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TYSTYSGRIF UWCHRADDDEDIG ADDYSGU MEWN ADDYSG UWCH
POSTGRADUATE CERTIFICATE IN TEACHING IN HIGHER EDUCATION

Cylch Dysgu 2 | Teaching Cycle 2
Improving Delivery and Accessibily of Physics Courses

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Cycle 2: Improving delivery and accessibility of Physics courses

Happiness through superior technology
(unknown, prob. Japanese origin, mid-1980s)
Cycle 2: Improving delivery and accessibility of Physics courses

Modules discussed: PH18010 Astronomy (primary)
PH38510 Sun & Interplanetary Space (secondary)

Themes discussed: Improving the way in which information is presented
Using information technology to support a wider range of learning styles
Making lectures material more accessible
Developing a wide range of on-line supporting material.

C2.1 Plan

In the past Physics lectures have been conducted primarily by means of “chalk and talk”, where the lecturer develops a physical principle or application on a blackboard (or whiteboard) and the students take notes. This approach remains unparalleled when teaching the quantitative aspect of physics, or when one is starting from the basic physical laws and deriving specific patterns of behaviour. In these cases the flexibility of being able to write – and draw – freely on a board while exploring the implications of fundamental physics is highly desirable. However, there are occasions – notably in introductory-level courses – where a more visual approach is desirable. This is particularly true when presenting material in a qualitative manner, or where one wishes to catch the attention of a class of new students. Visual materials – for example, the wonderful and informative movies of solar activity and solar wind evolution derived from space-based imagers and ground-based radio telescope networks – can also provide a great stimulus for learning. My aim in this cycle of development has been to take advantage of recent developments in multimedia technology and virtual learning environments to provide a wider range of learning opportunities for students and to provide increased support for students with disabilities – this latter, in part, being prompted by my own experience of being disabled.

C2.2 Background

This cycle discusses innovations in the presentation of two modules; PH18010 Astronomy and PH38510 Sun and Interplanetary Space. PH38510 has already been described in Cycle 1. The first year Astronomy module, PH18010, was introduced with the onset of modularisation and was intended to serve both as an introductory course in astronomy and space science for students following the Physics with Planetary and Space Physics degree scheme and as a course of wider general interest, likely to appeal to 1st year students from other departments. The course has proved very successful, attracting 70-90 students per year.

I began teaching on the module on my return from Germany in 1998, taking over the section covering stellar evolution, galactic astronomy and the large-scale structure of the Universe from Dr. W.P. Wilkinson. Dr. N.J. Mitchell continued to teach the history of astronomy, observational methods and solar-system astronomy, as well as co-ordinating the module. During the three years up until 2001 I continued to teach this section of the module. My lectures were delivered mainly using OHP slides as illustration and photocopied hand-outs for supporting material. Student performance in the module was generally very satisfactory, but I had reservations about the overall balance of the
course and the marking scheme for the multiple-choice examinations used to assess students. I took over co-ordination of the module for the 2001-02 academic year. For the first year I ran the course with few changes to see what was required. My notes from the time record:

This course was delivered essentially unchanged from last year, having proved satisfactory from the examination results, lecturing, progression and student satisfaction perspectives. No serious problems were encountered (though the course is beginning to get congested with material and some re-configuration may be needed next year). The course was presented (as in previous years) almost entirely through OHP slides and hand-outs. Student suggestions were confined to requesting that the viewgraphs should be made available on the web (see comments in section 2). If I present the same part of the course next year then this is a priority.

Examination results for this elective module were more than satisfactory. The problems encountered with this course were the same as in 2000 - unsuitable rooms. When lecturing to a large 1st year class in a large lecture theatre some form of functional amplification system is essential - particularly when the lecturer has only one functional vocal chord. Unfortunately it appears to beyond the abilities of many departments to ensure that microphones are present in lecture theatres (this is almost certainly an effect of the deplorable policy of central allocation of lecturing spaces and the resulting "common user" erosion of facilities). And scheduling examinations in lecture theatres where students have to sit side-by-side for lack of space is simply unacceptable.

My concerns about module structure were mainly directed at the first section of the course – on the history of astronomy – where I felt too much time was being devoted to discussing obsolete (and incorrect) models of the solar system. I therefore handed over my notes for the second part of the course to the lecturers who took over solar system and stellar astronomy and galactic astronomy and cosmology, respectively) and took over the first section of the course myself. I was unhappy about the examination design used – large numbers (80) of very simple questions to be answered in 40 minutes, a format which I believe to favour memorisation at the expense of understanding. The mark scheme deducted marks for incorrect answers – both anecdotal evidence from students taking the course and examination results suggest that this deterred students from attempting to answer questions, with the effect being most marked amongst less confident students. I therefore re-designed the multiple-choice papers, reducing the number of questions to 40 in each test and making the individual questions more difficult. In particular, questions were designed to test students understanding of underlying physical concepts rather than their ability to remember unrelated facts. Examples of PH18010 questions are enclosed amongst the supporting material in this portfolio, while a detailed discussion and comparison of marking schemes is set out in an appendix.

The problems with unsuitable lecture rooms in 2000 and 2001 were overcome by refusing to use rooms I considered unsuitable. Since 2002 all PH18010 lectures have been held in Physics A lecture theatre.

This left the question of lecture presentation and supporting notes. Until 2002 I had used OHP slides during the lecture and circulated photocopied hand-outs to students during the lecture. The cost and time required to copy 90+ sets of notes per lecture were unsustainable and unjustifiable, so a new approach was needed. This aspect of course development is discussed in the next section.

C2.3 Developments in lecture presentation and supporting material for PH18010

The PH18010 Astronomy module requires a very visual – almost theatrical – approach, and I have found comprehensive slide-sets essential for lecturing on this course. Until 2002 I lectured using OHP slides to illustrate the lecture and photocopied hand-outs for supporting material. A set of lecture slides from 2001 is enclosed on CD-ROM in the supporting material section of the portfolio.
For 2002 I made all lecture materials for my section of the course available online in portable document format (*.pdf), linked from a (rather basic) course web page in my personal webspace. I had conducted trials over the summer with saving material as Microsoft PowerPoint slides, but the degree of incompatibility between the different versions of PowerPoint on different machines made this an exercise in frustration—it was certainly inadequate for the job. The notes were therefore written in Sun StarOffice 5.2 and converted to PDFs by exporting them as postscript files, which were then converted to PDF using ps2pdf on the University mainframe (Central). This produced good-quality PDFs which normally printed reliably (something not always true of PDFs generated by a certain commercial software package) provided that they were downloaded to a local client machine before printing. I did conduct trials before the start of lectures in which I used the newly-installed data projector in the lecture theatre to project the PDFs in the hope that this would be a better method than using OHPs but the projection quality was too low for the PDF resolution, leading to bad “jagging” of fonts. I therefore gave the lectures using OHP slides, which generally worked well.

The students gave a mixed reception to the on-line material—some liked it, others objected to having to print out notes (though it turned out that the two most vocal objectors to the cost of printing notes had been printing theirs out in colour). A recurring problem was that print times were often long, partially due to the number of images in the notes, but mainly resulting from students printing notes directly from the Acrobat window spawned by the web browser instead of saving the file locally and then opening it—this problem still persists with PDFs.

The module e-mail lists were used to inform students of lecture times, exam times, location of lecture materials and any other information they might need. An example mail-to-module follows (in all the following examples mail from me is shown in red, mail from students in blue):

Welcome to Aberystwyth, and the first PH18010 Astronomy lecture is at 9am this friday (27 September) in Physics A. Information on the course is available from:

http://users.aber.ac.uk/azb/teaching/ph18010/index.html

with an introductory guide to the course (subjects covered, sequence of lectures, method of assessment, what you need to do) at:

http://users.aber.ac.uk/azb/teaching/ph18010/ph18010-intro.pdf

Notes covering the first two lectures are available on-line, with others to follow. You should familiarise yourself with the material in these notes before coming to the lectures. Please note that as this material is available on-line I will not be providing it as hand-outs in the lectures.

The notes for the first two lectures are available from:

http://users.aber.ac.uk/azb/teaching/ph18010/ph18010-1.pdf

and

http://users.aber.ac.uk/azb/teaching/ph18010/ph18010-2.pdf

See you on friday

Andy Breen

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Andy Breen – Solar Physics/Interplanetary Scintillation Group
I also tried to make e-mail the preferred way for students to contact me outside lecture hours - not least because it meant I had a record of any problem they had or requests for changes. A sample exchange follows (student ID supressed):

"................ <###@aber.ac.uk> writes:
> This is a multi-part message in MIME format.
> --=_NextPart_000_000C_01C2790D.7B6A6060
> Content-Type: text/plain;
> charset="iso-8859-1"
> Content-Transfer-Encoding: quoted-printable
> 
> Hello Andrew
> 
> I am 1st year Computer Science Student and not studied Astronomy before
> 
> and I am a afraid I had lack of information which resulted in a very
> 
> poor result. I was wondering if I could resit the first test again.

reply

The lecture material has been available on-line (and will continue to be). I regret that it is not possible to set resits during the period of the course - there should be ample scope to make up marks lost in this test in the next two (there's still 6/7% of the course marks to go). Failing all else there are resits in the summer, but I have every confidence that you'll be able to make up the marks. If you don't have any background knowledge of the field then you will need to spend more time going over the notes and reading the recommended texts (which are all in the physics library), but there are never going to be any questions asked which are not covered by the course notes or the recommended textbooks.

Good luck with the rest of the course.

This method of passing on information was not without its problems: A feature of PH18010 has been the tendency for student numbers to grow steadily over the first few weeks of term, possibly as word gets around about it being an interesting course. This means that students were attending lectures without (yet) being on the module mailing list, so some students did miss out on information. This was compounded by timetabling clashes which left two students only able to attend every other lecture. I attempted to put these two students off taking the module but failed. The complications introduced into teaching as a result of this left me resolved to not accept any student onto the module in future if they had timetabling clashes preventing them from attending all lectures. An e-mail discussing this issue with the other two staff on the module follows:

Date: Fri, 27 Sep 2002 12:57:35 BST
From: <arz@aber.ac.uk>
Subject: PH18010 - making lecture notes available on-line

We have a minor complication with PH18010, as two US exchange students
doing mainly economics courses are registered for it - they were both very keen on being allowed to take the course, but the problem is that the monday slot clashes with one of their other modules. I told them that /if/ they arranged with other members of the class to send a tape recorder to the lectures they can't attend and to make use of notes taken by other students, and /if/ they were prepared to put in extra work between classes then - if they so chose - they should be able to follow the course. As they were there this morning I obviously failed to put them off, so we will now have to cope with them. This means making the lecture notes easily available so that they will have all the notes available to them - I'm putting mine on the web as PDFs, and I'd recommend this as a way of making them available (for one thing it eliminates the ridiculous amount of photocopying that we always had to do for this course). I've set up a "master" page for the course at:

http://users.aber.ac.uk/azb/teaching/ph18010/index.html

that can link to notes elsewhere - I'm afraid that the notes for your parts of the course would need to be in your web-space, as mine is rapidly filling up.

It also means that we need to ensure that all three tests fall on Fridays - that'll mean a little bit of juggling with the lecture sequence, but there should be no problem in a test following the first lecture of the next segment of the course.

Sorry about this - I'd hoped to avoid this problem, but short of telling them that I wasn't going to let them do a course they obviously wanted to do there didn't seem to be an alternative.

The growth in student numbers (and the turn-over as other students leave the module because of timetable clashes) over the first few weeks of term also means that module attendance sheets become out of date rapidly. This makes monitoring of attendance difficult. After 2002, when a student fell through our attendance monitoring completely (he had completed registration but had never activated his computing account, nor had he attended any lectures or tutorials) I secured a Sequent account so that I could see for myself exactly who was registered for the module and revised follow-up policy so registered non-attenders would be e-mailed (and, if necessary, called in) from early in the term. These changes do seem to have produced an improvement in attendance - and have enabled students having problems to be identified, sometimes before the student's own department had noticed anything.

Other issues which arose in 2002 were:

• The need to have on-line notes available before the lecture - I had managed this, but it wasn't generally true across the module - so that students with Dylexia (or other difficulties) had time to become familiar with the material before the lecture itself. Procedures were therefore revised to make sure that notes would always be available in advance of the lecture.

• Inconsistency in the level of detail provided in the online notes for different parts of the course – the third section of the course (galactic astronomy and cosmology) was taught by an academic new to lecturing and although the level of his section of course was no more difficult than the others he had included much more detail in his supporting notes, which some students found confusing. One e-mail exchange concerning this issue follows:

>Dear Dr. Breen,
> I have just completed the final exam on the first year astronomy course, and I feel I must complain about the way the last part of the
module was taught. With over 22 pages of typed notes for each of lectures, as well as additional notes for the last one, it was incredibly difficult to revise comprehensively for the exam. How can it be possible to condense so much information for one short multiple choice exam? There was also a lot of physics and maths present in this section - even though the module prospectus stated that this would not be the case. XXXXX's lectures were far more difficult to take in than yours or Professor Habbal's. I am very disappointed, because even though I have worked hard throughout the module (and have grades for the first two sections that I am proud of) I know that my result for the last section will greatly drag down my average score. Maybe this input will help classes in the future.

I am aware that there have been some comments as to the number of equations in the notes for the final part of the course - few of these are actually needed to understand the material, but they do perhaps make things appear over-complicated. PH18010 is an extremely difficult course to write and present, as it demands presentation of very difficult concepts in a non-mathematical manner - something which is difficult to adjust to doing and which really does test understanding of the subject.

This year was XXXXX's first year teaching this course and he will have been facing the same steep learning curve as I did four years ago. Having said all that, I am fully aware that this section of the module has turned out to be more difficult for students than planned. If there is a significant difference in marks between tests 1 and 2 and test 3 then I shall take this into account in determining final marks.

As it was, marks for the three tests were closely comparable and no cross-normalisation was required. I discussed the issue with the lecturer concerned and we decided that much of the extra information could be moved to “Extra information – useful and informative but not essential for the course”. This seems to have worked well in 2003 and 2004.

- One student had thought he had left the module but had not completed any change of module forms - as he believed that he was no longer on the course he had not responded to any of the e-mails concerning his absence. As a result he finished 1st year with insufficient credits to proceed.

For 2003 I made a point of using the first lecture to stress the importance of going through correct module-change procedures, as well as including a line in e-mails to missing students stating that although they might think they’d left the module they were still listed on Sequent and so they still had to attend lectures and examinations, otherwise they’d fail.
• Some way of presenting lecture material via data-projector was desirable: projecting PDFs didn't work well enough, I continued to find PowerPoint unsuitable (compatibility issues, instability – requiring the lecturer to carry a set of OHP foils anyway) – this issue remained unresolved.
• I was aware that I had difficulty being heard, particularly by students at that back of the lecture theatre and most of all if I had a cold. I carried out a couple of trials with a portable amplifier and these convinced me that I needed to have access to similar equipment if I was to lecture large groups effectively and without further damaging my voice.

My notes from the end of 2002 record my impression of how the course had run:

PH18010:
Took over co-ordination of PH18010, took over teaching first section of course (history, positional astronomy, observational methods) – I had regarded the way this section of the course had been taught as deeply unsatisfactory, with far too much time spent on the details of obsolete views of the solar system and far too little on how observations informed the development of scientific thought. I also took over the “Life in the Universe” lecture at the end of the course. XXXXX took over the galaxies and cosmology section. All lecture notes available on-line (in PDF format for my lectures). Course went well, though some criticism of mathematical content of XXs notes (not lectures). After one student fell through our monitoring procedures during the first term and was only picked up after I contacted hall staff (student didn't complete registration, hadn't activated their computing account and never turned up for any lecture, tutorial or examination but was nonetheless in Aberystwyth) monitoring procedures were reviewed. In future, decided to contact any student missing a test in PH18010 immediately, with copies of the e-mail to year tutors in Physics and the student's department.

Apart from changes in procedure to prevent some of the issues discussed above recurring, I intended running the course in 2003 with few changes. This situation changed after I became seriously ill in March 2003, eventually spending almost six months off work (over two of which were in hospital and almost one in intensive care). I returned to work in August 2003 intending to return to lecturing in September, but aware that I might find that I could not sustain a full lecture load. On the positive side, I had a lot of time over the spring and summer to consider how the course could be delivered in a way which was less dependent on the presence of a particular lecturer (this was an important consideration as even in September I was unsure how my health would hold up after returning to lecturing, and during the summer there had been doubt as to whether I would be there at all). I therefore put a considerable amount of effort into re-designing the course web pages to make information easy to find and into checking, updating and in some cases re-writing the on-line and OHP notes to make the course as easy to follow for students as I could and as easy as possible for a lecturer to give. I did have hopes of having a video taken of me going over each lecture – almost in a tutorial manner, with me sitting in a chair and talking and the lecture slides displayed behind me, so that students could access the video-lecture if I was unable to actually physically present the lecture. Unfortunately work-loads in Information Services made this impossible – I still consider it a good idea, however, and one worth developing in future. The University and the Shaw Trust provided considerable resources to support my return to work, including a lightweight portable amplifier/loudspeaker and radio-linked headset microphone. As my voice and lung capacity (as well as diaphragm control) had been further damaged by Myasthenia and Pneumonia over the summer (and probably not helped by an extended period on a ventilator) this was essential for my lecturing. I found that I adapted to using it very quickly – and found the freedom to move around the lecture theatre while talking very liberating. It made lecturing a much more relaxing experience than it had been when tethered to an amplifier.
Once again I used e-mail as the main means of communicating with the students on the module
(accepting that the same problems with late registration would arise – this difficulty is common to all means of electronic dissemination of course material). In my initial e-mail to the course I stressed the importance of reading the course guidelines on the main web page:

Dear all,

Welcome to the Astronomy course. The first lecture will be at 09:00 on Friday (this Friday!) in Physics A lecture theatre. Lectures will then be on Mondays at 11:10 and Fridays at 09:00, always in Physics A. A description of the course, together with a course timetable and the lecture notes for my part of the course are available from:

http://users.aber.ac.uk/azb/teaching/ph18010

I also suggest that you read the notes for students given in my main teaching page:

http://users.aber.ac.uk/azb/teaching

The course ran smoothly with few problems, though attendance was poor by some students. My notes from December 2003 read:

I re-designed my teaching web-pages, making more notes and supporting information available on-line. I also added a section on general good practice and requirements for each module and made lecture (and assignment sheet and examination) times available on-line at the start of the term.

I made much more of an effort to monitor attendance at lectures and to chase up non-attenders immediately by e-mail (this generally had little lasting effect, however). There were some complaints by students who had attended lectures but not signed in – in these cases I replied immediately by e-mail explaining that these checks were carried out to pick up on any problems students might be having and that if they didn’t sign in then we could not be sure that they had been present.

PH18010:

The lecture notes for the first section of the course were revamped and additional material made available online. The suggested changes to XXX’s lecture notes were appreciated by students, but there were otherwise few large changes to the lectures. The assessment continued to be via three examinations spread through the term, but the format was modified following discussions with specialist examination designers so that each multiple-choice question had 5 possible answers (one correct) with 1 mark awarded for a correct answer and 0 for an incorrect or no answer, rather than the three possible answers, +3 marks for correct, 0 for no and -1 for incorrect previously used. The aim of this change was to encourage students to attempt each question. Questions were designed to test comprehension of the underlying physics rather than memorisation and as such a guideline of 1 minute/multiple-choice question was suggested. The average marks were slightly improved on last year, but more importantly the spread in marks was reduced. Students expressed a preference for an assessment system which did not include -ve marks.

No significant changes planned for next year in course material, but hope to have my section of the course videoed before next September and mixed video/audio/presentation material made available online to cover the whole course. This would introduce greater flexibility in teaching (important given health issues) and makes the material more easily accessible for students – material can be re-visited after the lecture if they feel a point needs to be re-checked.

I hope to convert the online notes to HTML format (from PDF) if a suitable means of generating clean, platform-independent HTML easily can be found.

Lectures were given using OHP slides for visual material, trials before the start of term having shown that the data projector units did not produce a sufficiently clear image and there were too many stability issues with the PCs in the lecture theatre to risk presenting a lecture this way. Very few lecture theatre PCs appear capable of opening a PDF document reliably without problems.

Use of animated visual aids and movies was intended to be extensive in this course, but the very poor MPEG playback software available on the machines in lecture theatres made this impracticable.

In the longer term it would be worth investigating means of running the three examinations on-line, in order to avoid the present unsatisfactory situation of running tests in crowded lecture theatres – however, this could cause timetabling difficulties. Improved monitoring procedures worked well – one student (in
another department) who was having problems was picked up this way before their own department had noticed.

The rationale and testing of the revised mark scheme is discussed in an appendix, and examples of course web pages are provided on the CD-ROM enclosed with the portfolio (I adopted the approach of a central web page containing links to all necessary course information – including timetables and information on assessment – for all my courses from 2003).

OHP presentation was more difficult than in previous years, with only a screen at the side of the hall really being suitable – and this was hard for some students to see. The need to find some effective way to deliver talks by OHP was becoming pressing. I was also keen to find a way of improving the on-line presentation of lecture materials. The solutions arrived in spring 2004, courtesy in part of my return to work funding and in part of the wonders of the open-source software movement. There had been a suggestion that part of the funding supporting my return to work should be used to buy me a laptop PC. I resisted this suggestion very strongly – one of the problems I experience with Myasthenia is muscle weakness, another is breathlessness when attempting stressful activity, so burdening me with well over a kilogram of PC would not be a good idea. My preferred alternative was a hand-held computer which, when equipped with an external keyboard and VGA output-driver would function as both a portable machine for note-taking, paper- and report-writing and communication when in meetings or at conferences and as a self-contained driver for electronic presentation of lecture slides via a data projector. Detailed comparisons of the available technology led to the purchase of a Palm Tungsten t3, a folding keyboard and Margi Presenter VGA adaptor, rendering software and remote control – together they provide a light, highly portable and very reliable means of presenting lecture material via a data projector. The difficulty in preparing on-line notes appeared to be resolved at the same time with the release of version 1.1 of OpenOffice – this included an option to export presentations as HTML, with a control panel to navigate between pages and each page saved as a single JPEG image (thus preventing cutting and pasting of text). The combination of these two means of presenting and storing information looked very promising (and the t3 performed excellently when used to present my research talks at the Asia-Oceania Geophysical Society meeting in Singapore in July 2004 – a meeting to which I could never have taken a laptop, given the physical effort of carrying it under such hot and humid conditions) so I converted all the course notes to the appropriate format, re-writing and updating as necessary.

Another innovation for 2004 was to move the course notes to the Blackboard server and to adopt Blackboard as the prime means of distributing course notes, information and communications. I decided to make this change – initially for PH18010 only – after attending a staff development course on using Blackboard: Kate Wright had no difficulty in converting me from a high degree of scepticism about Blackboard to seeing that it had major possibilities – and not just for getting my lecture notes off my personal disc quota.

The final strand in the changes for 2004 was to undertake a trial in which voice-recordings of lectures were made available on-line, so that students could re-visit topics covered in the course. I had been searching for a way of doing this which did not demand significant effort from an already-overstretched Information Services and did not demand major effort from the lecturing staff (initially prompted by the use tape-recording of lectures for later transcription described by Feynman et al., 1963). A solution was suggested by the release of the iRiver MP-400, a hard-disc based music player with built in recording and encoding to MP3 format. Trials with my own player showed that the lapel microphone worked well, picking up my voice clearly, and that although the controls were somewhat fiddly it was certainly possible to use it in a lecture. By putting recordings on-line in Blackboard as soon as possible after a lecture (ideally within a few minutes of the end of the lecture) I hoped to provide a resource which would allow more flexible learning, as well as building up an archive of
recordings which could be used in the future if I found myself unable to give a lecture.

One potential problem area, revealed by pre-lecture tests, was the revised lighting in Physics A. The old lighting system was very flexible, with separate control of lights in different parts of the theatre. This meant that the light level could be optimised to reduce glare on the board, while still providing enough illumination for note-taking. The new system lacks this, with all the lights wired together. The lights can be dimmed, but even the lowest setting is still too bright for projected slides to show up well – particularly those with complex pictures. If the lights are turned out, then the slides show up well but the theatre is too dark for students to take notes – and of course it would be impossible for a student who needed to lip-read to do so. I asked for estates to be contacted about this issue:

To: Diane Jones  
Cc: brb@aber.ac.uk  
Subject: Re: Physics A

Diane

An interesting observation! We shall take this up jointly with our colleagues in IS and investigate.  
Regards

David

----- Original Message -----  
From: "Diane Jones"
To: "David Henderson"
Sent: Monday, September 27, 2004 4:04 PM  
Subject: FW: Physics A

> Dr Andy Breen has asked me to contact you regarding a problem with the lighting in Physics A. These observations may well also apply to Physics B and possibly Physics Main.  
> When the lecture theatre lights are up, anything projected onto the board is almost illegible, when they are down so as to make projections clear, it is too dark for students to make notes, and also too dark for any students who need to lip read. This last point is particularly important in view of the increased number of students this year who are registered deaf, but who are proficient lip readers.  
> The problem would be considerably alleviated if it was possible to switch off the lights nearest the board, independently of the other lights.

A solution was agreed, in which the theatre would be re-wired so that the front two rows of lights could be switched off independently. This could not be done in time for the start of lecturing, so for
this year I gave the lectures with the main lights dimmed as far as possible, switching them off only for slides containing detailed images and warning the students before I turned out the lights. This was not ideal, but was the best that could be done in the circumstances. These problems do show why it is essential to consult teaching staff before making changes to lecture theatres, however.

My notes on intended course changes for 2004, made before the start of the session, read:

PH18010:
Notes will move onto the blackboard server as a way of trialling this method of making material available (and moving the material off personal accounts). Some of the material may be made available in forms other than PDF. Contacting BB team 2004/07/30 to arrange for PH18010 to be added to blackboard module list (Physics has no Blackboard administrator).
Moving PH18010 to Blackboard September 2004. On-line notes for my section of the course now in HTML format (with images and text as embedded JPGs to prevent editing-copying). Will use t3 palm + presenter to deliver lecture materials via data projector (trialled 2004/09/24). Intend recording each lecture as *.mp3 (using iRiver-140) and uploading to Blackboard server immediately after each lecture – will allow students to revisit material, should improve chances of all students being able to take worthwhile notes, in future years will offer coverage if illness prevents me giving a lecture.
All notes moved to Blackboard, all course information and discussion boards centred there. Voice recording (using iRiver) and playback (via Blackboard server) tested before start of term. Projection of slides difficult owing to lighting in theatre – discussed issue with estates and IS and a solution (selective switching of lights nearest board) has been agreed. Projection driven by t3 works very well – remote control of slides should make lecturing much more relaxed.

The combination of Blackboard and HTML-format notes, t3-hosted presentations and voice recording was introduced for my section of PH18010 in September 2004. Student response was generally positive – the voice recordings seem to have been particularly appreciated. The combination of the radio-linked amplifier and the remote-control for switching slides on the t3 made it easy to move around the front of the lecture theatre while talking – this made teaching more relaxed, though I had to remember to keep in clear sight of the class in case there was anyone in the audience who needed to lip-read. On the debit side, I found that using electronic media and a data projector (rather than OHP slides) imposes a much more rigid structure on the lecture – it is no longer possible to re-structure a lecture “on the fly” by re-ordering slides, or omitting or introducing slides as seems appropriate for the way the lecture is running. This felt like a real limitation, but some re-thinking of the material used for projection can probably address it. The best solution would be to differentiate between the slides projected and those used for lecture notes, with some material omitted from the projected slides (and the type size increased in those projected). This is particularly true in the “historical introduction” section of the course, where having to show every slide (instead of skipping some or using them as supplementary information, briefly shown or skipped altogether apart from a quick reference to the material covered in them being in the notes) led to this part of the course taking longer than in previous years.

My notes made while teaching my section of the course read:

PH18010: Palm t3/Margi Presenter works very well as driver for presentations – will shift all courses where I’ve used OHPs to this approach. Voice recording works well (technically) – not had any feedback yet on its usefulness (nor on how useful they find the notes on Blackboard) but will solicit comments/feedback at the next lecture (3rd one, on friday)
Third lecture – some of the detail needs reducing (perhaps try to distill the “history of astronomy” section down into one lecture for next year?)
This is a difficult course to give when fatigued – I can get through the material but it is hard to communicate the enthusiasm which some of the material needs. Cutting down dome of the detail (moving it to supplementary notes) might help – try this for next year.
On-line lecture recordings much liked (feedback from students). Problems printing out notes – make
them available as PDFs for next year as well as HTML. Blackboard thought to work well.

The class size was rather smaller this year – down to 65-70 from 80-90, due mainly to another physics module (PH19510 Chaos, Communication and Consciousness) being made a core requirement by Computer Science for some of their degree schemes. The reduction in class size meant that I could be more interactive in my lecturing style – asking questions of the class more often, dividing them into groups to think about problems I set them, based on the material on screen. This approach appeared to work well.

Student comment was generally positive – when circulating the module review forms in my last lecture I specifically asked for comments on the presentation style, the use of Blackboard for lecture notes and supporting materials and the usefulness (or otherwise!) of the voice recordings.

Student comments from module evaluation forms are set out in Figure C2.1. I found that asking students for feedback on specific issues produced a much better response – and a much more useful response – than is usually obtained from the assessment forms (the tick-box sections proved to be as devoid of useful information as in previous years – as shown by the high marks awarded for “lectures included suitable examples or applications”, when on this course the lectures include no examples or applications..).

One student made use of the discussion board feature of Blackboard to comment on the course:

> Subject: Re: Recordings of lectures

> Very useful, allows us to go over information not fully digested during a short lecture at a later date and better prepares us for exams. Long may it continue!

Comments and suggestions were also received by e-mail – I replied to these as soon as possible. One such discussion follows:

> Dear Andy,
> 
> I have been reviewing the lecture notes again, in preparation for the exam. I would have found them more helpful if there were a printable version of the slides (as per Microsoft PowerPoint handouts), because it is often easier to read printed, hardcopy material than soft-copy, on screen.

reply

PowerPoint would be difficult, as they've never been in that format (I've not had access to it - except in the public workstation rooms - for a couple of years now). PDF I could do, but there were complaints last year regarding printing times for PDFs. Were there problems printing out the HTML versions? I'd tested printing them and not encountered problems, but I don't think I'd tried doing it using Internet Explorer([1]). On reflection I ought to have tested that. I'll add PDFs next time around.

> Hope this is helpful feedback
Very much so. This is the kind of thing I need to find out about.
Figure C2.1: Student comment on PH18010, October 2004
Another message

> I was wondering if you had any past-exam papers of
> Phi8010 test 1 to help me revise?
> Thanks for any help

next message

> Sorry to bother you again, but I just wanted to ask
> whether the exam would be on the history of Astronomy (I believe
> this was
> the 3 first lectures), or will they just be on astronomy these
days etc?

reply

The questions will only tread into historical stuff insofar as to ask
how they figured things out (e.g. shape of earth, moon etc...). It is
an astronomy course, not a history one :)
As to past papers - we only changed to the current format of 5
possible
answers last year - all the older papers were marked in a rather
different
way and would be misleading. I've also changed the topics covered by
the
course a bit this year so the questions won't cover quite the same
ground.
It's not really possible to get much of an idea of this year's
test from older papers, so I'm reluctant to make them available.
Hopefully the two 'example' questions in the 'course information'
section
will give some sort of idea, though.

Andy Breen

> is there any past papers available plz?

reply

We only changed the examination format to the current one last year
so we don't have enough of a backlog of questions yet to make
it possible to put past papers up (at least, not ones which would be
useful).
We'll look into doing it in future years as we build up a larger set
of
questions.
There are sample questions available - see the "course information"
section on Blackboard.

Verbal feedback from the students about the voice recordings was also very positive – one student
said they had loaded the lectures onto their MP3 player to listen to on a train journey.
These comments were very useful – the problem with printing out the lecture notes was one I had
missed: I had checked that the notes could be viewed using a public service machine running
Internet Explorer (a necessary move, as one never knows exactly how a browser which doesn't
implement recognised web standards will behave) and had checked printing from my own machine,
but had not checked printing from a public service machine. For next year I will make the notes
available in PDF form as well as HTML – with a warning to download the PDF file to the local
client before attempting to print it.
The comments on the variation in the pace of lectures backs up my own impression – that the more
rigid style imposed by using electronic media led to the history section occupying more time than I had intended. Re-structuring the notes used for projection should remove this problem, which only became apparent during the lectures themselves. The point about question-and-answer sessions in the recordings is also valuable – in future I will repeat the question that I’ve been asked before answering it. Again, the problem of the question asked by the student being inaudible in the recording is something which only became apparent when listening to the recordings themselves.

I used both e-mail to the module lists and the Announcements facility in Blackboard to make announcements about the module – an example follows:

```
Date: Mon, 18 Oct 2004 17:18:32 BST
To: module-ph18010@aber.ac.uk
From: <azb@aber.ac.uk>
Subject: IMPORTANT

The first examination - accounting for 33.3% of the course mark - will be held in Physics A at 11:10 on Monday 25 October (NEXT MONDAY). If you do not attend and cannot provide a medical certificate to cover that period within 2 (two) weeks of the examination then you will receive a zero mark for the examination. Students who fail to attend more than one examination without a certificate of exemption may receive an N grade for the module (not allowed to retake). Please make sure you attend - it is in your own interests. If you think you’ve left the course and have not had your module change form signed by me then /you are still on the course/ - make sure you get the form signed /before/ the examination.

Enough of the warnings. The examination covers the first 6 lectures but you will /not/ be asked questions on historical developments except insofar as they can be used to ask questions on the underlying physics (e.g. methods of measuring Earth-Moon distance, size of Earth, Earth-Sun distance and why you need to be able to measure small angles to work out the distances to the stars).

The next lecture, as per usual, is Friday 0900 when I'll be giving an introduction to the solar system. The voice recording of today's lecture will be uploaded to Blackboard tomorrow.

Andy
```

In general, the same message was posted as an announcement in Blackboard and mailed to the module list. I created three discussion boards for course issues (course content, course presentation and general discussion) in Blackboard but very little use was made of them (one student posting in one of the groups) – e-mail continued to be the main means of communication within the module.
Rapid follow-up of students not attending lectures bore fruit this year, with much higher levels of attendance at the first examination than in previous years. The module continues to attract students from a wide range of backgrounds – although most students on the module are registered with Physics, Mathematics or Computer Science the 2004 contingent included representatives from Film, Theatre & Television, International Politics, Biological Sciences, Earth Sciences and English. Some of these external students were amongst the highest performers in the first examination, suggesting that the aim of providing an introduction to astronomy and space science suitable for the intelligent non-specialist is being achieved. The voice recordings have been an unconditional success and I will introduce them into my other courses in future. Possible future developments for the way this course is presented and particularly the use of recording equipment and Blackboard are discussed in section C2.6.

The changes made to the Astronomy module PH18010 since 2001 have been aimed at improving the learning experience for students. Over this time the examination questions asked have been made considerably more difficult, emphasising understanding of physical principles over memorisation, but the overall examination performance has, if anything, improved (see discussion in appendix). Sample questions from the first examination of the course in 1999 and 2004 follow, showing the change in emphasis:

1999:

7. Ptolemy's model of the solar system made use of which two of the following to explain planetary motions?
   - Equants and epicycles
   - Epicycles and equatorials
   - Equants and eclipses

Answer: Equants and epicycles

2004:

1. If you double the light-gathering capacity of a telescope, how many more distant galaxies might you expect to be able to see?
   - About 2.8 times as many
   - Four times as many
   - Eight times as many
   - Sixteen times as many
   - Thirty-two times as many

Answer: About 2.8 times as many – you can see a galaxy which is half as bright, brightness depends on \( \frac{1}{(\text{distance squared})} \) so you can see galaxies out to about 1.4 times the distance and if galaxies are spread randomly through space then you'll see about 1.4x1.4x1.4 of them – so about 2.8 times more

The 1999 question is simply a test of memory (and requires no knowledge of physics whatsoever). The 2004 question requires the application of basic physical principles (light goes in straight lines, so at twice the distance it is \( \frac{1}{4} \) as intense) – it tests understanding, not memory.

Other evidence for an improvement in learning performance and student appeal across the course includes the continued high demand for the course, in spite of word-of-mouth evidence (particularly amongst computer science students) that it is not an easy option and requests from students from
outside the Physics degree schemes for a second-year module developing the themes introduced in
the astronomy course. I am currently developing a programme of study for exactly such a course and
hope to introduce it in the 2006-07 academic year.

C2.4 Developments in lecture presentation and supporting material for PH38510

The challenges in improving the accessibility of lecture material were very different in the second
module to be discussed in this section, the 3rd year module Sun and Interplanetary Space (PH38510).
The learning objectives of this module have been discussed in Cycle 1 of this portfolio, but in this
section I want to focus on the teaching challenges and, particularly how a section of the course which
lends itself naturally to a traditional "chalk and talk" approach can be made accessible to students
who might find note-taking difficult.

A second theme is the use of movies derived from space- and ground-based observations to illustrate
the development and evolution of the solar wind – being able to see structures developing with
increasing distance from the Sun can be a powerful aid to understanding the physical processes at
work.

The solar wind and interplanetary space section of the module has been discussed in detail in Cycle 1
of this portfolio, but the essentials are that it covers the basic physics underlying the formation of
the solar wind and the development of its large-scale structure, the way in which the real solar wind
differs from these simple models, the ways in which the solar wind can be studied and solar wind-
comet interactions. I generally end the course with an unassessed lecture on long-period solar
variation, "space weather" and "space climate". The heart of the course focusses on the way in which
the solar wind is produced by the changing pressure/gravity balance in the Sun's atmosphere and the
large-scale structure emerges from the combination of an outflowing solar wind and a rotating Sun,
beginning with the basic equations and showing how a supersonic solar wind expanding radially and
tracing spiral streamlines of flow is the inevitable consequence. This structure of the material lends
itself naturally to a style of lecturing in which the basic equations are written on the board, developed
and their solutions discussed, using diagrams and sketches as well as mathematical derivation. A
viewgraph-based lecture would be intolerably rigid and restrictive when discussing this material, but
the classical "chalk and talk" style can present problems for students who have difficulty with note-
taking. In 2002 I carried out a trial using a MimioBoard and laptop (both borrowed from the
Department of Computer Science, for which thanks to Dr. Dave Price) to save images of my working
on the board. The Mimio system uses sensors placed along the edges of the board, together with
transmitters in the pens, to track movement of the pens on the board and record what is being drawn
or written. This can then be saved either as an animation of the drawing or writing itself
(unfortunately only viewable via Mimio's own software, and therefore unsuitable for use as a means
of recording lectures for general use) or as static HTML pages – a much more useful solution. The
Mimio recording software runs under 32-bit Microsoft Windows only (it does not seem to have been
ported to other systems), so that unless the software can be pre-installed on the lecture theatre PC it
is necessary to have access to a laptop which still runs this operating system – something which
cannot be relied on.

The 2002 trial was generally a success, though the writing style required by the system was not easy
to learn. Student comments suggested that the system could be helpful to them: Specific comments
from one (dyslexic) student follow:

To: <azb@aber.ac.uk>
Subject: RE: results of the MimioBoard trial yesterday
Date: Wed, 4 Dec 2002 11:52:00 -0000
X-Mailer: Microsoft Outlook, Build 10.0.3416

I like the mimio (but then I like almost anything techy with flashing lights on), and the way it makes WebPages of notes is very cool.

>From my limited past experience I've found you need to press firmly with
the entire surface of the board rubber so that it rubs out the right
areas on screen, there seemed to be some artefacts that hadn't been
erased properly on some of the diagrams.

I've also observed that users need to sometimes think ahead a little
more than usual when deciding which screens to capture in order to
make
the best notes (because of the way you can use some or all of the
previous page when drawing the next - unlike if your writing notes on
paper I think).

Hope that helps.

Overall I think its got the potential to be very useful in lectures,
no
more hurriedly copying fiddly diagrams (especially painful when your
as
dyslexic as I am) so you can concentrate on the important business of
actually listening to what the lecturer is saying (or just learning by
osmosis).

These comments were extremely useful and the results appeared positive enough for me to decide to
carry out a more extensive trial of the system in 2003-2004, covering the whole of my section of
PH38510. Unfortunately in 2003 the rooms used for PH38510 did not all have whiteboards, making
the more extensive trial impossible. This has been remedied for 2004, and I intend using Mimio to
record whiteboard images from my section of the course this year – starting in mid-November when
I take over lecturing on this module.

The success of voice-recording lectures in PH18010 suggests that similar recordings could work well
with the web pages generated by Mimio, while Blackboard provides an environment in which the
different course materials (voice recordings, Mimio-generated HTML records of lectures, supporting
material in the form of PDF files and movies) can be gathered together in a structured form.

Mimio-recorded lectures, voice recordings and any student comments will be included on the CD-
ROM accompanying this portfolio.

One of the great advances in making solar wind physics more accessible and understandable has
been the availability, since early 1996, of movies of activity in the solar atmosphere from the
LASCO instruments on the ESA/NASA SoHO spacecraft. Over the last 3-4 years these have been
supplemented by the tomographically-reconstructed movies of solar wind velocity and density
generated from radio scintillation data by Jackson and Hick at University of California, San Diego
(e.g. Jackson et al., 1997).

When data projectors were installed in lecture theatres I had high hopes of using these movies to
illustrate the origin and development of the solar wind and the interaction between the background
solar wind and transients, and indeed in 2001 I had a certain amount of success in doing so.

My notes from December 2002 read:

PH38510:
Continued with few changes (other than keeping course up to date), following successful changes in 2001.
Course was again taught in classical chalk-and-talk style, but with more supporting material available on-line.
I had planned to use *Mimio* extensively in 2003-04, but unfortunately upgrades of lecture theatre PCs led to the loss of any useful MPEG player, to be replaced by the almost unusably poor *Windows Media Player* – which not only has a most awkward user interface (making it unnecessarily hard to use in a lecture situation) but which unforgivably lacks any means of varying the speed of playback or even of advancing the movie frame-by-frame. As a result, movies play at a speed which makes it impossible to see the evolution of any structures. Owing to other demands on my time following my return to work in 2003 I had not checked that the lecture theatres were still equipped with useable MPEG playback facilities – I suppose, in my innocence, that I had supposed that no modern MPEG player would lack such elementary features as variable playback rate and stop-frame. Not for the first time I had underestimated the ability of commercial software companies to produce programs which were woefully inferior to their freely-available counterparts. I only discovered the inadequacy of *Media Player* when I began lecturing, by which time it was too late to do anything about it.

My notes from the time read:

I had intended to make extensive use of the (very striking, spectacular and informative) movies of solar wind variation derived from SoHO observations and tomographic reconstruction of radio scintillation data, but this proved impracticable due to the limitations of the MPEG playback software installed on lecture theatre PCs (no easy stop-frame playback).

I had intended using the MimioBoard to record lectures in this module, but as some of the lectures were timetabled in rooms without a whiteboard this was not possible.

This situation was most unsatisfactory, and I made it a priority to see that these problems were addressed in time for at least an extensive trial of *Mimio* and movie-display to be carried out in the last third of the 2004 PH38510 course. I therefore contacted Desktop Services in early September to discuss the problems and they stated that they would be happy to install a more suitable MPEG/AVI player on the PCs in the lecture rooms used for PH38510, as well as installing the *Mimio* software. I undertook to try and find a suitable Windows-based MPEG/AVI player – something which proved much more difficult than I anticipated. Eventually a suitable package was identified – *Media Player Classic*, written by Gabest and available under the General Public Licence. This offered easy control of playback speed, frame-by-frame advance and appears to offer a solution to the problem of using movies to illustrate space physics lectures.

My notes made while planning the 2004 PH38510 lectures read:

> We may use Blackboard for lecture notes and additional materials for this course. If lectures are timetabled for rooms with whiteboards then I will run a set of trials using Mimio.
> .... Blackboard will be used for notes and to hold recordings of writing-on-board made using Mimio (my section of the course only). If voice-recording works in PH18010 try it in this module too

The *Mimio* and *Media Player Classic* packages should hopefully be installed on the lecture theatre PCs in the two rooms used for PH38510 in time for my start of lectures in mid-November – and I would like to thank Desktop Services for their efforts in supporting this.

The first use of the combination of *Mimio* and voice-recording was on 12th November 2004 in the first lecture of my section of PH38510. The combination of the these two aids with photocopied hand-outs did appear to work well – student comments follow:

> Dear Dr. Breen,
> > I think that the voice recordings and wipe-board images are very useful.
> > The audio playback is surprisingly clear and loud enough to be useful,
Verbal feedback from students was very positive about the combination of Mimio and voice.
recordings – responses included "everyone should do this" and "all the lecture rooms should be fitted up with this" (referring to the Mimiio equipment). A summary of student comments will be included in the supporting material section of this portfolio.

C2.5 Common themes

The first common theme linking this cycle of development is the use of new technology to broaden the range of learning opportunities for students. A striking feature of these developments is how few of the really useful technological aids have come from what might be called "major" commercial sources: easy generation of PDFs and clean, platform independent HTML for on-line lecture notes have come from the Open Source movement, as have flexible, easy-to-use MPEG players. One of the most interesting and developments – and one which is much valued by students – is the ability to easily record and encode voice recordings of lectures. This has come from the consumer-electronics industry, and fortuitously the developments which allow easy recording and encoding have occurred at the same time that music players capable of handling the large files produced by recording a 50-minute lecture have become ubiquitous features of student life. The lesson here is to take advantage of serendipitous developments outside the mainstream. A second theme is the rigidity which electronic presentations can impose on lectures. "Chalk-and-talk" lectures are the most flexible of all, with the lecturer free to develop a subject at will, limited only by time constraints. In fact, chalk-and-talk can sometimes be almost too free, as there is always a temptation to derive equations \textit{ab initio} on the board – a temptation best ignored, as it is easy to make mistakes. OHP viewfoils impose a more rigid structure, but the lecturer still has the freedom to leave slides out or add extra slides in, depending on how that particular class is responding to the lecture. Electronic presentation removes this flexibility, and while this penalty can be reduced by redesign of course materials it cannot be eliminated. This is a restriction which has to be accepted if mainly-electronic means are used in presenting a course – which again returns to the principle that courses on different topics and at different levels must be approached in different ways: of the two modules discussed in this cycle, PH18010 is best suited to a very visual and now primarily-electronic presentation style, while PH38510 is well suited to classical "chalk-and-talk", with electronic media playing a supporting role. There is no single best-practice solution to applying new technology to teaching Physics and Space Physics at University.

The third and final theme is that of accessibility. This includes making module material available in a way which is as easy to access as possible and which, in the case of electronic media, makes no assumptions about the client with which the student is accessing it, as well as the need for lectures, lecture notes and supporting materials to be accessible to students with disabilities. This last is not an easy problem, though perhaps the combination of web pages which can be scaled up in print-out and voice-recordings for re-visiting material will be of assistance (both of these were considered to be very positive developments by Rhun ap Harri when we discussed this issue in September 2004). It should be noted that although the voice recordings will not be of direct help to deaf students they will be of great assistance to their note-takers\textsuperscript{1}, making transcription of lecture material much easier and more accurate. There is perhaps potential for trialling automatic transcription using voice-recognition software at some stage in the future, but my experience of voice-recognition (from its first appearance as part of IBM OS/2 in the mid-1990s through to packages running on MacOS in the last year) suggests that considerable improvement in the technology will be needed before it becomes

\textsuperscript{1} By November 2004 two note-takers working with a student taking one of my modules were using the voice-recordings to check their lecture notes.
truely useful for transcribing lectures.
A final accessibility issue, related to this, is audibility – none of the other technical improvements are the least use if any of the students cannot hear the lecturer, as even the most comprehensive notes only serve as a skeleton upon which the lecture can be developed. Without amplification my effectiveness as a lecturer would be severely compromised – so perhaps my portable amplifier is the most important accessibility aid of all.

C2.6 Conclusions and future developments

There are several conclusions which can be drawn from this development cycle. The first is that – in spite of the more rigid format it imposes – electronic delivery of lectures can be very useful, at least at introductory level or when a highly visual lecture style is appropriate. However, if electronically-delivered lectures are to be a success, then they need to be reliable – in the sense of knowing that the presentation equipment will work – and reproducible. This latter consideration is also important, as time and effort spent in developing lecture materials is wasted if quirks and incompatibilities in the projection software changes the formatting or substitutes random characters for symbols when displaying the slides. The conclusion which I have drawn from this is that PowerPoint, which has serious inter-version (and even intra-version) compatibility problems, is wholly unsuitable as a means of delivering lectures unless one has complete control of all the links in the chain. Effectively, this would mean bringing your own computer to each lecture (and if you did, why would you be running PowerPoint on it?). The t3 and Margi Presenter, by conrast, have proved extremely stable in operation and – by their self-contained nature – provide a means of delivering lectures which is reliable and reproducible. This is a great boost to lecturer confidence when delivering material via data projector and does, I believe, significantly improve the student experience of the lecture – it must be annoying for students, too, when PowerPoint fails to deliver again or when equations become incomprehensible through font-substitution. An unexpected bonus in using the t3 to deliver lectures was the impression it made on students – there were a number of comments (both to me and between students) on how "cool" the t3/Presenter combination was and how "cool" it was to see one used to control a lecture – in a subject like Physics, which has suffered in the past from a somewhat stuffy public image, there is considerable advantage in being seen to be doing something "cool".

The second conclusion is that Blackboard provides an excellent means of gathering related course material together – and that it does this on a separate server and not in one's own disc quota is a bonus! There is the drawback that students need to be explicitly added to the module as they join it (otherwise they miss access to materials over the interval between joining the module and the latest update to Sequent) which does add to lecturer workload. The virtue of Blackboard is the ability to combine different types of material (PDFs, HTML pages, sound files, movies) in a flexible manner and in a way which does not make any assumptions about the machine used by the student to access the material. Its demerits include a rather counter-intuitive interface for the course creator and an inability to log accesses of individual items (rather than folders). The learning curve in creating course pages in Blackboard is rather steep, but the system has considerable potential.

The third conclusion is that electronic recording methods can provide a means of making courses best taught via "chalk and talk" more accessible – this is most important, as it could provide a way of satisfying Disability Discrimination Act requirements without forcing the presentation of the course into a straitjacket (as would be the case if it were presented through viewgraphs) which could disadvantage all students taking the module. I begin a comprehensive trial of recording lecture
material using the *Mimio* system in mid-November and the results should be summarised in the supporting materials section of this portfolio.

Another conclusion from the development described in this cycle is that the most useful student feedback on changes in courses comes when it is requested on a specific issue – such solicited or guided feedback can be extremely useful, as seen in student comments on the use of Blackboard and voice recording in PH18010 or the *Mimio* equipment in PH38510. In both of these cases the comments received provided essential information on how the changes could be developed. By contrast, the tick-box section of the module assessment forms produces no worthwhile information at all. Although high "scores" on the form can serve as a massage for the ego of the lecturer, this is not of value in deciding how a course should be developed.

The final conclusion is the usefulness of making voice-recordings of lectures available online. This is something I have been wanting to try for some years and which has really only now become practicable. I hoped that the trial in PH18010 this year would provide some information on the usefulness of this facility – but I was surprised (and gratified) by the level of student enthusiasm for it. Voice-recording lectures and making the results available via Blackboard is something which I feel has been the outstanding success of this programme of development and is something which I would urge other lecturers to consider. I hope to be able to give a seminar on the use of voice recording in lectures, open to all interested staff, early in the new year.

Following the trials described in this cycle of development, Information Services are considering purchasing a number of encoder/recorder units similar to the *iRiver* for loan stock, allowing more extensive use of voice recording of lectures. I consider that pioneering this development is my greatest single achievement in improving teaching methods in the last four years. I have now extended the voice recording trial to my other modules this year, including PH38510. It will be interesting to see how the combination of *Mimio* - and voice-recordings work to improve accessibility and support a wider range of learning styles.

Feedback and discussion are essential tools in course development and in the introduction of technical aids to lecturing – the voice-recording and *Mimio* trials led to a very stimulating exchange of views in the USENET group *aber.infoserv.d* with considerable support for the use of voice recording from students from several departments who said that they had been making their own recordings and finding them useful, but that recording clarity was a problem. This is consistent with comments from students on PH38510 who said that the online recordings were much clearer than ones they had taken in other courses. An interesting comment made in the discussion was that "recordings mean I can go over notes or revise in time that would otherwise be wasted – when I'm walking or cooking a meal". This kind of use of recordings was not something I had expected, but it certainly means that voice recordings are making a wider range of learning approaches possible. I believe that I had underestimated how valuable online voice recordings of lectures could be when I began the trial.

The developments described in this cycle can all be taken further. The course pages in Blackboard could be improved considerably over those introduced this year, with all material (notes, voice-recordings, animations, supporting information) for each lecture gathered together in a single subfolder – which would also make tracking of accesses possible. The use of voice-recording should be trialled in other courses – I have already introduced it into PH28010 and intend using it for PH38510 at the end of this term, as well as for my courses next semester. A longer-term aim might be to integrate the voice recordings and the lecture slides more closely, producing a set of slides which change in time with the voice-over. However, this is contingent upon the availability of a tool
which allows the resultant slideshow-and-voiceover to be saved in a platform-independent format – at present I know of no such tool, though I would not be surprised to see one emerge from the open source community in the future.

A final strand in potential future development is that the falling cost of digital video cameras and the availability of good open-source editing technology may finally make it possible to add video-lectures to the range of online material for the course – again, this is something I hope to investigate in future years.

There is also scope for investigating online examinations, probably using the TWEEN system. The difficulty here is timetabling rooms for the examinations – an issue for discussion with the timetabling staff.

C2.7 Personal learning development

The last four years of teaching and co-ordinating the PH18010 and PH38510 modules – coming on top of the three years for which I had already been teaching them – has allowed me to develop my ideas on the best way to present these two very different courses and make them accessible (and appealing) to the students taking them. An important learning development for me was the realisation that comment and feedback are at their most useful when directed at specific issues (whether these be suggested by the lecturer or raised by the student). Another was the importance of thinking laterally when looking for ways of improving courses – the use of the iRiver to record and encode lectures probably being the best example of this.

When introducing changes into an already-successful course it is important to not be over-ambitious. There should always be an over-riding concern that if you make too many changes, the course may no longer work so well – and it will certainly be impossible to tell which of your changes produced any improvement. It is as well to follow one of the cardinal principles of engineering, and only make one major change at a time – learning this was an important step.

A final point is that the effects on student performance of almost any change made will be swamped by the year-to-year variation in classes. Perhaps the most important thing I have learned from co-ordinating and teaching on these modules over the last four years is to have the confidence to ignore scores on module assessment forms and small fluctuations in average exam mark in favour of asking students informally about specific features of the course, asking for feedback on specific changes – and on my own judgement of whether a change was producing a positive effect or not. In the end, the best judge of whether a change is effective is likely to be the tuned intuition of an experienced lecturer – and by this I draw parallels with what I term "scientific intuition", where a researcher familiar with the details of their subject can identify areas of interest almost without thinking by drawing on their deep, quantitative knowledge of the subject. In the same way, an experienced lecturer can judge what the immediately important factors in a module are likely to be – drawing on evidence from assignment sheet and examination performance in previous years and on student feedback.

C2.8 References


C2A: A comparison of assessment schemes for PH18010

When first introduced the module PH18010 module “Topics in contemporary Astronomy” was assessed in a rather adventurous way, using a combination of open-book examinations, essays and posters, but it rapidly became a victim of its own success and as student numbers rose past 80 an alternative had to be found. For most of its life the module has therefore been assessed using a number of multiple-choice tests.

Until the end of the course in 2001 the question format was:

- Three possible answers to each question:
  - Correct answer = +2
  - Incorrect answer = -1
  - No answer = 0

This mark scheme gave rise to a small but significant number of students each year receiving a negative mark for the test (reset to zero as the result for that examination in marking). I considered this to be undesirable and decided to alter the mark scheme on taking over co-ordination of the module in the spring of 2002.

A possible change was to alter the mark scheme to correct answer = +3, incorrect answer = -1, no answer = 0 and to increase the difficulty of the individual questions to prevent mark inflation.

While a considerable amount of material on assessment procedures in the physical sciences is available (e.g. Johnstone, 2003; Race) there is remarkably little information to be found on best practice in marking schemes for multiple-choice testing. As I wanted to be sure that students were very unlikely to be able to pass the tests by answering questions at random under the new scheme. I decided to carry out a programme of Monte-Carlo modelling, using a “Finite (though large) number of monkeys” approach in which 40 questions are answered at random by 32000 synthetic “candidates”. This gives a large enough number of samples for statistical validity.

A FORTRAN-77 program was written to perform the necessary modelling – a listing is given at the end of this appendix.

The results of the two early mark schemes – the one used from before 1998 until 2001 and the 2002 (+3, -1, 0) scheme can be seen in the blue and red columns of Figure C2A.1. The break points of interest are 30% (conditional pass) and 40% (full pass) – students should not have an appreciable chance of getting 40% or above by answering at random, and the probability of them gaining a conditional pass should be minimised.

Under the 2001 scheme students had an 0.3% chance of gaining a conditional pass on each paper by answering at random and a 0.006% chance of a full pass. Their chance of exceeding 50% was only 0.0003%. However, the use of +2, -1, 0 marking led to a large number of students performing poorly, either because the use of negative marks discouraged them from trying to answer or because slightly mis-judged best-guesses cost them marks (Figures C2A.2, C2A.4).

The 2002 scheme attempted to give students more incentive to answer questions by increasing the weight given to a correct answer to +3. Before introducing this scheme I modelled its effects to be certain that it would not lead to an unacceptable risk of passes-by-guesswork. Under the 2002 scheme students had a 3.6% chance of gaining a conditional pass on each paper by answering at random and a 0.36% chance of a full pass. I did not consider this to be unacceptable.
32000 random answers to 40 questions

Figure C2A.1: Probability of each 10% mark band under the four marking schemes tested

Test 1 2001 (old scheme) results:

Figure C2A.2: Results from test 1, 2001

The distribution of marks in 2002 (Figure C2A.3) was not dissimilar to that seen in 2001, suggesting that the more favourable mark scheme had, as intended, been offset by making individual questions harder. A smaller number of students performed very badly (<30%) - helping (or rather, not penalising) weaker students had been the aim of this change, so this was a satisfactory result.
Figure C2A.3. Results from test 1, 2002.

Figure C2A.4. Marks/120 in test 1 vs. number of questions not answered. Results from 2002 (a) test 1, (b) test 2.
I was still dis-satisfied with the mark scheme — student feedback had suggested that the use of negative marks discouraged weaker or less confident students from attempting to answer questions, and this was backed up by comparisons of numbers of questions answered with marks achieved (Figure 2A.4), which suggested a weak anticorrelation between mark obtained and number of questions left blank. Notes I made when marking in 2001 and 2002 record that there may have been a gender difference in unwillingness in attempting to answer questions, with female students perhaps under performing with this mark scheme. The sample sizes were too small to confirm this, but it was nonetheless a cause for worry.

I began considering alternative marking schemes during 2002 and early 2003. Monte-Carlo simulation of schemes with three answers and no negative-mark penalty for incorrect answers made it too likely that students would pass the exam by answering at venture, regardless of the design of the individual questions. Despite a considerable amount of effort put into looking for a best-practice approach, I did not find a scheme which gave satisfactory results when modelled and which did not include a negative-mark element.

Eventually I was informed of a possible model, based on the experience of Mr. R. Chicken, late of the North Regional Examinations Board (private communication, 2003). He suggested that if no negative-mark element was to be used (and he counselled against it) then each question should have five possible answers.

Following these recommendations, the mark scheme adopted for 2003 had the following features:

- Five answers per question
- Correct answer = +1
- Incorrect or no answer = 0

Modelling the results for randomly chosen answers under this scheme showed an 8.6% probability that a student could obtain a conditional pass by random choice of answers, but that their chance of obtaining a full pass on each paper was only 0.295 and they had less than a 0.0005% chance of obtaining 50% or above.

I considered that the increased chance (by 5%) of getting a conditional pass on any given paper under this scheme was more than offset by the decreased likelihood of random answers leading to a full pass or better. The module is assessed on the basis of three multiple choice tests, so the “random”
student would have to be lucky each time. The probability of getting a conditional pass for the module by answering at random under this scheme is 0.064% - acceptably low, I believe. The distribution of marks for one test expected from random answers under the revised marks scheme is shown in Figure C2A.1.

The new mark scheme was adopted for the 2003-04 academic year. The results from the first test are shown in Figure C2A.5.

The marks showed a broad distribution - the mean was satisfactory, albeit with a large variance, but a concern was the number of students performing poorly. Comparison of the marks with attendance sheets showed that these were students whose attendance of lectures had been poor (see the main
body of cycle 2 for a discussion of this issue and how it was addressed). A much higher proportion of students attempted all the questions – under this marking scheme unanswered questions have become a rarity, with only one or two students failing to attempt all the questions in a test.

The same marking scheme was used for the course in 2004-05, and the results from the first test are shown in Figure C2A.6.

With a rather stronger class the results were noticeably better – something which gives confidence that the marking scheme is doing its job. The smaller number of students receiving very low marks reflects a more aggressive approach to chasing up non-attenders in the first few weeks of the course.

During discussions of portfolio development in late 2003 it was suggested that an alternative marking scheme which distinguished between “nearly right” and “absolutely correct” answers might be worth trying. This is a very appealing idea, so a scheme in which each question had five answers, one of which was “absolutely correct” and carried +2 marks and one “partially correct” and carried +1 mark was modelled. Unfortunately this scheme carried an unacceptably high risk of students passing by guesswork, with a 47% chance of a conditional pass on each test (10% for the whole course) and more than a 7% chance of a full pass on each individual test (0.03% for the whole course). I consider that the chance of a student obtaining a random pass by guesswork is much too high under this scheme.

This mark scheme could be improved by increasing the number of possible answers to each question, but it is already difficult to come up with five plausible answers – more would increase the difficulty of test preparation to an unacceptable degree. The search for the ideal mark scheme continues!

**Supplementary information**

Figures C2A.2, C2A.3, C2A.5 and C2A.6 are the mark distributions calculated at the time of marking each test. The frequency distributions were calculated using the FREQUENCY function implemented in the StarOffice 5.x or OpenOffice 1.x packages (StarOffice was used for 2001 and 2002, OpenOffice for 2003 and 2004). The simulated examination results were calculated using a FORTRAN-77 program which made use of the RAN1 function (Press et al., 1992). A listing of the program code is provided overleaf:
program assessment

** Does simulation of expected marks distribution for multiple-choice papers assuming random answers

** Used for testing alternative marks schemes for PH18010

** (p.271) to generate random numbers between 0 and 1. Different starting seed used for each "student" (seed value = -1*student no)

** ARB 2001/12/01

`real totalpercent(4,32000)`
`integer totalmark(4,32000)`
`integer questionmark(4,32000,40)`
`integer markscheme,exam,candidate,question`
`character*9,file1,file2,file2`

`markscheme=4`

`do exam=1,markscheme,1`
`do candidate=1,32000,1`
`  iseed=-1*candidate`
`  totalmark(exam,candidate)=0`
`  do question=1,40,1`
`    random=ranl(iseed)`
`    if(exam.eq.1)then`
`      Mark scheme 2001`
`      3 choices, +2 correct, -1`
`      if(random.le.0.33)then`
`        questionmark(exam,candidate,question)=2`
`        else
`        questionmark(exam,candidate,question)=-1`
`      endif`
    `print*,exam,candidate,question,questionmark(exam,candidate,question)`
    `totalmark(exam,candidate)=totalmark(exam,candidate)+questionmark(exam,candidate,question)`
`  endif`
`c ***`
`incorrect`
`c ***`
`print*,exam,candidate,question,questionmark(exam,candidate,question)`
`totalmark(exam,candidate)=totalmark(exam,candidate)+questionmark(exam,candidate,question)`
`endif`
`c ***`
`do exam=2,3,1`
`do candidate=1,32000,1`
`  iseed=-1*candidate`
`  totalmark(exam,candidate)=0`
`  do question=1,40,1`
`    random=ranl(iseed)`
`    if(exam.eq.2)then`
`      Mark scheme 2002`
`      3 choices, +3 correct, -1`
`      if(random.le.0.33)then`
`        questionmark(exam,candidate,question)=3`
`        else
`        questionmark(exam,candidate,question)=-1`
`      endif`
    `print*,exam,candidate,question,questionmark(exam,candidate,question)`
    `totalmark(exam,candidate)=totalmark(exam,candidate)+questionmark(exam,candidate,question)`
`  endif`
`c ***`
`incorrect`
`c ***`
`print*,exam,candidate,question,questionmark(exam,candidate,question)`
`totalmark(exam,candidate)=totalmark(exam,candidate)+questionmark(exam,candidate,question)`
`endif`
`c ***`
`do exam=3,4,1`
`do candidate=1,32000,1`
`  iseed=-1*candidate`
`  totalmark(exam,candidate)=0`
`  do question=1,40,1`
`    random=ranl(iseed)`
`    if(exam.eq.3)then`
`      Revised mark scheme 2003`
`      5 choices, +1 if right`
`      if(random.le.0.2)then`
`        questionmark(exam,candidate,question)=1`
`        else
`        questionmark(exam,candidate,question)=0`
`      endif`
    `print*,exam,candidate,question,questionmark(exam,candidate,question)`
totalmark(exam, candidate)
&=totalmark(exam, candidate) +
&questionmark(exam, candidate, question)
endif
if(exam.eq.4)then
    print*, exam, candidate, question, questionmark(exam, candidate, question)
    totalmark(exam, candidate)
&=totalmark(exam, candidate) +
&questionmark(exam, candidate, question)
endif
enddo
endif
if(exam.eq.4)then
    Possible revised scheme
enddo
enddo
create and open output files
file1="exam.csv"
open (unit=1, file=file1, status="new")
do exam=1, markscheme, 1
    if(exam.eq.1)then
        do candidate=1, 32000, 1
            if (totalmark(exam, candidate) .lt. 0) then
                totalmark(exam, candidate) = 0
            endif
            totalpercent(exam, candidate)
            &=real(totalmark(exam, candidate))/0.8
        enddo
    endif
    if(exam.eq.2)then
        do candidate=1, 32000, 1
            if (totalmark(exam, candidate) .lt. 0) then
                totalmark(exam, candidate) = 0
            endif
            totalpercent(exam, candidate)
            &=real(totalmark(exam, candidate))/1.2
        enddo
    endif
    if(exam.eq.3)then
        do candidate=1, 32000, 1
            totalpercent(exam, candidate)
            &=real(totalmark(exam, candidate))/0.4
        enddo
    endif
    if(exam.eq.4)then
        do candidate=1, 32000, 1
            totalpercent(exam, candidate)
            &=real(totalmark(exam, candidate))/0.8
        enddo
    endif
enddo

do candidate=1,32000,1
write(6,10)candidate,totalpercent(1,candidate),
&candidate,totalpercent(2,candidate),candidate,
&totalpercent(3,candidate),
&candidate,totalpercent(4,candidate)

10 format(4(lx,i5,lx,f'/.l))
write(1,20)totalpercent(1,candidate),
&totalpercent(2,candidate),
&totalpercent(3,candidate),
&totalpercent(4,candidate)

20 format(4(f7.l,"'"))
enddo
close(1)
stop
end

function ranl(idum)
integer idum,ia,im,iq,ir,ntab,ndiv
parameter (ia=16807,im=2147483647,am=1./im,iq=127773,ir=2836,ntab=32
&ndiv=1+(im-l)/ntab,eps=1.2e-7,rnmx=1.-eps)
integer j,k,iv(ntab),iy
save iv,iy
data iv /ntab*0/,iy /0/
if(idum.le.0.or.iy.eq.0)then
  idum=max(-idum,1)
do j=ntab+8,1,-1
    k=idum/iq
    idum=ia*(idum-k*iq)-ir*k
    if(idum.lt.0) idum=idum+im
    if(j.le.ntab) iv(j)=idum
  enddo
  iy=iv(1)
endif
k=idum/iq
idum=ia*(idum-k*iq)-ir*k
if(idum.lt.0) idum=idum+im
j=1+iy/ndiv
iy=iv(j)
iv(j)=idum
ranl=min(am*iy,rnmx)
return
end

References

Race, P., *Designing assessment to improve Physical Sciences learning*, LTSN Physical Sciences practice guide, year unknown

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