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Student self-assessment: Results from a research study in a level IV elective course in an accredited bachelor of chemical engineering

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ABSTRACT

A summative Mid-term Test in a level IV course of an accredited bachelor degree from a cohort of 32 (8 female, 24 male) students was both self-assessed and assessed by the experienced course tutor, using the idealized solutions and shell-form marking scheme of the lecturer. The assignment required demonstration of discipline-specific, definitions in *Pinch Analysis* and calculation of temperatures and heat exchanger network (HEN) designs. The grades were analyzed for accuracy, that is, agreement between student self-assessment (S-A) and tutor, marks. In 32 valid responses (100% response rate) the mean mark awarded by the students and tutor was, respectively, 83.1 (stdev = 8.3) and 71.7 (stdev = 8.3) out of a possible 100. Overall student S-A was therefore about 1.16 times that of the tutor's mark ($p < 0.025$). There was no evidence of student collusion in solutions or "marks sharking". Granularity in student S-A and tutor grading was, respectively, a ½ and 1. There was no evidence to show any systematic concordance between the tutor's performance ranking and that of the students. An independent Student Experience of Learning & Teaching survey (75% response rate) revealed a mixed reaction: there was 63% broad agreement that S-A was an effective way to learn; but low confidence (50%) that self-marking was correct. The provision of the idealized solutions (and marking scheme) was considered essential (71% broad agreement) for successful student S-A. Significantly, there was good agreement (63%) that S-A stimulated discussion of key concepts out of normal contact hours, indicating good student engagement with their learning and pedagogical effectiveness of S-A.

Keywords: Student self-assessment with idealized solutions; Undergraduate self-assessment in a chemical engineering degree; Students' marking behaviour; Quantitative students' evaluation; Anonymous student feedback; Learning and teaching in higher education

1. Introduction

Only the educated are free.

Epictetus 55–135 AD

Typically, in higher education, once students submit work for assessment many become disengaged from the process of the assessment. As passive recipients, the opportunity for enhanced student learning is thereby lost (Thomas et al., 2011). One way to engender student engagement and to enhance learning is through student Peer- and Self-Assessment (Nulty, 2009). Universally, the main aim with both is to increase student autonomy and to shift the role from passive to active learner (Boud, 1995; Falchikov and Goldfinch, 2000; Topping, 1998, 2009).

In student Peer-Assessment (P-A), students assess the work of another (Topping, 1998). Student P-A has been extensively reviewed by Vickerman (2009). Research has been carried out since the 1920s (Kane and Lawler, 1978), however, according to Gaillet (1992), student P-A appears to have been used since the early 1800s. Recent findings in particular for chemical engineering cohorts, are presented by Davey and Palmer (2012) for undergraduate third year students, and Davey (2011) for

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postgraduate students enrolled in higher degrees by course-work. Findings support the widely accepted view that students highly value P-A as a complementary learning experience.

In contrast, Student Self-Assessment (S-A) is defined by Boud (1995) as "the involvement of students in identifying standards and/or criteria to apply to their work, and making judgements about the extent to which they have met these criteria and standards". This does not imply however that S-A occurs in isolation; normally it involves drawing on criteria and judgements of others (Boud, 1995). However decision making is left in the hands of the student. According to Falchikov and Boud (1989), and Falchikov and Goldfinch (2000), S-A appears to be less effective in earlier years when compared with student P-A, whereas P-A appears to offer equal soundness over all student year levels.

Motives for using student S-A are complex; they include both the educational and the expedient. It is clear that educationally, the ability to self-assess is a skill which is necessary for lifelong learning; now being recognized by traditional colleges and universities as important in addition to attainment of a degree (e.g. Sternberg, 1997; Sharples, 2000). As an expedient however, student S-A can also be an opportunity to reduce workload of teaching staff; staff can use their time more productively by not marking the same question year after year. It might be argued this could result in reduced academic stress for those that both teach and research (Davey et al., 2010; Goh et al., 2012).

Common misgivings regarding student S-A include that self-grading cannot be taken seriously (Andrade and Du, 2007), and; that some (including lecturers it is assumed) believe that it is the lecturer's responsibility to assess the work of students (Basnet et al., 2012). Because some studies confirm these misgivings (e.g. Lew et al., 2010) and others show benefits (Rolheiser and Ross, 2000) these ideas continue (Basnet et al., 2012).

However a major concern is the "accuracy" of student S-A i.e. the agreement between self-assessed grades and the lecturer grades. This literature has been extensively reviewed recently by Basnet et al. (2012) in which all of the studies used the tutor's (lecturer's) mark as the "gold standard". They concluded that accuracy "(of S-As) seem to vary widely depending on age groups, tasks, subjects and time periods". It was not clear however whether this was because students consistently over- or under-assessed in relation to the gold standard. Based primarily on the work of Ross (2006), Lew et al. (2010) and Eva and Regehr (2005), Basnet et al. concluded that there were "weak to moderate correlations" between self- and lecturer-grades.

Eva and Regehr (2005) nonetheless argue that accuracy in S-A is not critical to student learning, but instead, that S-A is a valuable process that forces students to critically review their own work with an eye for improvement (Andrade and Du, 2007) – and thereby develops learning (Willey and Gardner, 2009). Willey and Gardner (2010) believe that not using student S-A is a missed opportunity for student learning.

1.1. *This study*

Against this background a study was undertaken to assess the value and impact of student S-A in an undergraduate chemical engineering cohort as an active learning activity. Students were tasked to self-grade their solutions to a major, summative assignment using the idealized solutions and general shell-form marking scheme of the lecturer as a guide, and to evaluate their experience using an established voluntary, Student Experience of Learning & Teaching (SELT) survey. The assignments were also graded by an experienced tutor to examine the accuracy of student self-grading.

It was hoped that findings might be used to enhance learning in higher education in chemical engineering.

2. Aims

The aims of the study were to:

1. Assess the capacity of students to grade their own work using idealized solutions and marking scheme of the lecturer on a major summative assignment.
2. Determine the correlation (accuracy) between the student self-assessed mark and that of the tutor.
3. Identify whether students valued this type of active S-A, and in what ways they found it effective/ineffective using an anonymous and voluntary established survey instrument.

3. Materials and methods

3.1. *Course and cohort*

The course was a 3-unit (nominally 45 h contact, plus 100 h study time) level IV (fourth year) undergraduate elective titled *Pinch Analysis and Process Synthesis*. This course was delivered in one-semester in the School of Chemical Engineering, The University of Adelaide. The course is offered in the fourth year of the globally accredited (International Engineering Alliance, 1989) bachelor of chemical engineering degree programme. Students are introduced to the principles of heat pinch analysis. The course covers key concepts and is designed to serve as an introduction to methods likely to be of use to practicing graduates in chemical engineering.

Course outcomes are that students should be able to understand the role of thermodynamics in process design, calculate the minimum heating and cooling requirements for a process, identify existing non-optimal arrangements of heat exchangers, find lower cost solutions for arrangements of heat exchanges, and; critically assess any design changes to process (e.g. Kemp, 2007; Seider et al., 2009; Linnhoff, 1997). To meet the goal of maximum heat recovery, or, minimum energy requirement (MER) an appropriate heat exchanger network (HEN) is required. This HEN design is not always an easy task considering most processes involve a large number of process and utility streams. Traditional designs result in HENs with high capital and utility costs. With the advent of pinch analysis HEN design has become more systematic and methodical (Kemp, 2007).

The course cohort was a combined class of 32 students (8 female, 24 male). Thirty-one were undergraduate Australian (local) students, none of whom were repeating, and one was a postgraduate course-work student from Columbia University (male) undertaking the course as part of a conversion Master of chemical engineering. All the students had chemical engineering backgrounds in undergraduate study and had been enrolled for at least seven semesters. Their typical age was 21–22 years.

The course materials included detailed lecture notes, presented as four (4) progressive modules, six (6) tutorial assignments and, a design project, together with explicit