Diverse assessment methods in group work settings

Tim Langrish and **Howard See**, School of Chemical and Bio-molecular Engineering, The University of Sydney, Australia
timl@chem.eng.usyd.edu.au howards@chem.eng.usyd.edu.au

Abstract: The assessment scheme and mid-course feedback play a central role in the student's learning experience. However, within the student population there are many different perceptions of teaching and learning, and to accommodate these a diverse range of assessment and feedback activites are required. This issue is particularly important when group-orientated problem-based learning is employed, since much of the learning occurs within the groups and away from the direct supervision of the unit coordinators. We have explored a range of assessment styles in a suite of units of study in second year chemical engineering, centred around group-based project work. Group written project reports, interviews, confidential self and peer-assessments, individual laboratory reports, quizzes and a final examination have been used so far. Alignment of these assessments and teaching & learning activities with the learning outcomes guided our development of this framework, and this alignment has been verified by the students' results. The projects themselves are open-ended and present realistic engineering scenarios, including recommending the best type of artificial heart, the overall design of a desalination plant, and the design of a soap and cosmetics factory. A high level of student engagement and enthusiasm for the project work has been observed, arising mainly from the real-world nature of the projects, coupled with the stimuli provided by the range of assessment activities used.

Introduction

There are several reports in the literature which indicate that diversity in assessment leads to enhanced learning. For example, Ramsden (Ramsden 2003, p185) reports that a diversity of assessment tasks will enhance the student's perception of the course and will encourage higher level of engagement and the adoption of a deeper approach to learning. Similarly, Gibbs and Simpson (2004-5) found that a combination of coursework and examinations can lead to significantly enhanced learning, as opposed to examinations alone. Further, diversity in assessment would also appear to be encouraged by the institutions themselves. For example, the University of Sydney's assessment policy requires that the overall assessment scheme not "generate levels of stress which are so high that they interfere with performance" (policy, section 2.1.3.1.6). Having a variety of assessment styles should lead to a reduction in stress since the students are more likely to find at least one style of assessment with which they are comfortable. Here we present an assessment strategy we have recently adopted for a group-orientated problem-based learning unit of study in chemical engineering. The purpose of this paper is to report and discuss our experiences of learning and teaching with a diversity of assessment styles (projects, interviews, examination/quiz), starting with a description of the background to this work, the assessment approach, and the alignment of the assessment with the unit of study objectives.

Background

The unit of study in question, "Analysis Practice 1 - Energy and Fluid Systems", is a 6 credit point, core unit for second year chemical engineers, representing a quarter of one semester's enrolment. The class size is typically 60 students, and is co-taught between the authors. The unit is centred around three open-ended engineering projects, each lasting 4 weeks. The students work on the projects in teams of five, and submit a final group report. The groups are seeded according to academic performance in first year (so that there is a similar range of abilities within each group). Care is also taken to achieve a gender balance within each group (typically 40% of the enrolment is female). The students are reasonably comfortable with group work, since they have done a first year unit of study, called "Introduction to Professional Engineering" that introduces concepts and applications in information retrieval, written and oral communication, teamwork, ethics, problem solving, creativity, and leadership.

Assessment approach and the diversity of assessment

The current assessment structure is summarised here. Each student receives an individual mark out of 100 and a grade. The individual mark consists of the combination of a mark from a final examination, currently worth 50% of the overall mark, which is a closed book, 3 hour written examination and where there are six questions of equal value, and a mark for project work, where the three projects combined count equally for 50% of the final mark. This individual mark is determined by modifying the project report mark, awarded to the group, by two inputs. Individual performance at the interview session at the conclusion of each project is evaluated by an academic interviewing panel, and scores are received from self and peer assessment, reflecting effort and contribution to the group work. This information comes from the students in each group. At the end of each project and interview, each student receives a mark.

Since it is an important part of this unit's assessment process, it is worth explaining in some detail how the peer assessment and interview processes work. The peer assessment involves each student, in a confidential document to the unit coordinator, awarding a mark out of 100 to other group members depending on their performance as (a) a cooperative group member and (b) their technical contribution to the project (these are of equal weight). "Grade descriptors" are given to students at the unit's commencement describing how to assess these aspects. The average mark across the group is required to lie between 60 and 70 to assist in normalising the results. In addition to the marks allocation, the students also need to write, in their assessments of themselves and each other, a short paragraph for each group member as to why they have awarded that particular mark. These paragraphs are checked by the unit coordinators for reasonable and balanced content. For any one group, the matrix of marks awarded by this peer and self assessment exercise is used to determine a student's individual mark (the group's project mark is used as a basis for this calculation). To give a concrete example : a student generally regarded as hard-working by her peers will get a peer assessment mark above the group's average - her normalised mark may be, say, 1.2 (whereas a medium-performance student may be right on the group's average and would thus get a normalised mark of 1.0). If the group's project report mark was 70%, then the hard-working student would end up with an individual mark of 1.2*70=84%. The final stage is to possibly modify this mark depending on the student's performance at the group interview – an excellent interview performance may result in up to 5 bonus marks, whereas a poor performance will see the mark being decreased at the discretion of the academic interview panel. It should be noted that at the interview, individual students are typically asked questions on topics in the project that they may not have directly worked on themselves (this ensures that there is information exchange within each group and that students become familiar with the range of topics a particular project was intended to cover).

The peer and self assessment activities are a key feature of the assessment. These encourage student involvement with their learning, and give them some sense of responsibility for the running of the unit of study. For example, Elwood and Klenowski (2002) report that, in the postgraduate courses they teach, self-assessment exercises significantly enhance the learning of the student. Hence diversity in this assessment can be see n in the examination, a written assessment marked by academic staff, the interviews, which are oral assessments marked by academic staff, and self and peer assessments, which are written assessments marked by the students themselves. Oral presentations are used in supporting units of study, which are discussed in the next section of this paper.

Alignment

Biggs (1996) discusses the topic of alignment, discussing many of its aspects but emphasizing particularly the alignment of curriculum and assessment. Here, the curriculum can be summarised as the analysis of complex fluid and energy networks, including their decomposition into their essential component parts. The networks have included water supply and desalination in cities, the production

of skim milk powder, and the processing networks for soap. The functionality of each of these key components needs to be understood, and the performance of the network needs to be characterised in terms of both component and system-wide variables, allowing students to explore the optimum operating conditions for the network. In order to address this curriculum, the assessment is centred around group-based projects. The projects allow the system as a whole to be studied, rather than just individual parts of the system in the way that might be more likely to be studied in tutorial work. The group-based work allows individuals within the group to address each of the key components in a network, and the group setting encourages the discussion of how these components are integrated into the whole system.

Another aspect of alignment is that this unit of study runs concurrently with two other units of study that supply aspects of enabling technology. The first of these two units provides students with basic principles of mass, energy and momentum balances to solve engineering problems involving simple fluid flow, heat and mass transfer and also develops skills in the basic design of different types of chemical reactors. The second unit of study provides students with the basic principles of statistical analysis and the solution of nonlinear differential equations, the use of *Excel* and *Matlab* for data manipulation and equation solving, and the use of commercial flowsheeting software (Hysys) for solving engineering problems.

A key element of this unit of study is its focus on the integration of key engineering ideas. The assessment strategy has also been developed to align with this general principle. Literature suggests that such an integrative assessment scheme will lead to deeper learning: Ramsden (2003, p183) reports that an assessment framework which focuses on integrating key ideas works better than one which focuses on isolated parts of the material. Similarly, Prosser and Trigwell (1999, p109) argue that if students are able to see relationships between the elements of their studies, this will lead to higher quality learning outcomes.

Implementation of this assessment strategy

Explanation to students
The assessment structure was clearly explained to the students in some detail at the start of semester. A written summary of this was handed out, and was also placed for downloading on the unit's website. At this time, there appeared to be no disquiet or confusion from the students.

Organisational and logistical aspects
Careful timetable scheduling is needed to deliver the supporting material from the concurrent units of study on fundamentals and enabling technologies, just in time for appropriate projects. The extensive nature of the projects brings benefits in team teaching and staff collaboration between several lecturers and tutors, since the scope of the group-based projects is challenging for staff as well.

One aspect of the organisation of the student groups that deserves emphasis is our requirement for groups to develop their own Group Constitution, which is a set of working principles and practices for the groups to manage themselves. Each group is also required to keep a logbook, which is inspected in each session. The unit of study that was based on projects had weekly three hour sessions. The authors (TL, HS) circulated around the room at this time and spent 15 to 20 minutes with each group to discuss their progress and direction of their work. There were also two tutors assigned to this unit, who were also available for discussions during these sessions. The tutors and lecturers also answered many queries at times outside these sessions.

Mid-course feedback to students
A major feature of the assessment strategy in this unit was that it gave timely feedback to students on their progress. Clearly, students benefited from knowing well before the final examination that they

had inadequate understanding of key concepts in the material. Ramsden (2003, p183) points out that in the effective teaching and assessment of a course, a major role is played by useful and timely feedback on each student's progress. The important role played by mid-course feedback in the learning process has also been clearly highlighted by Gibbs and Simpson (2004-05) (their conditions 4 to 10). These workers make the point that feedback needs to be given in a way which students see as taking them forward with their learning. In terms of this unit, the feedback needs to be seen by students as providing help when it comes to sitting the final examination and tackling future projects. In the terms Gibbs and Simpson (2004-05) use, the feedback is "forward looking". Finally, it is worth pointing out that the university's policies also highlight the central role played by feedback in the student learning and assessment process (policy, section 2.2.7).

Feedback from the marked reports was designed to inform students of their progress. Detailed written comments on the project reports were provided, as well as an extensive discussion session with each group about their reports with the unit coordinators (20 minutes duration for each group). The good features of the report were commended, and suggestions were given for future improvement.

The group interviews also provided chances for feedback and development of understanding. Even if the question had been directed at another group member, the other students still needed to be thinking about the question since the interviewers would randomly switch their target of the questioning from one student to another. After a few questions on a certain topic, the interviewers would often explain the basic principle behind the questions asked – this proved to be a powerful way for students to receive feedback on their understanding of the key areas.

It should also be pointed out that the self and peer assessment scheme also contributed significantly to student feedback. Although each student is unaware of the individual marks they received from their fellow group members, there is an overall feedback on their general performance as a group member through the individual mark they receive (via the process as described above). Indeed the use of feedback from peers can encourage student learning and their engagement with the unit (Ramsden, 2003, p.189; Gibbs 2004-05). Indeed, this peer assessment is similar to the "community of assessment practice" discussed by Elwood and Klenowski (2002) with their masters students – by doing this the students become more engaged in obtaining meaning from and improving their own learning experiences. Rust (2002) also reports that having students actively participate in some type of marking exercise resulted in significantly enhanced student performance and enthusiasm.

Evaluation of the assessment strategy: methods and outcomes

In this section we seek to answer the question of how successful this assessment strategy has been. Three possible approaches of describing "success" will now be discussed, although only the last two will actually be used. First, our undergraduate program and this unit of study would be considered successful if we were able to follow these students into industry and see how well they carried out their professional duties as an engineers (hopefully better than their predecessors who went through the old curriculum). The aim of our School's undergraduate program is, after all, to produce high quality graduate engineers for the profession. However, we would need to wait several more years to get this type of information, since the new curriculum and this unit just started in 2005. Therefore this measure is not practicable at this stage. Second, another measure of the success of this unit is to measure what proportion of the students has achieved deep learning of the course material. This would need to be compared to their performance of the same in previous units, in order to see if we are really improving in this area. The third way to measure the success of this unit is to look at the student responses on the survey at the end of the unit (The University of Sydney's Unit of Study

Evaluation Survey). We have the anonymous survey results from the end of the 2005 running of this course. Henceforth, we will focus here on the second and third of these "measures of success".

As a preliminary step, we can evaluate any differences in assessment arising from the different assessment types by correlating the examination marks with the project marks for each student. The fitted correlation, using least-squares regression analysis, between the average project mark (%) and the examination mark (%) is that average project mark (%) = [44 ~ 54] + [0.27 ~ 0.44] * examination mark (%), where the square brackets denote 95% confidence intervals (R^2 = 0.56). The positive value of the coefficient on the examination mark, with 95% confidence, suggests that the differences in assessment between the project and examination assessments, including the effects of self and peer assessments and the interviews, on the ranking in the class are not high. At the same time, the spread of examination marks is much larger than the marks for the projects, which may have been grouped together due to the moderating effects of group work on the impact of the projects. It was difficult for less engaged students to "ride on the coat-tails" of the more enthusiastic ones, due to the influence of assessments from their peers, the use of examinations as another form of assessment, and the use of questions directed at individual members at group interviews. The correlation between these different types of assessment are a measure of the degree to which students perform well in both assessment methods. The alignment observed between the outcomes suggest that the two types of assessment measure similar learning outcomes and competencies.

An interesting aspect of alignment is an attempt to answer the question of whether or not the assessment scheme really assessed competency, by assessing the correlation between assessments in this project-based unit of study with the assessments in a parallel, "competency-based" unit of study that taught fundamental concepts. The latter was one of the units of study which supplied "enabling technologies", as mentioned above under "Alignment". The fitted correlation, using least-squares regression analysis, between the overall mark for this unit of study (%) and that for the fundamentals unit (%) is that overall mark (%) = [30 ~ 50] + [0.25 ~ 0.53] * fundamentals mark (%), where the square brackets denote 95% confidence intervals. These values and coefficients suggest a reasonable degree of alignment in the outcomes of both units of study.

The average student result from the previous first year unit has also been compared with the overall mark for this unit of study. The fitted correlation, using least-squares regression analysis, between the overall mark (%) and the previous year mark (%) is that overall mark (%) = [-5 ~ 31] + [0.53 ~ 1.05] * previous year mark (%), where the square brackets denote 95% confidence intervals. The positive value of the coefficient on the previous year mark, with 95% confidence, suggests there has been no no overall compromise in competency. All of the students in the second year had passed most of the first-year units of study, so it is not too surprising to find a value for the coefficient [0.53 ~ 1.05] that is weighted to values that are less than unity, since some students that had passed their first year had difficulty at this higher level. Two students failed both first year and this unit of study, and six students failed this unit of study but passed most of first year out of 51 students.

Overall, the student response to the anonymous survey of this unit of study at the end of the semester were very positive, showing an extremely enthusiastic engagement with project work. There were some concerns over the workload, but these were not major.

Future directions

We plan to use "engineering scoping calculations" to enhance deeper learning and engagement with the multiple facets of the material. "Engineering scoping calculation" is basically an integrative calculation exercise. These exercises, which will be linked with the topics covered in each project, will involve questions posed to the students on paper with brief explanatory text and with possibly a simple diagram. Critically, though, not all the information required to perform the calculation will be

given. The problems are deliberately open ended, and the student is expected to make reasonable assumptions and to understand the main steps required for solution. The solution will usually involve drawing together at least three of the specific topics to be covered in the corresponding project. There is not one correct answer or solution method for these types of calculations - it all depends on the assumptions made and the engineering judgement exercised.

The assessment scheme will be modified to incorporate this type of integrative calculation activity. We are considering the inclusion of a quiz in mid-semester based on this scoping calculation activity. This would be done after a similar exercise had been done with the class well beforehand.

References

Biggs, J. (1996) Enhancing teaching through constructive alignment. *Higher Education*, **32**(3), 347–364.

Elwood, J. and Klenowski, V. (2002) Creating Communities of Shared Practice: the challenges of assessment use in learning and teaching. *Assessment and Evaluation in Higher Education*, **27**(3), 243–256.

Gibbs, G. and Simpson, C. (2004-05) Conditions under which Assessment Supports Students' *Learning. Learning and Teaching in Higher Education*, **1**, 3–31.

Prosser, M. and Trigwell, K. (1999) *Understanding Learning and Teaching*. Open University Press: Buckingham.

Ramsden, P. (2003) Learning to Teach in Higher Education. 2nd edition, Routledge: London.

Rust, C. (2002) The impact of assessment on student learning: How can the research literature practically help to inform the development of departmental assessment strategies and learner-centred assessment practices? *Active Learning in Higher Education*, **3**(2), 145–158.

The University of Sydney Academic Board Resolutions: Assessment and Evaluation of Coursework (2004). Amended 8 Dec 2004. Available online at http://www.usyd.edu.au/su/ab/policies/Assess_Exam_Coursework.pdf (accessed 26 July 2006).