Challenges of progressive feedback in engineering management

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Structured abstract

CONTEXT
Feedback is certainly among essential elements of a learning environment and developing an effective feedback process is highly desirable. Evidence from literature (e.g. Walker 2009; Ferguson 2011; Orsmond & Merry 2011; Bailey & Garner 2010) show that detailed feedback to students could enhance their learning. Moreover, early informative feedback is an essential requirement for encouraging students to change their performance in future (Brown et al. 1997). Feedback can take many shapes and forms. It can be simply a final grade or a comprehensive descriptive response for an assessment. Nevertheless, it should be designed and provided in a way that it could manage students' expectations, learning process need and be consistent and supportive of course material. There are challenges, however, when engineering students carry out a course in management where content and feedback processes are somewhat different from other scientific and technical units they often have. These technical units unlike management units seem to provide more objective, measurable often linear understanding of a knowledge area. Therefore, education process in general and feedback mechanism specifically should help students to deal with this disparity between management and technical units.

PURPOSE OR GOAL
This paper asks the question on how feedback process should be customised in teaching a management unit for engineering students and whether such customisation is necessary.

APPROACH
According to literature review, we examine our feedback processes and choose an appropriate framework. Then evaluate the effectiveness of changes that have been implemented to one engineering management unit. Using focus group within teaching team and considering standard student feedback survey, the overall design of feedback process will be analysed. This could be a basis for improving feedbacks and eventually learning experience of students. Moreover, this is a pilot study for conducting an extensive research in similar units in collaboration with other universities.

ACTUAL OR ANTICIPATED OUTCOMES
The authors believe that by modifying several feedback processes through the semester, students will improve their performance and make enhancement to future work. More effective and efficient participation of students in team work activities and understanding the applications of subject contents will be the outcomes of changing feedback processes that teaching team is expected to achieve in this research.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY
Based on our observations, many factors should be considered when feedback process is designed for students. Students prefer frequent and progressive feedback process. Moreover, various forms of feedback should be embedded in assessment to provide opportunities for students to be self as well as peer assessed. Finally, there should be attempts to have transitional tasks between quantitative assessments (often found in engineering) to qualitative assessments (common in management).

KEYWORDS
Feedback, engineering management, enhanced learning

Introduction

With the increasing complexity and variety of works that engineers carry out in different industries, the development of organisational and project management skills in engineering courses appears to be critical. The identification of the need for education in *Engineering Management* is certainly not new. There is a body of evidence in literature that such need has been well highlighted and promoted early on in engineering education. For example, Grinter(1955) argues that " ….the foundation should be laid in college for an understanding of human relationships, the principles of economics and government, and other fields upon which the engineering manager can build''. Moreover, recent trends in business environment such as globalisation of supply chains, outsourcing of traditionally in house functions such as IT services, innovation in product and processes and many other trends give paramount importance to target effective educational experience in management concepts for engineers so much so that education in these areas appears rather to be compulsory. There are indications from various universities that management concepts in general and entrepreneurship in particular are getting more recognition than before. Centres such as Epicenter at Stanford University are established to provide management and entrepreneurship support for engineering students. At Swinburne's faculty of Engineering and Industrial Sciences, recently, two engineering management units have been changed into core units and now all engineering students have to study them. Given such emphasis on engineering management education, the question is whether any special consideration should be given to customise teaching management concepts to engineering students and if such customisation is necessary, how we should achieve it effectively. We wish to focus on two particular aspects of assessment strategies and feedback to students' practices.

This paper has been organised as follow: first elaborate on challenges of teaching engineering management. Second, a brief literature on feedback to students will be provided. We then introduce the changes in assessment and feedback processes followed by analysing the effectiveness of changes employed. Finally, we conclude this paper with our observations.

Engineering management and its teaching challenges

Unlike many other units in engineering courses, engineering management covers a broad range of concepts as it is often intended to provide knowledge in different aspects of managerial jobs such as administrative decisions, planning decisions, marketing decisions, financial decisions, etc. Also the content of these concepts often are classified differently from engineering units. These topics are often classified as management and business area which have common interests and approaches with economics, humanity and social sciences while engineering is more aligned with knowledge areas in mathematics and physics. Therefore, engineering management units for engineering students might appear to be ambiguous, inconclusive and out of required depth.

Also, traditionally assessment process in engineering units often concentrated on familiarising and mastering students with a particular algorithms and approaches that have been developed throughout the time by lead engineers and researchers. So, for posed assessment questions for students, the students are required to go through the given process and reach to some best unique undisputable answers. Such approaches lead to problems that students come across when they join the work force. Jonassen et al (2006) provide a summary of how engineering professionals find disparity between engineering education and real life practices. In their research, interviewees argue that work place problems are ill-structured problems which often have multiple conflicting goals, can be solved in many different ways and success or failure is not really measured by engineering standards.

Therefore, assessment strategies and feedback process in engineering management should address engineering students' expectation and motivation to different style of learning that

they accustomed to and any customisation requires an in depth understanding of feedback process for students.

Feedback to students, a brief literature review

Universities and training institutes are concentrating on learning and student centred education. No doubt, improving learning in both higher educations and training sector cannot be achieved without enhancing the assessment systems and feedback practices. Assessment systems will impact on students who are looking for qualification or high grades in order to be employed upon the accomplishment of their studies.

According to Taylor and Nelen (cited in Alquraan et. al 2010), feedback is the instructor's oral or non-vocal reply or activity in which s/he gives information to her or his students regarding their ideas, engagements, and in general, their assignments. Feedback is seen as a part of the assessment process. Assessment, by definition (Brookhart 2004), means gathering information, both quantitative and qualitative, in relation to something to be used for some purpose. Using a multiple-choice exam to measure student achievement of a set of knowledge is an example for quantitative information. Asking students to describe which part of learning activities they found difficult and why, is an example of qualitative information. In regards to categorising different assessment methods, Brookhart (2004), grouped them in four types: paper-pencil assessment, performance one, oral and portfolios (systematic collections of student work overtime and often associated with student reflections) assessment. Other researchers (e.g. Alquraan 2012 and Alquraan et al. 2010) added online and computer assisted testing, peer and self-assessment. Similar to assessment methods, several types of feedback methods exist for both instructors and students.

Feedback is certainly among essential elements of a learning environment and developing an effective feedback process is highly desirable. Evidence (e.g. Walker 2009; Ferguson 2011; Orsmond & Merry 2011; Bailey & Garner 2010) showed that detailed feedback to students could enhance their learning. Nicol and Macfarlane-Dick (2006) pointed out that good feedback practice should clarify what a good performance is and also facilitate the development of self-assessment in learning (i.e. reflection).

According to the literature, it is worthy to identify some principles of good feedback practice before classifying those feedback methods. Nicol and Macfarlane-Dick (2006, p. 205) defined a good feedback as "anything that might strengthen the student's capacity to self-regulate their own practice". In another study, Lipnevich and Smith (2009) declared that notes from teachers; would turn students' attention to applicability of feedback, specific information within the feedback, how the feedback would inspire their mental elaboration, and as a result boost their performance. In regarding effective feedback, Hounsell and associates (2008) suggested that guidance and feedback should be put in an iterative loop, which has a series of steps that would be potentially applicable to assessments.

In order to provide a framework of feedback methods and address the second research question, it is considerable that it should be better to start classifying the different feedback methods.

i. Formative vs. summative

In the first step, considering two types of assessments, formative and summative; then, there are two types of feedback. One is formative and another one is summative. According to Kealey (2010), the aim of formative feedback is to boost learning within ongoing monitoring of acquired skills to find out steps required to gain learning objectives. On the other hand, summative feedback, which is provided at the end of learning process, it is meant to be a determination of the extent to which a student has achieved learning objectives. Taras (2008) discussed that rough definition of summative assessment is associated with words "final" and "end". Those assessments are also associated with grading of students.

Perera and her colleagues (2008) suggested that formative feedback should be included as a basic module in all teaching and learning activities of curricula design. They mentioned

that formative feedback is vital element for directing students towards the desired performance goals. Nicol and Macfarlane-Dick (2006) stated that in academic settings, particular aims, norms, standards and other external reference points help outline goals. Then, feedback is information about how students' current state of learning and presentation relates to these goals and standards. Perera and her colleagues (2008) reviewed the literature and pointed out that the formative feedback in higher education is still largely controlled by instructors and declared that teachers deliver feedback message to students about what is right and wrong in their academic work.
Despite the benefits of formative feedback, Savin-Baden (2010) raised question about the extent to which feedback can really feed into next stage of learning; taking into account that many students recognise that next assignment is probably to some extent unconnected with previous assignment which they received feedback on it.

ii. Teachers feedback vs. peer feedback

The next stage in classifying feedback methods is to consider who will provide feedback to students' works. The assessment feedback for student performance can be produced either by a teaching team (an instructor) or peers (other students in the class). Feedback comments are made for various types of assessment such as: a) individual coursework assignments; b) team-work or group assignments; and c) test, quizzes and exams, however, for peer assessment, teaching team should look at only first two types. Reviewing the literature (i.e. Neus 2011) declared that peer assessment has been achieving significant step as a mean of enhancing accountability and responsibility of group members for group projects in higher education (please also see McMahon 2010). For instance, nowadays, teaching teams attempt to assess students' oral presentation by other students (using peer assessment for oral presentation).

iii. Written (text-based) vs. oral/audio feedback

After classifying feedback methods based on formative vs. summative and instructors vs. peers, the next stage is to look at feedback based on how they will be generated and presented to students, which could be classified within the following two types; written (text-base) vs. oral feedback. Bailey and Garner (2010) believed that feedback on assignment is predominately in the written form and it may be the only kind of feedback that students may receive in large classes, while teaching team is using structured feedback forms. Using structured feedback forms are recommended because teachers and institutes are concern about greater transparency and equity of assessing students' work and achieving greater consistency across different departments.

To provide comments to students, instructors spent lots of time to write and manage the feedback. Having said that, there is a question raised which whether students read the feedback and how long did they spend to read it? According to study conducted by Higgins and his associates (Higgins et al. 2002), it was indicated that 82% agreed that they paid attention to comments they got. Also, it was indicated that 39% of participants spent 5 minutes or less to read the feedback, 42% spent 10-15 minutes and 13% spent 15-30 minutes to read the feedback.

The quality of feedback is very important and addressed in many papers as well as reported in this article. Beside many issues of poor quality feedback, the poor timeliness of feedback provided could be overcome by using oral/ audio feedback for both formative and summative works. The use of audio to provide feedback is not new.

iv. Online vs. paper-based

Nowadays, most of audio feedback provided to students is delivered via email or other online tools such as email, Blackboard or WebCT. Also there is an option to deliver text-based feedback via online tools. Bridge and Appleyard (2008) compared electronic version verse paper-based regarding the feedback received by students. They found that about 93% of students declared that they received feedback electronically faster than paper-based. Also approximately 56% preferred to receive feedback electronically.

In summary major aspects of feedback can be structured in the following table:

Table 1: Major feedback types

Formative	Summative
Teacher feedback	**Student feedback**
Written	**Oral/audio**
Online	**Paper based**

The above structure might not be comprehensive as other aspects such as video recorded assessment and feedback, self-assessment and feedback, informal and formal feedback should be considered as well.

Introducing the changes of assessment and feedback processes

In this paper, we focus on Engineering management I unit, a unit that intend to introduce basic functions of management and how they can be carried out effectively and efficiently. Alongside basic management functions, project management concepts are also discussed. The subject is designated for third year students, however, practically students can take this unit anytime and there is no visible connection and interrelationship between engineering management units and other units in engineering courses. However, engineering management was taught somewhat similar to other units as this unit has a well-known text, a well related exam paper and a research that indicates some analysis from the students. However, during the course of couple of years, some changes have been introduced to address students' feedback about the unit and increase student engagement in the teaching process. We classify these changes as intermediate changes and additional changes. The following table shows the trend of changes in the assessments components of this unit subject.

Table 2: Changes in understudies unit

Past	*Intermediate changes*	*Additional Changes*
Final exam	**Final exam** **Feedback Test**	**Final exam** **Feedback Test I** **Feedback Test II**
	Minor Activities	**Enhanced Minor Activities**
Research project: • **Final report** • **Final presentation**	**Research project:** • **Initial presentation** • **Final presentation** • **Meeting minutes** • **Final report** • **Wiki (a group's brief effort presentation)**	**Research project:** • **Initial presentation** • **Final presentation** • **Meeting minutes** • **Final report** • **Wiki (a group's comprehensive effort presentation)**

According to literature review each assessment needs some forms of feedback. Thus, each assessment item mentioned above can be explored and matched with specific categories of feedback.

In the past, before any changes implemented, as part of assessments this unit had only one final exam and one research project including final report and presentation. Final exam could be considered as summative and the feedback was accordingly summative and teacher centred. Regarding the research project, the feedback was summative, written type and teacher centred and paper based. The benefit of such system is that they appear to be easy to organise and they set long term objectives for students.

In the first stage of changing the process of assessment and its related feedback, known as *intermediate changes* in this article, we introduced several concepts such feedback test, minor activities (also known as portfolio assessment), minutes of meeting, initial presentation and online group space (also called wiki on blackboard). Related feedback to the above assessments is as follow:

A formative feedback and teacher centred was related to Feedback Test assessment. The test created an initial perception of the unit and its assessments. The noticeable change observed by students is about minor activities. Each minor activity was a set of questions related to lecture contents and how the concepts were built up. Students were required to genuinely attempt the questions without being penalised for presenting wrong answers. The feedback for minor activities was formative and oral and it can be considered as self-assessment and peer feedback before receiving feedback from teaching team. For presentation in regard to research project, an additional initial presentation was introduced at the beginning of research project development. This initial presentation provided the opportunity of peer assessment and oral feedback to students.

On project management side two further components: meeting minutes and Wiki (as a collaborative website) were introduced. Meetings minutes were teacher centred, online and formative assessments. Wiki was an online show case (summary of project activities) for students. The feedback appears to be teacher centred and formative assessment.

In the third stage, known as Additional changes, the following changes have been implemented recently as: one additional feedback test, minor activities with reflective questions and Wiki as the collection of report and individual contribution of team members. The feedback process for the second test is similar to the first test and it provided further improvement in learning process. Self-assessment has been a major part of the reflection in minor activity question. Finally, the functionality of Wiki has been extended to include all elements of student' reports as well as group management activities. Online nature of Wiki provided a platform for online formative (progressive) feedback. At the same time, peer feedback is provided via online wiki.

Methodology

The elements of assessment process and related feedback provided were identified and monitored during a three year period. The effectiveness of the feedback on the students' learning progress were analysed via focus group with teaching team, standard Student Feedback Surveys and an online survey designed specifically for evaluating wiki in this unit. Noting that these activities were conducted on trial basis, the objective is to conduct an extensive research in similar units in collaboration with other universities with more research rigor.

Discussion and analysis

Final exam as a summative assessment is a long term goal and is considered to be as a major hurdle by students. It appears that providing several formative feedbacks during the semester could help students to achieve a better result and improve their performance. This comment and outcome also supports the seven principles of a good feedback practice presented by Nicol and Macfarlane-Dick (2006) in the earlier section of this article. As focus group discussion among teaching team reveals, with inherit vagueness in management subject, it could be difficult for students to decide what they need to learn in short term

periods. To eliminate or reduce the latter problem/issue, we found that those minor activities that introduced in this unit provide some opportunities for interaction between teaching team, students and peers. One could draw a parallel between minor activities and questions that are delivered via clicker sessions with some differences such as minor activities include descriptive and reflective questions and they can be attempted outside the lecture class. Minor activities encourage students to initiate their learning process early on in the semester and increase the students' engagement during the semester. They appear to be simple and achievable and a self-assessment tool that build up some level of confidence for final exam preparation. Academics often play dual roles of educators (educating) and regulators (award qualification of passing a unit). Therefore, assessments should reflect dual nature of this role and this might be considered in assessment design. Furthermore, the significance and weight that students perceive for each assessment might not be necessarily consistent with the perception and understanding educators. So, feedback tests are required along the way to motivate and also to provide feedback to students in shorter time frames. There were supportive statements by students via Student Feedback Surveys on minor activities and they requested more of such activities. Also teaching team that recorded lectures via Lectopia, appeared to be more useful if they have been associated with minor activities.

We investigated more rigorously the impact of using wiki as a means of intra group communications. The students as discussed earlier were asked to provide a summary of their project (executive summary, group profile, initial presentation and final presentation) via wiki. A short survey was conducted during 2011 to 2013 at the end of related semesters to examine students' perceptions about using wiki. The teaching team's expectation was that this element helps students to take initiatives as this tool provides a stronger presence of individual students even though the weight of the assessment was only 5% of total mark. The students' response to question "what was your experience using wiki?" was not particularly remarkable. The percentage of people who enjoyed wiki was marginally higher (only 10 per cent more) than who did not find wiki particularly interesting. This more and less was consistent across different surveys in various semesters. In the comment section of the survey, students provided some explanations on their lukewarm reception of the introduction of wiki. Some students argued that they should not submit the summary of their project online as they should eventually provide the detailed version of same material in their final reports. The students also complained that wiki tool as provided by blackboard is "buggy" and restrictive. It doesn't have features such as "sync" and "change notification" etc that are available via other platforms such as Facebook. Moreover, when students asked as to whether wiki help them to communicate more, the answer slightly slanted towards negative. The students seemed to favour email and SMS messages rather than using wikis for communication.

However, for the question on whether students have chosen to visit other wiki pages and in case they did what they learn about it, there seems to be two groups of students. A group of students that have checked other wiki pages and a group that they did not check and unexpectedly to teaching team the numbers were very comparable. In one survey 16 out of 50 people said no and 17 people said yes and the rest of students sat were neutral. In another survey 9 out of 23 people said no and the rest looked at other wiki pages. Those who have visited other pages mentioned following benefits: "just to get an idea of what was expected", "ideas on how present, layout etc", "just to see their progress", "learn how to do it well", "… how the other groups had interpreted what this project was…" and "That a lot of people left it till end and still didn't put much up", ….

In the current semester, we have asked students to develop their final report via wiki online and so there will not be any hard copy final submission. It will be interesting to see how the students will respond to usefulness of transparency for their progressive effort on their projects via wiki. However, for the teaching purpose, this will provide many opportunities for self-feedback and benchmarking, peer feedback and progressive feedback.

Conclusion

It is acknowledged in academia that feedback is an essential element in learning cycle, providing for reflection and development. So, academic educators should seek and identify opportunities that create timely effective feedback for students. These opportunities should not be explored from educators' points of views only and should consider students perspectives on how they need and how that can be motivated to evaluate themselves and their peers. The idea of having a big exam at the end might be considered logical from one perspective, without a properly scaffold process might not be as effective. The scaffold process certainly requires elements of self-feedback and peer feedback (reflection and benchmarking) as well as teaching team feedback. This particularly becomes critical when the knowledge area to be taught is conceptual and qualitative which is somewhat unexpected for engineers. Moreover, the importance of progressive feedback whether in the inception of a student project and whether in its monitoring stage should not be overlooked. Wiki as a shared website development tools, could provide many opportunities for educators to set up such progressive transparent feedback processes. It should be noted that this may not be perceived equally by students. Some students prefer traditional approach and consider such changes as distractive. Moreover, Wiki on blackboard has its limitations and increasing innovations in different platforms that are often freely available make it somewhat difficult to encourage students to use wiki. Despite all these, it appears to authors that wiki provides, as surveyed students clearly observed, feedback opportunities that might be not achieved otherwise. Authors believe that feedback design is a challenging complex part of education process but its appropriate application, could highly improve students learning and satisfaction. Finally, with the new trends in online technology, there are and will be new aspects that engineering educators should be considered in order to design an effective education process.

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