Maintaining academic standards and encouraging active involvement in engineering courses: The role of formative assessment

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Abstract

Relying on a single end-of-semester exam which carries most of the marks for a subject will tend to leave students on their own when it comes to closely guiding them through their semester-long learning experience. We argue that assessment approaches that heavily focus on summative tasks will usually not sample students' progressive involvement in a subject nor will such tasks provide the students with regular substantive feedback on their subject performance. We also believe that students' efforts and levels of understanding should be regularly monitored and assessed to provide students with a frequent indication of their progress and achievement in a subject. Furthermore, we argue that to encourage engineering students to develop as deep or higher-level learners, assessment needs to be a continuous activity where ongoing feedback becomes a positive reinforcing element which will motivate them to apply themselves to their learning during the whole semester to reach their full potential. This paper reports on an ongoing initiative in which these principles are being implemented in the undergraduate engineering classroom. Factors which may limit the extent to which such changes may continue to be implemented are also identified.

Introduction

In engineering subjects where a solid mathematics and physics background is needed, it is generally agreed[3] that significant time and sustained effort is required on the students' part for them to gain a good understanding of the main concepts, tools and techniques introduced during a semester.

We believe that it is also important to remind students that their own learning processes are subject to many external and internal inputs. In particular, we explain to them that what the lecturer and tutor do in the classroom or laboratory is just one of possibly many factors which may influence the level of learning achieved at the end of the semester. Indeed, we regularly remind our students that there are a number of very important learning settings where the lecturer or tutor are not present, for example, group study sessions, individual study sessions,

and library consultation sessions, to name just a few. We do this to encourage students to see themselves as the main agent in their learning process. In doing so, we draw upon a recent conceptual model of formative assessment and feedback that synthesizes current thinking by key researchers into these topics[4]. We also make clear to our students that they will not be spoon-fed and that they will be required to become active players in their learning experience. By doing so, we are trying to help our students to learn how to learn[8].

We have had a number of experiences which indicate that most current engineering students have not fully developed their independent study skills[5]. This may partly explain why students tend to perform poorly in the end-of-semester exam if there is no regular assessment of students' in-semester work. In such circumstances, subject coordinators are likely to feel under tangible pressure to moderate marks to protect their teaching reputation and to not compromise progression rates within the Department, School or Faculty. In most cases, mark moderation will usually translate into lowering academic standards[6].

As a matter of fact, the original motivation for the work reported here was the need to produce practical measures to avoid ("at all costs") grade inflation practices[6] which resulted as a direct consequence of inadequate monitoring of students' individual performance throughout the semester. Added to this, is the issue of student expectations: it has been argued that a significant number of today's students have an expectation of high marks without corresponding effort[5].

An effective (and possibly obvious) way of stimulating students' in-semester work could involve the allocation of a significant number of marks to a series of regular tasks and activities. In simple terms, these marks will constitute the incentive and reward that will initially encourage students to start working on the subject from day one of the semester. Frequent in-semester assessment of individual student work will also help instructors to meet "the need for knowing what students know"[7]. We also feel that formative assessment and feedback should be used to empower students as self-regulated learners[4]. We hope that when students become actively involved in their own learning, they will be able to identify the benefits arising from being able to understand the subject matter as it develops during the course of the semester. By coming to this realization, students will indeed grow and develop as learners[8]. Students will have engaged with the subject in a "deep" way[1] becoming builders of their own knowledge[9].

Introducing Regular Formative Assessment in Third Year Engineering Subjects

It is hard to deny that restrictions on teaching funding may easily impact on the way a subject coordinator designs (and later implements) the teaching and learning processes that will be part of the subject. In a number of teaching contexts it is possible to see how teaching budget constraints are one of the key factors currently influencing subject coordinators to deliver undergraduate subjects which rely on end-of-semester exams as their principal assessment method.

It has been argued that we can achieve increased reliability of assessment when there is uncontentious evidence of achievement on many occasions that comes from low-inference assessment routines[2]. A similar view is expressed by Roos and Hamilton's assertion that "the

whole process of becoming competent in any field must be divided into a very large number of very small steps, and reinforcement must be contingent upon the accomplishment of each step"[13].

As we are also interested in raising academic standards, we certainly see "formative assessment as the best way of achieving this raising of standards, tempered by the recognized need for valid and robust summative approaches"[14].

In the first implementation of the principles described in this paper, changes were initially introduced in the first subject on "Feedback Control" (Second Semester 2004). More recently, they were also applied in a "Signals and Linear Systems" subject (First Semester 2005), and are currently in use in the 2005 version of the "Feedback Control" subject. The reader should keep in mind that The University of Tasmania currently runs two thirteen-week semesters. Each semester is followed by a one-week study period, and a two-week examination period, respectively.

Inspired by recent research on the enhancement of student learning through effective formative feedback[4], we were also keen to identify the extent to which a number of relatively low stakes tasks with clear performance feedback enhanced our students' motivation and self-esteem. Given the technical nature of the above subjects, and the fact that we wanted to know what each one of our students knew we decided to have five one hour quizzes held every two and a half weeks during each semester.

Soon after each quiz, we provided students with detailed written solutions, and discussed those solutions in the classroom so that students could identify their mistakes and learn from them. We also marked the quizzes as soon as we could (usually within one week if not earlier) so that students received fast feedback on their current and cumulative performance. Timely feedback is vital[1]. We also made efforts to minimize the use of similar problems in quizzes and in tutorial sessions. This challenged students by encouraging thinking and understanding of the fundamentals rather than memorization of solutions to typical sets of exercises and problems. We also trained students in solving different types of problems. Student comments on these quizzes obtained through the University of Tasmania's Student's Evaluation of Teaching and Learning (SETL) surveys included the following:

- Quizzes were a good idea. I was always learning so I think this will help me for the exam.
- Quizzes were good as they kept me on top of my workload.
- Quizzes are a good idea, they make preparation for the exam much easier.
- Having a quiz every 3 weeks is good, it keeps you up to date to take the pressure off when exam time arrives.
- Having the quizzes was good so we studied throughout the semester.
- Quizzes were marked in one week.

We agree with Felder and Brent's assertion that "challenge alone — even at an appropriate level — may not be sufficient to move students to higher levels of development. Instructors should provide appropriate support to help their students meet the challenges[9]". We believe that we did our best to support students as we constantly encouraged them to use our office consultation times as well as to ask questions in the classroom. We also voluntarily conducted

a number of additional tutorial sessions that were not part of the face-to-face sessions scheduled by the University.

Recommendations for a Productive Learning Experience

We can all attest to the fact that current students are subject to an increasing number of distractions[5] (mobile phone text messaging, cable or satellite TV, INTERNET gaming, messaging, and surfing, etc.). It is very important to warn students of the dangers involved in spending too much time on these potentially unproductive pastimes, and encourage them to keep track of the actual time that they spend in study.

At the beginning of the semester we also provide students with an estimate of the time that an average student could reasonably expect to put in to get a pass level grade in the subject. We do this by drawing on guidelines provided in the University of Tasmania Code of Conduct for Teaching and Learning[17]. We are particularly careful in explaining to them that the word 'average' does not have a negative or derogatory connotation.

One of the key messages that we convey to our students is that they will usually get a grade that will closely reflect both the amount and quality of the efforts that they have made during the whole semester. Of course, different students may have dissimilar intellectual development levels, and this will also influence the outcome of the learning process. Students' different learning styles may also play a role in this outcome[9].

Some Preliminary Results

One of the most striking observations for us at the present stage of this program concerns a number of perceived changes in what may be termed our 'learning culture'. From the lecturer's perspective, the assessment regime put in place eliminated the need to moderate marks since most students passed the subjects having achieved a good working knowledge of the key ideas and concepts introduced during the semester. Because of this, staff felt that marks and grades closely reflected the level of understanding that students had actually achieved during the semester.

From the students' perspective, this new initiative originally attracted some negativity: many of the students in the Second Semester 2004 cohort initially vehemently opposed the increased workload that resulted from regular in-semester assessment. However, by the end of the semester, a number of them had modified their views and admitted to experiencing some benefits of having to develop a regular study habit.

The challenge for us now lies in establishing a learning environment where students see formative assessment tasks as key learning support that is there to enhance their motivation and their learning, as well as to encourage reflection and clarify understanding of subject matter[12]. We also face the challenge of achieving a healthy balance between the frequency of the formative assessment tasks and the allocation of time to debrief on the feedback such tasks provide, i.e., to better assist students in using feedback in meaningful ways to make a difference in their learning.

We also need to focus on the design of assessment for learning to help to gather and provide information for both students and teachers to improve learning and adjust teaching[15].

Conclusions

Maintaining academic standards in the face of increasing student numbers and reduced levels of funding is one of the fundamental challenges that the higher education sector is currently facing. In engineering education discussions[10], assessment issues continue to be at the center, and formative assessment is possibly one way to encourage students to study and learn on a regular basis without having to compromise standards[16].

We believe that carefully designed formative assessment tasks can contribute to a much more meaningful learning experience for our students in engineering. In future implementations of the principles introduced in this paper we expect to be able to further improve our classroom-based practices by more actively engaging students[11].

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