Reflective essays: a tool for learning, course improvement and assessment.

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Abstract: As broad generic attributes and the propensity for life long-learning become increasingly expected of graduates, engineering courses must actively foster a greater range of skills during undergraduate programs. Enhanced learning, reasoning and emotional intelligence can be enhanced by encouraging students to reflect on their learning experiences. Such reflections can be evidenced by means of written reflective essays, which themselves can be used as part of an authentic learning and assessment strategy. Reflective essays unlike formal technical reports are written in the first person and require the author to think in depth about what and how they learn, and about attitudes to team work and problem solving. Such essays can also be used by staff to gain feedback on subject structure and the effectiveness of learning experiences.
Examples of reflective writing, its formative and summative assessment and its use as feedback to improve subjects' structure will be discussed.

Introduction

The Institute of Engineers, Australia's report "Changing the Culture" (1996) recommended changes to engineering courses by stating 'it seems certain that the educational role of universities must move strongly away from the presentation of information and towards facilitation of learning." This theme was further extended when it advocated enhancing "problem solving ability, self-directed and lifelong learning, communication, management and teamwork skills, but on a sound basis of mathematics and engineering technology." It will be argued below, that a key approach to achieve any form of deep learning, especially the ability to go on learning after completing formal education, is by reflection.

Schon (1983) criticized education for the professions, engineering included, for all too often becoming centred on the teaching of the scientific underpinning and theory of the discipline, while ignoring the practice and relevant competencies required for graduates to apply their knowledge and skills in practice. Woods (1985) emphasized the difference in addressing real problems encountered in industry with calculations required in many academic subjects. He observed that real problems are ill-defined, multidisciplinary and information is limited, as compared to academic exercises where all necessary information is provided, the latest theory is used to solve them and the problem is clearly defined within the context of the subject. Woods saw problem based learning as a means to reaching those ends. Applying and extending Wood's approach, Wellington and Clarke (2004) discussed the formation of teams of industrial engineering, marketing, accounting and industrial design students at Monash University to work on feasibility studies for companies. One formatively and two summatively assessed aspects of these projects is the requirement for students to reflect on their experiences.

It will be argued that reflection and the writing of reflective reports can not only aid learning but can also broaden communication skills and promote emotional intelligence. The paper will examine the case for reflection, discuss appropriate styles for reflective essays, consider their use for student and course assessment and improvement and provide examples of their use in three subjects at Monash University.

Reflection

Moon (1999) derived a definition of reflection from Dewey (1933), King and Kitchener (1994) and others as "a form of mental processing with a purpose and/ or an anticipated outcome that is applied to relatively complicated or unstructured ideas for which there is not an obvious solution."

Moon goes on to state that reflection is a form of "pondering", deep or critical thinking and may be applied to developing a broad understanding of diverse but inter-related issues or dealing with high levels of uncertainty, leading to the old fashioned concept of wisdom. She sites the extensive empirical research of King and Kitchener and Belenky et al (1986) who separately arrived at the concept that reflection is a multilevel skill which for most requires fostering or coaching if it is to be developed at the higher levels. She goes on to discuss the work of the 4 authors who provided the foundations for our understanding of the process and value of reflection. These include John Dewey, Jurgend Habermas, Donald Schon and David Kolb.

Dewey emphasized the value of reflection in developing a deep understanding of complex issues based on rational thought analyzing available evidence. Habermas (1971) concentrated more on the nature of knowledge and how it is developed, especially in the social sciences.

Schon (1987) explored skills required by the professions, including engineering, developing the concepts of "reflection-in-action and reflection-on-action". He suggested that the theory which forms the basic knowledge of a profession (the focus of most courses) is remote from the day to day activities in which professionals engage. He formalized the conflict identified by Woods when he uses the term reflection-in-action to think deeply about and quickly respond to unexpected consequences of an activity. The failure of the Chernobyl nuclear reactor being a classic failure to reflect in action. Reflection-on-action on the other hand is seen as occurring subsequent to the particular activity, perhaps most readily exemplified for engineers involved in failure analysis of a collapsed bridge or fatigue failures in aircraft.

Kolb (1984) discussed the incorporation of reflection into the learning process with his idea of an experiential learning cycle, shown in Fig 1.

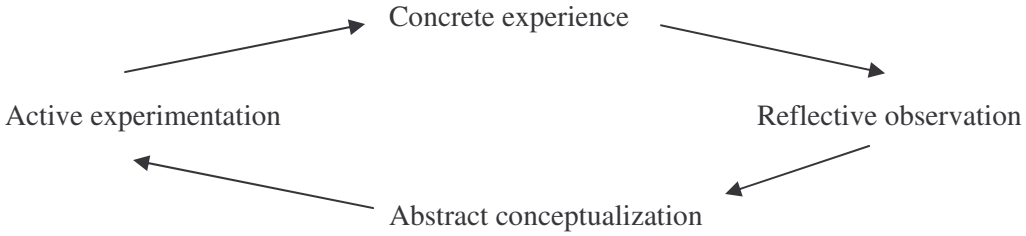

Figure 1. Kolb' Learning Cycle.

This model suggested that we learn by developing abstract ideas by reflecting on observations of concrete experiences. As we grow we seek to test the bounds of our world view by actively experimenting to test that view. Having planned the experiment and carried it out, we observe what happens. If the results are as expected, our abstract concepts are reinforced, if not, then we may revise that area of understanding by developing further experiments to gain enhanced understanding.

Emotional intelligence (EI)

Kelley and Caplan (1993) studied engineers' success at AT&T's Bell Labs, and found there was no correlation of success with IQ, but found a high correlation with Emotional Intelligence (EI). Goleman (1996) identified EI as including self-awareness (self-assessment, confidence), self-management (conscientiousness, initiative, adaptability), social awareness (empathy, service orientation) and relationship management (communications, conflict management, change catalysis, leadership, and teamwork), all of which are likely to be enhanced by reflective thinking. He emphasized that EI can be learnt and advocated engineering educators move to using more motivating and innovative teaching

methods, thus developing graduates with higher EI. It is apparent that these skills will largely be developed by reflection.

Writing reflective essays.

The purpose of reflective essays is for students to analyze in writing his or her thoughts and feelings about their learning, their team, the subject, the project, peer assessment, factory visits or any other appropriate issues. While technical reports are written in the third person, reflective reports should be about the author – what they think, or feel or action they propose and hence should be written in the first person.

True reflections will not necessarily be positive either about the subject or about specific activities, projects or teams. It is essential to establish confidence in the student that they will not receive poor marks if they make strong criticisms. However, students are encouraged to develop positive criticism skills where they identify ways of improving (in their opinion) on the existing situation. Such opportunities to "let off steam" may well develop several positive outcomes. Firstly, the student has to frame the frustration in words, helping them clarify the issue in their own mind. Secondly, they need to frame the comment in a way which will be understood and possibly empathized with by the facilitator. Thirdly, it encourages the student to think about possible ways of addressing the issue and fourthly it may result in them taking action which may at least in part overcome the frustration.

Examples of good reflections include: "The implementation of interim reports, I consider to be an integral part of meeting deadlines of the project solution, by the end of the semester. However, in respect to the project proposal or final report that ties everything together, there needs to be a structure provided to the teams. The other disciplines appear not to have had any exposure to report writing in the style of a business plan, hence it was left up to myself to structure and complete it. This requirement from the team needs to have a more structured approach to it. Perhaps an introductory session to the teams about proposal report writing and presentation development is necessary. It is not enough to consider that because marketing students have had exposure to this in the course of their studies, that they will drive the completion of these tasks." Marketing student
"I found that working in industry is very different from text books. Company X's variable cost accounting system does make things difficult when trying to determine costs. There is no structured way of costing their products. This forces me to research and interview company personnel. This makes me more open minded. This also gives me good experience in interviewing and the ability to talk to superiors when necessary." Accounting student**.**
One poor reflection was: "The outline of the project and the objectives specified created a basis for using our acquired skills to learn how to utilise them efficiently in a real life industrial problem. The meetings were held every Tuesday at approximately 1:00pm and enabled the group members to share their progress. These meetings became an important part of project management." Industrial engineer**.**

Subject improvement using reflective reports.

Over the last decade, quality has become an increasing focus of much university activity and a variety of standard questionnaires using both structured and unstructured questions have been implemented throughout higher education. While these may be appropriate for traditionally organised subjects, they often pose meaningless or irrelevant questions for subjects which seek to build in broader skill development using more radical learning approaches and environments.

Hence, the evaluation of reflective reports in such subjects can give more insight into positive and negative learning situations and insight into what aspects have motivated or failed to motivate students. Students can be asked to reflect on specific elements of subjects, so as to determine whether those elements should be expanded, stay the same or be reduced or removed in the following year. They may be encouraged to reflect on their own learning process and ways of further achieving lifelong learning skills. It is of course essential to generate confidence in the student that criticisms will not be marked down. Positive feedback from formative assessment of reflections can help overcome these fears.

Assessment of students – benefits of assessing reflective reports.

The importance of graduates achieving high levels of communication skills is emphasized in numerous documents on higher education as a whole and engineering in particular. While technical report writing has always been a requirement, many courses are increasing the emphasis on students making oral presentations, some of which are used for summative assessment. However, the formal impersonal technical report is only one kind of written report. It could be argued that for engineers dealing with those outside the engineering community, less formal styles may often be desired. Encouraging student to both think and write reflectively can enhance both their learning and their communication skills.

As Woods found, the ability of students to apply knowledge is best done by providing them with real world problems and observing their approach to finding a solution. This is often achieved through final year projects in which students work individually, in pairs or occasionally in larger groups on a problem, either proposed by a member of staff or by an outside organization. Students usually meet regularly with a supervisor who assesses their performance based on a combination of evaluating their approach to the problem, their skills in designing experiments or products, their results and conclusions they may draw. This assessment by observation, discussion and questioning is a desirable aspect of formative feedback and sometimes contributes to summative assessment. Such projects are commonly assessed mainly by evaluation of final reports and presentations by panels of staff members including the students' supervisor.

While students' thinking and hence learning processes may be explored in discussions with the supervisor, there is rarely an attempt to include this directly in summative assessment except indirectly by evaluating the ordered structure of reports and presentations and the success of achieving the projects' objectives.

However, it seems that if the reflective process is to be as central to learning as Kolb proposed and to the professional graduate as Schon indicated, students should be encouraged to gain a deeper understanding of their learning processes and attempts should be made to include the capacity to reflect effectively in essays which can be both formatively and summatively assessed. The LTSN in the UK (2001) emphasized the need to have assessment reflect learning outcomes; so if it is important that students learn to reflect, it is important that their reflective skills should be assessed.

Fostering reflection in engineering courses.

Reflection has been fostered extensively in the Industrial Engineering and Engineering Management course at Monash University and to a limited extent, in a first year Engineering Management elective and a third year Mechanical Design subject.

Reflective reports are an integral part of three subjects in IEEM – second year Engineering Management, the third year Multidisciplinary Industry Project and the fourth year Managing Strategic Change, each with somewhat different goals. Examples of extracts from student reports are shown below.

The Monash University third year multidisciplinary industry project.

This project was discussed in depth by Wellington and Clarke (2004). The main objective is to provide students with real world experience by carrying out feasibility studies for a client company on a brief of the companies' choosing, in teams of approximately 8 students drawn from Marketing, Accounting, Industrial design and Industrial Engineering courses. Reflective reports were introduced as part of the students' assessment in 1996 when the MDIP was first run.

The key change made to the subject in its second and subsequent iterations based on reflective comments from students, was to reduce the number of peer assessment questions from 16 to 8 and subsequently 4. In the first iteration, most students indicated that they felt that the peer assessment was appropriate in the large team format, even though some were not comfortable with assessing their team members. However, almost all complained about the time taken to give serious thought to so many questions about their 6 to 8 peers. While some information was lost as a result of reducing the number of questions, students were generally happier with the time taken and the majority believed that it was an appropriate process.

While there had been few complaints about writing the one reflective report at the end of semester, some students indicated that this personal style of writing was quite difficult for them as they were unsure what was expected. Accordingly, students are now asked to write 3 reflective reports; the first in week 5, the second in week 9 and the third at the end of semester. The first was assessed formatively with advice given by the teams' facilitators, the second was assessed both formatively and summatively for 5% of the total subject marks and the final one assessed summatively for 10% of the total mark.

Difficulties were reported with team leadership, identifying and allocating meaningful work activities, information gathering in an environment of uncertainty, novelty and commercial confidentiality, in communicating with busy company management personnel, and with using the peer assessment feedback. Accordingly, a leadership seminar was set up and additional printed information is provided during the project to address other issues.

The students are given an introduction to reflection by Thomas (2007), which establishes the benefits of reflection and suggests approaches to writing effectively viz. **"**I realize now how important it is to get the people on the assembly line on side so that I can learn from them about the job they do. I was reluctant to approach the workers. Maybe I can ask Chris (the manager) how I can do this. He seems a bit distant, I wonder how he will react if I call him. The workers have ideas about what needs to be done. Maybe getting their views and then getting them to comment on our suggestions might be productive. I should talk to other people in the group about this." This comment was taken from a 1996 report.

The reflective process indicated that almost all students are particularly motivated by the perceived "real" nature of the project, the company and the multidisciplinary team structure. Examples of useful comments made include:

D T (1996) IE. "At first I believed that this project would be largely engineering based but it was the marketing division which provided the driving force. This made me aware of the customer based mentality that is becoming increasingly important. As a result of working with other disciplines, I feel more confident about working in industry and with people from these other disciplines."

C R (1997) IE. "The peer assessment was a valuable part of the learning experience. It ensured the whole team worked together, and that the workload was shared equally. It was a great incentive for all group members to become fully involved in the project. As I now work in a company where this type of assessment is used for performance and salary reviews, it was useful to have this experience."

GB (1997) IE. "The peer assessment method had its good points but on the whole was not particularly useful. My feeling was that too much information on the feedback pages was too detailed for people to take in. …. It was also extremely tedious to fill out, taking quite some time."

LB (2000) IE. "Peer assessment has been a continual part of this project from week 1. At first I didn't really think that it would reflect much as I was very enthusiastic about my fellow team members, and I wanted us all to achieve the best possible mark from this subject. By the end of the project though, I was still enthusiastic about most of my fellow team members, but I didn't really think that it was fair for everyone to get the same mark, when some team members didn't contribute nearly as much as other members."

RK (2003) Acc. "The purpose of the site visit was to have a better understanding of the rotational moulding process. ….. Initially I expected this site visit to be irrelevant and a waste of my time. …. However, after the site tour, the three accounting students … sat on the couches situated at the reception. Almost in unison we said "wow". We then giggled and went on talking about how cool this whole experience has been. …. I should have spoken out more and asked them questions regarding the rotational moulding process….. This experience was unexpectedly good as I put into practice a lot of things I have learnt. For example, as part of an audit, an auditor should visit the work site and assess the functions."

AA (2003) IE. "I expected more information about the project and I was a bit concerned that the project brief was indeed so brief. .. I was a bit annoyed at the lack of answers to questions that both groups posed

to (the company rep). I could see his point, that he wanted us to think for ourselves on how to come up with solutions but I could see one major flaw to this approach. ……

What could I have done different or better? I think I could have tried to bring the team together by somehow getting everyone describing their own interests (both to this project and more generally). It can take some time for people to open up, so I guess it's not good to have people feel too uncomfortable at the beginning."

AJ (2004) Mkt. "Nevertheless, the most unforgettable part of the tour (Toyota) was the robots that assembled the cars; they were out of the world. I felt like a little kid watching a magic show. Moreover, the plant was so clean and had so many colour posters and picture charts/message boards that made vital information more interesting to look at, thus motivating the workers."

JT (2006) Ind Des. "Nov. 5th. . I admit, I felt really angry when I heard that no one had met up before today, and that many of the others were still unsure about what they were doing

Nov 13th We've done so much work yet many problems have occurred, however I think we've overcome most obstacles. I know that we have been getting on each others nerves quite a bit, but under the circumstances, I hope it's normal! I can't help but feel even more proud what we have achieved.

Nov 14th. The team can honestly say that this project was wholly ours, and all the testing, research, and concepts were from our own hard work and blood and sweat; and to me, that is more of a benefit then simply having an "easier" project and getting a potential better mark.

Overall, I thought we did great! No one sounded too nervous, everyone said what they needed to say and no one cried! So overall, Id say it was a great success."

The above comments provide insight into different perspectives on the values of the subject in terms of student learning; eg. DT emphasizes the cross disciplinary benefits, the business students RK and AJ gain motivation and understanding from the plant visits, and the comments on peer assessment by CR and GB helped improve the peer assessment process which CR and LB certainly endorsed as important in assessing the members of large teams. AA and JT were frank in their comments about their emotions and their personal responsibilities, significant elements for enhancing their EI.

Monash University second year Engineering Management

The first half of this subject revolves around a project for teams of about 5 students to build a model solar powered car with the emphasis on managing the project. The team prepares a technical report on their design, manufacture and analysis of the car's performance in a 10 metre drag race, but each student is required to write a short report in which they reflect on their team organization and operation for10% of the subject mark. This project was also run for several years in a first year elective, now discontinued. Examples of comments include:

RH (2002) 1st yr Eng. "My team worked really well together. It was great to be able to say, "this and this needs to be done", and to have 6 hands going up, as everybody told me how they could help. I even had people repeatedly tell me " I have never done that before, but if someone shows me, I'll have a go", or "I don't feel that I can do that but I can do this and this and this…. In leading such a great group of people, I think I have learnt a lot about what it means to be part of a team." A leader can't get the best out of their team by dominating and suppressing, and trying to do it all themselves; rather a leader should empower the team to do the work."

TB (2002) 1st yr Eng. "The best way to learn about project management is to experience it, and the model solar car challenge provided us with the opportunity. Whilst project management seems simple when explained from a textbook, it is difficult to do in practice".

JW (2002)1st yr Eng. "By completing a real project with real life constraints and boundaries, I was able to learn so much more than would ever be possible if studying the subject in a purely theoretical manner.

What may seem trivial in theory and not an issue can prove to be a major issue that needs to be dealt with when dealing with a real issue. Although if I were to complete the task again I would approach it in a very different manor, I believe it is positive to learn from our mistakes."

AA (2002)1st yr Eng. "Delegation and diplomacy. Delegation meant getting things done through people. I could see glimpses of what effective delegation was, but I think I learned more by my failures than my successes. …. "Differences between team leadership and race day leadership. I noticed "A" was good at making rapid well-informed decisions and he seemed to communicate well with the rest of the team, so I asked him to be race leader. His style of fast decisive conditions was better suited to race day than my leadership, which was more contemplative."

The reflective process provides opportunities for students to formally identify what they have learnt, a significant part of deeper learning. This is true both technically and in terms of leadership and team skills as RH and AA pointed out. TB and JW both flagged the advantage of a real project compared to theory. JW and AA realized the benefits of learning from their mistakes, a central tenet of lifelong learning. RH and AA identified the importance of effective delegation and good communication, indicating high levels of interpersonal awareness and skills, key elements of EI.

Monash University fourth year Managing Strategic Change

This subject is a final year elective for IEEM students in which students can negotiate aspects of their assessment. Most produce a reflective report worth up to 10% of their total mark written near the end of the semester. In this they reflect on the lectures, videos, tutorials, assignments, guest speakers etc.

H D: (2002) IEEM **"**The overall subject had a balance of theory, as well as student participation. I think that this subject allowed everyone to gain a different perspective on how to accomplish different tasks and to think in a non-traditional engineering mind set. I felt that the subject was exceptionally interesting and am promoting it to friends who are going into 4th year next year.
I have discovered that I am much more capable of doing things than I had originally thought. I also feel more confident in giving presentations nowadays, which was my main reason for selecting this subject."

SB (2006) IEEM "The other major difference about this subject was the negotiation in assessment. I thought this was a great opportunity to really think and act responsibly on what assignments and tasks one can undertake. Personally, I really enjoy freedom and flexibility so this subject scored another positive mark for me by giving me both freedom and flexibility to choose my marking structure and for me to choose which assignments I want to do.
The biggest aspect of these role play exercises was I think to see ideas and the points of view of different types of people. The senior management would have a differing point of view when compared to the suppliers or compared to the unions. To actively undertake a role play and see different points of view from other people's perspective is a big positive and an important tool for engineers."

WL (2006) IEEM "By this assignment I also got an opportunity to taste of being an actor, because the presentation we did for this assignment were by showing a video which we had done before hand instead of doing a normal power point presentation. In this video I was taken the role to act as the shareholder for the tobacco's company and a doctor who are representing the Victoria Health Ministry. This is a thing that I never think of before, because I never think I can act. But by this video I had learned that other than a normal power point presentation, making a video also can be a way for presenting an idea."

GR (2006) IEEM "Managing Strategic Change was definitely not what I was expecting. Before classes started I was expecting to endure 13 weeks of management theory and irrelevant claptrap that merely stated the obvious. This was not the case. Upon learning in the initial lecture that I would be the master of my assessments and that the subject was not solely about change but was change, I felt excited about experiencing something new at university.
On the whole, the lectures weren't all that exciting, although it musty be said that business management is a pretty dry subject. The series of videos viewed throughout the semester were a welcome change, and

generally provided a case example of the preceding lecture. I think the first video we watched was about changes in employee health and safety standards and focused mainly on child labour. Seeing what those young kids had to do down those coal mines really put some perspective on the national uproar over IR reforms. … I remember thinking "what the hell were those guys on? Sending children down coal mines and inside industrial machines."

Feedback on course structure is important in aiding improvement of any subject and the above reflections identified what did and did not work. GR's comment on lectures helped flag directions for improvement, although endorsement of the videos, more flexible assessment and greater delegation of responsibility for students' own learning provide support for the basic ideas of the course. The enthusiastic use of role plays and videos perhaps comes as a surprise from supposedly introverted engineers. However, their exploration of new experiences indicates that, along with the confidence that their skills are broader than they had thought, further enhances their range of personal and interpersonal skills, in other words their EI.

Conclusions

Reflective essays are a form of communication rarely used in engineering courses but they can generate benefits to students in formalizing and deepening their thinking, enhancing their range of skills and increasing their confidence, as well as providing feedback and recommendations to staff who can use them to improve subjects and better understand student learning. The reflective experience has been shown to be important in learning and enhancing EI and could well be more widely adopted to help more graduates enhance their long term career prospects.

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