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Case Study

" Attempting Student Interaction within Second Year Engineering Mathematics Lectures"

Part 1: Background Information *(1-2 pages)*

Information Pack 1: Student Support	*Attempting Student Interaction within Second Year Engineering Mathematics Lectures*
Abstract	*The introduction of skeletal notes (in which essentially the right hand side of mathematics equations are missing and are added in lectures) has released some time to attempt student interaction in a large lecture class. This took the form originally of asking the class to answer standard mathematical questions in concert. When it worked, it appeared that a significant proportion of the class were able to respond correctly. More recently use has been made of a Personal Response System (zappers) to elicit responses to straightforward multiple-choice questions. The use of this system polarized the class into those in favour of its use and those against. Moreover, early indications suggest that a large proportion of the class got the answers wrong. This needs further investigation.*
Teaching Context	
Subject Area	*The approach has been used for teaching mathematics to second year Aeronautics, Aerospace and Ship Science engineering students, but it is a generic one for teaching within Mathematics, Science and Technology generally.*
Participants	*The student cohort of second year Aeronautics, Aerospace and Ship Science engineering students was around 150 in 2001/2 .*
Study Mode	*The students are full-time studying within the university.*
Pedagogical Approach	*Conventional "chalk and talk" lectures employing skeletal notes and setting time aside for interactive sessions with the students.*
Teaching Methods	*2 units each consisting of 2 lectures a week for 12 weeks. The students are set 4 extended pieces of coursework which consist of a series of examination-type problems. They are offered tutorial support by the client engineering departments on a fortnightly basis. These sessions are run by a mixture of lecturers, research assistants and postgraduate students.*
Materials	*The students are supplied with skeletal notes, unit profile, unit summary (a copy of which is made available in the examination), coursework assignments and solutions (distributed after the deadline has elapsed) and a PRS handset (zapper). The unit is supported by a Blackboard website which includes the completed notes, all the other supporting materials including past examination papers and some helpful websites.*
Assessment	*The coursework is collected up, marked and returned and counts for 10% of the*

	final assessment. The other 90% derives from a conventional closed book examination.

References	*d'Inverno, R.A. On the success of a self-paced course. Int. J. Math. Educ. Sci. Technol. 24, 1993, 727-739.* *d'Inverno, R.A. On the use of sketetal notes. Int. J. Math. Educ. Sci. Technol., 26, 1995, 195-204.*
Technical Context	
Communication outside of lectures and tutorials is through the unit Blackboard site.	
Contact Details	
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About the Author	*Ray d'Inverno was appointed as a Mathematics Lecturer in the Department of Mathematics, University of Southampton, in 1970. He was subsequently promoted to Senior Lecturer and Reader and finally to a Chair in General Relativity in 1995. He has taught both applied mathematics and pure mathematics as well as computer science and he also taught for 3 years in the Music Department at the University of Southampton where he first introduced Jazz into the curriculum. He has taught service courses in both the Engineering and Science Faculties. In particular, in 1974 together with Dr Leslie Cohen, he introduced the well-known Self-paced Mathematics Course for First Year Engineers which still runs today, albeit in a modified form, and it has become one of the largest innovations in the UK. He has also taught mathematics to second year engineers for over 30 years. He is currently Deputy Dean for Learning and Teaching in the Mathematics Faculty. His research interests include Computer Algebra in General Relativity and Numerical Relativity.*

Part 2: Main Case Study Text

Skeletal Notes

When I first came into university teaching, virtually all mathematics lectures consisted of "chalk and talk" with the lecturer writing notes on the board which were copied down by the students. Apart from a few perfunctory inquiries of the students as to whether there were any questions then there was virtually no interaction with the students present. The bigger the class, then the less chance there was for any interaction. Some thirty years later it seems to me that little has changed apart from the chalkboard being replaced in some instances by the OHP. From the start I found the fact that lectures consisted largely of note copying, especially when it is just text, a somewhat redundant and frustrating process. It was no wonder that students complained that lectures were boring. I have therefore tried at several times in my career to base lectures on a set book. There were problems here of finding the right book because of syllabus constraints. This was rarely a success: if I moved away from the book, the students complained the material was not in the book, and if I stuck religiously to the text then there was little opportunity for employing any active teaching using the discovery method. The only time it worked well was when the students were asked to work through a set book in a self-study mode, supported by specially prepared materials and periodic tests which formed the starting point for one-to-one tutorials. This was the basis of the so-called Self-paced Mathematics Course for First Year Engineers (d'Inverno 1993). I do not wish to discuss this further here but, instead, briefly chart my use of full printed lecture notes. I tried these in various formats, issuing notes after lectures, then before lectures and finally, through student demand, in full at the start of the lectures. All the approaches had their strengths and weaknesses. The worst weakness was that, because the students did little writing in class, they soon became bored or distracted. Moreover, they were not writing any mathematics and I believe that it is important that students develop a "tactile" familiarity with mathematics simply by shuffling the symbols around. So some tears ago I pioneered the use of skeletal notes (d'Inverno 1995). These are full printed lecture notes apart from the fact that the right hand side of the equations are missing. The missing parts are then added in lectures. This way I was able to provide the students with a full set of lecture notes, which include a lot of textual material to help make the notes readable, and yet the students write in the bulk of the mathematics in the lectures. More importantly, by getting rid of the redundant process of copying down text, I released some time in the lectures for more interactive forms of teaching to which I wish to turn next. It is worth remarking that the skeletal notes approach proved to be very popular with students, This popularity was robust in the sense that it did not depend on the students perception of ***my*** *preference for using them (what I call the "halo" effect) since the approach was still rated highly when used by colleagues who were not particularly disposed towards the method (as long as they used the notes properly). This popularity led to other colleagues in several faculties adopting the approach, although with a number of variations.*

Why Student Interaction

Why should one bother with student interaction? First of all, anything which breaks up a lecture is, I believe, good news. It gives students a chance to take a breather and to refocus. It is well known that most people cannot concentrate for extended periods beyond about 20 minutes. So a break in the lectures of any kind is often helpful. Secondly, student interaction means that, in some limited sense, the students are being treated as though they are human. The monolithic lecture based on relentlessly copying down notes could well take place without the students being present (apart for any copying actually taking place!) Thirdly, it means that one has the opportunity to put in more light and shade into the lectures: by looking at structural issues, reinforcing important points and so on. Finally, it provides one with some means of monitoring the students understanding and checking that the lectures are proceeding at an acceptable pace. If we are to expect students to attend lectures then there surely needs to be some "value added", other than that of providing them with a complete set of notes. I believe that student interaction can provide some of this value added component. Although there is quite a lot of literature about developing student interaction in lectures and large groups in the Arts and Humanities, I do not know whether these approaches work so well in more technological subjects. So let me describe my approach.

Modes of Student Interaction

When I first used skeletal notes I would start with an informal period in which I would try to elicit replies from students about the next topic for consideration. I would earmark a particular section of the blackboard for this part of the lecture, so that students knew we were going into the informal part of the lecture, and proceed by question and answer. This would then be followed by a formal part of the lecture in which the missing parts of the notes were added. Although I undertook the informal part in large part by question and answer, the truth of the matter was that only a few of the very many students present supplied those answers. So I then introduced periods of consolidation where I would expect the class to answer in concert. Here is an example of the type of interaction this would involve: "Q: So we need to differentiate sine x squared; what is the name of the rule for doing this?" "A: Function of a function." "Q: What is the outer function?" "A: Sine."Q: What is its derivative?" "A: Cosine." "Q: What is the inner function?" "A: x *squared." "Q: What is its derivative?" "A: 2x." "Q: So what do we write down for the derivative of sine x squared?" "A: Cosine x squared **times** 2x." Of course, being questioned like this smacks somewhat of school and, not surprisingly, some students object to the questioning. What is perhaps more surprising is that, after some initial promptings, the majority of students appear to accept the mode of discourse and go along with it. The class answering in concert suggested that some learning was taking place. Or, at least, that is what I thought was happening.*

Zappers

Towards the end of the academic year 2001/2, in an attempt to improve student interaction, I began to employ a Personal Response System (PRS) where each student is equipped with a PRS handset or zapper. These are used for students to answer simple multiple-choice questions. The results are then displayed graphically on a screen. Academics in Engineering at the University of Strathclyde have used Personal Response Systems in lecture theatres (the NATALIE project[1]) to introduce a question-based approach to teaching. Lecturers use the response systems to increase the interactivity of lecture courses and at the same time enhance the feedback on the progress of understanding and learning during lectures for students and academics alike. The approach was not pioneered at Strathclyde but builds on a substantial experience and body of knowledge developed in the US by several innovative groups - in particular the University of Massachusetts, Amherst, Physics Education Research Group[2] and Eric Mazur's group at Harvard[3]. The system can also be used to track individual student responses and, through this, lecture attendance. My use of the system has been rather naïve to date, although I hope to learn more about how it can be best exploited. Nonetheless, what I appeared to have discovered is that a large cohort of students, typically around 40%, get the answers to simple questions wrong. I have even asked the same question twice, having previously been given the correct answer, and still 20% get the answer wrong. It could be that this group do not know how to use the zappers correctly (unlikely) or that they are deliberately giving the wrong answer because they disapprove of the technology (quite possibly). End of unit questionnaire results revealed that the use of the system polarized the class into those in favour of its use ("an exciting new development") and those against ("stop messing around with technology and get back to good basic teaching"). It suggests that, because previously I had what seemed like a large part of the class answering together in concert correctly, this masked the other cohort who presumably are not following, or are generally disengaged. It may be this disengagement which lies behind the observation. After all, most of the lectures which students attend require little engagement and they may well have developed a passive mentality in which some largely expect to switch off in lectures. My attempt at involving them may not be well received. Moreover, I imagine that the majority of those who give incorrect answers are precisely the students who object to the introduction of this technology in lectures. This clearly needs further investigation. In the next academic year I plan to use the system from the outset and work harder at embedding it into the lectures. The hope is that if this becomes an integral part of the lectures from the outset then students may be persuaded to attend with a different mindset, and one in which they expect interaction to take place and are prepared to become engaged in it.

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[1]NATALIE project http://www.ltsneng.ac.uk/nef/features/featurearchive/natalie.asp

[2]Amherst, Physics Education Research Group http://umperg.physics.umass.edu/

[3]Eric Mazur's group at Harvard http://mazur-www.harvard.edu/

Please Indicate the Level of Material i.e. year of study.

(a) 1st Year		**(b) 2nd Year**	**x**	**(c) 3rd Year**	