This is the authors’ final peer reviewed (post print) version of the item published as:


Available from Deakin Research Online:

http://hdl.handle.net/10536/DRO/DU:30029772

Reproduced with the kind permission of the copyright owner.

Copyright : 2000, ASCE
STUDENT RESPONSES TO ACTIVITIES DESIGNED TO DEVELOP GENERIC PROFESSIONAL SKILLS

By Stuart R. Palmer

ABSTRACT: This paper reports on student responses to a range of assessment activities in a final-year engineering unit. Existing assessment activities were supplemented with new activities, the overall aim being to link the assessment activities more effectively to the material being studied, and to develop a range of generic skills important in professional engineering practice. A class survey was undertaken at the beginning of the semester to establish the initial attitudes to the new assessment activities. This was followed up with an end-of-semester survey to determine the change in perceived value of the assessment activities, and to collect student feedback regarding the activities. The perceived value of the assessment activities was determined using a Likert rating scale, while student feedback was collected using open-ended questions. The assessment activities evaluated were group work, case study investigation, report writing, oral presentation, group self-assessment, industrial interviews, and written reflective journals. The responses indicate that engineering students value a range of assessment activities. They value highly visits to real engineering organizations, and—contrary to popular belief—value and enjoy oral presentation exercises.

INTRODUCTION

This paper reports on student responses to a range of assessment activities in a final-year engineering unit. Existing assessment activities were supplemented with new activities, the overall aim being to link the assessment activities more effectively to the material being studied, and to develop a range of generic skills important in professional engineering practice. An analysis of the students’ perception of each of the assessment activities is presented.

GENERIC PROFESSIONAL PRACTICE SKILLS

Many reviews of engineering and engineering education in Australia over the last two decades have identified a preponderance of technical and discipline-specific course content over nontechnical and professional practice skills (Lloyd et al. 1979; Williams 1988; Bates et al. 1992; Johnson 1996). Yet these same reports identify that it is exactly these non-subject-based skills that both students and employers of graduates identify as generally lacking in current engineering undergraduate studies. In this regard, these recent reviews of Australian engineering education mirror the findings and recommendations of similar review exercises conducted in the United States (American 1994; Grinter 1995; Engineering 1997), Canada (Canadian 1993), and Europe (Working 1998).

Other recent sources identify the increasing importance of generic professional practice skills for undergraduate students (Smith 1992; Riley and Pickering 1995; Adamski 1999). Employers value the possession of these skills (Aulich 1990; National 1992), and the inclusion of these elements in undergraduate curricula is conducing to the development of lifelong learning habits in students, which in turn are likely to assist graduates in their long-term professional careers (Candy et al. 1994; Hargreaves 1996; Hecker 1997). The list of desirable generic skills identified in the literature includes, but is not limited to, the following:

- Self-direction
- Critical self-awareness
- An understanding of societal context
- Resource-based learning
- Experiential learning
- Written and oral communication
- Computer literacy
- Leadership and supervision
- Research and analysis
- Managing and organizing
- Teamwork

Many of these skills are closely related to the concept of student-centered learning, and to the development of deep rather than shallow learning (Hargreaves 1996; Fraser and Deane 1997). The recent engineering education literature shows many examples of attempts to incorporate these generic skills into undergraduate curricula, indicating educators’ growing awareness of the value of these skills.

APPROPRIATE ASSESSMENT ACTIVITIES

Closely related to the idea of curricula designed to develop generic practice skills and student-centered learning is the application of appropriate assessment activities (Adams 1993). Traditional assessment activities are often designed to test the ability of the student to recall learned information, or to handle forms of academic problems with which they are familiar. These types of assessment reward a surface approach rather than a deep approach to learning.

The unit that formed the setting for the assessment activities described in this paper was a final-year engineering practice unit at Deakin University: SEB421, Strategic Issues in Engineering. This unit consists of three modules:

- Technological forecasting and assessment
- Policy design in engineering organizations
- Issues in productivity improvement

The technological forecasting and assessment module discusses methods for forecasting, creativity, factors in technological innovations, and the impact of technological changes on business and society. The topics in the policy design in engineering organizations module are policy concepts, approaches to policy design, policy interactions, and examples in policy design. The issues in productivity improvement module focuses on labor productivity, productivity improvement techniques, benchmarking, the changing nature of work practices, and management productivity.
In SEB421, Strategic Issues in Engineering, existing assessment methods were supplemented with a number of new assessment methods intended to exercise and develop a range of generic professional practice skills. The total inventory of assessment activities was

- Group/team work
- Case study analysis
- Report writing
- Oral presentation
- Group self-assessment
- Industrial visits/interviews
- Reflective journals

It was not considered necessary to change the existing subject content, and a conventional end-of-semester, closed-book exam was also used, accounting for 50% of the total unit grade.

**STUDENT PERCEPTIONS OF THESE ASSESSMENT ACTIVITIES**

Since a number of new assessment approaches were being introduced concurrently, and the students’ prior exposure to these assessment techniques was not known, the students were surveyed at the beginning of the semester. The survey measured the level of prior experience with the assessment activities to be used, and was an attempt to quantify the students’ initial perceptions of them. To complement the initial data, the measurement of the students’ perceptions was repeated at the end of the semester, following their exposure to them in this context. At the same time, descriptive comments were invited regarding the benefits and limitations of each assessment approach.

The team/group elements were made optional for off-campus students, so the survey was limited to on-campus students only. The on-campus class size at the beginning of the semester was 18; the end-of-semester survey size was 15, because some students either withdrew from the unit after commencement, or switched to off-campus mode to better suit their personal circumstances. The mean age of the students was 22.4 years. Fig. 1 presents the students’ prior experience with the assessment activities. More than 75% of the students reported prior experience with group work, case study analysis, report writing, and oral presentation. Although these are compulsory activities to be used, and was an attempt to quantify the students’ perceptions, indicating the mean student ratings and the standard deviation of those responses. The following sections summarize the students’ start-of-semester and end-of-semester perceptions, indicating the mean student ratings and the standard deviation of those responses. The following sections present and analyze the responses of students to each of the assessment activities via a Likert rating scale (the exact questions asked for each assessment approach are described in the following sections). A rating of 1 indicates strong disagreement with the question/statement presented, 2 indicates moderate disagreement, 3 indicates indecision, 4 indicates moderate agreement, and a rating of 5 indicates strong agreement. A mean student rating for each assessment activity was obtained by averaging the numerical sum of the individual student ratings. As indicated, this exercise was undertaken at the beginning of the semester and repeated at the end of the semester to establish both initial and final perceptions. Fig. 2 summarizes the students’ start-of-semester and end-of-semester perceptions, indicating the mean student ratings and the standard deviation of those responses. The following sections present and analyze the responses of students to each of the assessment activities.

**Group Work**

While no formal grade was attached to participation in group work, students were required to work in groups of three for all assessment activities except the reflective journal. The students were briefed about the potential benefits and drawbacks of group/team work, and strategies for dealing with group organization and decision making were suggested. The students organized themselves into groups, and were responsible for organizing all of the group’s tasks among themselves. Group work had been experienced previously by 88.9% of students. Students were asked to rate their perception of the value of group work to a level of prior experience with the assessment activities. More than 75% of the students reported prior experience with group work, case study analysis, report writing, and oral presentation. Although these are compulsory tasks in units prerequisite to SEB421, not all students had given an oral presentation or worked in a group. Apparently some of the students enrolled in SEB421 had transferred into the Deakin University course with exemptions in the prerequisite units based on prior studies undertaken elsewhere. The responses for prior experience with the remaining assessment techniques were 50% or less.

Students were asked to indicate their perception of the value of each of the assessment activities via a Likert rating scale (the exact questions asked for each assessment approach are described in the following sections). A rating of 1 indicates strong disagreement with the question/statement presented, 2 indicates moderate disagreement, 3 indicates indecision, 4 indicates moderate agreement, and a rating of 5 indicates strong agreement. A mean student rating for each assessment activity was obtained by averaging the numerical sum of the individual student ratings. As indicated, this exercise was undertaken at the beginning of the semester and repeated at the end of the semester to establish both initial and final perceptions. Fig. 2 summarizes the students’ start-of-semester and end-of-semester perceptions, indicating the mean student ratings and the standard deviation of those responses. The following sections present and analyze the responses of students to each of the assessment activities.
requested to provide descriptive feedback on this assessment activity via the question, “What do you perceive the positive and negative aspects of group work to be?” Typical responses received were as follows:

Positive:
- “Provided extra motivation”
- “More discussion of the problem and more ideas”
- “Shares the work around”
- “It was fun”
- “There was a synergy and teamwork”
- “A chance to practice teamwork”

Negative:
- “Requires good organization and communication abilities”
- “Hard to find times to suit everyone”
- “Some people don’t complete their tasks on time”
- “Not everyone pulled their weight”
- “Some work was duplicated”
- “Some members didn’t input, they sat back and took the credit with the group”

Group work offers perceived benefits to students and is more representative of the true engineering work environment. This benefit comes at the cost of requiring students to be more organized and to exercise communications and group dynamics skills. It has the administrative benefit of reducing the number of assignment submissions to be graded. Care must be taken to ensure that group work does not become an excuse for lack of individual learning and performance. The significant component of group work employed here was counterbalanced with a conventional end-of-semester examination worth 50% of the unit grade, and a mandatory requirement to pass the examination; an apparently good performance in the group work activities would not by itself be sufficient for success. Additionally, it was required that all group members contribute to all group activities. For activities such as oral presentations, the contribution of each group member was obvious. For each assessable group assignment the group was required to submit a signed group work declaration documenting their relative contributions, as peer-assessed by the group.

Case Studies

For two assignments, the student groups were asked to locate recently published case studies relating to the course material being studied at that time. Examples of undertaking a review of the literature, appropriate sources of information, and the expected “quality” of the case studies were provided to the students. They had to answer a series of questions regarding how the organizations documented in their case studies responded to particular issues. A third case study exercise involving the student groups visiting a real engineering organization is described below. Additionally, each case study exercise involved preparing a written report and giving a class oral presentation; these are also described in more detail below.

Case study exercises had been experienced previously by 77.8% of students. Students were asked to respond to the question, “Do you think that case study exercises are a valuable learning tool?” The initial mean student response was 4.00 and the standard deviation was 1.00, indicating moderate support for case study exercises. At the end of the semester the mean student response was 4.27 and the standard deviation was 0.77. While this is not a significant change ($p > 0.2$), it does indicate significant support for case study exercises, and good agreement in this perception. At the end of the semester students were asked, “What do you perceive the positive and negative aspects of case study exercises to be?” Typical responses received were as follows:

Positive:
- “Opportunity to review how others write reports”
- “Helps relate the class theory to real life practice”
- “Makes the study notes easier to comprehend”
- “Allows us to utilize the new skills and knowledge learned in class”
- “Will help me avoid some of the mistakes made by others”

Negative:
- “Difficult to locate relevant material”
- “Extra reading to do”
- “More difficult than course work alone”

Significantly, a number of students reported that they could see no negative aspects to case study exercises. One section of the class theory in this unit was presented almost completely as a series of case studies, and student feedback indicates that this approach was not well received. A number of students commented that this approach left them confused and unclear about what the main point of the course material was. They said case studies were inappropriate as the principal learning tool, but when used as an adjunct to conventionally presented theory, they provided a valuable supplement, and helped place the classroom theory in a real world context.

Report Writing

For the three case study exercises, the student groups were asked to prepare a written report detailing their findings. These reports were required to be professionally presented, including referencing, diagrams where appropriate, and good spelling and grammar. A checklist of requirements and good practice for written reports was provided to the students. Across the semester, the three reports totaled approximately 6,000 words per group. The companion exercise to each written report was an oral presentation, described further below.

Preparing written reports had been experienced previously by 100% of students. Students were asked to respond to the question, “Do you think that preparing written reports is a valuable exercise?” The initial mean student response was 4.28 and the standard deviation was 0.99, indicating good support for the value of written reports. At the end of the semester the mean student response was 4.07 and the standard deviation was 0.57. While this is not a significant change ($p > 0.2$), it does indicate significant support for report writing, and good agreement in this perception. At the end of the semester students were asked, “What do you perceive the positive and negative aspects of report writing to be?” Typical responses received were as follows:

Positive:
- “Improves written communication ability, industry employs articulate engineers”
- “The preparation required reinforces the theory”
- “Good experience—even though most engineers don’t like documentation, it is required by many aspects of engineering”
- “Being able to express collected information in a logical argument or finding”
Oral Presentation

For the three case study exercises, the student groups were asked to prepare and deliver oral presentations to the class. These presentations were to be professionally delivered, and an array of visual display equipment was made available to the students, including overhead projection, video playback, and computer projection. A checklist of requirements and good practice for oral presentation was provided to the students. Across the semester, the three presentations totaled approximately 40 minutes per group.

Delivering oral presentations had been experienced previously by 94.4% of students. Students were asked to respond to the question, “Do you think that giving oral presentations to groups is a valuable exercise?” The initial mean student response was 4.14 and the standard deviation was 0.94, indicating good support for the value of oral presentations. At the end of the semester the mean student response was 4.53 and the standard deviation was 0.72, a moderately significant increase ($t = -1.32, p = 0.098$) indicating very significant support for oral presentations, and good agreement in this perception. At the end of the semester students were asked, “What do you perceive the positive and negative aspects of oral presentations to be?” Typical responses received were as follows:

Positive:
- “You really have to know your stuff”
- “Requires self-confidence, a clear mind and has to be entertaining—all good challenges to take on”
- “Has been extremely positive”
- “An extremely valuable skill for industry and an underdeveloped skill at Uni”
- “The more practice the better”
- “You learn cooperation and respect”
- “Personally satisfying when completed”

Negative:
- “Other presentations can be boring”
- “I don’t like it much”
- “It would be fun too if I wasn’t so nervous”
- “Not an enjoyable process (personal opinion)”

These results seem to dispel the belief that engineers dislike and shun public speaking. Oral presentation received the highest rating of all the assessment activities employed, and this score was obtained at the end of the semester after three presentations had been made. In fact, many students reported no negative aspect to oral presentation. The enthusiastic, positive response from students suggests that oral presentation could be incorporated more widely into assessment to improve both learning and student engagement.

Self-Assessment

In prior assessment activities involving group work and, indeed, in the case reported above, some students had cause to comment that not all group members contributed their share of the group’s work. In an attempt to encourage the groups to resolve this issue themselves, or at least provide a mechanism to cater for circumstances where they couldn’t, each group assignment submission had to be accompanied by a group work declaration form. On this form the group had to indicate what percentage of the overall effort was contributed by each group member, and all members had to sign the form. For example, in a three-member team where the contribution was equal, each member would indicate 33.3% on the form. Overall grades were assigned by the author and, if all contributions were equal, each group member received the same mark. If the contributions were not equal, the mark for those contributing less would be reduced proportionately.

Group self-assessment had been experienced previously by 50.0% of students. Students were asked to respond to the question, “Do you think that self-assessment, where you contribute to the mark you get for the piece of work, is better than assessment solely by the teacher?” The initial mean student response was 3.61 and the standard deviation was 1.16, indicating limited support for self-assessment. At the end of the semester the mean student response was 3.53 and the standard deviation was basically unchanged at 1.15. There was no significant change ($p > 0.4$), and no strong agreement in the perceived value of self-assessment. At the end of the semester students were asked, “What do you perceive the positive and negative aspects of self-assessment to be?” Typical responses received were as follows:

Positive:
- “Our group worked well, but it was good to have the flexibility to change marks if needed”
- “It lets us decide the amount we actually did”
- “Group assessment was good, but individual assessment is too subjective”
- “It forces group discussion about individual input and helps highlight inequities”

Negative:
- “Don’t think it makes much difference, everyone judges themself anyway”
- “It is unlikely that you would give a team member a lower mark than yourself, unless they did nothing”
- “If you work with friends, you feel reluctant to cut others’ marks”
- “Discussions about individual performance may be uncomfortable”

It is interesting to note that, even though some students have commented as if they actively participated in the group self-assessment process, every single group assignment submission received indicated that all members contributed equally. This perhaps reflects the practical difficulty and discomfort expressed by some students in passing critical judgment on the performance of their friends, peers, and work colleagues.

Industrial Interviews

Each student group was required, as a group, to interview a senior manager of a local engineering organization to discuss
that organization’s approaches to the issues studied in class. The goal was to expose the students, first hand, to real engineering management practices, and to allow them to compare this to the theories discussed in class. Since surveys, questionnaires, and interviews fall under the university’s classification of human research, and are therefore subject to the requirements of ethics approval, significant preparation was required to brief the students on acceptable interview protocols. A list of suggested interview topics was provided to the students, and an introductory letter was provided that explained the purpose of the exercise to the interviewee, but, other than that, the students had to identify, contact, secure the participation of, and interview a manager of their own choice. The resulting case study was presented in a written report and a class oral presentation, as described previously.

Industrial interviews had been experienced previously by 44.4% of students. Students were asked to respond to the question, “Do you think that visiting and interviewing a member of an engineering company would be a valuable exercise?” The initial mean student response was 4.44 and the standard deviation was 0.76, indicating strong support for industrial interviews. At the end of the semester the mean student response was 4.33 and the standard deviation was 1.14. This does not represent a significant change (p = 0.35), but does show a greater spread of opinion regarding support for industrial interviews. At the end of the semester students were asked, “What do you perceive the positive and negative aspects of industrial interviews to be?” Typical responses received were as follows:

Positive:
- “Extremely valuable as we obtained an insight into how various companies operate”
- “It was valuable to practice communication skills with people involved in management”
- “An insight into the way businesses operate in the real world”
- “Easier to research and remembered much better in comparison to reading a book”
- “Very much a learning experience”

Negative:
- “The time required—but the positives outweigh the negatives”
- “Time constraints”
- “No negative aspects”

This exercise was clearly valued and appreciated by the students. The slight decrease in support and increase in the spread of the score perhaps reflect the amount of time taken up in completing this exercise. The time required was the only negative aspect identified by the students.

Reflective Journal

Each student was required to keep a reflective journal individually. The purpose and value of critical reflection as one of the main avenues for the self-development and consolidation of knowledge based on the experience of the practicing professional was explained to the students. At the completion of the weekly class, students were asked to respond in writing in their journal to the following two questions: “What did I learn today?” and “How will this be of use to me in the future?” As long as the response was thoughtful and considered, students received 1% of their final grade for each week they completed a journal entry, up to a maximum of 10%.

Reflective journals had been previously kept by 38.9% of students. Students were asked to respond to the question, “Do you think that keeping a journal of your thoughts and ideas about the material studied in class would be a valuable exercise?” The initial mean student response was 3.83 and the standard deviation was 0.83, indicating moderate support for a reflective journal. At the end of the semester the mean student response was 3.33 and the standard deviation was 1.07; a moderately significant decrease (t = 1.42, p = 0.083). At the end of the semester students were asked, “What do you perceive the positive and negative aspects of reflective journals to be?” Typical responses received were as follows:

Positive:
- “Introspection”
- “Easy marks—encouraged me to come to lectures”
- “By putting what we learnt in writing it makes you think about it and we may remember it for longer”
- “Forces review and self-assessment of things learnt”

Negative:
- “A little repetitive”
- “It’s OK, but I found myself trying to reproduce notes, rather than putting down thoughts and ideas”
- “Value of journal as an educational tool is questionable”

The desired effect was reflection and critical evaluation. It appears that the way the journal was introduced did not achieve the desired effect, except in a few cases. This was the least “successful” of the assessment activities as perceived by the students, though many of the journal entries produced in class did demonstrate evidence of critical reflection and subject knowledge. Since critical reflection is one of the key means by which practicing professionals develop and consolidate their experiential learning (Schön 1995), it is intended to develop alternative approaches to introduce and exercise this important activity.

DISCUSSION

Significant changes in perceived value of assessment activities are noted in the preceding sections. It is interesting to note that the two assessment activities with which the students were most familiar (report writing and oral presentation) obtained high ratings for perceived value. While this perhaps indicates comfort with the familiar, the assessment activity initially indicated as the most valuable (industrial interviews) was one that students reported low levels of prior experience with.

Two of the assessment activities employed (peer/group self-assessment and reflective journals) were not successful, receiving both low ratings of perceived value (including a decrease in rating over the duration of the semester) and negative comments. The ability to give and receive constructive feedback/assessment to/from peers, and to reflect critically on events and actions, are valuable skills in professional practice. It is planned to modify the implementation of these assessment activities in the future to improve the student perception of their value.

In the case presented, student groups were given the opportunity to collectively assess the relative contributions of each member, principally as a means of encouraging individual student effort. The literature on assessment in science and engineering suggests that the validity and student appreciation of peer assessment are increased by the provision of marking criteria that address multiple dimensions/characteristics of the activity being assessed (Orsmond and Merry 1996). One specific approach is to provide students with a pro-forma marking
The concept of peer assessment could be extended to peer marking of classwide activities, such as the oral presentations, although the possible benefits need to be weighed against the additional administrative work in collating and moderating a large number of student gradings.

Reflective thinking based on experiential learning is a key skill required for the lifelong learner and the socially mature engineering professional (Kolb 1984; Schön 1995). Even though the reflective journal exercise described above was not wholly successful, the use of a reflective journal (due to the requirement to transfer thought processes into words) is thought to be a valuable tool in developing “reflexivity” (Jolly et al. 1999), particularly for students (Collier 1999). It has been suggested that the introduction of a reflective journal into a single point of the engineering curriculum may be less effective than if students encounter its use across the curriculum. The introduction of a reflective journal early in the students’ studies should be reinforced with additional later encounters (Jolly et al. 1999). Similarly, the introduction of a reflective journal at the final-year level (as described) without prior experience may not be most effective. It is noted that a reflective journal has been introduced at first-year level as a tool for students to reflect upon their experiences of the transition into university studies. While there has not yet been time for students from this cohort to reach the final year, it is hoped that these students will have an increased appreciation of the value of reflection on action.

Student perceptions of assessment activities are important, since if students enjoy their studies, they are likely to be more motivated to actively engage with them, and derive more value and learning from them. However, undergraduate students typically do not have experience of engineering professional practice, and their views on the value of assessment activities should be seen as one perspective only. Other valuable perspectives would come from recent graduates, experienced practitioners, and employers of graduates. University ethics approval has been obtained for a continuation of this study to conduct a survey of recent graduates of the Deakin engineering program. One aspect of this survey will investigate the perceived effectiveness of the assessment activities employed as part of their undergraduate studies.

CONCLUSIONS

A number of new assessment activities were introduced into a final-year engineering practice unit. While the number of students participating does not permit wide generalization, some observations can be made.

Most of the assessment activities were related by the students as having a moderate to high perceived value. Even where students described negative aspects of a particular method, they often described positive values as well. Many students commented that these techniques helped them to relate course theory to the real world, and that their comprehension of the material was enhanced.

Case studies were perceived as inappropriate as a principal learning tool, but when used as an adjunct to conventionally presented theory, provided a valuable supplement, and helped place the classroom theory in a real-world context. One hundred percent of students reported prior experience with written reports, and while report writing was identified as a valuable skill for engineers, students indicated that they already get plenty of practice at this task. The enthusiastic support for oral presentations suggests that this form of assessment task could be used effectively as a replacement for (or in conjunction with) written reports. It also suggests that, contrary to popular belief, engineers do enjoy public speaking. Finally, the opportunity to visit, experience, and analyze a real engineering organization was appreciated enthusiastically.

APPENDIX. REFERENCES


