The use of new technology in module delivery to large cohorts

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Abstract
Teaching mathematics to level 1 engineers is a difficult task due to the size of the cohort, the diversity of ability and the limit on both space and staff resources. Modern equipment provision in lecture theatres means that staff have been forced to adapt lecture delivery from the traditional multiple board delivery to the one screen data projector delivery. I will outline the different technologies which I have used in delivering the first 12 weeks of the level 1 module Mathematics for Engineers in 2011-12 to a cohort of about 250 students. The technologies used comprise annotation of projected lecture notes using a Tablet PC and annotating software, lecture recording using screen-capture technology, voting system technology used to question the lecture cohort and on-line assessments tests delivered via the web outside module contact time.

The advantages and difficulties encountered with the different technology outlined above are given with respect to ease of implementation and student engagement.

Keywords
Use of technology, large cohorts, lecture recording.

1. Introduction

In recent years the mathematical teaching team at UWE has been forced to rethink their lecture delivery, particularly to large cohorts. The reason for this is the re-equipment of lecture theatres and more recently classrooms with roller-boards being replaced by data projectors. Given the need for new approaches to lecture delivery, training in the new approaches is required as well. I attended a HE STEM workshop in November 2010 on *Using IT when Teaching Mathematics Classes*. The workshop included talks on *Teaching from a Tablet PC* (Joel Feinstein), *Screen casting* (Joel Feinstein) and *Integrating software into your lectures* (Peter Rowlett). The workshop gave me the confidence to pilot the Tablet PC and screen casting technology in the 2011-12 delivery of the level 1 module Mathematics for Engineers. I also attended the workshop, *Turning Point – An Interactive Response System*, in December 2010 run by the UWE Learning and Development Centre. The workshop described the implementation of Turning Point in both the classroom and lecture environment. Having delivered engineering mathematics lectures to the level one 2010-2011 cohort, I saw Turning Point as an appropriate tool to engage students during the lecture. A grant from the Faculty enabled the purchase of a HP Elite Book Tablet PC and the necessary software for annotation and lecture recording. Following the practical advice from the HE STEM workshop, I purchased Camtasia Studio software for screen cast recording of the lectures and Adobe Annotator for lecture note annotation. Three lecture theatres in UWE are equipped with key-pad remote response devices needed for Turning Point presentations. I ensured that Mathematics for Engineers was scheduled in one of those large lecture theatres for the 2011-12 lecture delivery.

The mathematical teaching team at UWE has been using on-line assessment for at least 12 years in many modules across mathematics and engineering. I have experience using both QM Perception and AiM to deliver on-line assessment. More recently, due to implementation problems associated with both QM Perception and with AiM, I have started using the DEWIS platform to deliver on-line assessments. 2011-12 is the first year that on-line assessment using the DEWIS platform was fully implemented for Mathematics for Engineers.

With the appropriate hardware and software in place, the pilot delivery strategy was as follows:

- Each student receives two module books at the start of the academic year – one containing a full set of notes and the second containing a full set of worksheets and answers.

- In the lecture, lecture notes are projected and annotated using the Tablet PC and annotation software.

- Lectures are recorded using screen-capture software, Camtasia Studio and recordings posted on the university VLE.

- At the end of each lecture student understanding of that lecture is gauged by questions delivered using the Turning Point software.

- Every 4 weeks, there is on-line assessment delivered using the DEWIS platform. Each assessment will count towards 3.33% of the final module mark. The assessments are used to gauge student engagement with the module and their understanding.

In section 2, I describe the implementation process of the above strategy, the difficulties encountered and the achievements made. Conclusions and future plans are given in section 3.

2. Implementation of the new technology within the module Mathematics for Engineers.

2.1 Notes and lecture annotation

A full set of lecture notes was created which each student is expected to bring to every lecture. The booklet of notes for the first 12 weeks was 100 pages long, which together with the booklet of worksheets implies a substantial printing cost for a 250-plus cohort. The notes were projected from the Tablet PC using Adobe Annotator. During the lecture I would handwrite on the screen either in the gaps provided in the notes or on an appended page. After the lecture the annotated notes were posted on the university VLE. Therefore students could ensure the accuracy of their own hand-written notes or if they preferred to concentrate on what is being said in lectures, they could download the annotated lecture afterwards. In reality, all students wrote down everything that was projected.

The first difficulty encountered was the projection of the Tablet PC screen. Unfortunately the screen aspect ratio of the Tablet PC screen (which is long and thin) does not match the aspect ratio of data projector screen, which is more square in shape. This means that full screen mode, which is in portrait form on the Tablet PC, is projected in landscape form and fills only the middle third of the projection screen. I experimented with several different projections, none of which were satisfactory. Outside full screen mode, I found the Adobe Annotator menu bar took up too much valuable projection space, about 2.5 cms high band at the top of Tablet PC screen of height 16 cms. I have since experimented with OneNote (annotating software which is part of the MS Office suite) and have found that the working space therein is an improvement for projecting my notes and annotations. Other difficulties encountered involved ease of use with the software and hardware. It took a while to get used to the different features of the annotation software and hand-writing on the tablet screen. Despite practicing beforehand in my office, it is not quite the same as doing it live in

a lecture theatre. The Tablet PC is both touch-sensitive and pen-sensitive. The touch-sensitivity caused problems in the lecture through inadvertently touching the "close" button or some menu tool button. This problem was fixed by turning off the touch-sensitivity.

Next year, I plan to produce a full set of notes without gaps. Each week, I will import sections of the notes into OneNote to form the week's lecture material and use appended pages as and when necessary for further explanation. I am currently using this approach in a level 2 module and I think it is working better than the approach used in the autumn term in Mathematics for Engineers.

2.2 Lecture recording

I used Camtasia Studio, the software recommended by Joel Feinstein (2010), to record screen casts of everything that appears on the Tablet PC. The software is loaded onto my Tablet PC. The software is very easy to use. Once opened, a screen pops up with the option Record the Screen. When this option is chosen, a small screen is opened with a REC (record button). Clicking on the REC button starts the recording. Recording is stopped in a similar way.

After each lecture, the recorded file must be exported and converted. I choose to convert to a web delivery file. Camtasia Studio then produces a folder with a number of files, including specifically an html file and an mp4 file. The html file streams from the mp4 file which holds the recorded lecture. The mp4 file is typically 30 Mb for a one-hour lecture. The VLE environment does not permit the uploading of too many large files – at UWE there is an upper limit of 400MB per module. Therefore the best way to make the recording available is to upload the html file (typically 5KB) which links to the mp4 file of the recorded lecture stored within the same Camtasia-produced folder.

The microphone at the lecture podium must be connected to the Tablet PC. This means that the lecturer must remain close to the podium so that the voice recording is sufficiently loud and clear. Similarly questions from the floor are not properly picked up. Feinstein recommends that questions from the floor are repeated for the sake of the recording.

2.3 Questions in lectures using turning point.

Turning Point Software is freely available and can easily be downloaded onto one's PC from the internet. The key pad remote response devices are purchased from the company. With a familiarity with PowerPoint, it is quite straightforward to set up an interactive PowerPoint session using Turning Point. I wrote six different Turning Point presentations for the first term of Mathematics for Engineers, with about three to four questions being asked at the end of each lecture hour. The questions were all multiple choice. A typical question is shown in Figure 1. The system allows individual student responses which are collated

anonymously. The instant response questions were very useful to me as the lecturer as it showed me and the lecture cohort what had not been well understood and therefore what I should go over again and recap in the next lecture. Not all students took part. The response rate was typically 80%. Nevertheless all present could learn from the answers given.

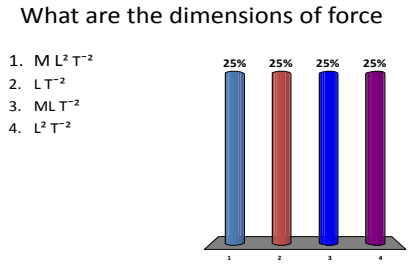

Figure 1: Typical multiple choice Turning Point question

Time is required to produce each Turning Point question. The preparation of three to four questions with suitable multiple choice answers took about one to two hours each week. The input of mathematical expressions is not straightforward. One either has to use the Menu Bar to insert special symbols from the Insert/Symbol tool bar or one can create a mathematical expression in other software, (such as Word) and copy across. Both methods are fiddly and awkward. It also takes time to become familiar with running Turning Point live in front of a large cohort. I ran the tests from the podium PC rather than the Tablet PC which meant that this part of the lecture was outside the lecture recording. The podium PC was used in preference to the Tablet PC because in the fully equipped lecture theatre, the USB dongle connection for the remote key-pad controllers was to the podium PC. I presume the dongle could be attached to the Tablet PC instead and will experiment with this next year.

Ideally, when all responses are in, I would like to have gone over the question, showing the method by which the right answer is obtained. This is a case of requiring a split screen facility, so that the questions and students' responses could be projected alongside the correct solution and the method required to obtain the correct solution. Unfortunately the lecture room technology did not permit split screen projection. I experimented with writing on the podium screen with the PC touch pen with limited success. The pen required calibrating on a frequent basis and often one's writing appeared removed from the point of pen-screen contact. The other method was to switch projection from the podium to the Tablet PC in order to write the solution using the annotation software. The drawback here was that the students lost sight of the question itself together with the multiple choice set of answers and the corresponding bar chart of their answers.

2.4 On-line assessment tests

Mathematics for Engineers has six on-line assessment tests. They run approximately every 4 weeks. This year all tests have been delivered over the web using the DEWIS platform. DEWIS uses an algorithmic approach to generate the question and the associated solution and feedback, Gwynllyw and Henderson(2009). In generating the question, question parameters are randomized and generated at the point of delivery. More details are given in Gwynllyw and Henderson (2009). No two students receive the same question within an assessment since the parameters are randomly generated. Also a student can do the assessment several times and each time the question parameters will be different. All questions within the DEWIS system have extensive feedback. Research has shown that students learn from on-line test feedback and use this knowledge to perfect their technical knowledge, Greenhow and Mundeep(2004).

The students are allowed multiple attempts at practice tests which correspond closely to the assessment test, (either the practice and assessment tests are the same or the assessment test is a subset of the practice test). The practice tests are open from the beginning of term and close the day before the assessment test opens. The assessment test is open for 11 days and students can have up to three attempts with the attempt with the highest score counting.

The assessment tests are one of the main ways we use for assessing student engagement. The first test runs in the fifth week of the academic year. We can then follow up those students who did not attempt the test at all or who did not achieve a pass mark.

It is relatively straightforward to master the setting up of a test in DEWIS and the Reporting System. The writing of the algorithmic questions takes time and some knowledge computer programming is beneficial. Nevertheless the time is well spent, for once the question is written and checked, all the work is done. The time taken to construct, deliver and mark the tests is minimal for large cohorts compared with traditional pen and paper based testing. Furthermore, the same questions can be used for several years. I have used QM perception to deliver on-line tests in the past and prefer the DEWIS system, particularly because of its algorithmic approach which allows random parameter generation within questions.

3. Conclusions and plans for the future

Despite difficulties encountered when piloting the Tablet PC note annotation and projection together with recording as detailed in section 2, I am persuaded that this is the way forward for lecture delivery to large cohorts. The module cohort includes a part-time section which attends UWE one day a week. Their day is extremely full. The lecture recording means that it will not essential to timetable the Mathematics for Engineers lecture on the part-time attendance day, thereby enabling a more sensible student timetable to be constructed for the whole module cohort. This should have a favourable effect on all the engineering programmes for which Mathematics for Engineers is delivered.

Lecture attendance was approximately 50% of the cohort. This is no different from previous year. Other work reports "no link between availability of recordings and absenteeism", (Rowlett, 2011). Anecdotally, the students said they liked knowing that they could revisit the lectures in their own time and catch up if they'd missed one. In particular, the part-time cohort said that they appreciated the recording availability.

Figure 2 shows the access data to the recording and annotated notes over the three month period Dec.2011-Feb.2012. The mid-term examination on 9 Jan 2012 probably accounts for the spike in the data 5-9 Jan 2012. The data shows that the students do access the first term recorded material and continue to do so in the second term.

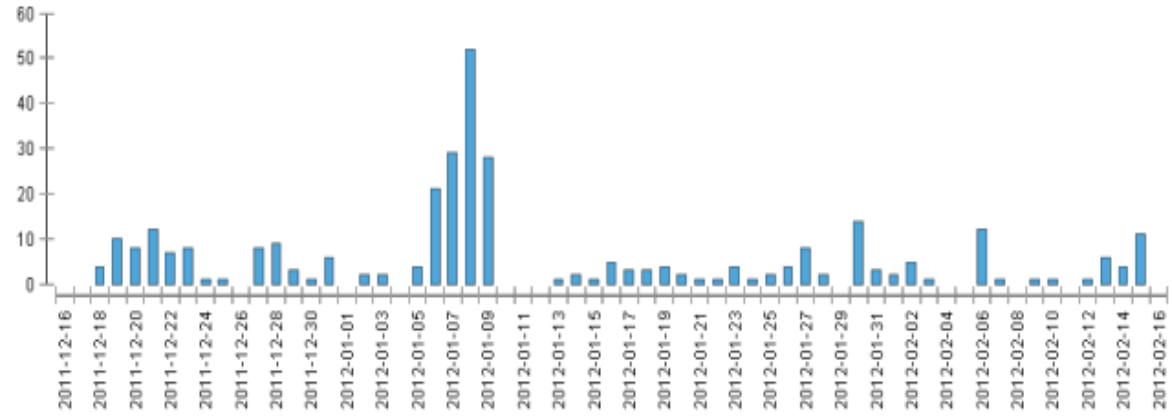

Figure 2: Access statistics to all lecture annotated notes and recordings over the period 16-12-11 to 16-02-12.

In a Turning Point survey conducted at the end of the lecture in week 11, the following results were recorded with respect to the delivery mechanisms used in the module. Of the 52% that said they did not access the recorded lecture at all, see Fig.3, some qualified this by saying it was useful to know it was there, especially for revision purposes.

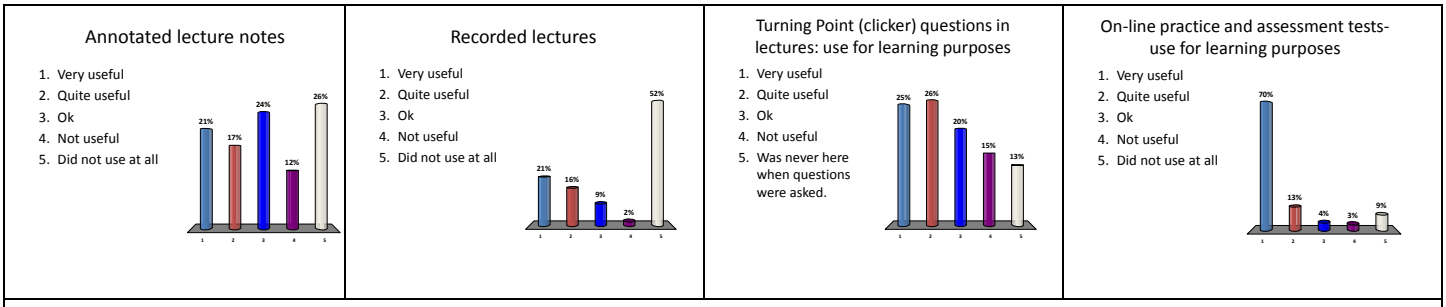

Figure 3: Survey results of module delivery strategy for mathematics for engineers 2011-12.

From Figure 3, one can see that the one aspect of delivery that students universally perceive as useful to their learning is the on-line practice and assessment tests. I believe that this is partly due to the extensive feedback given within each question and partly due to test delivery, (practice tests before the assessment test and multiple attempts). The tests are really designed to be formative but experience shows that a small summative element means that the whole student cohort properly engages with the on-line testing process.

Finally exam results from last year and this year show an improvement in performance, see Figure 4. A direct comparison is difficult because the module cohort comprises one less programme in 2011-12 but conversely the 2011-12 exam was thought to be more challenging than equivalent 2010-11 exam.

Year	Number in Cohort	Jan Exam Average %	Jan Exam pass rate %
2010-11	267	48	69
2011-12	241	61	83

Figure 4: Data showing exam results for 2010-11 and 2011-12.

Given my increased competence and confidence using the new technologies (Adobe Annotator, MS Office OneNote, Camtasia Studio, Turning Point and the Tablet PC), I anticipate that my delivery with the technology will improve next year. Therefore I plan to deliver the module in 2012-13 in a similar manner to that piloted in 2011-12. Furthermore, it should be noted that annotating and recording technology have benefits beyond lecture delivery such as providing a useful tool for constructing hand-written solutions and providing students with comprehensive electronic feedback on questions.

4. References

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