Embedding professional skills in a second-year chemical engineering unit

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BACKGROUND

Curtin University's undergraduate chemical engineering degrees underwent a curriculum review through 2009/10. One feature of the new degree structures is the intention to embed the development of professional skills, like effective communication, problem solving and teamwork, in one unit each semester. Although most units in the course give students the opportunity to *apply* professional skills, we wanted to *teach* and *assess* these skills explicitly.

Process Engineering and Analysis 212 (PE&A) is a new, second-year unit that was selected to develop professional skills. It teaches introductory flowsheeting, including the structure of chemical processes, numerical solution of the associated equations, and optimisation. Excel / macro-programming is used in the first half of semester, while the commercial flowsheet simulator Aspen HYSYS is used in the second half. The unit is problem-based in the sense that students do weekly homework and in-class, PC-tutorial problems, and then have a review lecture at the end of the week. It is the only second-year chemical engineering unit taught in this way. Students also do two group projects, due around mid-semester and at the end of semester, that require the integrated knowledge from previous weeks. The projects are assessed by both written reports and presentations.

In the curriculum review, the plan for PE&A was to focus on developing *communication skills* and *personal skills and attitudes*, as defined by the CDIO framework (Crawley, Malmqvist, Lucas & Brodeur, 2011). However, in 2011, the first year PE&A was taught, we followed the usual practice of assessing the *results* of communication skills without actually teaching them. Personal skills and attitudes were not even considered. For 2012, we reassessed the professional skills to be developed and then attempted to embed their teaching in the unit.

PURPOSE

The increased focus on professional skills was motivated by feedback from graduate employers and by the requirements of Engineers Australia and the Institution of Chemical Engineers. The key question we wish to answer is whether the embedding approach taken was effective in improving the targeted professional skills.

DESIGN/METHOD

The revised professional skills we wished to target in PE&A were report writing, oral presentations and problem solving, particularly the consideration of alternative approaches.

Report writing and oral presentation skills were covered by 30–40 minute sessions at the end of the usual technical lecture in Weeks 3–8. Table 1 shows the plan for these sessions.

The development of problem solving skills was tackled by adding a series of questions to each homework and tutorial exercise, and to the group projects. Example questions include:

- There are several ways you could have solved this problem in Excel. Outline some possibilities you considered and briefly explain why you chose the approach you did.
- Based on your experience with HYSYS so far, what do you think are two of the main advantages of using HYSYS over Excel for performing process flowsheet simulation?

- Say you weren't given the values to use for checking your simulation. What are some actions you could take to help give you confidence that the simulation was correct?

Table 1: In-lecture sessions used to develop communication skills in PE&A.

Week	Activity	Student involvement
3	A guest lecturer gives a poor, short presentation on optimisation.	Students discuss shortcomings of the presentation / report in groups and report their findings to the class. The results are collated and posted on the unit's web site.
4	Students are given a poor, two-page laboratory report.	
5	A guest lecturer gives a relatively good, short presentation on optimisation.	Students mark the presentation using the same rubric that will be used to assess their Week 6 project presentations
6	Students are asked to bring in a previous report they have written.	Students swap reports and assess them using the same rubric that will be used to assess their project reports due in Week 7.
7	Feedback is given on the students' Week 6 presentations.	
8	Feedback is given on the writing aspects of the students' Week 7 project reports.	

INTERIM FINDINGS

The in-lecture sessions were effective in reducing student uncertainty about the content, format expectations and marking criteria for the project presentations. Each group gave feedback on another group's presentation; the comments were consistent with issues raised in the Week 3 and 5 in-lecture sessions. However, to date no data have been collected that will allow us to measure the effectiveness of this approach to developing professional skills.

FURTHER RESEARCH

A research plan needs to be developed. It could include the following elements:

- Analysis of the assessments to gauge the development of problem solving skills;
- Questionnaires to judge student understanding of good presentations and reports;
- Student comments in standard unit evaluations; one-on-one or group interviews.

CONCLUSIONS & CHALLENGES

The professional skills chosen for embedding in a unit need to be compatible with the nature of the unit and the position of the unit in the course. Even potentially "dry" topics, like numerical methods, can be used for professional skills development by setting suitable project tasks and by asking students to reflect on their decision processes. The current challenge is to formulate a research plan to investigate whether the in-lecture sessions and problem solving questions are actually effective in developing the desired skills.

REFERENCES

Crawley, E.F., Malmqvist, J., Lucas, W.A. & Brodeur, D.R. (2011). The CDIO Syllabus v2.0: An updated statement of goals for engineering education. Retrieved from http://www.cdio.org/files/project/file/cdio_syllabus_v2.pdf.

KEYWORDS

Professional skills; CDIO; Chemical engineering.