

Problem Based Learning Approach to Drilling Engineering

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This case study has been developed from data gathered through an observation of the teaching component; interviews with the tutor; and student questionnaires and focus groups.

Background

This report covers the use of problem based learning, supported with mind-mapping and online document sharing, in an MSc module on drilling engineering. The module is part of a course that is offered to engineering graduates who wish to broaden their expertise to Petroleum Engineering. The class studied contained 45 students, who come from a wide range of nationalities, many of them have previous industrial experience, with only a handful coming straight from an undergraduate course. The module is delivered over a ten week period in the first term of the course, during which students are expected to spend approximately 120 hours on this topic.

The problem based learning was implemented as a series of weekly 'challenges' that students undertook. In the classroom the tutor presented the students with the challenge, and gave a brief introduction to the subject area addressed by the challenge. Each challenge includes a statement of what the students will need to know to complete it, i.e. the learning objectives/outcomes addressed by that challenge. In groups of five working in their own time, students distilled the necessary information from a set of comprehensive notes provided by the tutor, constructed a mind map using software provided, and went on to solve the problem. Mind maps and solutions were posted to shared folders on the course web-based discussion board, which the tutor and other students could access. At the end of the week, the tutor would discuss the pros and cons of some of the suggested solutions with the whole class.

The Institute for Petroleum Engineering is a well-equipped post graduate teaching and research institute, with highly specified lecture rooms and ample space and facilities for students to use as 'break-out' rooms in their own study time.

Reasons for introducing this method

Over a number of years the tutor has become convinced of the value of problem based learning in motivating students, presenting them with tasks which mirror those they will face as practicing engineers and in nurturing broader key skills such as team work and problem solving. This course is also available to distance learning students, for whom the course notes had been prepared: since these notes cover all the factual content required for the course, the tutor did not see any reason to repeat this content as conventional lectures.

Lecturer Perspective

Several local factors eased the introduction of this teaching innovation. The Institute for Petroleum Engineering offers an environment where individual lecturers can try out new ideas without undue interference from departmental committees, it also has ample resources to support non-traditional teaching. The distance education initiative provided the course notes, which would otherwise have been a significant upfront overhead on introducing problem based learning. That same initiative also meant that the tutor had gained experience with other techniques which were brought in to support the problem based learning, e.g. communication tools such as web discussion boards for sharing the students' work and the mind mapping software. The tutor used his previous experience in industry to create the contexts for the problems.

The tutor found that student expectations had to be addressed explicitly, while some students appreciated the novel approach, on the whole they *"simply wanted to be lectured to—they simply wanted me to get up there and give them a lecture, tell them what they need to know for the exam so that at some point they could go off and revise and do the exam."* The students were nervous that a new (to them, and initially to the tutor) and unfamiliar approach to learning might prejudice their chances of passing the exam. To counteract this the tutor takes care to introduce the concept of problem based learning at the beginning of the course; he is, however, aware that time spent in this way leaves less time for covering the material in the course.

Overall, the tutor is convinced that problem based learning works, *"the quality of the answers that I'm getting in the examinations ... is much better than it was previously. ... I feel that I can see that they have understood the subject"*

matter a lot better", and also that the learning and teaching experience is enhanced *"I think students are much happier about going into the classroom, I think they get a lot more out of it and I get a lot more out of it"*.

Student Perspective

The tutor is popular among the students: all students who took part in this evaluation praised his approach to lectures and commitment. The questionnaire also showed broad student approval of the approach taken, especially relating to the questions about whether the approach was boring and whether it helped them understand the topic. The aspects of problem based learning that students identified as *"most useful"* were that it ensured that the students studied the course material during the course and that it promoted interaction (and peer-learning) between the students. There were also strong objections raised by students through the questionnaire, notably concerning the amount of time and the distribution of workload within mixed-ability groups. Perhaps more interestingly the average responses solicited showed a divide in student opinion, which, as far as can be traced through the interviews, correlated with the extent of the student's previous experience.

Of the six students interviewed, three had little previous experience and three had a significant amount of industrial experience. Those with little experience were full of praise: *"I think problem based learning made a very complicated technical subject quite simple and very easy to absorb, and it was easier to concentrate in lectures as well ... especially with the use of mind maps alongside [the PBL] because then you're seeing it visually in a simplified format rather than a whole paragraph of words"*, *"Whatever we learned we were able to envisage it in industry ... we could see the practical application"*. These students felt that they had taken responsibility for their own learning, and had endeavoured to keep up with more experienced members of the group during the problem solving sessions, while at the same time benefiting from their experience. They felt that the time they spent during the course was recouped in a reduction in the amount of time that had been required for revision.

The three students with more experience felt rather more negatively. They complained that there had not been sufficient personal feedback, that when they had spent time in a group arguing over a part of the problem they never received a definitive statement as to whether they had arrived at the right or best answer. This led to a disengagement with the process so that in the end they focussed on solving the problem in as convenient way as possible. They dispensed with discussion or any attempt to explain within their group why they were taking the approach they did, even though they acknowledged that the process of solving the problems was meant to be the learning experience. *"In a group there always used to be just one person in the group who did the work ... for me it was more of a burden because I'm not a teacher but I had to answer all these questions to the guys."* These students did less well in the exam than they expected, reinforcing their belief that the time spent on problem based learning had not been well spent: *"how to get marks here, that's what really counts"*.

Issues

- The student expectation that they will be lectured to needs to be addressed, as does their expectation about how much effort and what sort of activity is required to learn something well.
- Students expect there to be a right answer to each problem, and to receive individual feedback as to how close they came to this answer. In reality, there may be several equally valid approaches the choice between them depending on context not presented in the problem statement.

Students are result-driven, several students felt that they weren't benefiting from the problem based learning and so disengaged from it in a way which minimised the benefit they gained.

Benefits

- The tutor and many students felt that problem based learning had improved student learning outcomes. Notably, the technique was reported to be suitable for learning the hard 'facts' required for engineering as well as attaining learning objectives which relate more to the application of this knowledge.
- This approach offers students the opportunity to acquire and develop skills relating to resourcefulness, problem solving, group work, knowledge sharing, time management, knowledge organisation through mind mapping, and requires them to be responsible for their own learning.

Reflections

All students interviewed, and the tutor agree that the problem based learning approach was an improvement on the alternative of traditional lectures, one of the students who had expressed strong reservations said *"if I compare it to how the other subjects are being taught, it is definitely better relatively ... much better"*.