SIMULATING REAL-LIFE PROBLEMS

Use of Problem-Based Learning in Information Systems

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Abstract: This paper explores use of problem-based learning (PBL) in an introductory first-year undergraduate course in systems analysis and design. Problem-based learning is a pedagogical approach that encourages students to become active learners and to take responsibility for their learning within the setting of their intended profession. Learning is initiated by problems that are sourced from actual situations in the profession. The fundamental principle is that the problem is always introduced first and must precede any teacher-supported learning such as a lecture. This paper describes how problems are used to initiate learning. The problems in this course initially simulate real-life systems development situations that information systems professionals may face, followed by problems that involve a real client. Students are required to plan and reflect on their learning weekly. In the use of PBL a number of issues arose for both staff and students. The issues were derived from student's perceptions, weekly planning sheets, diary submissions, and staff observations. For students, major issues include: dealing with a new approach to learning, workload, the requirements of group work, class and meeting attendance, and group communication. For staff major issues are: using facilitation rather than lecturing, design of appropriate teaching environments, assessment of process skills, and developing problems to match curriculum. Feedback from students indicates that PBL challenges and motivates them. However, they perceive the course requires more work and time than the lecture-based courses.

Key words: Information systems education, problem-based learning, real-life learning.

1 INTRODUCTION

Problem-based learning (PBL) is an approach that encourages students to become active learners and to take responsibility for their learning. Some

researchers such as Fogarty (1998 p.1) see PBL as "learning in its most authentic state." PBL contextualizes learning towards the real world. An objective of PBL according to Biggs (1999, p.71) is "to get students to solve problems they will meet in their professional careers – the teaching method is to present them with problems to solve; the assessment is based on how well they solve them." The learning begins by presenting a problem scenario to the student before any relevant theory or practice is given. Engaging in a problem scenario within the discipline context drives motivation to learn and apply appropriate theory. Students work in small learning groups and, through a process of inquiry, have to develop their skill at acquiring, communicating, and integrating information to solve a problem (Woods, 1994; Savery & Duffy, 1995; Delisle, 1997; Fogarty, 1998; Savin-Baden, 2000).

PBL has been used successfully in disciplines such as medicine since the mid 1970s (Savery & Duffy, 1995; Boud & Feletti, 1997). The use of PBL is being adopted in computing education as is evidenced at sources such as the ACM Digital Library, by the increasing number of papers since 2000.

PBL is seen by Bentley et al. (1999) as a better way to develop graduates who are more suited to the practice-based and project-oriented world of the information systems professional. Also McCracken and Waters (1999) using PBL for software engineering suggest that PBL is an approach to overcome the "instructional gap" between what is taught, and what needs to be taught. By simulating real-world scenarios PBL should lead to a closer alignment between the teaching and learning approach used in undergraduate education and the work of an information system professional, with the outcome of an IS graduate better equipped to work in professional practice (Bentley et al., 1999).

Savin-Baden (2000, p.15) identifies from the PBL literature four key reasons to adopt PBL: 1. develop student's reasoning skills; 2. enable learning to take place within a context that is relevant to the students; 3. ensure that learning is attuned to the world of work; and 4. promote student's self-directed learning abilities.

This paper discusses problem-based learning in an introductory first-year undergraduate systems analysis and design course.

2 METHODOLOGY

The study used a qualitative approach to understanding PBL and employed action research in refining the approach to PBL. A phenomenological research approach was used to gain student's perceptions of PBL. Student perceptions were obtained from face-to-face interviews,

focus groups, tutor observations, student emails, course evaluation forms, and examination of diaries and planning sheets. Individual interviews were conducted with PBL students. Email feedback was sought from course graduates. The data collected was analyzed for shared themes, experiences, key words, and phrases.

3 TEACHING USING PBL

The first-year compulsory course "Introduction to Business Systems Development" has used PBL as the teaching method since 1999. The teaching structure and PBL resources are summarized in Table 1.

Table 1. Teaching structure and PBL resources

Timetabled classes	Learning aids and information sources
2-hour tutorial/workshop	PBL handouts and video.
1-hour lecture	Course and student expectations.
1-hour group meeting	Internet, intranet, self-assessment tests, discussion server and e-mail, textbooks and libraries.
	Weekly planning sheets and diary entries.
	KNDA Planning sheet.
	Mini-lectures
	Workshop exercises

Small class sizes and the delivery format have allowed some freedom to experiment with PBL. Class times are scheduled to provide an opportunity for students to meet regularly and spread their contact across the week. In an attempt to achieve an academic balance within groups, students are placed into groups based on their prior academic performance. Groups generally consist of five members. To foster a strong working relationship and team commitment, groups are together for the whole semester.

The IS professional activities of planning and reflection are simulated by students completing weekly planning sheets to guide their learning and weekly reflective learning diaries where they record their reflections on their learning and activities for the past week. The ITiCSE Working Papers (Ellis et al., 1998, p52b) state, "A key issue in professional development is to have the skills of self-evaluation and the ability to steer one's activities." Students are encouraged to see themselves as junior IS professionals.

To aid in the understanding and tackling of a problem a KNDA planning sheet is used. The KNDA has columns headed: What we already Know, What we Need to know, What tasks we need to Do, and Who the task is Assigned to. The KNDA is an adaptation of KWL (Know, Want, Learned) in Barell (1998, p.35) and a KND (Know, Need, Do) in Fogarty (1997, p.6)).

Using the completed KNDA planning sheet students develop their own individual learning plan for the week(s).

The PBL problems are sourced or adapted from real situations, though structured to provide clues and "scaffolding" to guide the students in their learning. The use of tiered problems (parts a, b, c etc) provide students with an example of what an IS professional is likely to do. This allows students to reflect on their solution and provide direction for tackling the next part of the problem.

Table 2 shows the schedule of problems over a 12-week semester. The early problems simulate real-life systems development situations, followed by problems that involve a real client. Large problems, termed "assignments", involve a number of weeks. In smaller problems each part is completed over one week. The smaller problems early in the course assist students in understanding the PBL approach. Student feedback indicates they see the problems as realistic and relevant to the work of an information system professional.

Table 2. Schedule of problems

Problem	Nature of the problem
Problem 1 Parts a, b & c	Understanding systems and roles and incorporates EAI. Feasibility and project selection.
Problem 2 Assignment 1	SDLC, project planning, analysis modelling techniques, data gathering.
Assignment 2 Parts a & b	Methodology, requirements specification, design and prototyping.

After reflection and discussion of the solution to a problem, a "mini" lecture is often given. The timetabled lecture is sometimes used to present material related to the student questions or comments from the previous week's planning sheets and diaries. Assessment includes the process of learning, as well as the content learning and deliverables.

The benefits perceived by both staff and students include: increased motivation and enthusiasm; improved problem solving; improved time management; improved self-directed learning skills; improved research skills; improved self-evaluation skills; and improved group work skills.

4 MAJOR ISSUES AND CHALLENGES

Major issues in the course include: a new approach to learning; design of the physical teaching environment; group work; assessment of process skills; attendance; facilitation and small group teaching; and, problem design. Some challenges include: a focus on factual knowledge; problems with group work

participation; weaker students requiring more direction; and, preparation and motivation for PBL. Some of these are now discussed.

4.1 New Approach

PBL is often a new approach to learning for students, as is the role of a PBL facilitator for many teaching staff. The first three weeks emphasize the techniques of the PBL approach, however, only about 4 hours is spent specifically on PBL. It is observed that students have to unlearn their prior conceptions of learning. Some students, especially the weaker ones, find responsibility for self-learning difficult. In feedback this year on PBL, Student A wrote: "Has been a very difficult subject. Learning new topics and learning approach."

Students require reassurance that they are learning content as well as acquiring process skills. Students report they are uncertain as to whether they are learning anything. Self-evaluation content-based tests are given on a regular basis. Students report these tests help confirm their knowledge or lack of, and provide pointers for follow-up learning if they identify a knowledge gap.

The role for tutors in PBL is to be a facilitator to empower students. Russell et al. (1994, p.59) suggests "educators are therefore required to implement strategies which promote self-directed learning skills, are conducive to students' construction of knowledge, and promote reasoning skills". The challenge for lecturers in Information Systems is to adopt a philosophy of using active learning strategies from traditional passive teaching approaches. Lecturers' skills in PBL for this course were gained by attending PBL workshops, reading (especially the work of Woods (1994), subscribing to PBL and education list servers, visiting lecturers at educational institutions using PBL, and through team teaching.

4.2 Group Work

Issues regarding group work include: leadership, composition, contribution and meeting attendance. Acquiring group leadership skills is addressed by having each student act as team leader during the semester, so that everyone in the group has at least two weeks as leader. The leader chairs meetings, acts as a communication facilitator and monitors team member's progress during the week.

The knowledge that groups are together for the whole semester seems to engender a greater sense of group commitment and motivation. A positive comment by graduate Student B reflecting on their PBL experience from a few years ago wrote: "Considering that all components of the PBL subject

were done in teams, my ability to work successfully within a team environment improved. Working within a team environment has also improved my social skills and has enabled me to become a pro-active team member within the working environment." Having a coherent semester group fosters a stronger team environment.

4.3 Physical Environment

Consideration has to be given to the design of the teaching environment to support PBL. Group work in computer laboratories causes difficulty, as the room arrangement does not allow students to interact well as a group. Computer laboratories often lack tables where students can sit around to have meaningful face-to-face discussions. An effective meeting environment that encourages interaction needs to be available. Fortunately students have been able to utilize vacant classrooms near the computer laboratory. Extra classrooms are not a resource that universities can usually sustain. If PBL is to be adopted as the major teaching approach, the teaching environment and arrangements to support PBL group work should be provided.

4.4 Attendance and Time Management

Attendance at classes and group meetings is crucial in this format of PBL. As an incentive to maintain attendance and participation, marks are awarded. An unsupervised laboratory hour is timetabled for students to meet; this provides a common time and little excuse not to attend group meetings.

Students are concerned about the time they spend on preparation, meeting time, reading and completion of plans and diaries. The completion of these tasks is often seen as encroachment on their time. Student C commented, "administration takes more time than the learning." The tools to aid and reflect on learning are seen by some students as a burden that is not encountered in other courses. Student D wrote "Another problem I am having is time management as PBL requires a lot of time to work with which I am finding hard to spare with other subjects as well."

4.5 Problem Design and Development

Setting and developing the PBL problem is a challenge. There was uncertainty about the nature of problems set, and whether the problems were authentic PBL problems. McCracken and Waters (1999) compare PBL problems in software engineering with medical school problems suggesting there is a potentially significant difference between problems in the two

fields. Medical problems tend to be shorter, with solutions consisting of a diagnosis and proposed treatment, the students then move onto the next problem. In software engineering, however there are deliverables developed over a longer period of time and the assessment of these is a substantial part of a student's grade.

Problems need to be authentic and presented as such, rather than being task-based or project-based. Explicitly setting learning objectives for each problem is required to assist in scoping problems, so solutions and learning are achieved within the time limitations imposed by courses. Problems should be fully written up as a PBL case for tutors to understand the learning objectives of the problem and assist them in guiding students' learning. Wider discussion and sharing of PBL cases in the computing education community may help to develop a norm of applicable IS problems.

4.6 Academically Weak Students

There is a danger that academically weak students can be left behind and likely to achieve only surface learning. The challenge for tutors is to identify and support weak students. Tutors need to provide them with encouragement and feedback as they require more direction and structure to direct their learning, whereas Conrick (1994, p.250) suggests "deep learners may be intrinsically motivated." Graduate Student E who when doing the course a few years ago would have been considered a weak student, recently wrote: "I found with the PBL is that at the time as a student, it was such a diversion from the normal course for me that I didn't fully appreciate the skills I was learning and didn't like it as much. However in hindsight I can see that it was a useful way of placing us in that kind of self-learn environment as if we are in the workforce." This graduate also stated "My other studies were influenced through having gained a better ability to research and utilise the tools available. Additionally it provided me with valuable teamwork skills that have already come in useful in the working environment."

5 CONCLUSION

This paper has presented the approach, benefits, challenges and issues of PBL in an Introductory Systems Analysis and Design course including a snapshot of typical student responses. Outcomes of PBL indicate improved active student learning leading eventually to better graduate outcomes. Students perceive the course presents them with real-life learning situations. Typical of student responses is this statement from a graduate Student F now in an IT position: "From my experience with PBL I found it had the

advantage of placing the student in a more realistic (i.e. work-like) environment when considering a task. Rather than the normal procedure at university it placed more emphasis on yourself researching and learning rather than being fed the information to take in through osmosis it was a more interactive approach."

6 REFERENCES

Barell, J. (1998) *PBL: An inquiry approach*. Australia: Hawker Brownlow Education.

Bentley, J. F., Lowry, G. R., and Sandy, G. (1999) Towards the compleat information systems graduate: a problem based learning approach. In *Proceedings of the 10th Australasian Conference on Information Systems (ACIS)*, vol. 1, B. Hope and P. Yoong, Eds. Victoria University, Wellington, New Zealand: School of Communications and Information Management, 65-75.

Biggs, J. (1999) What the student does: teaching for enhanced learning, *Higher Education Research & Development*, 18, 1, 57-75.

Boud, D. and Feletti, G. (1997) *The challenge of problem-based learning*. 2nd Edition. London: Kogan Page.

Conrick, M. (1994) Problem based learning - managing students transistions. In S. E. Chen, R. M. Cowdroy, A. J. Kingsland, and M. J. Ostwald (Eds.), *Reflections on problem based learning*, Sydney, Australia: Australian Problem Based Learning Network, 237-255.

Delisle, R. (1997) *How to use problem based learning in the classroom*, Association for Supervision and Curriculum Development, USA.

Ellis, A., Carswell, L., Bernat, A., Deveaux, D., Frison, P., Meisalo, V., Meyer, J., Nulden, U., Rigelj, J., and Tarhio, J. (1998) Resources, tools, and techniques for problem based learning in computing: report of ITiCSE'98 working group on problem based learning. In *The Working Group reports of the 3rd annual SIGCSE/SIGCUE ITiCSEC Conference on Integrating Technology into Computer Science Education*, (30), Dublin, Ireland, 45b-60b.

Fogarty, R. (1997) *Problem-based learning and other curriculum models for the multiple intelligences classroom*. Australia: Hawker Brownlow Education.

Fogarty, R. (ed.) (1998) *Problem-Based Learning: A Collection of Articles*, Skylight-Hawker Brownlow, Frenchs Forest, Australia.

McCracken, M. and Waters, R. (1999) Why? When an otherwise successful intervention fails. In the *Proceedings of the 4th annual SIGCSE/SIGCUE conference on innovation and technology in computer science education*. Krakow, Poland, 9-12.

Russell, A. L., Creedy, D., and Davis, J. (1994) The use of contract learning in PBL. In S. E. Chen, R. M. Cowdroy, A. J. Kingsland, and M. J. Ostwald (Eds.), *Reflections on problem based learning*, Sydney, Australia: Australian Problem Based Learning Network, 57-72.

Savery, J. R. and Duffy, T. M. (1995) Problem based learning: An instructional model and its constructivist framework. *Educational Technology*, (35), 31-38.

Savin-Baden, M. (2000) *Problem-based learning in Higher Education*. Buckingham, UK: Open University Press.

Woods, D. R. (1994) *Problem-based learning: how to gain the most from PBL*. 2nd ed. Waterdown, Canada: Donald R. Woods.