) in the Construction Management industry have control over what up and coming professionals are being taught at university. There has been an increase in the value of competency standards in the professions, which has influenced learning outcomes of tertiary institutions also.
The link between universities and the professions is complex and changing rapidly. There is a greater application of quality assurance processes both within the universities and within the professions themselves. The professional bodies believe they should have greater involvement in determining the minimum level of requirement for entry into the profession. Demands are placed on universities regarding entry level course content and structures by the professional bodies who advocate the professional graduate must have certain levels of competencies in order to work in the profession. Increasing moves for requirements of professional practice to be based on competencies rather than completion of an entry level qualification have the potential to change the future relationships between the professional bodies and the universities, and may lead to a greater focus on outcomes rather than inputs (Higher Education Council, 1996). This is an advocacy for problem based learning which focuses on developing the skills and outcomes of the student.

**Theoretical Basis of PBL**

There is no definitive document which outlines where the concept of problem-based learning developed in relation to educational theory. It appears that the learning approach is derived from a number of educational theories developed through the practice of PBL in innovative medical programs (specifically the McMaster and the Case Western Reserve programs). Key studies which have focused on the educational theory overlying problem based learning include Schmidt (1983), Savery & Duffy (1995), Barrows (1985) and Coles (1985, 1997). This section will explore those studies whilst also investigating other similar or contradictory theories.

Schmidt (1983) suggests that an information-processing orientation supports problem based learning by citing prior knowledge, encoding specificity and elaboration of knowledge. Processing in the information-processing model involves encoding (gathering and representing information), storage (holding information) and retrieval (getting at information when needed). A key aspect (which is addressed by PBL) is the gaining of student attention. Students will not be able to process something they do not recognise or perceive, so presenting a student with a real-life, relevant problem at the beginning of learning gives the student reason to pay attention to what follows so that they will have a better chance to solve the problem.

Once information in the sensory memory is noticed and transformed it is temporarily held in working memory. Information must be kept activated in the working memory through maintenance rehearsal or transferred into long-term memory by being connected with information already stored in long-term memory (elaborative rehearsal). The way one absorbs information in the first place affects how one remembers it later. Elaboration is the addition of meaning to new information through its connection with already existing knowledge. Problem based learning requires students to use elaboration as they are asked to translate information into their own words and apply information to problems. This insures
that students have a deeper understanding of material and ensures easier retrieval from long-term memory.

A recent alternate view of the information processing model is the connectionist model which assumes that all knowledge is stored in patterns or connections amongst basic processing units in the brain (Woolfolk, 1998). Connectionist models can explain the slowly developing, incremental, ever-changing nature of human learning - not just the recall of information. As connections are constantly adjusted, learning occurs. Metacognition, having knowledge about knowledge, has a key role to play. Metacognition involves knowing what to do in performing a task, knowing how to use strategies and knowing when and how to apply these strategies. Students become aware of their own metacognition through planning, monitoring and evaluating.

Today there are two related challenges to the information processing perspective - constructivism and situated learning. Grounded in the work of Piaget, Vygotsky, Bruner, Bartlett and Dewey, the constructivist orientation emphasises the individual's active construction of meaning. The focus is on meaning making and knowledge construction. There are many constructivist theories but they can be categorised into three groups: exogenous theories that include information processing and focus on "constructing" an accurate representation of external reality; endogenous constructivism that emphasises transforming internal cognitive structures to construct unique personal understandings; and dialectical constructivism that asserts that both internal cognitive structures and external factors are important in constructing knowledge (Woolfolk, 1998). Situated learning, like dialectical constructivism, emphasises the importance of physical and social contexts in learning. Figure 7 summarises different aspects of the categories along with the behavioral view of learning and identifies key work in each area. In aspects of knowledge, learning, teaching, and in role of the teacher, student and peers, problem based learning reflects the dialectical constructivism or situated learning view of learning which is evident in the work of Vygotsky.

Savery and Duffy (1995) explore the links between the instructional model of problem-based learning and a constructivist framework. They identify and elaborate on eight instructional principles for the design of a constructivist learning environment and outline the problem based learning model described by Barrows (1985, 1986) as the best example of this type of learning environment. A constructivist framework is used by a number of authors to underlay the problem based learning approach (Creedy, Horsfall & Hand, 1992).

Contemporary learning theorists argue there is danger in equating learning solely with its practical value. There is a possibility that students will become focused on only learning what is needed to solve the problem, with professional practice becoming a series of problematic situations that can be interpreted and resolved by using existing schema and available routines. An alternative approach is 'idea based social constructivism' where there is less focus on problems and more on the teaching value of concepts. In this way classroom simulations of professional practice and practical work experience work together to stimulate inquiry (Boud & Feletti, 1997).
Barrows (1985) argues following Bruner's theory of discovery learning which suggests that learning is enhanced when students actively participate in the process and when learning is based around a problem. PBL was first linked with 'discovery learning' in Barrows & Tamblyn (1980). Barrows argues that medical students can not adapt knowledge learned through conventional means as knowledge is structured into mental organisations which are not useful to practice. He proposes that by structuring knowledge around real-case situations such as a particular illness or symptom then it will be easier to retrieve when needed in clinical practice.

Coles (1985) equates problem-based learning to contextual learning theory. This is justified by using a medical case as an example. The three elements of the contextual learning model are: the context of learning; information; and opportunities for handling the information. This model relates closely to experiential learning (Kolb, 1984). Coles (1997) further emphasises the importance of a contextual model and in fact prefers the model to PBL, suggesting that PBL be abandoned and conventional courses be adapted to evolve in terms of contextual learning.

As proposed by Hughes Caplow, Donaldson, Kardash & Hosokawa (1997) problem based learning has multiple and overlapping theoretical foundations. The study discussed the medical school model of PBL and related the foundations of information processing theories, constructivist perspectives and co-operative learning. As illustrated in Figure 6 problem based learning is influenced by many theories, some of which overlap or are contested by theorists themselves.
**Figure 6: Theoretical Influences on PBL**

**KEY:** Contributing theorist Ideas of one influence the other.

Theory Ideas connect with one another.

<table>
<thead>
<tr>
<th></th>
<th>Behavioural Constructivism</th>
<th>Exogenous Constructivism</th>
<th>Endogenous Constructivism</th>
<th>Dialectical Constructivism/ Situated learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge</strong></td>
<td>Behavioural</td>
<td>Exogenous</td>
<td>Endogenous</td>
<td>Dialectical</td>
</tr>
<tr>
<td></td>
<td>Skinner</td>
<td>J. Anderson</td>
<td>Piaget</td>
<td>Vygotsky</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td>Fixed body of knowledge to acquire</td>
<td>Fixed body of knowledge to acquire</td>
<td>Changing body of knowledge, individually constructed in social world</td>
<td>Socially constructed knowledge</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td>Stimulated from outside</td>
<td>Stimulated from outside, Prior knowledge influences how information is processed</td>
<td>Built on what learner brings</td>
<td>Built on what participants contribute, construct together</td>
</tr>
<tr>
<td><strong>Learning</strong></td>
<td>Acquisition of facts, skills, concepts. Occurs through drill, guided practice</td>
<td>Acquisition of facts, skills, concepts and strategies. Occurs through the effective application of strategies</td>
<td>Active construction, restructuring prior knowledge. Occurs through multiple opportunities and diverse processes to connect to what is already known.</td>
<td>Collaborative construction of socially defined knowledge and values. Occurs through socially constructed opportunities</td>
</tr>
<tr>
<td><strong>Teaching</strong></td>
<td>Transmission Presentation (Telling)</td>
<td>Transmission Guide students towards more 'accurate' and complete</td>
<td>Challenge, guide thinking towards more complete understanding</td>
<td>Co-construct knowledge with students</td>
</tr>
<tr>
<td>Role of teacher</td>
<td>knowledge</td>
<td>Role of peers</td>
<td>knowledge</td>
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<tr>
<td>Manager, Supervisor.</td>
<td>Teach and model effective strategies.</td>
<td>Co-facilitator, Co-participant.</td>
<td>Co-construct different interpretation of knowledge; listen to socially constructed conceptions</td>
<td></td>
</tr>
<tr>
<td>Correct wrong answers</td>
<td>Correct misconceptions</td>
<td>Not usually considered</td>
<td>Not necessary but can stimulate thinking, raise questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not necessary but can influence information processing</td>
<td>Ordinary part of process of knowledge construction</td>
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<table>
<thead>
<tr>
<th>Role of student</th>
<th>knowledge</th>
<th>Role of students</th>
<th>knowledge</th>
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<tbody>
<tr>
<td>Passive reception of information</td>
<td>Active processor of information, strategy user</td>
<td>Active thinker, explainer, interpreter, questioner</td>
<td>Active social participator</td>
</tr>
<tr>
<td>Active listener, direction-follower</td>
<td>Organiser and reorganiser of information</td>
<td>Active construction (within mind)</td>
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<td></td>
<td>Rememberer</td>
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**Figure 7: Four Views of Learning.** Note - there are variations within each of these views of learning that differ in emphasis. Source: Woolfolk, 1998. Page 281.

**An Analysis of the Sources of the PBL Literature.**

Sources of literature in the area of problem based learning are journal articles, edited books and authored books. This paper draws on such published sources. Others include evaluative studies of the literature, conference papers and the Internet. In particular the papers for the Problem Based Learning Conference held by the Problem Based Learning Network - Research and Development in PBL have a wide variety of contributors from different professions. It is evident that PBL is emerging as an approach for primary and secondary education but due to the need to focus on a particular body of research the learning approaches used in these areas will not be investigated. In the study, and in this paper, PBL will be explored in the tertiary setting only.
There is a large body of research in the problem based learning area. Of this body a significant proportion is based in the field of medicine and health sciences. Published articles on the subject are found in journals such as Medical Education, Academic Medicine, Medical Teacher, Journal of Optometric Education, Optometric Education, Australian Journal of Advanced Nursing and the Journal of Nursing Education. In the mid-80s those interested in adopting a problem based learning course had to rely more on the stated philosophy and unique experiences of a handful of institutions than on robust curriculum evaluation data. Since then, there has been a greater emphasis on empirical research and reviews, plus recognition for the need of good qualitative studies (Boud & Feletti, 1997).

In recent numbers of the journal Medical Education there are at least one or two articles on problem based learning in each edition with particular focus on empirical research studies. As the PBL approach in medicine matures there are more studies being carried out to test student perceptions and attitudes (Hughes Caplow, Donaldson, Kardash & Hosokawa, 1997; Hill, Rolfe, Pearson & Heathcote, 1998; Birgegard & Lindquist, 1998; Bhattacharya, 1998; Kaufman & Mann, 1997); outcomes of the approach (Albanese & Mitchell, 1993; Thomas, 1997); effectiveness of problems (Mpofo, Das, Murdoch & Lanphear, 1997) and tutor expertise (Kaufman & Holmes, 1998).

In contrast there are few journal articles in key education journals such as Studies in Higher Education, Higher Education Review, Higher Education Research and Development, Educational Technology, Assessment and Evaluation in Higher Education, Australian Educational Researcher and New Directions in Teaching and Learning. Of the journal articles found in key education journals, most are descriptive rather than empirical in nature. The major source of information in professional fields other than medicine or health related science are conference papers and edited books (Boud & Feletti, 1997; Chen, Cowdroy, Kingsland & Ostwald, 1994; Boud, 1985). Problem based learning is not a term used in current education handbooks. The Encyclopedia of Education, the International Encyclopedia of Education, Blackwell’s Handbook of Education, the Penguin Macquarie Dictionary of Australian Education and The Facts on File Dictionary of Education have no mention of Problem Based Learning. The Australian Education Index has only used problem based learning as a key term since 1993.

There is significant difference between the numbers of journal articles found in medical and health based science journals and those found in educational journals (see Graph 1 below). The numbers for the graph are taken from articles found in the journals mentioned above.
Graph 1

Literature in problem based learning may generally follow the trends in professional education literature. The Encyclopedia of Educational Research states the following regarding professional education literature. "It is virtually all profession-specific and, within each profession, it consists primarily of studies conducted within individual institutions...of the professions, the research arena is still dominated by health profession education, particularly medical education" (Encyclopedia of Educational Research, 1992, p.1059). As illustrated previously in this paper, problem based learning literature is also dominated by medical education literature. In addition, as different professions take on the PBL approach, it is possible that instead of reporting research through educational journals, they will follow this trend and report back to individual institutions or to journals specific to that profession. This will be further investigated in the study of the Construction Management Degree at the University of Newcastle.
Construction Management

The first Degree programs in Construction Management (or Building as it was formerly known) were introduced to Australian Universities in the late 1950s. CM is a fast growing profession, with recent graduates in high demand in the construction industry. Construction Management is defined in very loose terms by the Royal Australian Institute of Architects (RAIA) as 'a generic expression covering any form of management of building or engineering construction activities' (Standen, 1993, p.121). The mainstream activities of a construction manager centre on the management of the construction process through all phases of a building's lifecycle, beginning with the initiation phase through to the management of the building as a facility. In essence the construction manager is a hands-on manager, much of whose role is taken up with the solution of problems to do with people and buildings. The range of skills and abilities of the construction manager are extensive, encompassing at one end of the spectrum physics and building science, through to industrial relations, economic and political issues.

The challenge for educators and curriculum designers in CM is to create a learning environment that captures the knowledge base of CM in what is a rapidly moving and rapidly changing environment. There is also the added challenge of integrating discipline areas into a single knowledge base. Much of the Construction Manager's work entails the coordination of discipline experts - the construction management does not need to know how to carry out complex calculations of building structures however he/she does need to know how to integrate and coordinate the input of the expert structural engineer.

Construction Management at Newcastle

The University of Newcastle Construction Management undergraduate course was introduced in 1991 with the enrolment of its first student intake. The Department of Building was established under the umbrella of the Faculty of Architecture. The Newcastle Construction Management undergraduate degree was the first degree with an integrated problem-based learning curriculum worldwide in the construction management area. The Department developed its own specific version of the model of problem based learning which the University of Newcastle uses in a number of academic programs in other disciplines. The program aims to produce graduates equipped for the building industry as lifelong learners able to solve problems with technical proficiency. The Bachelor of Building (Construction Management) is presently the only undergraduate course offered by the
Department of Building, in internal or external mode. Students taking this course complete an honour year that involves completing a minor thesis. The Department consists of ten staff members and approximately 240 students (120 internal and 120 external).

The course was initially developed by a small number of staff for a pilot group of students. As student numbers increased the course expanded, necessitating the employment of more staff. The present course structure has been in operation for seven years. During this period curriculum development has been ongoing and directed towards industry standards. The CM curriculum caters for the needs of students, the community and accreditation committees. Graduates qualify for accreditation by both the Australian Institute of Building (AIB) and the Australian Institute of Quantity Surveyors (AIQS).

The approach taken by the Department of Building at Newcastle was to define four notional bodies of knowledge (subject areas) - communication, technical studies, economics and management - which comprise the integrated problem-based learning curriculum. Students take a one year subject that consists of a number of phases varying in duration. The program covers fifteen phases over four years. Each phase has a theme that provides a focal point for a number of issues directly related to construction management. Phase objectives are developed which are appropriate to each theme and integrate the four subject areas into the phase.

Research Questions

The research questions arising from the study can be divided into six categories: problem based learning; problem based learning in construction management; philosophy; implementation; evolution; and future directions. The research questions are outlined below in appropriate categories:

1. **Problem Based Learning (PBL)**

   What are the current trends in higher education? Where does PBL fit in? Are educational theories in evidence in the PBL literature?
2. **Problem Based learning in Construction Management**

Which educational theories are evident in the Construction Management curriculum? To what extent is the Construction Management course modelled on other PBL courses? Is the delivery of Problem-based Learning in Construction Management consistent with the predominant educational theories evident in other PBL courses?

3. **Philosophy of the Construction Management program**

What is the curriculum of the Construction Management course? Is the essential philosophy of the Building Department evident in the curriculum? How visible are all aspects of the Construction Management curriculum? Are some aspects hidden and what aspects are documented in their entirety?

4. **Implementation of the Construction Management program**

Are there any significant differences between the documented Construction Management course and the actual implementation of the course? What can be said of the central focus, that is aims, of the department? Do all staff members share this focus? To what extent do they differ and in what ways? In order to deliver PBL what teaching practices were regarded as most appropriate initially? Do assessment procedures reflect the problem-based learning approach?

5. **Evolution of the Construction Management program**

Did teaching practices change as the course developed? Has the essential philosophy of the course remained the same for all seven years of the course? Have assessment procedures remained the same for all seven years of the course? Are new staff members to the course provided with a sound foundation in problem-based learning?
6. **Future Directions for this research area**

How effective do those involved in this program perceive it to be? How do the following groups of people perceive the content and effectiveness of the course? Community; students; building industry.

**About the Study**

The primary data collection strategy is document analysis. The primary source of material is curriculum policy and other documentation (including personal files/correspondence). After thoroughly examining all documentary materials, gaps and new questions will emerge (and already have). As a result there will be a need to undertake interviews. Several in-depth interviews of key informants such as the foundation members of the program and lecturers will be conducted. Group interviews will be held with the initial group of staff involved with the implementation of the program to generate discussion on key issues and to cue the memories of those involved in earlier aspects of the program. It is possible that focus group interviews may be utilised if there is an issue that needs clarification. Participation in interviews and sharing of documents by members of the Department is voluntary. In addition, interview transcripts will be given to the interviewee to read, check details and adapt if necessary.

Data analysis of the documents and interviews will be conducted simultaneously with data collection. Analysis will be ongoing and involve the use of multiple databases and spreadsheets. Coding procedures will be such as those described by Tesch (1990) and will involve looking for themes rather than specific words in the text. At this stage it is envisages the coding process will be a mechanical one, rather than one that utilises specialised qualitative data analysis software.

This study takes a two-pronged approach which meets two key needs in the field of PBL: a study of the literature in educational terms - what is PBL and how was it conceived; and describing and explaining a particular case-study of a program in terms of philosophy, implementation and evolution. These two approaches will lead to a strategic outcome contributing to the planning of the construction management program and recommendations which can be applied more generally to future studies in the area of PBL.
CONCLUSION

Leaders in the field of professional education recognise that in the late twentieth century professional practice requires skills that cannot be developed in a traditional style of university course. It is generally advocated in the field of construction management that today's professionals need to be equipped with self-directed learning strategies to help them cope with the knowledge explosion of the last twenty years. Problem based learning is seen as one method of achieving this.

REFERENCES


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