Assessment

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A Briefing on Assessment in Problem-based Learning

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Summary

This briefing examines some of the main principles of assessment as applied to problem-based learning (PBL). In particular, the need to ensure alignment between the objectives and student learning outcomes of the course, the learning environment and assessment methods is stressed. A number of assessment methods have been developed specifically within the PBL community whilst others have been adapted for the context. A main characteristic of PBL is that it allows learning to occur in a practice-based or professional context, wherever possible. It follows that assessment should also reflect this characteristic rather than merely testing for the acquisition of knowledge. The primary audience for this briefing is teaching staff from all disciplines and from all types of institutions. Given the international interest in assessment of problem-based learning, this should have a broad appeal. A secondary audience would include staff and educational developers who support those introducing it into their teaching. The briefing is also expected to be useful to those involved in the leadership and management of higher education as it will offer them an overview of the issues in this field.

Introduction

Problem-based learning (PBL) is becoming widely used across a considerable range of subjects and professional areas in higher education following its introduction into medical education in the 1960s. Much has been written about approaches to PBL, curriculum design, the role of the tutor and various other aspects but much less attention has been given to assessment in PBL. The result is that difficulties are emerging as many people retain the assessment methods they used in their traditional approaches resulting in a misalignment between their objectives and student learning outcomes, the learning and teaching methods adopted and the assessment of student learning.

This briefing draws on the others in the LTSN Generic Centre Assessment Series, particularly that by Peter Knight on Key Concepts, as well as establishing some additional principles of assessment for problem-based learning contexts.

Before explaining PBL as a concept, it is worth making the point that the word 'problem' itself has proved problematic for many potential users. 'Problem' to some may imply 'solution' which, as we will see, is not the real point of PBL. Alternatively, other people have objected to the word 'problem' because it is seen, particularly in health related areas, to have negative connotations related to someone's state of health and well being. As a result some have used alternative terms such as concept, enquiry/inquiry, theme or context-based learning and instead of using 'problems', have described them as triggers, scenarios, tasks, queries or cases. However, what is common to all is the notion that the problem situation is located centrally in the curriculum and is designed to provide the focus, stimulus or motivation for student learning.

What is problem-based learning?

In problem-based learning the focus is on organising the curricular content around problem scenarios rather than subjects or disciplines. Students usually work in groups or teams to solve or manage these situations but they are not expected to acquire a predetermined series of 'right answers'. Instead, they are expected to engage with the complex situation presented to them and decide what information they need to acquire and learn and what skills they need to gain in order to manage the situation effectively. Many people have asked us about the relative importance of teams and why students in problem-based learning should be expected to work in teams. We argue that in life we invariably have to work in teams yet there is little in our school and university systems that equips us for this. Investment in team learning would seem to us to be a vital component of higher education – one that we should embrace – and problem-based learning can help us to do just that (Savin-Baden, 2003).

There are many different ways of implementing problem-based learning but the underlying philosophies associated with it as an approach are broadly more student-centred than those underpinning traditional problem-solving learning. This is because students are offered opportunities, through problem-based learning, to explore a wide range of information, to link the learning with their own needs as learners and to develop independence in inquiry.

The early literature on PBL reflected the fact that much of the original development was in medical education at institutions such as McMaster University in Canada, Maastricht University in the Netherlands, Linköping University in Sweden, and Newcastle University in Australia. Although some would suggest that it has been used in Art and Design for some time, others have suggested that what is predominantly used in these areas is actually problem-*solving* learning. What is important in this debate is to recognise that it is possible to trace the origins of problem-based learning back to early forms of learning such as Protagoras (and later Aristotle) and the approach was popularised by McMaster Medical School in the 1960s (Major *et al.* 2000). However, the approach has subsequently been taken up in many other areas of professional education such as engineering, architecture, law, social work, business and management and other professions allied to medicine such as nursing and physiotherapy (Boud and Feletti, 1997). Additionally, PBL is now being adopted in areas such as computing sciences, history, English literature, physics, carpentry and food sciences.

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Many lecturers express concern that their students will not be able to adapt to the more self-directed approach to learning required in PBL. Whilst some may find the transition difficult, most students easily adapt to PBL especially with appropriate support from a committed tutor. (For detailed perspectives on the student experience see Savin-Baden, 2000.) Many students find PBL motivational as they realise that it is really about how they learn outside the classroom (Macdonald, 2001) and when they see that they are dealing with scenarios they are likely to encounter in their future professional practice. However, the same will not necessarily be the case with lecturers, who may find the adjustment more difficult (Toohey, 1999). The shift from the 'expert role' determining how a body of knowledge will be learned to a facilitator role where the students have to take greater responsibility for what they learn, and even how their learning is evidenced, may prove very uncomfortable. It is very difficult for some tutors to 'let go' and to stop providing answers to the questions when those very questions provide the basis for students' learning activities.

There are also claims that certain groups find it difficult to adapt to the group-based learning which is a feature of most PBL experiences. However, the following quote – which could equally apply to any attempt to introduce PBL – is pertinent:

One of the most important measures to be learned from the Hong Kong experience is that students seem to have less difficulty adapting to a PBL curriculum than do academic staff. We found that students' ability to transcend their cultural inhibitions and prior educational experiences was related to how well the conversion was managed. The challenge, therefore, lies in properly managing the process of curriculum reform (MacKinnon, 1999).

In the introduction to the second edition of their book, Boud and Feletti (1997) note some changes in PBL since the first edition six years earlier, not least the fact that the different context of many disciplines has led to different approaches to PBL and the use of different terms to describe it. This evolution has also encompassed students from a much wider ability range than those traditionally found on medical programmes, with a consequent need to review the level of tutor support and resource availability and to make assessment clearly understandable.

Readers wishing to find out more about PBL are directed to our references or to use 'problem-based learning' in any of the major web search engines such as Google or AltaVista.

Some principles of assessment in PBL

Assessment in problem-based learning requires no less thought and care than it does under other approaches to learning and teaching. However, there are many examples of where assessment has been out of alignment with other aspects of the curriculum. Biggs (1999), amongst others, stresses the need to align curriculum objectives, teaching and learning activities and assessment tasks, particularly where the intention is to encourage deep, rather than surface, approaches to learning. Using PBL as a prime example of alignment, Biggs paraphrases Kingsland (1995):

The essential feature of a teaching system designed to emulate professional practice is that the crucial assessments should be performance-based, holistic, allowing plenty of scope for students to input their own decisions and solutions (Biggs, 1999, p.210).

This, Biggs argues, requires criterion, rather than norm-referenced assessment, adopting a much more holistic and divergent approach, involving a lot of peer and self-assessment, as we will see later. Heywood (2000) reports on a study at Southern Illinois University where students were critical of courses using a problem-based approach and then only a factual recall for assessment. This is not uncommon. The authors of this briefing had a (scripted) public disagreement at a recent conference as to the use of examinations in PBL, with the one supporting them in the belief that examinations can still be problem-based, the other feeling that they have no place in a practice-based experience. This perhaps highlights the point made by Boud and Feletti that PBL has now become a much broader phenomenon than originally designed.

It has become commonplace to hear lecturers claim that students will not do any work unless it is being assessed – by which they often mean graded. However, as Knight (2001) notes, assessment for summative purposes is seen as being of such high stakes that those being assessed see it as being in their own interests to play up what they do know or can do to cover up as much as possible what they do not know or cannot do. In problem-based learning, where students have to make statements about what they already know and can do and where there are gaps in their knowledge and competence, assessment needs to be developed which encourages learners to be open and honest. So, whereas Knight suggests that it is through formative assessment that students can disclose their shortcomings (p.10), in PBL learners may be rewarded summatively for identifying learning needs and reflecting on areas for further development without these being seen as personal shortcomings. As we will see later, it is through peer, self and collaborative assessment that students are able to make judgements about how well they are learning and not just how much they have learned.

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Knight's section on the four assessment concepts of reliability, validity, affordability and usability are also particularly pertinent. For example, in saying that, for assessment to be reliable, we expect it to be objective, accurate, repeatable and analytically sound:

Although these routines might produce 'objective' data, they often fail, say their critics, to reflect the complexity of human achievements (p.11).

Further:

The need for reliability pushes us towards certainty and simplicity but modern higher education curricula value complex, fuzzy achievements exemplified by soft skills, autonomy, creativity, incremental self-theories, interpersonal fluency, etc. (p.13).

This might equally apply to the knowledge, skills and attitudes expected of students in a problem-based context.

Woods (2000) who uses PBL in his Chemical Engineering courses at McMaster University in Canada, defines assessment as 'a judgement based on the degree to which the goals have been achieved based on measurable criteria and on pertinent evidence' (Woods, 2000, p.21). He contends that the definition can be best applied by breaking it down into five principles:

1. Assessment is a judgement based on performance – not personalities.

2. Assessment is a judgement based on evidence, not feelings. Whatever our intuition about a student's abilities, we need evidence.

3. Assessment should be done for a purpose with clearly defined performance conditions.

4. Assessment is a judgement done in the context of published goals, measurable criteria and pertinent, agreed-upon forms of evidence.

5. Assessment should be based on multidimensional evidence: static and dynamic situations; small assignments and lengthy projects; academic, social and personal contexts; under a variety of performance conditions; formative and summative data and with different persons being the assessors.

From these principles Woods lists six issues in practice, which need to be addressed:
- goals or what is being assessed

- criteria relating to the goals

- forms of evidence consistent with the criteria

- resources to enable evidence to be collected in the available time

- the assessment process, and

- training in the assessment process.

This latter aspect is important because it is often assumed that both students and assessors are competent and confident in the assessment process and this is often far from the case. For example, in giving peer feedback, are students able to comment on the performance they see without making it a judgement on the other person?

If you want to work with a set of principles to guide you in assessing students in PBL you might start with some of the following:

• Assessment should ideally be based in a practice context in which students will find themselves in the future – whether real or simulated.

• Assess what the professional does in their practice, which is largely process-based professional activity, underpinned by appropriate knowledge, skills and attitudes.

• Assessment should reflect the learner's development from a novice to an expert practitioner and so should be developmental throughout the programme of studies.

• Students should begin to appreciate and experience the fact that in a professional capacity they will encounter clients, users, professional bodies, peers, competitors, statutory authorities, etc. who will, in effect, be 'assessing' them.

• Students should also be able to engage in self-assessment, evaluation and reflection as the basis for future continuing professional development and self-directed learning.

• As lecturers, we need to ensure that there is alignment between our objectives and the students' anticipated learning outcomes, the learning and teaching methods adopted, and the assessment of learning – strategies, methods and criteria.

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Thinking strategically about assessment

As well as ensuring that our assessment is aligned with the course objectives and the learning and teaching approach adopted, in this case PBL, it is important to ask ourselves a series of questions when planning how to assess students:

Why are we assessing the students?

- to support learning
- to measure learning and provide certification
- assure standards

Whilst the second purpose of assessment tends to dominate, not least in the students' minds, the third is increasingly required by external agencies, but it is the first that should be foremost in our minds.

What are we assessing?

Traditionally, assessment has been about finding out how much students know, usually in terms of knowledge or content. Increasingly, skills are seen as being important for students' future employability. Attitudes and values have also been added to the list. However, in PBL what we are really interested in is the students' ability to perform in a professional context, to recognise their need to acquire new knowledge and skills, and to view learning holistically rather than atomistically.

When are we going to assess?

Experience has often shown that if we adopt the 'big bang' approach to assessment at the end of a course, students will spend most of the class time trying to spot cues as to what they will be assessed on and, preferably, the answer that the lecturer wants! A variety of continuous assessment methods have been used in PBL including the 'Triple jump'.

Who is going to carry out the assessment?

As we are giving greater responsibility to students for their own learning, then it makes sense for them to take more responsibility for judging whether they have achieved the learning goals and provided appropriate and adequate feedback. Similarly, given that they will be working with peers, supervisors, clients, etc. in professional capacities, and assessment is matching the contexts in which professional capability will be demonstrated, the range of those involved in assessment and providing feedback needs to be extended.

How are we going to assess?

In the next section we look at a number of approaches used in PBL but you might also wish to consider how to modify or adapt other approaches. However, it is important to look across the whole programme to ensure balance and variety in the types and timing of assessment (Knight, 2000). Where

PBL is being used on a whole-course, totally integrated basis this is less of a problem than where students are taking a number of units or modules at the same time.

How are we going to grade/mark?

Many PBL courses use Pass/Fail with a consequent greater emphasis on the feedback. Knight (2001) in this series examines some of the problems with grading, not least if a norm-referenced approach is adopted. It is also worth asking why we are giving marks other than to aggregate them in a highly dubious process to arrive at degree classifications! Biggs (1999) refers to the SOLO (Structure of Observed Learning Outcomes) taxonomy as a way of grading and as an alternative to Blooms' hierarchy of educational objectives - knowledge, comprehension, application, analysis, synthesis and evaluation. SOLO has five levels or stages which can be used to gauge students' understanding of a topic:

prestructural, unistructural, multistructural, relational and extended abstract (Macdonald, 1999).

What feedback will students receive?

Will it be timely enough and sufficiently forward looking as to help them move forward rather than just look back? Traditionally, students have received little or no feedback on the major component of their assessment – examinations – adding to the pressure and providing even less of a learning, and more of a measuring, purpose. Engaging with assessment criteria, and the use of self and peer assessment, will help improve the quality of feedback.

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Methods of assessment in PBL

To date, research has been undertaken on assessment in the field of PBL to ensure that the assessment of the students' performance in PBL is consistent with the teaching method and to establish the effectiveness of PBL; in particular to establish that students are acquiring abilities in problem-solving and professional competence.

Although studies in the area of assessment are becoming more student-centred, many courses (particularly in the field of medicine) still see assessment as predominantly a measurement activity. PBL courses of the future, which seek to make assessment more learner-centred, will need to offer students mechanisms to develop self-assessment skills in conjunction with knowledge of the subject matter being studied. Thought will therefore need to be given to who does the assessment (self, peers, tutor), what is being presented for assessment (presentations, reports, observations of practice) and the criteria being used with regard to process (how well the learning took place) and outcomes (what has been learnt in terms of knowledge, understanding, skills, etc). Consideration will also need to be given to the requirements of professional bodies in areas such as health care, law and engineering where standards/norms may differ from those traditionally used in higher education.

Furthermore, assessment in PBL courses will primarily need to focus on how students integrate the whole learning process (including assessment) as distinct from what has actually been learned (Savin-Baden,

2000). The following section lists some of the forms of assessment that have been used successfully with PBL and which also move away from the need to have outcome-based examinations:

1. Group presentation

Asking the students to submit their work orally or in written form as a collaborative piece models the process of PBL but is difficult to mark. Is content, process, presentation or a combination of these being marked?

2. Individual presentation

Here students are asked to submit the component of work that they have researched for their contribution to the overall solution or management of the problem scenario. This has some of the problems of the above and if the students just present the component they have researched there is little synthesis over all with the problem scenario. This is also time consuming with large cohorts.

3. Tripartite assessment
(Savin-Baden 2003)

This has three components!
a)   The group submits a report for which they receive a mark.
b)   The individual submits the piece of work they researched .
c)   The individual writes an account of the group process that is linked to the theory of group work.

These three components are added together to form the overall individual mark. The advantage of this is that it does not privilege some students who do less work and an individual student will be responsible for gaining two-thirds of the marks. As a result, most students perceive this kind of grading as being fair.

4. Case-based individual essay

Here the student is presented with a case scenario which they respond to in the form of an essay. Students may be given a choice of scenarios from which to choose and the level of detail and complexity can vary from year to year. This links well with PBL but still tends to focus largely on cognitive abilities (unless students are allowed to use narrative style essays).

5. Case-based care plan based in clinical practice/client-led project

Here students are presented with a real-life scenario to solve/manage for a client. One group of engineering students was given a bunch of coconuts and asked to design an effective tool to remove both the flesh and the milk. Another set of students was asked to work out how to resolve the difficulty of cracks occurring in railway lines crossing Central Australia caused by the excessive heat and train vibration. These are very effective but must be criterion referenced and therefore are disliked by some staff and external examiners if the criteria are perceived to be too broad.

6. Portfolio

These can be unwieldy if not managed well and are difficult to mark. They are fine if they are well designed. Portfolios have been used in a number of programmes that educate students for the professions. In recent years, the requirements for these have been refined down from a vast quantity of materials towards a slenderer version that offers greater reflection and criticality than before. Attention must be paid to setting criteria to ensure there is a requirement to create an overall synthesis.

7. Triple jump
(Painvin et al, 1979; Powles et al, 1981)

This is an assessment that has been specifically developed for PBL, but it is time consuming and costly and tends only to be used in well-funded programmes with small student numbers. The 'Triple jump' exercise has three phases: hop, step and jump. In the hop phase the tutor questions the student, thus they are caught on the hop. The step phase allows the student time to research the findings and hypotheses that have emerged from the hop phase. In the jump phase they are expected to provide the tutor with a written report of their findings.

8. Self-assessment

This works well with PBL, but students must be equipped to undertake it. Self-assessment allows students to think more carefully about what they do and do not know, and what they additionally need to know to accomplish certain tasks. Confusion arises in many courses in

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understanding the difference between self, peer and collaborative assessment (but we discuss this below).

9. Peer assessment

A good fit with PBL. Providing students with an assessment rubric often helps guide the peer evaluation process even better. This kind of assessment also emphasises the cooperative nature of the PBL environment.

10. Viva voce examinations

These were used very effectively before PBL was widely in use and have since been adopted by several curriculum designers for use with PBL. However, they are best done in practice situations and, although they are very effective, they can be costly, time consuming and extremely stressful for the student.

11. Reflective (online) journals

These have worked well in engineering and health. Students hand them in each week and receive a mark at the end of each term/semester. Students tend to be more open and honest about their learning than one would expect and these can be criterion referenced.

12. Facilitator/tutor assessment

There is much debate globally about this type of assessment because if the group facilitator is also the assessor, it tends to affect the power dynamics in PBL tutorials.

Even if the facilitator uses formative assessment, students tend to rely on the facilitator and find it difficult to become independent in inquiry. It is usually better for assessment in PBL to be done anonymously, as in most other assessment. If assessment of group process is to be undertaken then this is best done by someone other than the group facilitator.

13. Reports

Written communication is an important skill for students to acquire. Requiring written reports allows students to practise this form of communication, particularly if the word allowance is short and it is used in the final year, as it can promote succinct, critical pieces of work.

14. Patchwork text
(Winter, R. et al, 1999)

This is a way of getting students to present their work in written form. Students build up text in course work over a number of weeks. Each component of work is shared with other students and they are expected to use different styles, such as a commentary on a lecture, a personal account, and a book review. This kind of assessment fits well with PBL because of its emphasis on critique and self-questioning.

Other assessment methods from other contexts such as exhibitions, artworks, artefacts and performances in art and design or laboratories in science and engineering may be easily adaptable.

Growing trends: self, peer and collaborative assessment in problem-based learning

These terms are often used together or interchangeably but are different:

Self-assessment – involves students judging their own work. It may include essays, presentations, reports, and reflective diaries. One of the difficulties with self-assessment is the tendency to make judgments about what the students meant rather than what they actually achieved. Boud has defined self-assessment as:

The involvement of students in identifying standards and/or criteria to apply to their work and making judgments about the extent to which they have met these criteria and standards (Boud, 1986:12).

Peer assessment – involves students making judgments about other students' work. This is generally used for presentations and practicals but it can also be used for essays and exam scripts. Using peer assessment with essays is really useful with PBL and also highly informative for the student and the tutor. Ideally, the students design their own assessment criteria and use them to assess each other, but in many programmes they are designed by staff. It can be carried out in a variety of ways including:

• anonymously with assessors randomly chosen
• open but with several assessors used to assess each element of the work.

Inter-peer assessment – this is where students from a PBL group assess the work of another group.

Intra-peer assessment – students assess the product of what they themselves have produced as a group.

Collaborative assessment – students assess themselves in light of the criteria agreed with the tutor. The tutor assesses the student using the same criteria and they negotiate a final grade.

Tips on implementing student assessment in PBL

1. Remember that the real benefits of these forms of assessment are the processes that are being used in the actual assessment.

2. Developing criteria
   • is vital
   • is something students find hard to do
   • needs to be allocated plenty of time
   • feels risky to students.

3. You need to consider
   • what to assess – process or product
   • what criteria to use – grades or pass/fail, weighting
   • how to apply the criteria
   • how the assessment will be carried out.

4. Examine your pedagogical stance to consider where you, as a teacher, have situated yourself in the assessment process – as judge, partner or neutral.

5. Remember that it takes time to set up and train students so that it works and is done well.

6. Make sure you develop strategies to discourage passengers in groups
    • tell the group that they have a total of 80 percent to distribute between them and ask them how they want to split it up
    • use vivas
    • use other assessments that will ensure that only those who have contributed get the marks e.g. exams, tripartite assessment.

7. Other strategies
    • use the same group mark for each group member
    • divide up the group tasks and assess each component separately
    • add contribution marks (e.g. individuals are all given 80 percent but then they are asked to award other members of the group between 0-10 for the extent to which they contributed to the work).

Advantages and disadvantages of self and peer assessment in problem-based learning

1. As a result of peer and self-assessment many students perform better on other forms of assessment.

2. It encourages students to move away from strategic approaches to learning.

3. It encourages honesty and personal responsibility in the group.

4. It promotes the valuing of the process of learning.

5. Problems occur if external examiners are not experienced in self and peer assessment and are consequently suspicious of its reliability or validity.

6. There is a tendency for some staff and students still to think in terms of norm rather than criterion-referenced marking and judging performance against that of others rather than on its own merits.

7. It can be time consuming to set up.

8. Tutors often feel they need to moderate self and peer assessment.

Some examples of assessment in PBL

These examples have been chosen to reflect a variety of contexts, subjects, professions and countries. Other examples appear in the literature (Boud and Feletti, 1997) and in journals such as *Teaching in Higher Education, Studies in Higher Education* and *Assessment and Evaluation in Higher Education.* Online search engines such as Google provide an increasingly rich source of examples.

Medicine and Dentistry

Details provided by Sally Reagan, University of Western Australia

The Faculty of Medicine and Dentistry at the University of Western Australia took 130 medical and 45 dental students, 4 weeks into the first year of their programme, to a country town for a week. The aim was for the students to learn about rural life and health and, in particular, what promotes, and detracts from, health.

Working in groups and with the contact details of only one person in the town, the students were asked to research a sub-population within the town (e.g. youth, elderly, cultural groups). This innovative approach to PBL, the Rural Week, received highly positive feedback from students, academic tutors and the community (Reagan *et al.* 2001).

Formative assessment was provided by regular meetings throughout the week, which allowed students to discuss what they had learned and receive feedback from their peers and staff. A summary of their findings was given in an oral presentation at the end of the week after which they received verbal and written feedback on their communication skills and findings.

Summative assessment comprises an individual report on their findings and reflection on the process, and a group poster. The report includes a description of their research strategy and its effectiveness, and highlights the ability of students to write concisely and identify the sources of their thoughts.

There are no formal guidelines for the poster, leading to very imaginative and exciting pieces of work. Producing the poster promotes wonderful team skills, which some students saw as being the whole point of doing them. Posters were presented at a display session to which Faculty members were invited and someone was nominated to answer questions. There is peer marking of posters, which is worth 30 per cent, with an average of staff marks contributing the other 70 per cent.

Students are given feedback on their written assignments and posters, with verbal feedback to the year as a whole and individual written feedback. Students can also discuss the assessment in a private meeting.

Nursing

Details provided by Kay Wilkie,
University of Dundee

The School of Nursing and Midwifery at the University of Dundee uses a range of assessments in their PBL programmes, admitting that not all of them match PBL as closely as they would like. Two methods used are the PBL essay and the scenario-based examination.

For the PBL essay, students are asked to select one nursing issue identified during a PBL session, explore the issue in depth and then produce an evidence-based essay linking the research to the patient in the PBL scenario. The method is used when students progress from the Foundation part to the specialist Branch programme, where students are expected to demonstrate learning at a higher academic level.

The goals being addressed through the essay include: to promote identification of nursing issues – something the students find difficult; to enhance literature-searching skills; to relate theory to practice; and to increase awareness of the depth of learning expected as a result of the PBL experience. It is also anticipated that the essay will consolidate some of the process skills acquired through PBL.

In the scenario-based examination students receive a scenario, similar to some of the PBL triggers, 6 weeks before the exam. They have to identify their own learning outcomes and then learn the material. The examination is a choice of 'long answer' questions where students can demonstrate their learning. Students are allowed to

prepare for the examination in their PBL teams but the examination is individually assessed.

The goals of the examination are: to promote identification of learning needs linked to patient care; to develop skills required to undertake this learning; and to apply the learning to the patient.

A further approach used is critical incident analysis whereby students consider an incident that challenged them and reflect upon it. While the main goal for this is to promote reflective practice, it again requires students to identify learning needs (through reflection) and to undertake the necessary learning to meet those needs, thereby fitting with skills developed in PBL.

As with many programmes, staff are continually looking at alternative assessment methods, including the use of peer-assessed assignments and a formative clinical skills exercise.

Physics

Details provided by Dr. Brian Bowe,
Dublin Institute of Technology

Over the last five years the School of Physics at the Dublin Institute of Technology has been developing the use of problem-based learning (PBL) to teach physics. In May 2001 the School of Physics developed a PBL first year physics course, in the Degree in Applied Sciences, which began in September of that year.

The course itself involves two two-hour PBL tutorial sessions each week along with a one-hour class that is used for evaluations,

presentations, feedback, reflection and self-directed learning. There is also a three-hour laboratory session. The students work in groups of six or seven and are presented approximately one problem per week. They use the 'four-column process' and either produce a report or give a presentation at the end of each problem. The 'four column process' is an approach where students divide a piece of A4 paper into four columns and head them with the words 'ideas' 'facts' 'learning issues' 'action plan'. This is a useful aid to help students focus on their learning needs when they are new to problem-based learning.

The assessment strategy includes assessment of the reports, presentations, oral examinations, multiple-choice questions to assess lower level cognition, and assessment of the group process. At the start of the year the students attend a two-day PBL orientation programme where assessment criteria are discussed and negotiated.

The group process is assessed by collaborative assessment where the tutor gives each student a mark for his/her individual contribution to the group process based on negotiated criteria. The students also give themselves a mark and justify that mark by not only identifying where they did well but also where they lost marks.

At the start of the year all assessments are purely formative with extensive feedback given to the students. After a number of problems, the assessments are both summative and formative in that the marks will account for the students end-of-year

mark but the students' are still provided with feedback. The criteria for the group process include being responsible for group learning so that it is not sufficient for a student to ensure he/she learns the physics but that each student must also take responsibility for the learning of the whole group.

The course also includes an integrated formative evaluation strategy and is continuously being enhanced.

Law

Details provided by Gina Hefferan,
Auckland University of Technology

'Contract Issues in Business' is a final year paper in the Bachelor of Business degree at Auckland University of Technology. The paper is taught by way of PBL. Students are presented with a new scenario each week/fortnight and work in small groups to analyse the issues, frame research questions, and conduct research to explore the legal issues inherent in the factual situation, and apply the law to the facts to reach conclusions.

Assessment comprises a final exam and the submission by each group of a portfolio of the results of their research into four of the weekly problems. The aim is to recognise (and give credit for) the amount of preparation required for PBL classes without diverting students' energy from the learning, as well as to give equal weight to the process of legal problem solving. Some of this is inherent in their presentation of their result: stating the central issue and relevant law before applying it to the facts.

In addition, groups submit their initial research questions, their refined research questions, their collection of cases, with notes attached as to relevance, and some record of the issues traversed in group discussion. For the latter, most groups choose to provide a printout of their discussion on the online platform, in which each group has a private workspace. Finally, groups submit some self-evaluation of the process.

Groups are required to submit their initial results for each problem prior to the whole class discussion to ensure that each group engages with the process, rather than relying on the whole-class discussion to make the issues clear. The difference between initial results and their final one gives added material for the final evaluative step of the problem solving process.

Group marks can be redistributed (according to agreed criteria) among group members to reflect different individual contributions to the group.

The final exam is an individual assessment. The set-up facts are pre-issued and groups have the option of working together to research the issues. In the exam, the situation unfolds in two stages and the students are required to write an individual answer. By this point the process is implicit in the answer, and the final evaluative step is not assessed.
It is too soon to make assessments of how well this assessment programme achieves the objectives, since this is the first time this paper has been offered, though the tutor has been delighted by the amount and

quality of the work that has gone into the portfolio, and the animated discussion on the online platform, on which she is able to eavesdrop.

Optometry
See Lovie-Kitchin, 2001

Students became less inclined to do work which was not graded so a reflective journal was introduced which contributed 62.5 per cent to the final assessment in 2000 compared with 35 per cent in 1997. The significant weighting of the journal means that students take it seriously. The journals are assessed against five criteria: description of knowledge and facts, events and process; critical thinking; personal exploration; making connections between theoretical principles and professional practice; and cyclical reflection. Journals are read by the tutor two or three times during the semester to give feedback and encourage greater reflection. Students are very positive about the journals as part of a reflective process.

Nursing
See Fisk, A. et al, 2001

Using the term 'Context-based Learning' (CBL) so as not to see all situations as problematic, six major curriculum elements were identified as part of this Collaborative Nursing Programme in a number of Canadian institutions: writing across the curriculum; group process; critical thinking, nursing practice; content. Looking to experience from elsewhere, they adopted three elements as part of their assessment strategy:

- Objective Structured Clinical Examination (OCSE) – where students demonstrate skill achievement, contextual awareness and the ability to attend to the most important factors in a test situation.
- 'Triple jump' – using a written format to test the application of critical thinking skills.
- Evaluation of student performance in CBL tutorial - to evaluate group process, critical thinking and self-direction, and to provide regular formative feedback.

Introductory Science
See Allen, D.E. et al, 1996

Recognising the need to assess the acquisition of skills as well as content knowledge, the University of Delaware uses a range of assessment methods in its introductory science courses, including:
- Group projects – requiring extensive out-of-class research and collaborative effort.
- Hour exams – that use problems requiring students to reapply concepts previously used to solve in-class problems.
- 'Triple jump' exam – following analysis of a problem and fixed time to resolve self-identified learning issues, students undertake individual oral examinations
- Peer evaluation – rating peers on criteria such as attendance, preparation for class, listening and communication skills, support for the functioning of the group.

Economics
See Segers, M. 1995

The Economics Faculty at the University of Maastricht uses two separate tests to measure at different levels within the Bloom taxonomy. The 'Knowledge Test' primarily tests at the level of knowledge and comprehension, and comprises 100 to 150 True/False questions.

The 'OverAll Test' aims to measure application, analysis, synthesis and evaluation, as well as problem-solving skills and competence in scientific reasoning. Students receive a number of academic or journalistic articles two weeks before the examination, together with a study guide, in preparation for the open-book exam. As well as True/False, the exam has open-ended or essay questions, which will take up most of the students' time and are based on cases handed out during the exam. The aim of the 'OverAll Test' is to assess the students' application of knowledge to real life problem situations.

The Ancient World Explorer
See:http://score.rims.k12.ca.us/activity/ acncientworld/index.html

A web-based PBL activity involving searching for information on the architecture of ancient civilisations. Assessment includes developing a rubric with the teacher and fellow students to evaluate group research and presentations. Students are also expected to reflect on what they learned and the importance of group activities.

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Questions for you on your course

- What is the relationship between your assessment methods, your learning outcomes and the learning experience?

- How is PBL to be assessed?

- What types of assessment will best suit PBL in this curriculum?

- In what ways might assessment prompt disjunction in students' lives in this programme?

Conclusion

Issues about the impact of assessment on student learning in problem-based curricula have been the subject of much debate and educational research (Boud, 1990; Gibbs, 1992). Many of the concerns about assessment seem to relate to the unintended side effects that undermine or contradict staff intentions to encourage students to learn effectively. Such side effects include rote memorisation at the expense of understanding, description rather than critique, attendance only at sessions that are being assessed or provide cues to assessment questions and criteria, issues of fairness and the clarity of marking criteria. This briefing has sought to offer a number of suggestions about the types of assessment that fit well with problem-based learning and to examine some of the difficulties with assessment in the problem-based learning community. Whilst we acknowledge that many of the problems are not specific to problem-based learning we have attempted to unpack some of the issues that are particular to this approach to learning.

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