Innovation in Engineering Education

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ABSTRACT: *Supporting engineering students throughout their studies places a heavy demand on academic staff. Increasingly, to meet the challenge of widening participation and semesterisation it is necessary to provide help beyond the scheduled lecture and tutorial periods and to cope with a disparate range of student abilities. This is particularly the case in those topics which are mathematically based as the impact of changes in pre-University education takes its toll. An efficient and effective way of providing the support is through E-learning and the Blackboard Web portal has been used for this purpose.. Through the use of Blackboard a convenient and effective means of enhancing and improving student learning has evolved. The visual impact of presenting teaching materials using MS PowerPoint has also been evaluated and using this medium an opportunity for students to re-play a lecture in their own time has been provided. This has been found to offer students the opportunity to reinforce their learning and to work at their own pace. These presentations have been integrated into Blackboard by packaging them for delivery via the Web.*

1 INTRODUCTION

The teaching of engineering undergraduates is demanding and intense, for both staff and student, class contact hours are usually considerably greater than for other degree subjects and the volume of taught material consequently greater. The pressure of time is also an issue as the opportunity for students to absorb key concepts is compressed due to the intense 12 week teaching period dictated by semesterisation.

With widening participation high on the agenda of all Institutions increasingly disparate student cohorts are faced and increasingly the need to be able to cope with a wide student ability range is required. Unfortunately as these pressures are faced both external and internal constraints restrict the time that can be devoted to the teaching of students as staff strive to meet other demands on their time, for example research and the increasingly financial imperative of generating revenue through commercial activities. Thus, at a time when students are likely to need more direct hands-on support, it is likely that the majority of staff have less time to allocate to them. These problems affect all subjects but for engineering the cross-transfer of ideas and concepts from one module and level to another presents additional challenges.

The hierarchical nature of most core topics in engineering means that any inherent weaknesses in the early stages of study are likely to be amplified later at the expense of the overall learning experience, thus the foundations laid in the early stages are of critical importance to successful future study. Even with well motivated and dedicated staff, the demand for support and the varying nature of the needs of each individual student, stretch the limits of provision. E-learning systems are one means of bridging the gap between lecturer and student providing a convenient and practical way of both facilitating student learning and motivating students effectively. At the University of Salford a pilot scheme using the Blackboard 5.5 Educational web portal, has been conducted and following the Pilot-scheme the University has adopted the Blackboard 6 portal to support all of its teaching at both under-graduate and post-graduate level and by the end of the academic year 2004-5 if the University's Learning Technology strategy is fully implements all taught modules will be supported by Blackboard.

2 THE BLACKBOARD PILOT

The approach adopted was a simple one, the hard-copy material which was already provided for students in the form of printed material was simply re-packaged in small sections using Adobe Acrobat

and posted to Blackboard. The advantage of this was that immediately any restriction to black and white was eliminated and colour could be retained. Thus in the E-learning environment it was possible to present material so that it had visual impact with important concepts or equations emphasised.

Somewhat surpeisingly it was found that a closer relationship and rapport that could be developed between lecturer and student through the VLE than in traditional delivery. For the lecturer it was possible to interrogate the system to find out who had, (or had not), done what and when and through observation of the results of the on-line assessments provided it proved possible to judge the progress of individual students and if necessary provide tailored support and guidance to address at an early stage areas of difficulty. For the student the facility to easily contact the lecturer via e-mail through the VLE to ask for help was a definite bonus enabling even the most reluctant student to seek help. Since the access to the VLE was available off campus the VLE offered a facility enabling students to be supported in vacation periods and also when on industrial or international placements

For the two level 1 modules for which Blackboard was used in the academic year 2000-2001, Engineering Thermodynamics and Fluid Mechanics, the following priorities were identified.

1 The provision of all the course notes packaged in a form readily accessible to students.

2 The inclusion of the tutorial exercises followed some time later by the corresponding solutions.

3 On-line assessments which were scheduled to fit in with the appropriate stage of the module delivery.

4 Access to past examination papers as the end of module approached.

5 A re-vamp of the site after completion of the module so that any student who failed could obtain support over the summer vacation in preparation for the re-sit examinations in September.

3 EARLY FEEDBACK

The results obtained from the first module supported through Blackboard 5.5 were encouraging. Many students commented favourably on the support they had received through Blackboard in the module evaluation. Whilst not every student with access to the resource used it the analysis of the examination results at the end of semester 1 was very positive. No user of Blackboard failed the module and the module average of those using Blackboard was 15% higher than those who chose not to use it. A steady use of Blackboard throughout the semester was evident with a definite crescendo prior to the examination date. Over the Christmas vacation period whilst students were at home and revising there was a continued use of the site.

Whilst considerable effort had been placed on putting on-line assessments on the site there was an apparent in-built reluctance for students to tackle these - even with the inducement of an end of session trophy as a reward. This it was suspected is that these assessments did not form part of the formal assessment for the module. This was overcome to a certain extent by printing out the tests and requiring students to undertake them in tutorial sessions. Later this problem was addressed using the PRS system, (Personal Response System), described later in this paper and more latterly be revamping the formal assessment for the module so that the Blackboard tests formed part of the formal assessment accounting for 20% of the total mark.

The positive feedback received was judged to be sufficiently strong to extend the use of Blackboard to other modules and to encourage other colleagues to do the same. Over the next two academic years Blackboard was used to support modules at levels 2 and 3 in Fluid Mechanics, Aircraft Design and Engineering Thermodynamics and at level 1 in Solid Mechanics.

4 LECTURE DELIVERY

At the end of the 2002 academic year the University as part of its Learning Technology strategy went out to tender for the VLE that would be used across the University for the period 2003-8. Since it was by no means certain that Blackboard would emerge as the ‘winner’ in this selection process it was considered that no further development of Blackboard sites should take place beyond maintenance of the existing material since it may be necessary after the choice of VLE was known to change to a different form of provision.

Having identified through the Blackboard pilot that retention of colour added impact to material a decision was made to deliver lectures through MS PowerPoint enabling the use of full colour and the

ability to use animation and transition effects. This was used throughout the academic year 2002-2003 at both level 1 and level 2, (Engineering Thermodynamics, Fluid Mechanics and Aerofluid Dynamics) and also for level 3 Fluid Mechanics. Figures 1-4 show sample lecture content.

The students reaction was monitored through questionnaires issued on a regular basis throughout each semester. It was found that students responded favourably to this teaching medium and that even mathematically demanding material was well received when presented in this way. For example when cancelling terms in complex equations using Powerpoint the terms could be made to vanish using animation effects which enabled the students to understand more easily the analysis being undertaken.

Many students expressed the view that both interest and understanding was enhanced throughout the delivery of the lecture. Some commented that the use of PowerPoint could restrict spontaneity and a solution was arrived at where lectures were delivered using PowerPoint but some tutorials using overheads.

In putting together the PowerPoint material and deciding how to employ animation it became possible to consider in some detail how the material would be received by students. It became clear that in general the module content was very demanding, both in terms of the mathematical skills required and the different concepts introduced. The difficulty faced by students who have only a semester to absorb the material before being faced with an examination on the topic was recognised. For a lecturer who has delivered a particular module over a number of years it is often difficult to appreciate the position of the student for whom the material is new, technically demanding and where there is limited time available.

With the prior experience obtained from delivering laboratory explanations using pre-recorded presentation with embedded sound it was decided that in addition to the PowerPoint presentation used in the lecture a second PowerPoint presentation would be produced in the form of a self-running lecture with embedded sound. This move was facilitated by the use of Office XP in which the PowerPoint package accepts the use of sound files in compressed .MP3 format enabling a sensible balance between sound quality and file size to be achieved. It was then possible to convert the presentations into a form which enabled them to be accessed through the World Wide Web and to integrate them into Blackboard.

This integration was achieved by the use of a package which is part of the XP Office suite called MS Producer which replaces the PowerPoint Viewer provided with earlier Office versions. Figure 5 gives a screen shot from MS Producer showing the import of PowerPoint with the corresponding sound files. It would also be possible to add video content. The advantage of packaging the presentations through Producer is that each title from a slide in PowerPoint appears as an itemised list as shown in figure 6. When the presentation is ‘produced’ as shown in figure 5 the list of titles appears alongside the PowerPoint slides with the sound playing in the background. The student would have the opportunity to click on a particular slide title and the presentation would jump to that point in the lecture, so that it would not be necessary to listen to the entire re-run of a lecture if only a part of it was unclear a particular section could be selected. Even if an entire lecture were to be re-played the time involved is typically 20 minutes. Thus the material presented in a 50 minute standard lecture when stripped of the additional material, digressions and explanations usually occurring in face-to-face lecturing reduced on average to a 20 minute recorded presentation

Figure 1 Introductory Lecture Engineering Thermodynamics Level 1

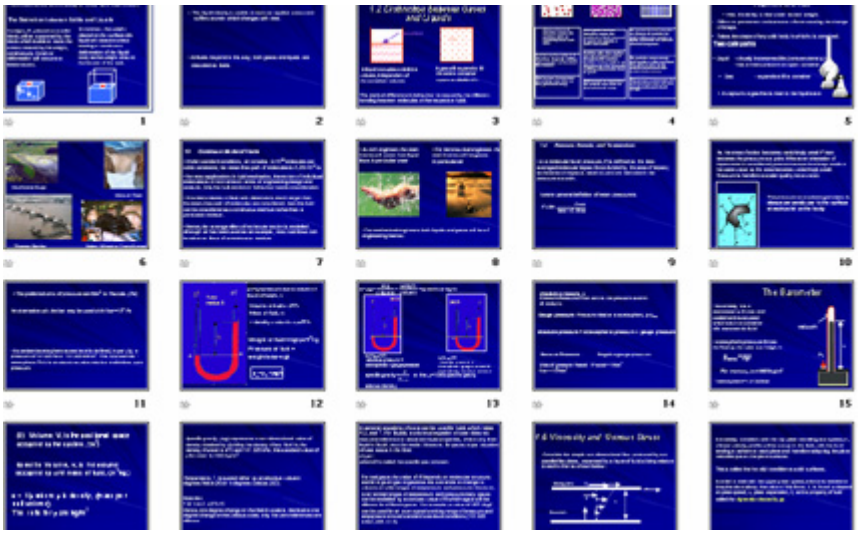

Figure 2 Introductory Lecture Fluid Mechanics Level 1

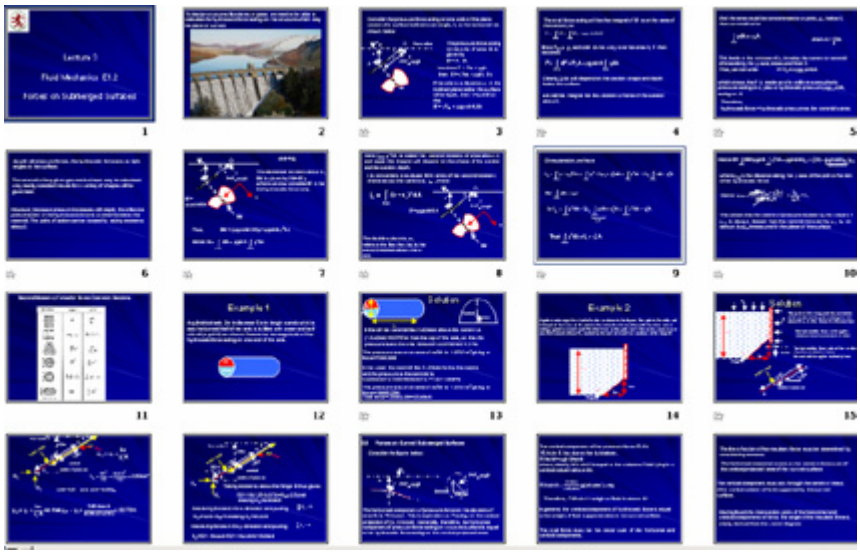

Figure 3 Forces on Submerged Surfaces Level 1 Fluid Mechanics

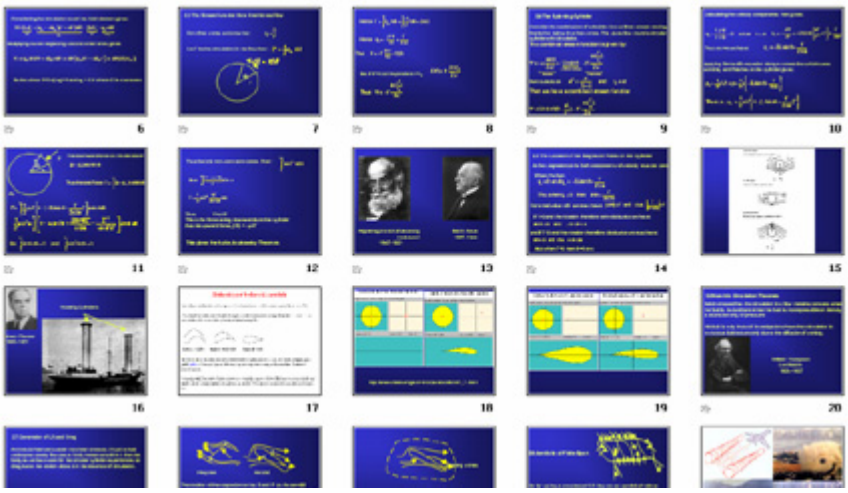

Figure 4 Flow Past a Circular Cylinder Aerofluid Dynamics Level 2

5 FURTHER DEVELOPMENTS

Blackboard 6 was selected by the University as its VLE choice and for the academic year 2003-4 with the adoption of Blackboard 6 the original sites were migrated across and the PowerPoint lectures have been added to the sites. Both the silent versions and the versions with embedded sound have been included since if a student were to be using a PC without a sound card or without a recent version of Windows Media Player installed the sound would be unavailable to them.

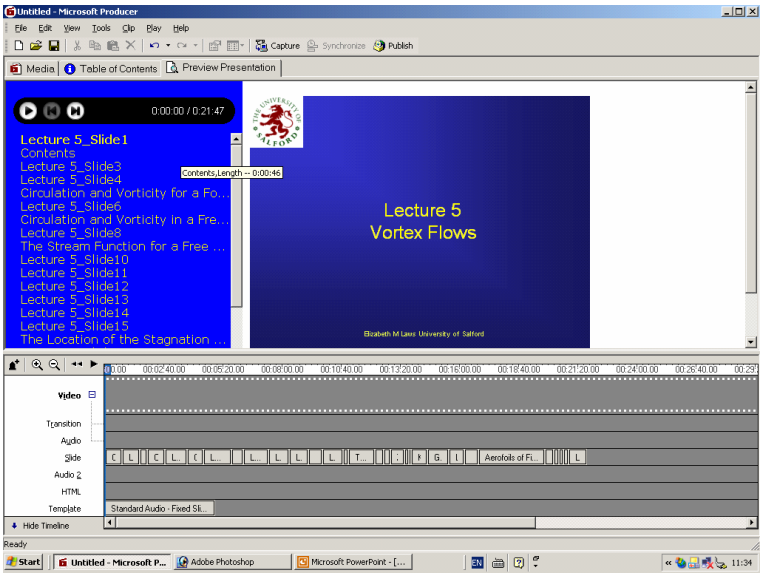

Figure 5 Importing Powerpoint With Embedded Sound To Ms Producer

Figure 6 Produced Version of Presentations from MS Producer

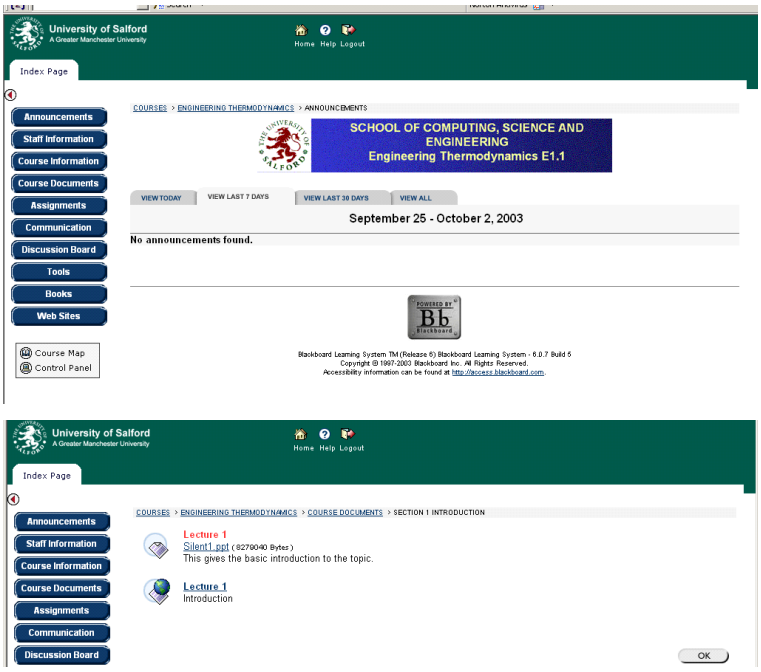

Figure 7 Embedding The Presentations In Blackboard

6 LEARNING STYLES

During the induction week new students were asked to complete two different learning styles questionnaires one developed by Felder and Silverman(1988) and the other termed the VARK developed by Fleming (1995,2001)). Analysis of the results of these questionnaires in both the academic year 2002-2003 and 2003-2004 showed that the majority of students had a medium to strong preference for a visual style of learning. Only a minority did not demonstrate at least a mild preference for a visual mode of learning, this was considered to be one reason which explained why the PowerPoint presentations had been so effective.

Were we in the supermarket business we would go to great lengths to ascertain the preferences of our customers so that we could provide for them what they want and need and thus maximise our profits. We need to do the same in education to know what preferences our students have and to provide a variety of approaches which meet their needs. This blended learning approach is likely in the medium to long term

to be the one which will increase our effectiveness as educators. Whilst we may be unable to satisfy everybody not to even attempt it is no longer an option open to us.

7 STUDENT ATTENDANCE

Throughout the academic year 2002-2003 regular monitoring of student attendance was maintained and an attempt to correlate this with student performance was made. This showed clearly that whilst regular attendance does not guarantee good performance, poor performance correlates strongly with poor attendance. Whilst student attendance is clearly to be encouraged there may be certain valid reasons why students are not present, illness being one. For many students the conflict between paid employment, (an increasing financial necessity in the UK), and regular attendance is real. For students to be able to access material outside the timetabled class contact periods is seen to be one major benefit of the approach adopted here which is likely to be of increasing usefulness making a positive contribution to student retention.

8 CONCLUSIONS

Positive benefits have been identified linked to the use of an e-learning support strategy to assist in engineering education. These benefits have been demonstrated both in terms of improved student performance, interest and in general engagement with the learning process. Whilst the initial work involved in adopting an e-learning strategy and in the development of the Powerpoint presentations is considerable the ability to re-use, enhance and further develop the material over time gives lasting benefits which in the medium-long term more than repays the time outlaid in development.

The overall effectiveness of the work described here is intrinsically linked to the student learning process and no matter what material is provided by the lecturer unless it meets the needs and engages the interests of the students it will not be of any lasting practical benefit. Balancing the conflicts of teaching and learning and transferring ownership for learning from lecturer to student is the challenge facing our profession.

ACKNOWLEDGEMENTS

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