FDTL4 project 48/02

HELPING ENGINEERS LEARN MATHEMATICS
TRANSFERABILITY PROJECT

HELMet Symposium

Wednesday 28 June 2006

SYMPOSIUM PAPERS

helm@lboro.ac.uk
http://helm.lboro.ac.uk

Loughborough University

FDTL4 project 48/02

HELPING ENGINEERS LEARN MATHEMATICS TRANSFERABILITY PROJECT

HELMet Symposium

Wednesday 28 June 2006

Contents

List of Participants

NAME	AFFILIATION
Robert Beale	Oxford Brookes University
Tony Corbett	University of Leicester
Tony Croft	Mathematics Education Centre, Loughborough University
Myles Danson	Professional Development, Loughborough University
Ian Drumm	University of Salford
Malcolm Farrow	University of Newcastle
Bill Foster	University of Newcastle
David Green	Mathematics Education Centre, Loughborough University
Michael Grove	Higher Education Academy – MSOR Subject Network
Martin Harrison	Mathematics Education Centre, Loughborough University
Stephen Hibberd	University of Nottingham
Robin Johnson	University of Newcastle
Joe Kyle	Higher Education Academy – MSOR Subject Network
Fiona Message	University of Portsmouth
Walter Middleton	University of Sunderland
Aruna Palipana	Mathematics Education Centre, Loughborough University
Lynn Pevy	University of Portsmouth
David Pidcock	Mathematics Education Centre, Loughborough University
Sabine von Hönerbein	University of Salford
Joe Ward	Mathematics Education Centre, Loughborough University
Liz Willis	Higher Education Academy, Eng CETL, Loughborough University
Andrew Wilson	Director, Professional Development, Loughborough University

HELM
Helping Engineers Learn Mathematics

Report from Transferability Lead Institution

Loughborough University

HELPING ENGINEERS LEARN MATHEMATICS

HELM in 2005-2006 – An Overview

David Pidcock

Background

In September 2005 the original HELM FDTL4 project reached its successful conclusion culminating in a well attended conference at Loughborough University. This marked the achievement of the original projects intentions, namely to develop learning and teaching resources which would be instrumental in obtaining improved outcomes in mathematics for undergraduate engineers.

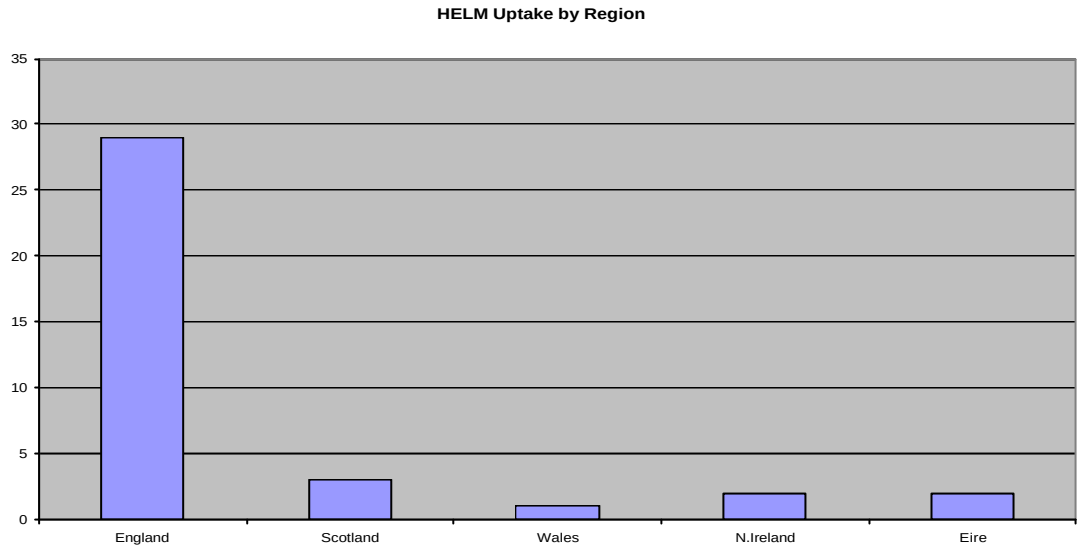
Transferability funding was then sought, and obtained, with the purpose of encouraging the effective transfer across institutions of the HELM learning resources and assessment. More specifically, the principal aim was to convert a small number of HEIs who had been involved with trialling - and some newly identified potential HEI users - into long-term users of the HELM materials and approach, and to monitor this transition. The resulting collaboration of Leicester, Newcastle, Nottingham, Oxford Brookes, Portsmouth and Salford then became the nucleus of the new project: HELMet (HELM educational transfer).

It was anticipated that the partnership institutions would use the HELM deliverables in different pedagogic ways and that the project should aim to evaluate the difficulties, successes and failures in transferring HELM to these institutions, and ultimately produce a report that would enhance the existing HELM Tutor's Guide and thus further aid the transferability process.

Uptake

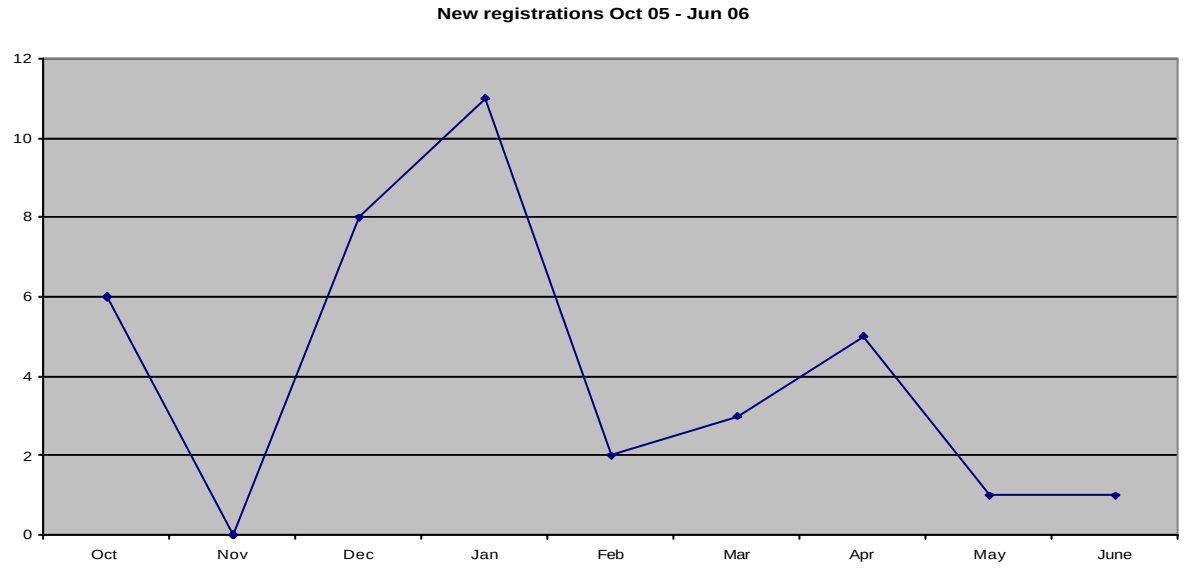
By end of September 2005, and not including the five founder members of the original HELM consortium, the HELM project had attracted 45 participants covering 37 institutions split between HE and FE in the ratio 31:6

Though funded by HEFCE principally for the benefit of those institutions in England and Northern Ireland, HELM attracted interest from other regions as the following table illustrates.

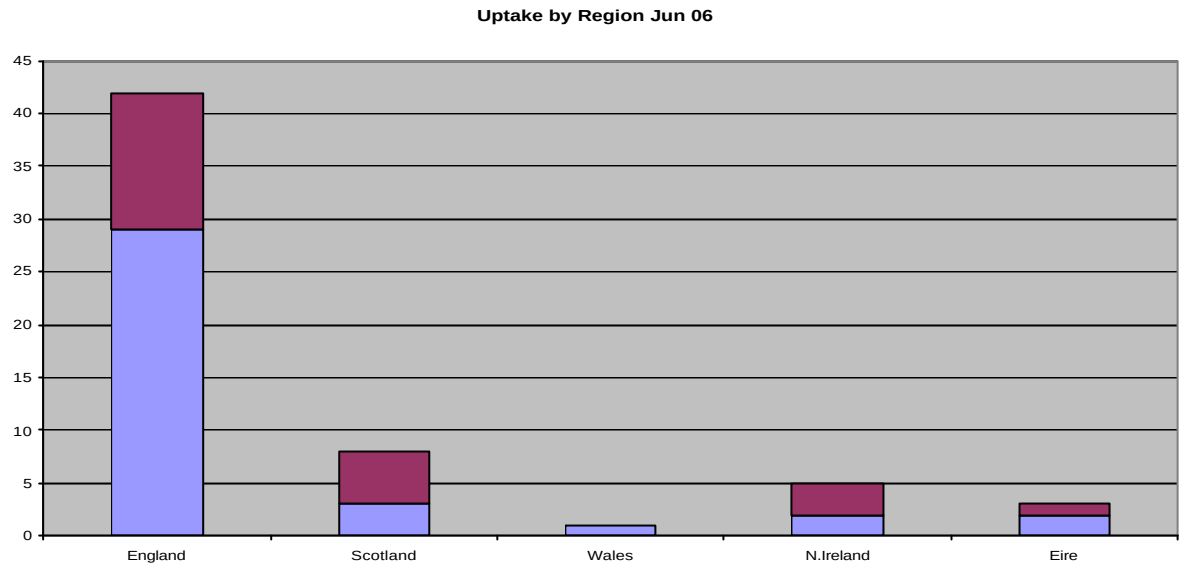


In addition to the HELMet partnership institutions' involvement, interest in HELM has continued to be generated via our web presence http://helm.lboro.ac.uk and conference presentations such as: Fifth Southern Hemisphere Symposium on Undergraduate Mathematics and Statistics Teaching and Learning, November 2005, Queensland, Australia.

For the period following the project's conclusion in September 2005 the pattern of individuals registering with HELM was as depicted in the following chart. This has added a further 22 new institutions to the list of registered users of the project materials, two being in the FE or FE(HE) sector.



The changed regional distribution including these newly registered users by institution is now (at June 2006):



Though these charts make reference only to UK and Eire, it should be noted that enquiries for use of the HELM materials have been received from staff members of several other overseas institutions as well as individual students. A flavour of this is given in the next table.

Institution	Location	Staff Member	Date
University of Western Sydney	Australia	Senior Lecturer Mathematics	Nov 05
University of Kebangsaan	Malaysia	Associate Professor Engineering	Dec 05
British School	Netherlands	Second in Faculty	Dec 05
University of Technology	Jamaica	Senior Lecturer Mathematics	Feb 06
University of San Carlos	Philippines	Engineer Educator	May 06

Individual contacts in the same time period have been received from students at Universities and Colleges in Denmark, Egypt, Pakistan, Philippines, Saudi Arabia and the USA.

Usage Pattern

As one would expect, the majority of institutional requests for HELM materials come from members of Engineering Departments (Electrical/Electronic/Mechanical/Chemical, etc) or Mathematics Departments where there is a teaching or supporting role for engineering students. However, there is a degree of diversity: for example we have also received requests from a Medical Statistician teaching Statistics to Medical Students and from a Chemistry Lecturer responsible for providing Mathematics tutorials to Chemistry students. In a wider context our materials are used by the Open University Faculty of Technology and are available to OU students and staff from selected Technology course websites. We also find our material has been requested for possible use in a wider supportive role such as that provided by the Skills Centre based at Leeds University (http://www.leeds.ac.uk/skillscentre).

While our materials were primarily designed for use within the HE sector, we also have some interest from the FE sector where our coverage of topics on Algebra, Algebraic Fractions, Differentiation and Integration has been found particularly useful.

Variety of Materials and Accessibility

HELM materials comprise Workbooks, Interactive Courseware (formerly called 'CAL'), and the opportunity to operate a regular testing regime via the use of CAA.

There were 37 requests for HELM materials processed in the period Oct 05 – Jun 06, of which:

- 37 requested the Workbooks

- 8 requested the Question Mark Perception based library of HELM questions for use with their institutions' QMP based CAA systems.

Regarding the HELM interactive web-based courseware, which supports some of the workbook content, we issued passwords and logins to all registered institutions so their students could have direct access to the materials hosted on our Loughborough server. However, the common password/login for all institutions was withdrawn in February 2006 and a unique password/login is now allocated to each institution who applies for one. So far, four have done so. This will facilitate usage monitoring - logins for each institution can be abstracted, although this has not been done to date. Many more such requests are expected as the new academic year approaches.

We continue to supply our materials via CD ROM.

Some Issues

During this transferability phase we have encouraged constructive feedback and have occasionally actively prompted it. In April, in response to such a request we noted:

- Two users had experienced technical problems implementing the CAA.

- One user supplied detailed comments and corrections on sections of four workbooks.

All such comments have received consideration and a revised set of materials is currently being prepared which will correct known errors.

A section of the HELM web site has been used throughout this period to inform CAA users of any errors found in the question libraries, and updated on a monthly basis. In the case of both the CAA and Interactive Courseware there will be additional content available building on the original release.

It is planned that the revised CD ROMs will be sent out in early September 2006 to all institutions who have registered as users of HELM. As before, these will incorporate the latest versions of the Workbooks, some sample Courseware, and some sample CAA which may be used for formative practice.

Final Words

It is appropriate that the final words are provided by some of our potential users …..

> *…. I find them to be very well written and understandable. Absolutely brilliant! … (Professional Engineer, Pasadena)*

> *… I am a student studying aeronautical engineering and have recently come across a few of your workbooks. Upon reading them, I found them to be very helpful and easy to understand…. (Student, BAE Systems)*

> *… I am an undergraduate engineer and need some extra material to get me up to speed with the maths. The workbooks you have created look they would be a big help…(Student, Bristol)*

And my personal favourite….

> *…. It would be an honour to register with you, to learn more about mathematics, and to join you in this great project ……. (Student, Menofiya University, Egypt)*

HELM
Helping Engineers Learn Mathematics

Report from Transferability Partner

University of Nottingham

Helping Engineers Learn Mathematics – Transferability of HELM to MELEES

Dr Stephen Hibberd, School of Mathematical Sciences, University of Nottingham

Report for HELMet Transferability Symposium
Wednesday 28 June 2006, University of Loughborough

Abstract
The provision of a HEFCE Transferability award to the FDTL4 - HELM project has enabled the transfer of HELM materials to be embedded within the Service Mathematics provision at Nottingham University to enhance support for the learning of mathematics to Engineering and Science undergraduate students. HELM materials are now readily available to students for general study support in Mathematics and module specific support within a local VLE provision termed MELEES (Mathematics Electronic Learning Environment in Engineering and Science). The report identifies the embedding of HELM workbooks into MELEES and consideration of CAA for formative and summative assessment.

1. MELEES – Mathematics Electronic Learning Environment in Science and Engineering

The principal challenge within the service teaching of mathematics is to address the needs of students who are often not provided with as extensive a support structure as that associated with their main subject area(s). The scale and diversity of the service teaching provision at Nottingham invited the establishment of a web-based development focussing on:

- establishing a unified supportive environment matched to the student intake and needs;
- providing learning and assessment resources to students from established local expertise;
- incorporating additional supportive materials (e.g. from FDTL & LTSN initiatives);
- identifying, informing and supporting e-learning strategies for module staff;
- enabling specialist support for students with special learning needs.

MELEES now provides such an integrated framework for supporting students in learning mathematics. Students are given access to module materials strategically released in concert with the module teaching. Postgraduate Student Teachers and client School staff have prior access to student learning materials to help in planning and providing tutorial support.

MELEES is based on WebCT and at the project start in 2003 was in the vanguard with respect to implementation issues and student experiences gained from integrated use of a VLE. The introduction of Special Educational Needs and Disability Act (SENDA) has highlighted the responsibility of teachers in providing accessible resources. Special attention within the MELEES project has been made to identify the extremely supportive role e-learning can offer.

Students have enthusiastically adopted using a MELEES as an effective way of obtaining quality learning support. It has also been well used by many teaching staff as a means of providing an integrated and versatile support mechanism. This is enabled within a VLE by proving a flexibility in terms of access both in terms of location and time and giving students choice. Students are using the environment extensively, this in turn encourages a culture to support and invest in more 'e-learning' activities.

Registrations onto MELEES in 2004-5 expanded to the whole service teaching cohort of some 1500 students, and regular use made by over 83% of the cohort. A telling result is that only

4% of students discarded MELEES after an initial login. The extent of MELEES usage to support learning was explored between the end of teaching and the end of the Autumn Semester. An email survey of students (130 replies) identified 88% used MELEES within that period; with graded responses 1. (extremely useful) - 36%, 2. -37%, 3. -11%, 4. -13%, 5. (not useful) -3%. Associated locations used were: Campus – 58%, Nottingham (Off campus) – 62%, Outside Nottingham (UK) - 52%, Overseas – 3%

MELEES has significantly influenced the development of e-learning in Mathematical Sciences and it has become embedded and integrated into the School's teaching and learning provision. A more detailed overview on the development of MELEES is provide in [1].

Website: www.maths.nottingham.ac.uk/melees (info entry: username/password: melees2006)

2. Embedding HELM Workbooks

The increasingly available technology associated with 'e-learning' is now predominantly web-based and a growing implementation within HE Institutions of Virtual Learning Environments (VLEs). Such environments, with an underpinning content management system (CMS), enable learning and support materials to be configured, targeted and readily managed to local requirements by teaching staff and readily link to other local or possibly national or international, supporting resources.

Within MELEES the availability of HELM Workbooks has enabled this resource to be made available for students:

i) global support – comprehensive access to additional learning materials readily available from an initial entry module.

ii) Module specific support - directed HELM workbooks within teaching modules

i) global support:

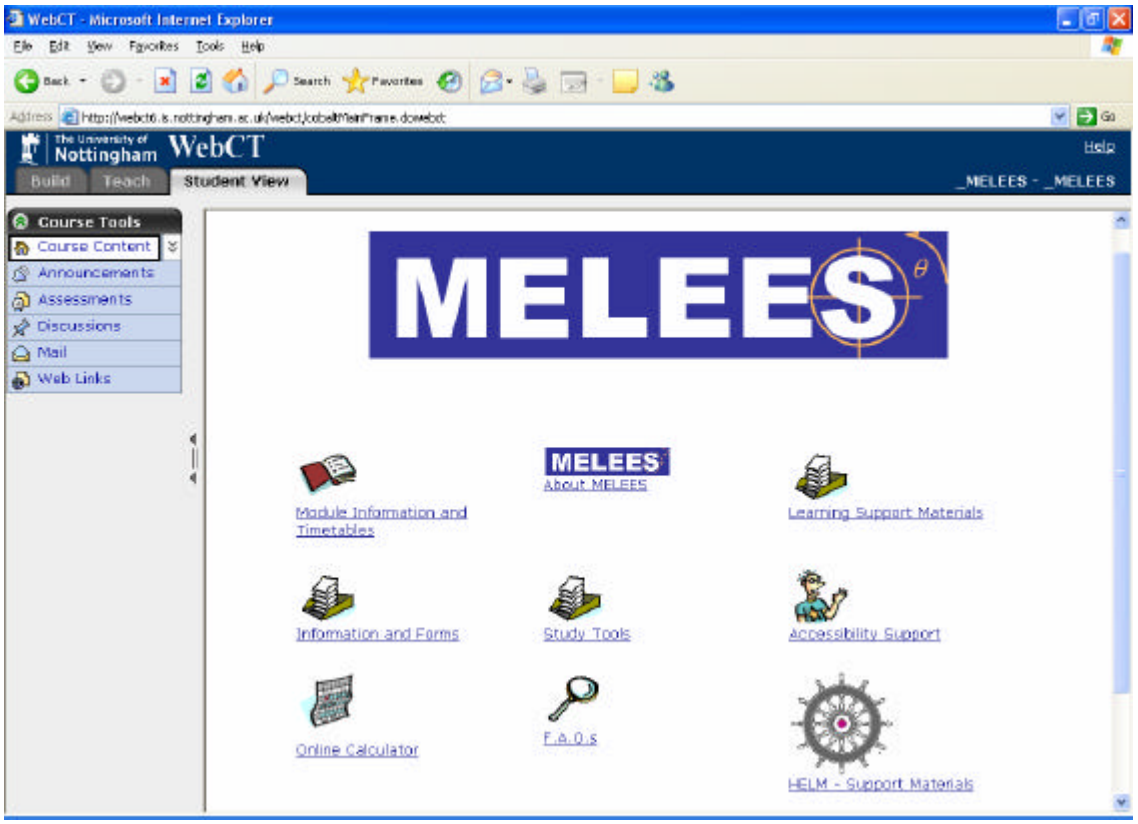


Figure 1 – Initial display for Entry unit - MELEES

All students are provided with access to the Entry unit - MELEES which provides general information on the Service Teaching provision, student learning resources and access to general support materials. Such materials can be used for supporting the mathematics students needs within their mathematics modules or additional topics they may meet within their Engineering courses. A further important aspect is to provide students with refresher materials to help in the transition from School/College to University. Figure 1 shows the top level access which is configured within an icon-based hierarchy.

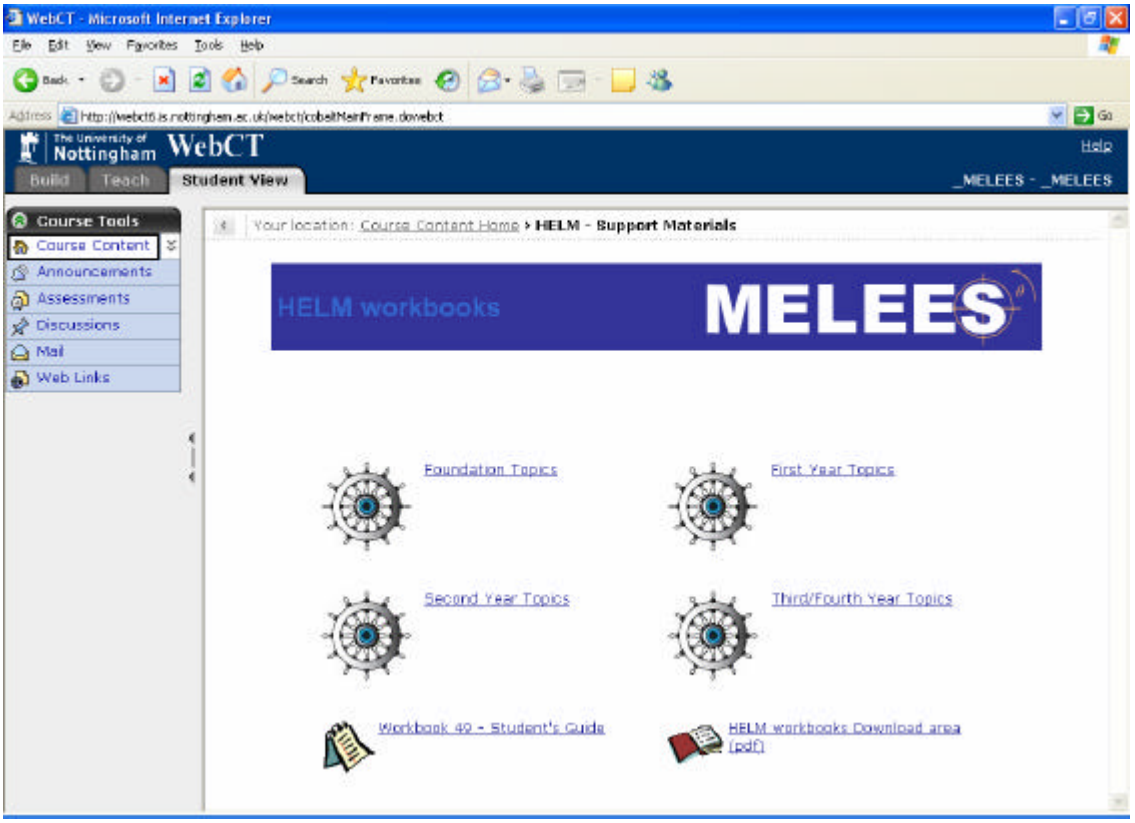


Figure 2 – Arrangement of HELM Workbook access in MELEES

Selecting the HELM icon provides students with a structured framework of Workbooks arranged in topic groupings that correspond to the 'Year' most relevant to the Engineering Mathematics modules that students will generally take or meet within their Engineering course. The selection starts with 'Foundation Topics' which corresponds to mathematical concepts to which intake students are typically expected to have competency. Topics selected in 'First Year' and 'Second Year' are based on the mathematics content of (compulsory) mathematics modules taken by students and those in 'Third/Fourth' are the more specialised topics associated with advanced/optional modules. Prominent on the display is access to the HELM – Student Guide to provide students with information on the project context and best-use guidance on using HELM. Experience in the development of MELEES indicates that many students prefer to download materials onto their own PCs for future use, and particularly useful for students with visual impairment where they can use specialist viewing software or screen settings. For quick reference an icon is provided that gives ready access to any of the HELM workbook sections as illustrated in Figure 3.

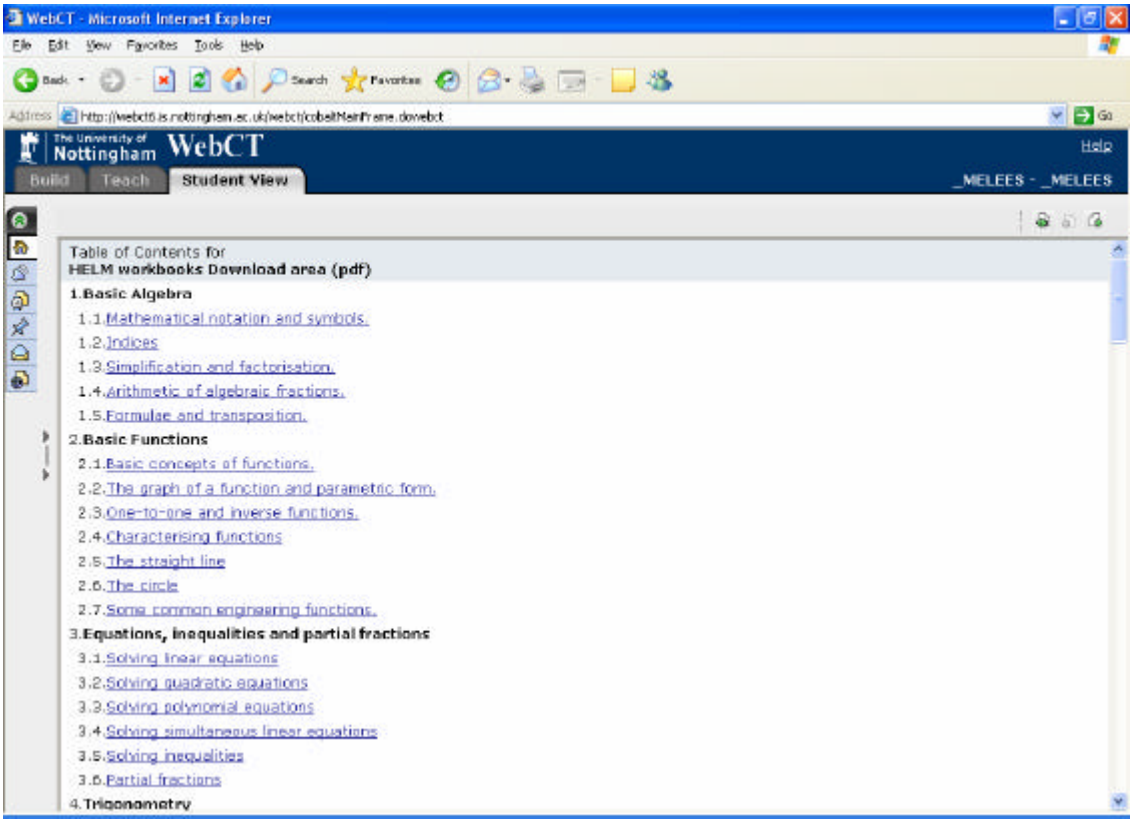


Figure 3 – Structured access to .pdf download of HELM Workbook sections

ii) Module specific support

Within MELEES each taught module has an individual entry unit that is available only to the relevant registered students. The module unit provides access to module specific materials identified by the module leader and incorporates a range of student learning resources that typically includes lecture handouts, example sheets, past examination papers etc., and sourced internally.

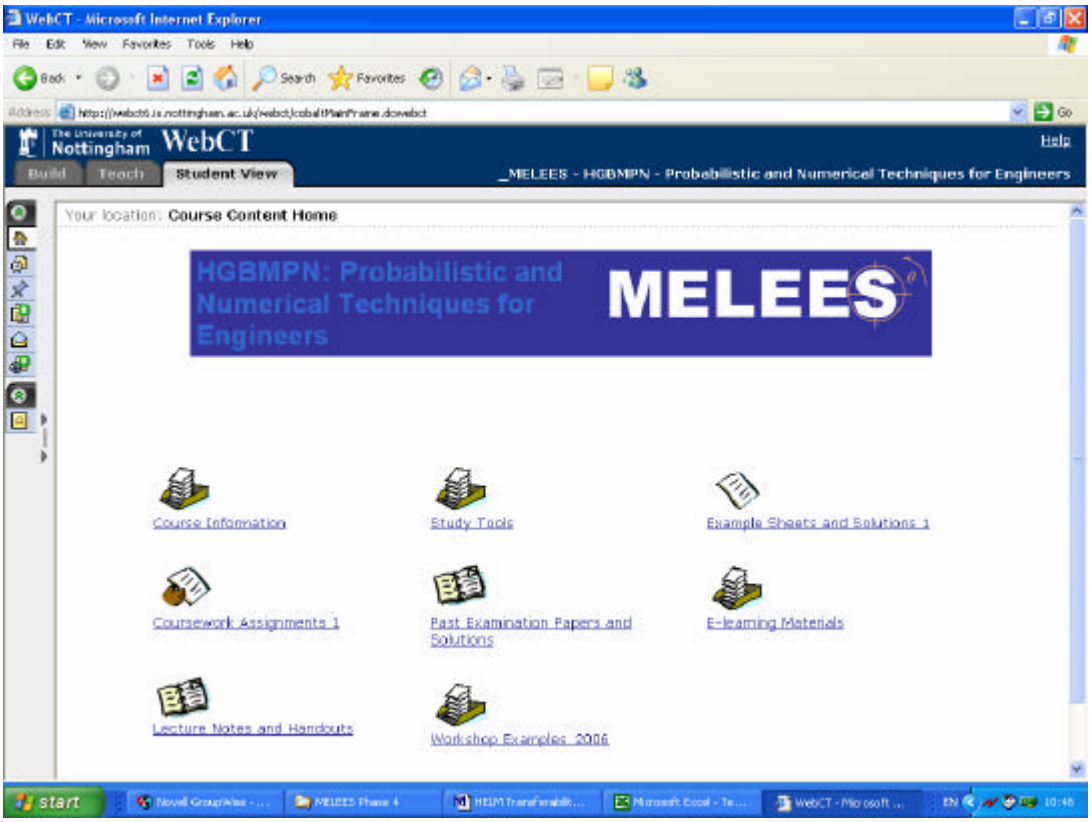


Figure 4 – Entry unit for module Probabilistic and Numerical Techniques for Engineers

An example is shown in Figure 4 for a second year module ‘Probabilistic and Numerical Techniques for Engineers’ (HGBMPN) which covers both the basic theory of numerical solution of ODEs, probability distributions and an introduction to statistical tests.

Module staff can direct students to additional (external) materials and trialling has been ongoing with HELM Workbooks. Figure 5 identifies the HELM Workbooks relevant to this module and these are readily accessed from the icon ‘E-learning Materials’. In this instance the module HGBMPN has ten workbooks that is relevant to the module topics and integrated with additional materials – in this case an interactive self-test on use of tables of the normal distribution.

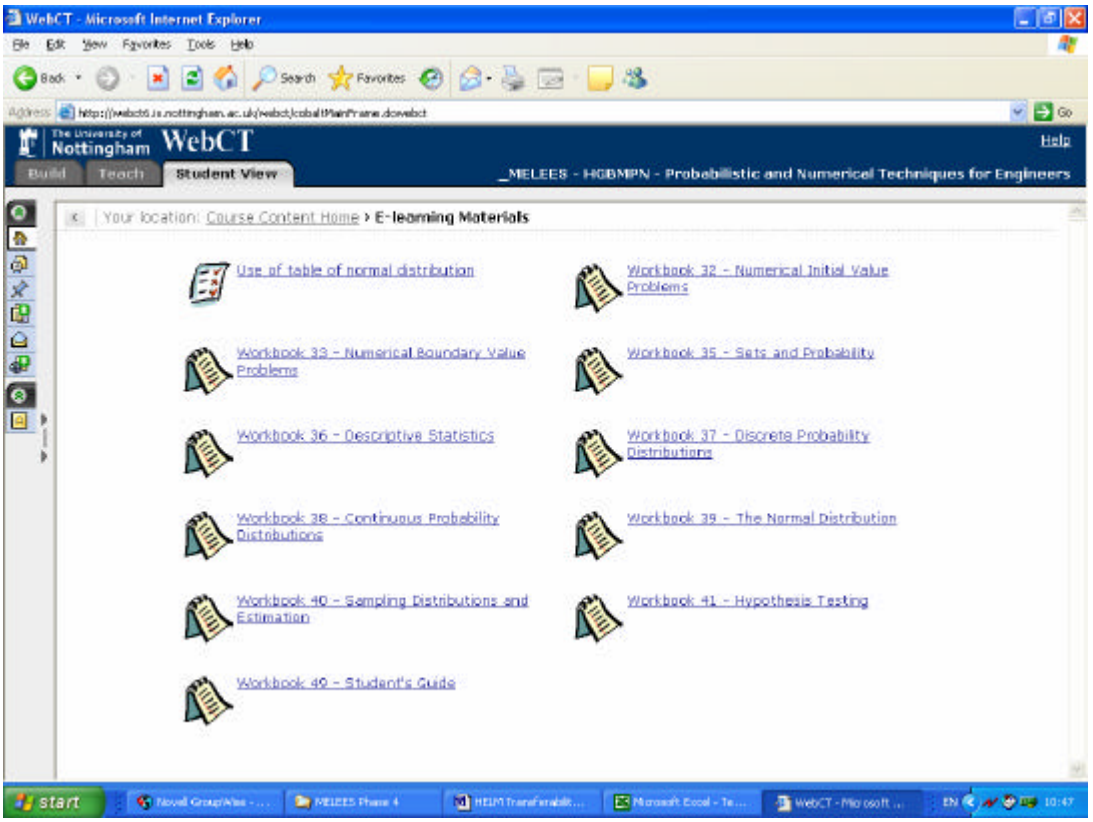


Figure 5 – HELM modules selected to support the module HGBMPN

The flexibility of the HELM Workbooks aids considerably in targeting detailed support to students, particularly in modules that covers a range of topics as is typical in Engineering Mathematics teaching.

3. Using HELM in Assessments

The use of Computer-Assisted Assessment is an increasing area of interest both in allowing students to self-test on important topics (formative assessments) and also the administrative gains that may accrue from using CAA for summative assessments. A further crucial element in formative assessment is not only providing students with an indication of their strengths but also to identify their weaknesses and provide directed access to support.

At Nottingham, the non-availability of QMP has restricted adoption of the CAA question database. An informal Workshop by the HELM Team in Autumn 2005 to teaching staff at Nottingham highlighted the benefits of CAA and how these may be exploited with use of the HELM resource.

Computer-based self-assessment is a typical interactive feature within MELEES. An example is a Diagnostic Test which First-Year Engineering students are encouraged or required to take within their first week at University to provide teaching staff with an indication of cohort proficiency on Foundation topics. The test is of a multiple-choice format and questions are selected from a data-bank from five key topic areas. Feedback to students, such as shown in Figure 6, indicates an individual profile of competencies and importantly suggested sources for study materials to help refresh any areas of weakness. The effectiveness of the test has been enhanced in that students can now be directed to HELM materials.

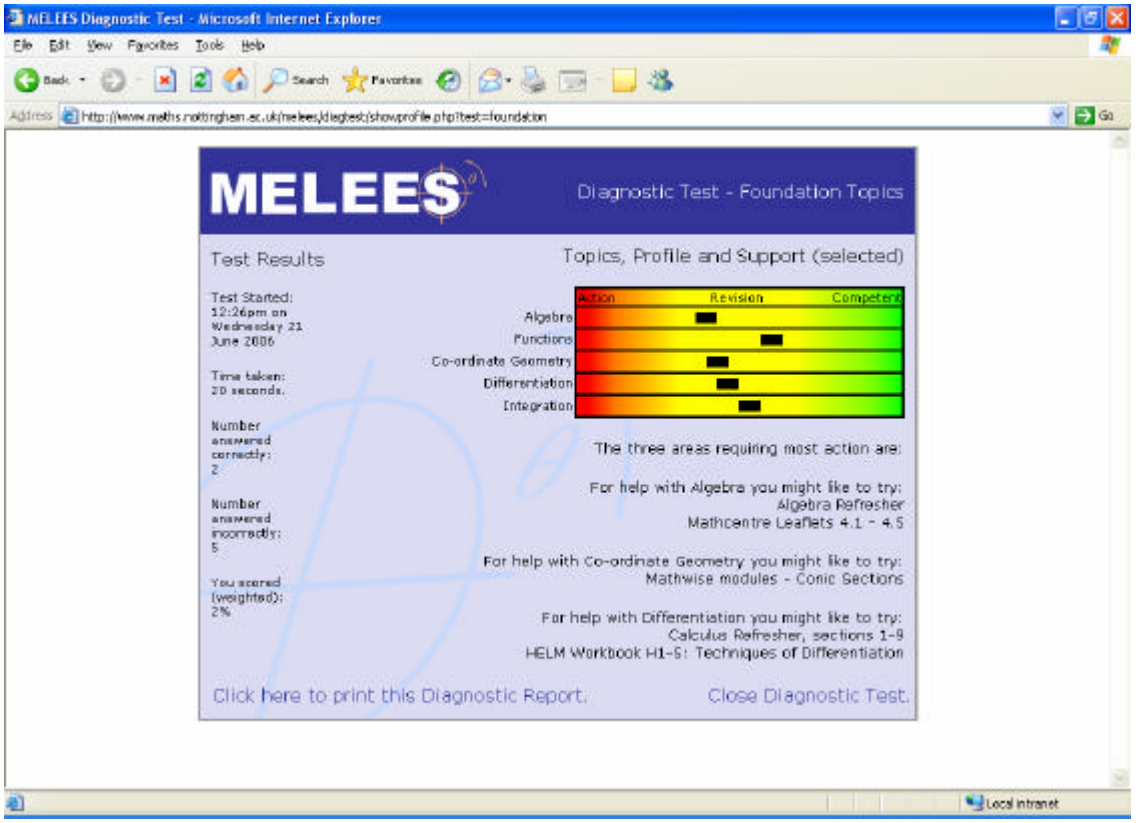


Figure 6 – Typical output from Diagnostic Test directing students to support materials

4. Conclusions

HELM was a major curriculum development undertaken by the consortium of five English Universities. The follow-up transferability stage has enabled the range of resources to be evaluated and exploited at a range other Universities. At Nottingham University we have embedded the extensive range of high-quality Workbooks within our existing web-based support giving Engineering (and Science) students additional choices in their learning preferences. Further, the ready availability of the resources has enabled teaching staff to incorporate the resource within their own teaching. Recently the University has decided to adopt QMP as a web-based CAA-tool and this will enable Mathematical Sciences to evaluate further to use of the HELM databank of over 4500 questions to support student learning.

5. References

Hibberd S., Litton C.D. and Chambers C., (2006). MELEES - *Reflective overview on use of a VLE in supporting student learning*, Proceedings HELM Conference, Loughborough University, HE – Academy Engineering.

HELM
Helping Engineers Learn Mathematics

Report from Transferability Partner

University of Portsmouth

University of Portsmouth HELM Transferability Partner Report

Part 1 – Overview

The University of Portsmouth first used some of the HELM workbooks with approximately seventy second year Electronic and Computer Engineering students in the 2004-2005 academic year. These workbooks were well received by the student cohort, and seen by the lecturer concerned to be a valuable resource which would be also benefit other groups of students. Portsmouth was keen to become one of the HELM Transferability Partners in the hope of encouraging greater awareness and use of the materials, and appreciated the opportunity for greater involvement in the 2005-6 academic year.

HELM workbooks:

The only HELM materials extensively used at Portsmouth are the workbooks, and these have primarily been issued as paper-based workbooks directly to the intended student users. They have been distributed in this form to first and second year Engineering students and to second and final year Mathematics students. The manner in which the workbooks have been used has been different for the various student groups. At one extreme the materials have been provided for independent study as one of a number of resources, and at the other extreme the materials have been deliberately allowed to exert a controlling influence of the course delivery. All the lecturers currently using HELM materials are member of the Mathematics department, however some individuals in other department have expressed particular interest in using the materials themselves.

Summary of HELM Workbook Usage in the 2005-6 Academic Year

Student Department or Facility	Unit	Year	Workbooks used
Electronic and Computer Engineering	Engineering Analysis	2	9 (matrices) 20 (Laplace Transforms) 22 (Eigenvalues) 23 (Fourier Series) 24 (Fourier Transforms) 21 (z transforms)
Mechanical Engineering	Mathematics	1	6 (logarithms) 10 (Complex Numbers) 11 (Differentiation) 13 (Integration) 14 (applications of Integration)
Electronic and Computer Engineering	Engineering Analysis	1	13 (Integration)
Mathematics	Calculus of Several Variables		28 (Differential Vector Calculus) 29 (Integral Vector Calculus)
Mathematics	Complex Analysis	3	10 (Complex Numbers) 26 (Complex Variables)
Maths Café	Various	Various	Miscellaneous Extracts

Access to the pdf versions of the workbooks has been provided for all lecturing staff. For students access has been provided, when requested, to pdf versions of those workbooks which have not already been distributed to students in paper-based format. The two Engineering departments mentioned above also run some high level courses that include an element of distance leaning over the summer months. It is anticipated that the HELM material will be made available in pdf form to the students on these courses over the coming months.

The HELM workbooks were one of a number of resources provided for independent study for a second year mathematics unit on the Calculus of Several Variables. A diagram of the integration of HELM with other resources is shown in *Appendix A.* In this unit the students are required to submit learning diaries containing a record of their work, and their answers to HELM questions were expected to form a part of this. The lecturer was concerned about the fact that the answers in the workbooks are in close proximity to the questions. It would have been helpful for the lecturer to have had access to a copy of the workbook with white spaces instead of answers. In this instance the answers to all the exercises were blanked out before the workbooks were distributed to the students. The answers were later made available to the students via WebCT. The HELM materials were well received by the students and extracts from their learning diaries are included in *Appendix B.*

The other instance where HELM materials were used entirely for independent study was in a final year Mathematics unit in Complex Analysis. In this case workbooks 10 and 26 were handed out as a starter pack for the unit. In week one of the course the students were advised to work through Workbook 10 in order to revise work that they had met some time previously. Workbook 26 was also handed out at the same time and the students were told that this contained some of the basic material for the course, and they would find it useful to complete the exercises in HELM before continuing to more advanced exercises to be distributed on tutorial sheets throughout the unit. The lecture course then continued entirely independently with only the occasional reference to the relevant section in workbook 26. At final year level this proved to be an entirely satisfactory use of the materials. When the lecturer enquired whether anyone had any questions relating to the content of the HELM material the response was 'Why should we? The answers are all in the pack'. When asked about the materials the only negative comment was that there were some typographical errors.

Portsmouth provides a facility through which students of all level and from all parts of the university can access one-to-one mathematics support. This facility is called the Maths Café, and a complete set of the HELM workbooks is kept as a Maths Café resource in the Maths Café baseroom. Almost all Mathematics Department lecturing staff (and also some research students) have timetabled hours in the Maths Café, and the expectation is that the staff on duty will endeavour not only to answer the immediate maths problem that might have brought the student to the Maths Café, but will also try to identify other useful resources which the student might also find helpful. The HELM workbooks now constitute such a resource. The Maths café does keep stocks of those workbooks known to be in current use by various student groups, but does not keep stocks of additional workbooks. If a section of a workbook is identified as a potentially useful resource, then the relevant material is photocopied, and the student is sent an e-mail to say that it is ready for collection from the Maths café baseroom. During the year all Maths staff had opportunities to hear about and view the Math Cafe resources at a staff development lunchtime session and at the Christmas Maths away-day. The potential for using HELM materials was emphasised by the Maths Café team at both of these events. The HELM materials were also highlighted at two Maths and Engineering Teaching Forums held in the current academic year. There was considerable interest in the materials form both departments. In particular the additional engineering examples booklet was seen as valuable by the Mechanical Engineering staff.

The Maths Café has had difficulty in finding good resources for statistics. The advent of the Statistics workbooks was therefore greatly welcomed by Maths Café staff. Unfortunately the non-standard

notation used in the workbooks ($\bar{x}$ and s rather than m and s) meant that these particular workbooks were thought to be liable to cause confusion rather than being useful. The workbooks would be extremely useful to us if we could have a copy in a format to which we could make local corrections.

Workbooks 9, 20, 23, 24 and a large part of workbook 22 were printed and distributed to year two Engineering students in semester one. This amounted to a considerable volume of paper, and of necessity resulted in students following this unit having an even more extensive and comprehensive set of personal notes than the lecturer might previously have thought necessary or desirable. Unfortunately with the exception of workbook 22 (Eigenvalues & Eigenvectors) the excess material was not completely contained in a section that could easily be omitted. This might have caused students using the workbooks independently to cover too much material. To overcome this problem the students were provided with a study schedule that clearly indicated which sections were essential, and which sections could be treated as background reading. The schedule also identified those questions which the students should attempt from HELM, and when they would be provided with additional questions. This was a satisfactory compromise in terms of student learning, however it should be noted that students were being provided with some notes that were likely to be viewed as redundant by many students, and the photocopying of such material therefore constituted an unnecessary cost.

The second year Electronic and Computer Engineering courses traditionally attract a high proportion of direct entry international students into the student cohort. These students place particular value on printed notes, as English is the second language for many of them, and making notes while following a lecture is more of a challenge to them than it is for those for whom English is their native language. The decision taken by the lecturer was to try to refer to the workbook examples as much as possible during the lectures in order not to confuse students or add greatly to the quantity of written material collected by the students. Occasionally the lecturer felt the notation used in HELM, or the presentation in the workbook was not as good as the way the material had previously been presented. In order to avoid confusion some compromises had to be made in the interests of conformity with HELM format. A particular case of a conflict of interest was in respect of the formulae provided. The Portsmouth standard Maths and Stats formulae book was to be made available to students in assessments as well as additional formulae sheets including Fourier Series formulae and tables of Laplace and Fourier Transforms which followed the HELM notation. This resulted in duplication of information provided, and students had to be advised to use whichever source they found most useful. Our intention is to produce a new formula book specifically designed for Engineering students that contain formulae and standard tabulated results in exactly the same format as that used by HELM.

On first year Engineering Mathematics courses taught by two different lecturers the lecture course was not altered greatly to suit the HELM material, but the students were directed to selected workbooks throughout the course. The second part of the report contains a full record of one lecturer's personal experience of using the HELM material in this manner.

There has been no antagonistic resistance to the introduction of HELM with the exception of the statistics workbooks. To date, some have been more cautious than others in the way in which they have used the materials in lectures, but even for those non-users the workbooks are recognised as a resource to which engineering students (and others) can be directed if they need to catch up on missed work, or review work that is poorly understood. The use of the HELM material is not expected to remain the preserve of the informed, and use of the material is expected to continue to grow. We can be confident about this because, in the Maths Café and its resource- update staff development sessions, Portsmouth has an excellent mechanism for keeping the material permanently in the sight of all members of the department and reminding them of its potential.

Computer Aided Assessment:

Portsmouth Mathematics department has a fairly long tradition of using Questionmark Perception tests for both formative and summative assessment in various units for Mathematics and Engineering students. The Portsmouth sample (practice) tests are made available for students to access at any time, but the summative assessment are conducted under examination conditions. The examination conditions are imposed because the summative assessments are not taken at the same time by all students, and also because the assessments can be retaken a limited number of times by any student wishing to improve their mark. This system was introduced to encourage students to engage with learning the essential material early in the semester. However our experiences have demonstrated the necessity for CAA summative tests to be run with diligent invigilation. The production of Questionmark Perception test question databanks has already proved very time-consuming, and there is always student demand for additional practice tests. This meant that at the start of the year we were very keen to use the HELM resources to supplement our existing resources, particularly with respect to formative assessment. Unfortunately this did not happen as planned. A local delay in the resources being made available for lecturers to view and use resulted in the CAA material not being used by any HELM users as, although some lecturers looked at the resources, none found themselves able to integrate the resources into their delivery schedules after the term had started. In essence this was an area where in the current academic year we did not use the materials as originally intended, however the resources are now accessible to potential users of HELM materials, so for the 2006-7 academic year we expect to be integrating the CAA tests into the courses for some groups of students.

There is considerable interest in the potential for the use of MapleTA at Portsmouth. The advantage of MapleTA is that a once a question has been written it can be reused extensively as the parameters are automatically changed to produce a similar question assessing the same essential skills and knowledge. If the HELM questions were in this form, then we would be able to use the same questions in both formative and summative assessments. One lecturer whose students have made considerable use of HELM workbooks over the last semester has now undertaken the task of writing some of the HELM questions in MapleTA. This is a major task, but one which, in the long run, could result in a considerable reduction of the staff time which must be allocated to this form of assessment.

Further Feedback Comments:

Given our relatively limited use of the materials, and the natural variation in student cohorts between one year and the next we cannot attempt to produce quantitative data to demonstrate an improvement in student performance. However the students feedback clearly demonstrates that the students consider that the materials have contributed greatly to their understanding, and have valued the impact that this has had on their learning experience. Maths Café staff have also welcomed the resources.

The materials cannot possibly fit all purposes exactly, and we have been pleased to note that materials designed for Engineering students have been so well received by Mathematics undergraduates. In some case there is too much material and it would be good to be able to delete sections, and sometimes the material has to be supplemented by material from other sources. Typographical errors continue to irritate both students and lecturer. It would be helpful if the workbooks were available in a form that would allow for some local variations to be made (additional questions, deletion of unnecessary sections, changes in statistics notation, correction of odd typographical errors). It would also be helpful if there was an alternative set of books in which the full solutions were not given in close proximity to the questions, and the spaces currently occupied by

the solutions were replaced by blank spaces. If it were possible to produce such a version, then additional separate books of full solutions would also be helpful.

Part 2 – A Lecturer's Perspective

I have introduced HELM material for the first time this year to first year Mechanical Engineering students. The students are taught in 2 groups – about 25 on the accredited course, and 20 on the lower level non-accredited Mechanical and Manufacturing course. The syllabus for the first year maths is the same for each cohort (approximately A'level core plus a few extras) but the tests and exams have questions set that reflect the difference between the 2 groups. Since some of the smaller group have no post GCSE mathematics experience and some of the other group have further maths A'level, there is a wide range of ability.
I have never used a set text book before, or handed out printed notes, as I think, on the whole, that students concentrate more if they are copying examples as we go through them, rather than just looking at a piece of paper. However, I liked the structure and layout of the HELM workbooks and felt that it would make a change of delivery and provide some variety during the year if I made use of some of them for suitable topics.
The following summarises the advantages (or otherwise) of the workbooks as I see them – my student feedback follows later.

Plus points
The students liked having a whole topic 'infront' of them so they could see a clear beginning and end (!)
I liked having background information on a topic so that I didn't need to waste class time reading it out.
Students that miss a class didn't lose out on notes.
The books should have provided a good revision source for the exam – though most students seemed to only look at past papers, and not revise particular topics.

Minus points
I don't like being restricted by someone else's idea of exactly how the topic should be taught.
There is a danger that students may collect the workbook and then not attend classes – so I was careful not to let them know how long we would spend on any particular topic!
There were not enough exercises on any particular topic so I still had to give out photocopied exercises.
It would be expensive to use the books exclusively.

Student Feedback

Of the 25 responses the feedback can be summarised as follows:

To the question '**Positive features of HELM**'?
Clear explanations - 8 students
Portable – 3 students (though I'm sure more would have agreed with this)
Easy to use – 6 students
Clearly laid out – 11 students
A lot of, and useful examples – 13 students
Solutions included – 10 students
Other points included :
Need to take fewer notes

Gradual increase of difficulty
Formulas always given

To the question '**Ways to improve HELM'**?
More exercises – 11 students
Tutorial sheets – 8 students
Solutions should not be with exercises – 5 students
Layout was mentioned with suggestions to use colour (!), spread things out more, use bold type, use layman's terms, provide more space for exercises.
Only one student wanted more theory !

To the question '**How do you best learn Mathematics**?'
Attending lectures – 3 students (again – I'm sure more students would have agreed with this – I hope!)
Being shown an example and then practising – 16 students (phrased in various ways)
Other answers:
By osmosis ! – If only
Working with others
Practising at home (only 1 student)
With a lot of help
Using handouts
1 to 1 tuition

Of course it's no surprise that students say they learn best by DOING maths. It is a bit surprising that none of them mentioned a text book or other external resources.

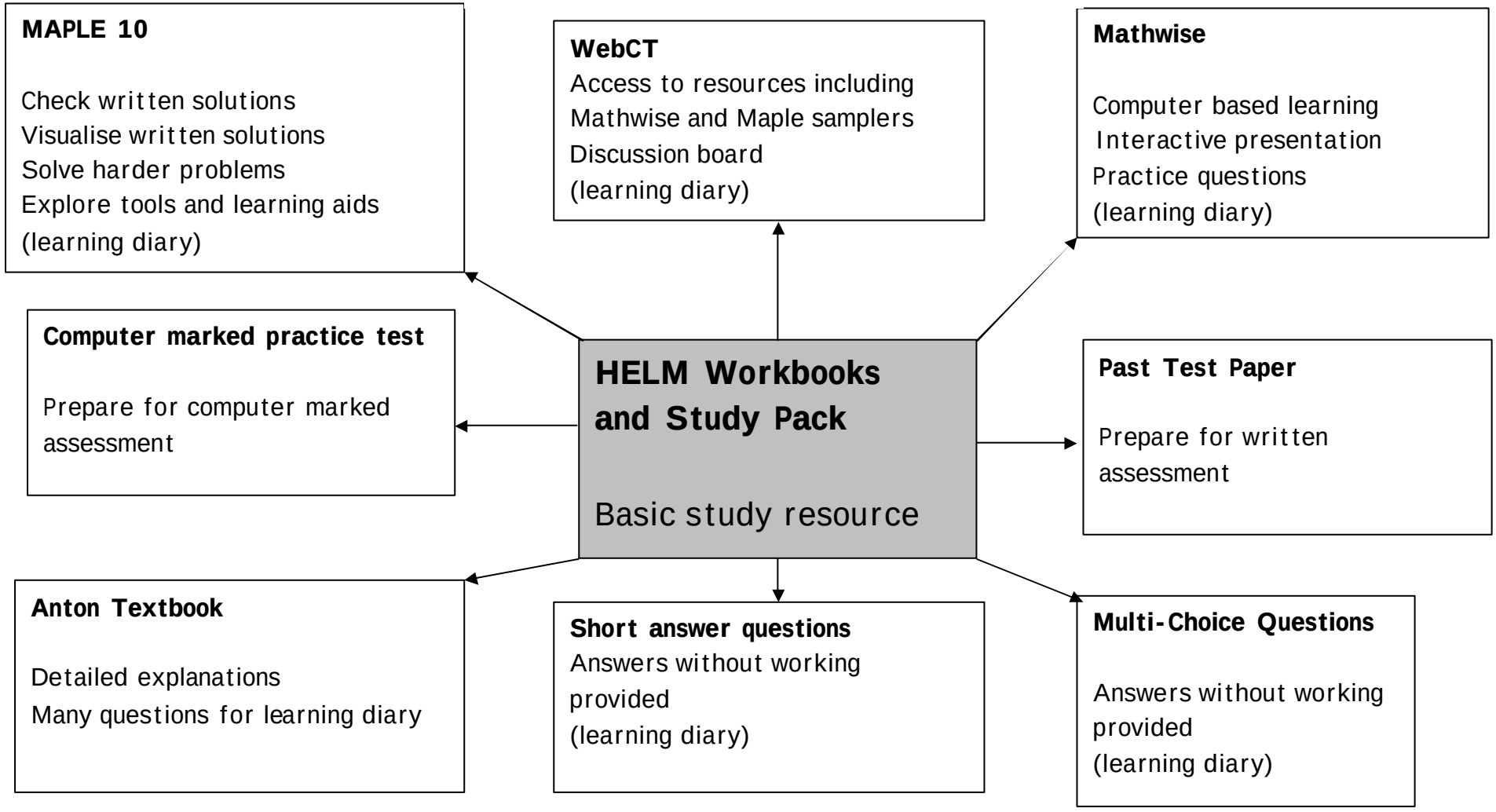
Overall the HELM books have been well received. The fact that the students were able to comment on the explanations given, hopefully means that they have looked beyond the examples, which is positive.

To address the main complaint of the students – that the books are short on exercises/ tutorial sheets - should be quite straightforward. Since the books are downloaded as and when required there is no difficulty in attaching extra sheets (or removing some of the areas I don't want to cover).

<u>Future Use</u>
I will certainly use the books again, albeit in a limited capacity. They are well constructed and provide variety. For certain topics in particular (Complex numbers, Differentiation, Integration, Differential Equations for example) it will be useful for the students to have the foundations in front of them so I can concentrate on the application of the process without having to spent valuable lecture time on theory that they will never have to 're-create' and only need a basic understanding of . I very much believe that I am teaching students to use Maths as a tool – I am not attempting to make mathematicians – just good method followers!
As far as other HELM resources go – I have yet to be convinced of the benefits of on-line assessment as I prefer to see how students have arrived at their answers – and with smallish groups I have the luxury of being able to do so. The perception tests would be ideal for individual formative testing, but, unfortunately, my students rarely do any work that is not 'marked', so I can't see them taking advantage of this resource.
Overall the HELM experience has been a positive one, and I look forward to receiving the latest (and last) edition.

Appendix A

MTH204 STUDY RESOURCES



Appendix B

Section 1 - Comments from Maths students using HELM for independent learning together with other resources:

1. I used the recommended text quite a lot, but HELM provided better working out and simplified examples.

2. I did make full use of HELM as I attempted nearly all the tasks. Towards the end of the unit I realised how important the examples and the explanations in HELM were, this is because I found the last weeks work harder. I found the HELM books supplied good examples and information throughout.

3. I did not like (names resource) but I really enjoyed the HELM worksheets….
   My favourite part of the course was completing the HELM worksheets as I think they were very well presented and easy to use. Although I struggled with some of the questions and found that a number of the answers were incorrect, I did find them easy to use and I think that they are a good way to learn the material.

4. The HELM booklet was a reasonable source of information but was not very in-depth, which was off-putting for me to use it again.

5. I made extensive use of the HELM and recommended text. For each week I began my learning with completing the HELM exercises, followed by use of the recommended text.

6. HELM being my best friend throughout, as it was really easy to follow and gave excellent examples in order to complete the questions.

7. The HELM workbook was good as it had a variety of different questions and most of the material was explained clearly and I understood what was happening. There did seem to be a few mistakes in the workbook.

8. I mainly used the HELM material and the recommended text. This was because the HELM material is great to get you started on what you need to know and then the recommended text follows on from HELM and gives you even more questions and more in depth descriptions of the material being learnt.

9. Overall HELM was useful, but not detailed enough.

10. I only really used the recommended text book, as HELM was very complicated to understand. The worked examples were not as straight forward as the recommended text book.

11. HELM booklets – my studies were based around these, they were straight forward and easy to follow and had lots of worked examples before challenging you to do some.

12. I used mainly HELM, although I would use the recommended text every now and then to clarify things. I tried using Maple and Mathwise in the early stages of the term however I found them to be confusing and more hassle so I just used HELM.

13. The HELM workbook is exceptional! I cannot emphasize enough how helpful it has been. It is a brilliant piece of work.

14. The HELM workbook was the main learning tool that I used and most of the time it was fantastic but some weeks I did not find it as helpful. This was due to the huge jump in difficultly between the examples I was shown and the questions set for me to do. In the weeks where HELM was not as good I turned to the recommended text.

15. I found the HELM workbooks well-paced and accessible so concentrated my studying there and found this sufficient to gain full understanding of nearly everything involved. On a couple of topics I referred to the recommended text book for an alternative explanation just to reinforce what I learned from HELM, and found this a well-balanced and effective contrast.

16. I struggled with some of the areas in this unit and have had to work hard in order to understand concepts and methods. Overall the HELM was useful, despite some unclear patches. In general I only used HELM to aid my learning.

17. My preferred learning resources were HELM and the recommended text book. I found together they provided a comprehensive and solid basis for learning.

Section 2 – General Comments from Engineering students using the HELM materials as the main resource for their unit:

1. Are there any HELM workbooks relevant for my semester two Maths unit? I found the workbooks useful in semester one and would like to continue using them.

2. HELM is a good reference for Maths and analogue electronics. The workbooks provide electrical circuit examples, which is useful for my degree subject.

3. Quite different from other resources. It gives more examples and solutions to questions (although at times the solutions are not detailed enough)

4. From an Engineering perspective HELM fits very well in the environment as the notation is focused on the Engineering aspect rather than pure maths.

5. HELM is my first source of reference. I either use it alone or to supplement lecture material.

Summary of good features of HELM identified by students:

- Well structured. Clear progression of material.
- Good presentation – clear, bold and easy to read.
- Good use of graphical examples.
- Learning outcomes and pre-requisites are clearly stated.
- It is simple and straightforward to use. You can pick it up and make your way through it.
- Comprehensive coverage - it covers pretty much every aspect in detail.
- Good examples
- Inclusion of proofs is helpful
- Key points help me locate the material I need.

Student suggestions on ways to improve HELM:

- More emphasis on important points.
- Add white spaces around critical material, particularly formulae. Some sections look packed in.
- More examples.
- Answers at the end, not just below the questions.
- Paragraphs are too long. It can be too much. Some explanations are too full, and only the key points should be included.
- More thorough fully-worked solutions to problems. Some steps which may seem obvious need to be included.
- More background in general. I would have benefited from more fundamental explanations.

Report from Transferability Partner

University of Leicester

HELM at Leicester

June, 2006

Institution Background

The University of Leicester is a medium size, research university in the Midlands. The Department of Engineering is a general engineering department and offers a range of degree courses at BEng/MEng level, including Communications & Electronic Engineering, Electrical & Electronic Engineering, Electronic & Software Engineering, Mechanical Engineering and General Engineering. There are about 100 students in each year's cohort. Three mathematics modules are taught: two in the first year course (one for each semester) and the third one in Semester 1 of the second year. All students are required to attend those modules which are given by the staff members of the Department.

Use of HELM Products

We started to use HELM workbooks and introduced Perception as a continually assessed element into our first year maths teaching in 2003-04. In 2005-06, we further recommended HELM workbooks in the second year maths teaching. Sixteen workbooks (Nos. 6, 7, 9-14, 16, 18-20, 23, 35-38) are used in the first year and 6 (N0s. 22, 24, 25, 27-29) in the second year. Those workbooks cover most of the syllabuses of the first year maths modules (EG1010 and EG1070) and part of the second year's (EG2010). Purchase of the workbooks is compulsory for the first year students at a discount price thanks to the HELM Project subsidy. The maths teaching in the first year is based on the HELM workbooks while the workbooks in the second year are just recommended, reference material.

In the first year's course, we set 6 assessments in each semester using Perception software (CAA). For each assessment, the students have 4 days for practice. During this period, students can make any number of attempts at the questions and see feedback when it is available. That is followed by a two-day period for the formal assessment. For the formal assessment, two hours are (generously) allowed and only the first attempt is counted. The formal assessment is not a timetabled session. Instead, the students can attempt it anytime in the 48-hour period over the internet where a computer on campus or in hall can be used. The resultant marks of all 6 assessments are counted as 40% of the module mark. The rest 60% is from a normal paper exam at the end of the semester. The table below lists the average marks for the past 6 years, before and after the use of HELM.

	EG1010 *(Mathematics 1)*		***EG1070*** *(Mathematics 2)*	
	Examination	***CAA***	***Examination***	***CAA***
2000-01	54.1%		51.1%	
2001-02	51.8%		48.3%	
2002-03	56.5%		51.6%	
2003-04	58.3%	57.6%	60.8%	64.2%
2004-05	55.4%	51.6%	51.9%	68.1%
2005-06	63.5%	62.7%	(Not available yet)	68.1%

It is encouraging to see that the paper exam mark of EG1010 in the last year has been improved significantly.

Feedback from Students

We had a HELM Project Focus Group meeting in December, 2005, attended by both first and second year students. Students also commented on the workbooks and CAA using questionnaires as well as our tutorial system. The general feedback is positive. They found these aids very useful. In particular, they like the following features:

- Easy to understand
- Very informative
- Large number of questions at different levels
- Computerised learning and assessing
- Clear layout/organisation of material, though some want to reduce the overlap between workbooks

A few students would like to see more challenging, comprehensive questions.

Feedback from Staff

Five staff members are involved with teaching, setting up Perception exams and maintaining the software. Again, the general response is very favourable. We think the HELM workbooks are well designed and compiled. They are a very useful tool to assist the maths teaching. We appreciate the number of available questions with worked-out solution procedures which greatly help students in developing their self-learning and problem-solving skills. For engineering students in particular, the workbooks and CAA have been designed to focus on problem solving rather on theories.

The workbooks helped us in preparing teaching material and, thus, reduced our workload. Tutorial time has been reduced as well, since students can use Blackboard to communicate the lecturers about their queries and get the response.

We would like to see more materials on vectors, linear algebra, 2D/3D geometry, for instance, which are all important for engineering students.

Setting up CAA sessions and maintenance of Perception are straight forward. It is also easy to arrange individual schedules for students who are ill or have their sessions cut off in the middle of a test. The facility to export summary CSV file is

very helpful. We created a script file to extract the information details we are interested in.

A list of typos (not many) found in the workbooks has been sent to the HELM Project team.

Summary

In brief, we think HELM Project and the products it generated are a great support to mathematics teaching for engineering students such as ours. It can raise teaching quality, improve students' learning, as well as reduce staff workload. We will continue to use the workbooks and CAA software, and will consider to extend the CAA into the second maths module. We are grateful to the HELM Project team for their hard work and enormous assistance we received in installing the software.

(EP, GH, AGC, PRB, DWG)

HELM
Helping Engineers Learn Mathematics

Report from Transferability Partner

Newcastle University

Videos for HELM

1. Introduction

Experience at Newcastle

Short videos have been used at Newcastle University to support some mathematics and statistics service modules for engineers and scientists. The focus has been on solving typical exercises from the modules. Students have accessed these via a VLE or a CD. The videos have been used as back-up resource and have been welcomed by students as being very useful. This was especially so in a large engineering class this academic year. The videos used so far have been clips produced by chopping up those created in the Mathtutor project.

The HELM project

The opportunity arose via the HELM project to follow up this experience. The idea was to exploit the structure of the HELM Workbooks, with their standard approach to engineering mathematics and statistics, together with the worked examples and exercises, to create appropriate videos for those examples and exercises.
So far 80 plus videos have been created (June 2006) of which 60 have been edited and processed ready for this presentation. The initial focus has been on the basic mathematics found in the early Workbooks and on some elementary probability and statistics. These videos will be linked from the Workbooks, streamed from the Newcastle or any appropriate site or can be supplied on CD Roms or DVD.

Video Quality and Compromises

The videos have been looked at by about 20 students finishing the first year at Newcastle and the feedback (limited and not part of a module) has been positive, both in terms of the perceived usefulness and the quality of the videos.
The videos are not of high production value but are seen as reasonable by all reviewers so far; lighting could be improved and there is often some external noise. (This did not seem an issue with the students, in fact the only complaint I received from a student reviewer was the creaking of a whiteboard as it moved up and down!) This was a consequence of using any reasonable and available room for videoing, as we often had to rearrange times due to staff commitments and fit videoing in when we could, often at short notice.
Finally, the original proposal was for 20 videos, but we quickly found that the pragmatic approach adopted – fitting in with staff commitments, choosing a fixed format for videoing, choosing a standard and easy to use editing tool, having postgraduates who were interested and capable, being able to set up equipment very quickly - led to an easy-to-manage process with much quicker turn around than expected and so we have produced many more videos than originally planned.

2. The Original Proposal

Proposal to create short videos for HELM

Professor Robin Johnson, Dr Phil Ansell, Dr Bill Foster.

School of Mathematics & Statistics, Newcastle University

The School of Mathematics & Statistics of Newcastle University has the capability to produce short videos of lecturers solving and/or explaining the solution of exercises relevant to HELM material.

The initial proposal is to produce 20 such videos, each up to a maximum of 5 minutes in length.

- The videos will be linked from the relevant HELM pdf files.
- They can also be used as stand-alone videos and ideally are planned to be accessible by any course developer in an HE institution.
- The content and topics will be based on the material in the HELM workbooks and agreed by HELM.
- After the choice of material, the project will take 2 – 3 months to complete, and is planned to finish in or before May 2006.
- The format will be informal, with a lecturer acting in tutorial mode ideally addressing a group of students and with some interaction, although other formats will be investigated.
- In order to produce these videos it is estimated that each will take about 1 hour to video, and 3 hours to edit and produce a final version suitable for publication.
- It is planned to use a final year postgraduate student for the videoing and editing.

3. Why Videos?

There is evidence that short videos of experienced presenters working through the solutions of standard exercises and problems in basic mathematics and statistics are of value in reinforcing student acquisition of important skills.
One recent project, Mathtutor, produced videos of a relatively high production value together with careful indexing. These are part of CD Roms on elementary engineering mathematics with theory, practice, worked examples and quizzes all indexed and cross referenced.
http://www.mathtutor.ac.uk/
Also see the mathcentre site
http://www.mathcentre.ac.uk/resources_for_category.php?f=1&c=32 where these videos are also linked..
However, students appreciate their initial exposure to new mathematics or statistics from lectures and/or tutorials as human interaction is seen to be important at this stage. A good tutor/lecturer can quickly assess the student's background knowledge and tailor the explanation and presentation according to the learning styles of the students; this also gives the students greater confidence. Once the initial learning stage is over, then true facility in basic mathematical technique is achieved by reinforcement and repetition via plenty of practice. It is at this stage that videos are seen as useful – giving plenty of opportunity to review the material in the video with immediate feedback subject to student control. It is still very important to have tutor help available as the videos solutions may not cover every difficulty that a student may encounter in solving similar exercises; it is wise to regard. At this point, the videos as back-up material rather than central to the practice regime.
At Newcastle, during the last three years, we have used the Mathtutor videos on Blackboard modules for several service courses in mathematics and statistics for Computer Scientists, Physics and Chemistry students, and for Engineering students of all disciplines.

Initially we had to break the videos, after permission, into suitable smaller clips; each of these clips covered an exercise on a skill. We found that there were two factors which determined the student use of the videos:

1. The length of the video
2. The relevance of the video.

The video had to be short and directly relevant to the task that the student was undertaking : for example, assignments (whether CAA or text based, module exercises), for aiding the understanding a text based solution or for practising a past-exam. The video had to be precisely aimed at the problem that the student needed help on, or else it was seen as irrelevant. Also the video should be easily reached – usually only a link away.
Feedback from students on the directed use of such videos was very positive. This was especially so for the large engineering class; there was especially positive feedback from the dyslexic students.
The evidence is that videos do increase student engagement as measured by the amount of time they spend in looking at and using the various available resources. The drawback to this is that many short videos need to be created and, at first sight this seems to be a major resource problem; quality issues to do with the presentation of the video may also become important. Those issues are dealt with later, but first we address the problem of the method of presentation.

4. Video Presentation: Emulating the tutorial

One approach is to emulate as closely as possible the learning environment that most students are familiar with and consistently report as the most useful: the small group tutorial with a tutor going through examples on the board with full explanations . Ideally student/tutor interaction should be present and the original proposal to HELM had this as a possible format – but this was not feasible for resource and time constraints (and not least being able to guarantee an audience).

The presenter of the video should speak clearly, write legibly, be enthusiastic and behave as if there is engagement with a student by addressing the camera. Not too much material should be written on the board as moving the board up and down can be distracting. One principle we have adopted is that there should be minimal camera movement or zooming - for short videos this is not necessary and there is the added advantage of a fixed camera position – so no real expertise is needed by the camera operator.

Each video should be short as possible, consistent with a satisfactory and correct solution and full explanation of a worked example. If the video is too long then students tend to switch off and/or may be intimidated at the amount of detail implied by the length of the video. There is no need at this level of mathematics to have long explanations. For example, in small group tutorials, tutors will always look for the quickest way, consistent with background knowledge and learning styles, to explain methods to students. The advantage of videos is that students can look at them as many times as they like, and will tend to do so if they are short and relevant.

5. Creating the Video – practical issues

Our experience is that videos need not be of a high production value as long as the presenter does a good, clear job of explaining. Although we have had limited student feedback on the videos we have produced, all of this has been positive – there were no quality issues raised and they were seen as very useful.

The video session

Lighting and sound are of course important – however we did not use a studio as we required access to rooms at short notice; we found that a standard lecture room had adequate lighting and, as long as the camera was not too far from the lecturer, the sound picked up by internal microphone of the video camera was also adequate. Typically we would use a room without too much external noise and for which all lights were working, set up the camera on a tripod facing a not-too-dirty white board about 6-8 metres away. The presenter would prepare for each video by writing any titles and other appropriate material before videoing. The presenter would then use a black pen and speak to the camera and would control when to start, stop and when to repeat (if necessary). The camera operator would usually be a postgraduate student whose job was to start and stop the camera and to listen for any obvious mistakes – and then interrupt, if appropriate.

Editing

Given the time constraints, and the number of videos created we decided to produce all videos on Windows media format (.wmv) and use Windows MovieMaker to edit – although we have kept all AVI files in order to produce RealPlayer files later.
This kept editing time down to a minimum and a short video of say 4 minutes would take about 1 hour in all. Postgraduate students did most of the editing – with an overview by the presenter.
Most videos were selected to run at 768 Kbs as this produced suitable quality, given either access via CD Rom or DVD or by broadband.

Equipment

A Sony DCR PC1000E DV camcorder, a spare battery, a tripod and 10 dv60 tapes.

Cost around £850 ex vat

Ideally: external microphone and extra lighting. Around another £100

Software

Windows Movie Maker, Adobe Premier Elements 2.0, RealProducer Plus, Adobe Acrobat.

Cost: £200-300

Personnel and required training

- Presenters: Members of staff, willing to be minimally trained in presenting. Training consists of adopting a natural enthusiastic style as in a small tutorial, wearing appropriately coloured clothes, not moving around too much, not obscuring the board, writing legibly, talking clearly and not making too many mistakes!
- Camera Operators: Postgraduates. Training is minimal given the format of a more or less fixed camera.
- Editors: Postgraduates. Once again, the shortness of the videos and the minimal format makes editing via Movie Maker, Adobe Premier or RealProducer relatively straight forward The two postgraduates used for editing have found this easy to do once the basic production process was agreed. Training was about one or two hours of demonstration.

Production Control

Quality Control. The Video Preparation Record (see 8. below), usually completed by the postgraduate editor, is the means by which the production process was controlled, timed and monitored.
The finished video was then uploaded to the streaming server.

Production Costs
(After all equipment costs).
Payment to postgraduates for videoing and editing: £12.00 an hour.
The only other major resources used were rooms (free), and staff time (free).
Staff time:

1. Preparation time per video: looking at a workbook and preparing an example from a section.
2. Presenting. No video took more than 20 minutes in presentation (including repeats)
3. Reviewing. About half an hour per video.

Postgraduate time

1. Videoing: 15mins per video average.
2. Editing and other post processing: One hour per video. Sometimes longer if after review changes are needed.

6. Dissemination

1. All videos are on the Newcastle streaming server stream.ncl.ac.uk running at least at 768 Kbits/s. And we are happy to host these videos
2. On CD Roms and DVD.

Linking from HELM workbooks
It is easy to install links into the present pdf files using Adobe Acrobat. This is a standard editing process.

7. List of Video-clips for Sections in HELM Workbook.

Workbook 1 – Basic Algebra (89 pages)		
1.1	Mathematical Notation and Symbols	OMIT
1.2	Indices	index laws; index negative;
1.3	Simplification and Factorisation	expand diff squares; expansion; expansion of brackets(3);factor complete square; factorisation; factorisation2;factorisation3;
1.4	Arithmetic of Algebraic Fractions	combine alg frac;
1.5	Formulae and Transposition	Changing the subject of an equation (2 videos)
Workbook 2 – Basic Functions (75 pages)		
2.1	Basic Concepts of Functions	OMIT
2.2	Graphs of Functions and Parametric Form	compare curve; sketch function specified in 2 parts; solving equations using graphs
2.3	One-to-one and Inverse Functions	Checking that a function is one-to-one; Finding the inverse of a function.
2.4	Characterising Functions	sketch function; periodic functions
2.5	The Straight Line	line through two points; line given gradient and one point;
2.6	The Circle	equation circle;
2.7	Some Common Functions	sketching a function involving the modulus; graphing sine of a multiple angle; periodic functions; sketching x+1/x; sketching parabola; sketching tan(x)
Workbook 3 – Equations, Inequalities and Partial Fractions (71 pages)		
3.1	Solving Linear Equations	Solving a linear equation; solving a rational equation
3.2	Solving Quadratic Equations	Solve complete square;factorisation2;
3.3	Solving Polynomial Equations	Roots cubic;
3.4	Solving Simultaneous Linear Equations	Solving pair linear eqns;
3.5	Solving Inequalities	Linear inequal;
3.6	Partial Fractions	Parfrac intro; parfrac linear; parfrac linear2; parfrac compare coeff; parfrac quadratic; parfrac quad2; parfrac repeated;
Workbook 4 – Trigonometry (77 pages)		
4.1	Right-angled Triangles	Trig pythag1(finding the side of a triangle);
4.2	Trigonometric Functions	(Covered elsewhere)
4.3	Trigonometric Identities	Trig expand cos6x;
4.4	Applications of Trigonometry to Triangles	TO BE DONE

Workbook 5 – Functions and Modelling (49 pages)		
5.1	The Modelling Cycle and Functions	OMIT
5.2	Quadratic Functions and Modelling	OMIT
5.3	Oscillating Functions and Modelling	OMIT
5.4	Inverse Square Law Modelling	OMIT
Workbook 6 – Exponential and Logarithmic Functions (73 pages)		
6.1	The Exponential Function	Simplifying powers;
6.2	The Hyperbolic Functions	Formulae for hyperbolic functions
6.3	Logarithms	Graphing by taking logs of a function; Simplifying log expressions
6.4	The Logarithmic Function	Solving an equation using logs; Solving an equation involving exponentials; Solving the hyperbolic equation sinh(4x)=1;
6.5	Modelling Exercises	OMIT
6.6	Log-linear Graphs	OMIT
Workbook 7 – Matrices (50 pages)		
7.1	Introduction to Matrices	OMIT
7.2	Matrix Multiplication	OMIT
7.3	Determinants	OMIT
7.4	The Inverse of a Matrix	OMIT
Workbook 8 – Matrix Solution of Equations (32 pages)		
8.1	Solution by Cramer's Rule	OMIT
8.2	Solution by Inverse Matrix Method	OMIT
8.3	Solution by Gauss Elimination	OMIT
Workbook 9 – Vectors (66 pages)		
9.1	Basic Concepts of Vectors	OMIT
9.2	Cartesian Components of Vectors	OMIT
9.3	The Scalar Product	OMIT
9.4	The Vector Product	OMIT
9.5	Lines and Planes	OMIT
Workbook 10 – Complex numbers (34 pages)		
10.1	Complex Arithmetic	OMIT
10.2	Argand Diagrams and the Polar Form	OMIT
10.3	The Exponential Form of a Complex Number	OMIT
10.4	De Moivre's Theorem	OMIT

Workbook 11 – Differentiation (58 pages)		
11.1	Introducing Differentiation	Differentiating from first principles; Differentiating from first principles; the square root function;
11.2	Using a Table of Derivatives	Differentiating standard functions
11.3	Higher Derivatives	First and second derivatives
11.4	Differentiating Products and Quotients	Diff prod1; diff prod 3 fns; diffquotient rule1; diffquotient2;
11.5	The Chain Rule	Diff chain rule1;
11.6	Parametric Differentiation	Parametric diff; parametric diff first and second derivatives;
11.7	Implicit Differentiation	Implicit differentiation 1; Implicit diff 2 (arctan(x));
Workbook 12 – Applications of Differentiation (63 pages)		
12.1	Tangents and Normals	Implicit diff 3: tangent and normal to a surface
12.2	Maxima and Minima	TO BE DONE
12.3	The Newton-Raphson Method	TO BE DONE
12.4	Curvature	TO BE DONE
12.5	Differentiation of Vectors	TO BE DONE
12.6	Case Study: Complex Impedance	TO BE DONE
Workbook 13 – Integration (62 pages)		
13.1	Basic Concepts of Integration	TO BE DONE
13.2	Definite Integrals	TO BE DONE
13.3	The Area Bounded by a Curve	TO BE DONE
13.4	Integration by Parts	TO BE DONE
13.5	Integration by Substitution & Using Partial Fracs	TO BE DONE
13.6	Integration of Trigonometric Functions	TO BE DONE

Workbook 35 – Sets and Probability (53 pages)		
35.1	Sets	OMIT
35.2	Elementary Probability	TO BE DONE
35.3	Addition and Multiplication Laws of Probability	TO BE DONE
35.4	Total Probability and Bayes' Theorem	The law of total probability; Bayes' Theorem;
Workbook 36 – Descriptive Statistics (45 pages)		
36.1	Describing Data	OMIT
36.2	Exploring Data	OMIT

Workbook 37 – Discrete Probability Distributions (60 pages)		
37.1	Discrete Probability Distributions	TO BE DONE ?
37.2	The Binomial Distribution	An example using the Binomial distribution;
37.3	The Poisson Distribution	Poisson Process (an example);
37.4	The Hypergeometric Distribution	OMIT
Workbook 38 – Continuous Probability Distributions (27 pages)		
38.1	Continuous Probability Distributions	OMIT
38.2	The Uniform Distribution	OMIT
38.3	The Exponential Distribution	OMIT
Workbook 39 – The Normal Distribution (39 pages)		
39.1	The Normal Distribution	The normal distribution;
39.2	The Normal Approximation to the Binomial Distribution	OMIT

8. Video Preparation Record

Video Record	
Presenter	
Title	
Date and Time	
Room Comments on Room	
Camera Operator	
Duration of Videoing	
Tape Record	
Tape Number	
Position on Tape	
Duration of video on tape	
Editing Record	
Wmv files	
AVI file created and saved	
wmv file created and saved	
Name	
Location	
Bit rates	
Titles added	
Size of file	
Reviewed and passed	
Location	
Streaming file created	
Location	
Editor	
Time taken	
RealPlayer files (.rm or .rv)	
RealPlayer file created and saved	
Name	
Bit rates	
Titles added	
Size of file	
Reviewed and passed	
Location	
Streaming file created	
Location	
Editor	
Time taken	

HELM
Helping Engineers Learn Mathematics

Report from Transferability Partner

Oxford Brookes University

HELM Transferability Report
by Dr Robert Beale (Principal Lecturer)

Department of Mechanical Engineering
Oxford Brookes University
June 2006

Introduction to the use of the HELM project at Oxford Brookes University

I transferred from the School of the Built Environment, Department of Civil Engineering and Construction Management to the School of Technology, Department of Mechanical Engineering in July 2002. For over thirty years the Civil Engineering Mathematics classes ranged between 20-50 students. The number of students in the Automotive, Mechanical and Electronic First Year module in 2002 was approximately 110 students. In 2002-3 this module was taught using lecturer prepared handouts and contained four class tests under examination conditions as well as a three hour end-of-module examination. The first year module is worth 30 CATS credits. The following year the module was taught in a similar manner with the addition that to each topic, as well as the lecturer prepared material, HELM workbooks were issued to each student. In 2004-5 all the workbooks were made available on-line via WebCT and the HELM CAA question bank used to replace four class tests with on-line quizzes. Finally in 2005-6 the online quizzes were amended to reflect changes in syllabus delivery and to add questions on topics not within the HELM CAA question bank. All lecturer material, HELM workbooks and solutions to lecturer prepared exercises and the last three examination papers were placed online. In response to requests from students, from 2004 the HELM workbooks were made online to second year students, directly accessible from their module home page. The second year module is worth 15 CATS credits. First year students were always given printed copies of workbooks together with on-line access, second year students only had access on-line. In addition, following a request from the University 'Upgrade Service' (a University-wide mathematics and English help facility centred in the Library each lunch-time during term time) and the Mathematics Department, in 2004 the HELM workbooks were made available online to all students within the university who could, in WebCT parlance, self-register for the HELM resources web-pages. Looking at last year's registrations about 20 non-engineering students made use of this facility.

Workbooks

The workbooks are between 30-70 pages long and if distributed in paper form are best printed by the central print room. Difficulties were experienced initially because the print room required explicit copyright consent. In transferring the workbooks to other education establishments a statement on the printing and copyright conditions should always be included with the media.

When printing the workbooks in the academic year 2005-6 some earlier workbooks were included. This occurred because in previous years they had been printed but not used. These workbooks included solutions printed upside down. In addition all students had some workbooks with the questions printed with the solution the normal way up. It is interesting to note that strong feedback from students, including dyslexic

students, found that when using the workbooks they found it easier to have the solutions printed up-side down rather than the normal way as they found that they could easily accidentally expose the solution and therefore lose the benefit of the question.

Neither students nor staff encountered any problems in distributing/accessing the pdf versions. In WebCT the University web manager simply created the equivalent of a module which was available to all staff and students to self register. Any module leader was given rights to release the files to all the students on any particular module. However, some students found difficulty in producing printed versions of the pdf files if they wanted to work off-line.

CAA files

In 2003-4 a decision was made to use the CAA files. Loughborough provided zipped files of some of their databanks covering first year differential and integral calculus, trigonometry, complex numbers, exponential and logarithm functions, matrices and vector algebra. Each zipped file contained an xml form of the question databank and the jpg files containing the question image and the solution image. By a roundabout procedure the files were unzipped, imported into Respondus and then exported into WebCT. Each question of the database then had to be individually inspected and sets of answers included. The details are given in Appendix 1.

Oxford Brookes University was given transferability money to translate all the latest questions into WebCT. However, although the money was released in December it took two months to get a version of QM Perception onto a server at the University. This version proved to be the wrong version and the IT Technician only finally managed to get the questions onto the system at the end of May. The major difficulty that occurred was due to the University having Unix servers. The Technician had to mount a Microsoft server before QuestionMark could be mounted. The University is currently developing a conversion procedure and will supply the finalised version to the HELM development group when complete.

Many of the questions in the data set ask for two digit numerical answers. It was discovered that if a question specified the input of a two digit result and if the number in the supplied answer set was integral or only had one decimal digit that WebCT/Respondus was unable to correctly import the answer. If the student inputted the correct two digit answer he/she was marked wrong! In every case manual editing of the question database had to be made to change the integral or one digit answer into a two digit answer and also to add alternative responses of the one digit or integral result with reduced marks.

Secondly when using a given dataset, depending upon the teaching order of the lecturer, the resulting set would need to be clearly checked to see that the students were correctly prepared and able to answer all the questions in the set. For example, the last section in the workbook for the exponential and logarithm functions also includes the hyperbolic functions. At Oxford Brookes University, exponential and logarithm functions are taught at the beginning of the course, followed by trigonometric functions and much later in the course, after differentiation principles and applications and simple integration techniques have been covered but before

advanced integration techniques are taught, hyperbolic functions are introduced. This means that the databanks for exponential and logarithm, differentiation and simple integration have to be edited to remove the hyperbolic functions in early exercises. They obviously can be used in later on-line quizzes. This requires the lecturer to carefully check every question in a database.

One of the major limitations of the databases is that most of the questions ask for numerical answers only. There are relatively few multiple choice questions asking for analytical answers, such as partial fractions or symbolic integration/differentiation. If these are required then the authors must prepare their own questions to cover these topics.

Feedback

Use of quizzes

Currently preparing WebCT quizzes using the CAA databank has not saved any time over setting and marking traditional class tests. However, the major advantages that have occurred have been in meeting flexibility and disability requirements. The procedure that has been adopted by me in setting class tests is similar to that used in Loughborough. A sample test is available for four days which can be taken as many times as the student wants with an extended time limit on the test. For a period of 36 hours the test is then made available to all students. Each test requires the student to answer between 7-10 questions, each question being drawn from a bank of between 5 and 15 questions testing similar material. Students without disabilities have one hour to complete the test, those students with disability have 1.25 hours. The advantages with regard to flexibility are that the test can be taken anywhere within the university or off-campus and the test does not require staff supervision or special rooms being made available for those students entitled to special facilities. The tests are not monitored and hence I do not intend to use them for my second year module where the results can count towards classification. Currently students are only allowed one attempt at the test. I am going to allow multiple attempts next year in order to encourage the students to improve their marks. This procedure of allowing multiple attempts at assessments and recording the best mark has been used successfully in other disciplines within the university.

Feedback from students has shown that those students who enjoy working with computers like the tests, the others would rather have traditional tests. Secondly they have complained that a purely numerical result does not give any method marks and so they feel they have often done better than the test results imply and would obtain higher marks in a traditional test.

Use of workbooks

Oral feedback from students has shown that they value the HELM workbooks as giving additional opportunities to practice material within the mathematics course. Frequently during problem classes students can be observed working through the lecturer produced material and/or working through a HELM workbook. Students particularly like those workbooks which cover material which I had to omit from the lecture course as the students were assumed to have seen the material in previous

courses. An example of such material is the introductory workbook on differentiation as a limit. I have to assume that students have met the calculus before. In practice there are a small number of students who, although they have taken National Diploma Mathematics courses for two years, appear to have not encountered the calculus, although it is within the standard syllabi. In addition they have valued being able to access the workbooks electronically.

Changes to teaching strategies during HELM introduction

It is impossible to isolate the effects of the introduction of the HELM project materials into the teaching of engineering mathematics at Oxford Brookes University due to the following additional changes which have taken place simultaneously:

- Between 2002-5 the mathematics classes were delivered by two lecturers, one concentrating on the calculus parts of the course and the other the remaining parts of the syllabus. In 2005-6 only one lecturer was used.
- Two research students were also employed to assist the lecturers when the students were split into problem classes containing approximately 24 students to a class. In 2002-5 each research student assisted a single lecturer. In 2005 the lecturer had to go between problem classes during the sessions.
- The university changed from a three term structure in 2002-4 to a two semester structure from 2004. The introduction of semesterisation was particularly unpopular with engineering students as they felt it reduced the amount of study time.
- As part of workload planning changes contact and problem class hours underwent significant reductions.

The results are summarised in this table:

acad-emic year	student group	number of stud-ents	number of passes	lecturer contact hours	Prob-lem class contact	class tests	final examin-ation	HELM usage	module mean mark
2002-3	year 1	104	72	81	54	4 paper	3 hours	no	54
	year 2	80	55	54	36	2 paper	2 hours	no	49
2003-4	year 1	83	59	81	54	4 paper	3 hours	yes	43
	year 2	83	58	54	36	2 paper	2 hours	no	47
2004-5	year 1	61	41	66	44	4 CAA	2 hours	yes	45
	year 2	66	35	44	44	2 paper	2 hours	yes	47
2005-6	year 1	104	54	60	40	4 CAA	2 hours	yes	45
	year 2	45	34	40	20	2 paper	2 hours	yes	51

Note that the 2005-6 results are before examination committees and resits.

In addition to these changes to teaching of the engineering mathematics modules the university introduced in 2004 an ‘Upgrade’ service, centred in the library each lunch-time with additional support for mathematics which weaker students were encouraged to use.

Participation in lectures and problem classes remained the same over the period except that this year’s first year had much lower attendances across all modules. This

behaviour is being investigated. Throughout the four year period students have made a reducing number of visits to staff offices outside timetabled slots. This may be due to more material being made available through WebCT during this time.

Dyslexic students who have always had additional support supplied by the university have stated that they like the workbooks and find them useful. However, they have stated that they prefer the earlier format of workbook solution.

The class tests undertaken through the CAA databank have proved more popular with many students than the traditional pencil and paper test taken by the second years. They have taken significantly more time to prepare than paper tests but as I now have built up a reasonable number of questions I anticipate a reduced amount of time in the future. The students like the ability to take the test at a time of their own choosing and as a result of their comments I have slightly changed the availability to ensure that they can take the test at a more convenient time on Saturdays. Their adverse comments are related to the difficulty of not obtaining 'method marks' and the mark allocation for slightly incorrect answers. I will need to further investigate the solutions to produce improvements to marks for slightly wrong answers such as ignoring negative signs.

The amount of time taken to support the HELM workbooks is not different to that taken to support standard lecturer material. Students have asked for assistance in using the workbooks at the same rate as using traditional materials. Students have expressed a strong liking to being given the choice between working through a HELM workbook and working through lecturer supplied material. The amount of assistance required has not changed as for many students the HELM workbooks are considered to be supplemental material, others use it as their main material.

Critical issues

All lecturers who have been involved in delivering the engineering mathematics courses have found no difficulty in using the materials and have readily given out the handbooks when required. The complex number workbook was used by one lecturer in preference to writing new notes but with additions relating to the use of complex numbers in electronic circuits.

The costs of printing workbooks are high and I have faced criticisms from within the department about the costs of the module. The module has the highest paper cost per student within the department. In order to keep the costs down I have taken to printing workbooks close to the time when they are being required so that the number of copies can be kept in line with module attendance. I also have to use up spare copies of earlier workbooks which have been superseded to avoid paper wastage. Putting the workbooks online has meant that students do not always bother to collect a workbook but simply work from their own or university computers, hence reducing the overall demand. There have been technical difficulties in printing online copies of workbooks by some students on some computers.

The major problems with the workbooks come from the sequencing adopted. Firstly, although exponential and logarithm are correctly introduced early in the sequence of workbooks, it seems odd that hyperbolic functions are included in this workbook as

many students needing exponential and logarithm functions are still not fully conversant with trigonometrical formulae and have not covered complex numbers so that the link between trigonometric functions and hyperbolic functions cannot be demonstrated. These students would find the early use of hyperbolic functions confusing. Secondly, partial fractions are introduced outside of their use in integration which would mean that engineering students, who need motivation, would not see one of their common applications. In general, individual workbooks are usually well written and their contents graded. However, the author of the differentiation workbook assumed that he was revising the product and quotient rules and the examples in the exercises rapidly get very complicated. In addition the exercises are written assuming that every lecturer is following the full sequence of workbooks. This leads to, for example, exercises in differentiation using hyperbolic functions before an alternative sequence would cover it. I have also found that the use of inverse functions is scattered throughout the text and many students do not fully appreciate them and still confuse the inverse function with reciprocals. In some workbooks there is an excess of material for my class. However, I do not feel that this is a problem as other courses will include different sub-topics. This is not different to any textbook. The students are notified that a particular sub-topic is not going to be examined.

It is a long time since I found an error in a workbook. The authors and editors are to be commended for their attention to detail and accuracy. Most workbooks develop a topic in a sensible manner with the major exception mentioned above regarding hyperbolic functions.

Students have fully engaged in workbooks and I have found second year students printing off and using relevant workbooks with very little prompting.

The major limitations of the CAA questions have been described above with regard to handling two digit answers when the supplied QuestionMark answer is either a single digit or an integer, assigning marks to partially correct answers and the difficulty of translating the questions into WebCT. However, a justifiable criticism of the questions levelled by students is that the majority of questions require a numerical answer. I have had to develop questions involving symbolic integration and partial fractions. In addition the questions on trigonometry which I had only covered wave theory. I therefore produced questions on other aspects of trigonometry. These additional questions are available to anyone requiring them. Oxford Brookes University will, over the summer, develop and implement procedures to translate the existing QuestionMark databases into WebCT. The resulting files will be distributed via the HELM administrator. An appendix to this report shows the method of converting older QuestionMark files.

Conclusions

Using the HELM workbooks has enhanced the student experience. Student find them easy to use.

A significant effort is required to adapt the CAA files for use on non-QuestionMark systems but the CAA files can be translated.

Appendix: Detailed instructions on converting old QTI questions into WebCT

The following procedure was adopted at Oxford Brookes University to convert QTI questions sent from the HELM Project in 2004 into databases for WebCT.

1. Unzip the files into a temporary directory.

   e.g. fn_10_02_02_argand_diag

2. Within the temporary directory use Notepad or equivalent word processor to edit the .XML file as follows:

   - find %SERVER.GRAPHICS%
   - replace with /_COURSEID_/*local_folder*/
   - save

   In the above example *local_folder* could be *argand_diag*

   Note the trailing '/' at the end of the replace and also that '_COURSEID_' must be WebCT directory.

3. Enter RESPONDUS and perform the following steps:

   - Change "personality" to IMS QTI. This is found under the START tab.
   - Import questions.
   - Whilst in this sub-menu Browse to the temporary directory containing the XML file and browse to the temporary directory containing the images folder.
   - Create a new document names as *local_folder.*
   - The 'stem' is also *local_folder.*
   - Finish
   - Under the START tab change "personality" to WebCT 3x4x.
   - Replace current file.
   - Under the PREVIEW AND PUBLISH tab - publish to WebCT.

4. Copy the .fb or .sb files from the unzipped temporary directory to the WebCT directory containing the question bank using either WebDAV or my-Network_places.

Note when composing WebCT tests that you must carefully look at the answers that have been imported. I noticed that a question which asked for a two digit answer with an answer which was either an integer or 1 digit was converted to a one digit answer. WebCT quiz then marked the two digit or an integer response as wrong. Only a one digit response was given a correct mark. I am currently trying to get from WebCT a procedure to enable a range answer to be accepted. You need to edit the allowed answers to give correct marks for all possibilities that you want to accept.

Report from Transferability Partner

University of Salford

Helping Engineers Learn Mathematics

Transferability Funding Report

Dr Ian Drumm
Acoustics at Salford
Computing, Science and Engineering
University of Salford.

Introduction

This report pertains to the delivery of mathematics to students doing acoustic related degree programmes in the department of Computing, Science and Engineering at the University of Salford. Salford has been carrying out teaching, research and consultancy in acoustics and audio for three decades offering a range of degree and postgraduate courses in acoustics, audio and video. The department has world class laboratories used for commercial work, teaching and research and the associated acoustics research centre gained a 6* in the last RAE.

The main degree courses offered 'BSc (Hons) Acoustics', 'BSc (Hons) Audio Technology' and 'BSc (Hons) Audio, Video and Broadcast Technology' typically have the high mathematical content associated with elements of classical physics, signal processing, electronics, computing and experimental methods/analysis.

HELM materials were adopted to directly assist in the delivery of a 20 credit undergraduate mathematics module at level 1. Though some of the more advanced materials were also offered to support acoustics modules with mathematical content at Level 2, 3 and MSc.

Issues with the past delivery of Mathematics

Over the last the decade there had been a steady increase failure rates in the level 1 mathematics module associated acoustics degree programmes. This trend could also be observed in the more physics orientated acoustics modules at level 2 and 3 where a strong mathematics pre-requisite is essential.

To some extent these problems can be related to the ever increasing need to offer flexible recruitment paths to include students with a strong interest in acoustics and audio yet without a strong A level grade in mathematics. Indeed some 40% of our students are now recruited without A level mathematics at all but are instead recruited with A-Levels that include a 'Numerate Science'. The 'Induction Week' test this year based on elementary algebra, trigonometry and some very simple calculus yielded 42% getting below 40% in the test.

One could also possibly cite perceived falling standards in 'A' level mathematics as suggest by reports such as Engineering Mathematics Matters (The Institute of Mathematics and its Applications 1999) or statistical work from the likes of Ken Todd of York University who wrote in Mathematics Today "It appears irrefutable that students with ostensibly identical A-levels grades are substantially less well prepared than they were five, 10 and certainly 15 years ago" (cited Guardian 5th October 01).

However, despite the above explanations there was clearly a degree of introspection required as mathematics delivery was becoming less successful at meeting the needs of the students.

It was decided to investigate key problems with mathematics pedagogy in the hope that different delivery, assessment and support strategies might mitigate for poor mathematical knowledge or acumen. A number of specifically tailored surveys were conducted; these included interviews with

a) students to establish needs, difficulties and expectations

b) module coordinators to gain a more focused picture of prerequisites

c) 41 employers to gain a clearer view of their expectations of student attainment.

It was also felt important to share experiences and resources with other institutions to better establish best practice.

Some key considerations would become clear

- Delivery should not sacrifice a range of content that would still be vital in subsequent modules.

- Delivery should be in a way that builds confidence and interest of weaker students.

- Delivery should provide challenges for stronger students and thus encourage their participation throughout.

- The mathematics content should be immediately relevant to the student with respect to aims and objectives of an acoustics degree programme and their chosen acoustics/audio related career path.

- Students should be encouraged to exploit wider support mechanisms and resources beyond lectures and tutorials.

- Students should be gently introduced to the concepts of student centred learning and ownership to hence gain the learning skills that would be vital when more difficult mathematical content is presented later.

- Some peer support and mentoring should be facilitated.

- Students need to be encouraged to work consistently and opportunities for formative feedback exploited.

- Changes should be manageable with limited staff resources and time.

Previously ‘Level 1’ mathematics was presented as two 10 credit modules in semester 1 and 2. Assessment was a summative exam held at the end of each semester. Students were expected to take notes in classic ‘chalk and talk’ fashion and encouraged to engage with some maths problems during the two hour lecture period. Although some bright or highly motivated students would find this style an efficient way to guide their learning many poorer students would devote their concentration to note taking, fail to follow the chosen pace of the lecturer, have little knowledge of expectations and not devote enough of their own time to learning.

The New Module Structure

The change proposed a new 20 credit module structure. It was decided that HELM resources would play a central role hence the new module would make timetabling and resource provision for workbooks and computer aided learning / assessment.

Workbooks

Key to the delivery of the module would be the HELM workbooks. These were the main learning resource defining the teaching content. The exercises would also outline the likely assessment expectation. Students would be able to work through workbooks during lectures and in your own time. Hard copies of the workbooks were given out in lectures to students during the progression of the module (typically one workbook per fortnight over the 24 week period). Level 1 workbook topics are listed below; which are essentially a combination ‘A level’ revision and elementary degree level mathematics. Other important workbooks dealing with the likes of matrix algebra, Fourier, Laplace, z-transforms, probability, statistics etc would be available to students / lecturers as support materials later.

Week	Topic	Workbook	Assessments
1	Basic algebra	1	
2			
3	Functions	2	
4			
5	Equations, inequalities, partial fractions	3	
6			Phase Test A
7	Trigonometry, coordinate systems and series.	4	
8			
9			
10	Logarithms and exponentials	6	
11			
12			Phase Test B

Semester 2			
1	Complex numbers	10	
2			
3			
4	Differentiation	11	
5			
6			
7	Integration	12	Phase Test C
8			
9		13	
10			
11	Differential Equations	19	
12			Phase Test D

Lectures

There were two hours of lectures every week. Power point slides (~20 per lecture) were created would follow very closely the explanations and worked examples presented in the workbooks. This was important to give the students the feeling that the workbooks were central to their learning as opposed to yet more support material. Exercises provided an excellent way to break up the lectures into three 20 minute periods of talk punctuated with opportunities for student application, inquiry and recall. The author found it useful to provide in addition to answers provided in workbooks the school's own worked solutions given as handouts during lectures. Clearly many students wouldn't complete all of the exercises during lectures so external study and use of Mathscope (the University's maths support unit) was encouraged. Students doing badly in early phase tests were asked to have signed receipts to confirm their visits to Mathscope.

Assessment

Although HELM's computer aided assessment was not used summatively the module's assessment strategy was re-structured to make use of the formative feedback potential of CAA (as will become clear). The module is assessed as follows:

- There were four Phase Tests (A, B, C, D), two in each semester. Each counted for 20% of the marks for the module.

- If a student passed all Phase Tests then he/she would not need to take the examination in May/June. Otherwise a formal exam would require students to complete exam question sections corresponding to topics assessed in those phase tests they had failed.

- In addition there was a Group Assignment, which counted for the remaining 20% of marks for the module.

A student failing to attend a phase test and then the subsequent exam if required or failing to contribute towards the group project would suffer a large marking penalty to

discourage students skipping components and playing the numbers game to clear 40%.

To avoid resource intensive marking two postgraduate students were paid to mark phase tests based on clear assessment criteria with questions tailored to make quicker marking easy.

Computer Tutorials

In addition to the two hour lecture slot there was a one hour session in a Computer lab timetabled for a later part of each week. Here students were able to familiarise themselves with important tools (notably Matlab) to help understand the application of mathematics in acoustics. These sessions followed the workbook topics closely where computer exercises would try to marry the workbook topic of the week with acoustic application and Matlab (e.g. to draw graphs, synthesise sounds, etc). Computer tutorials were also an opportunity to try other HELM resources such as interactive lessons and computer aided assessment. Although CAA was not used during formal phase tests; online practice tests were constructed and a 'mock' phase test run for each week prior to a formal test. These proved very popular as a confidence building exercise. Given a cohort would typically consist of 60 students two separate computer rooms of 35 places had to be run simultaneously. We decided to make good this constraint by streaming the students according to the results of the mathematics test in induction week. Students in the weaker group B tended to prefer the hour used for extra tuition with workbook exercises where as group A students preferred the creative application of Matlab. It should be noted students were also introduced the online videos at mathcentre.ac.uk and some students liked to access these briefly on a weekly basis.

It should be noted that use of computer labs tended to distract some weaker students from the learning outcomes of the module when they get stuck with Matlab or simply refuse to engage and use the computers for other purposes instead. Also attendance in the Computer tutorials has been low with an average of less than 30% of the weaker students turning up. This suggests that although the HELM workbook material can be very effective the computer laboratory it is perhaps not the best place to engage with it for some weaker students. In addition to the exercises provided in the HELM workbooks it turned out to be useful to the weaker students to be given additional exercises to get more practice.

Reflections on the use of HELM resources

Students

An online survey was conducted where students were shown twenty statements pertaining to 'Level 1' mathematics delivery in the department. We recorded 35 participants for one day. They were asked to select from five options

1, Strongly Disagree, Disagree 2, No Opinion 3, Agree 4, Strongly Agree 5

The following table shows the averaged student opinion so for example a statement scoring 4.5 will have strong agreement from the students.

1	Mathematics is one of my strongest subjects	3.6
2	Mathematics is an interesting subject	3.9
3	I believe at degree level learning is the responsibility of the student	4
4	Topics presented during the level 1 module are too basic	3
5	Topics presented during the level 1 module do not sufficiently address the basics	2.3
6	I have or will find extra maths support (e.g. Mathscope) useful	3.6
7	I am better able to understand mathematics topics because of the Helm workbooks	3.4
8	The Helm workbooks are clear and informative	3.6
9	Helm workbooks aren't sufficiently concise	2.7
10	Helm workbooks are too concise	2.4
11	Helm workbook exercises are too easy	2.4
12	Helm workbook exercises are too hard	2.6
13	Lecture sessions that closely following topics in the workbooks are appropriate	4.3
14	I have found HELM's computer aided learning resources useful	2.7
15	I have found HELM online practice tests useful	4
16	I would be happy with purely computer based assessment	2.9
17	I would like access to HELM workbooks covering more advanced topics at later stages of the degree programme	4.1
18	I think a number of assessments throughout the year more appropriate than a single exam	4.6
19	I find other online resources (e.g. videoed lectures) useful	3.3
20	I dedicate much of my own time to working through workbooks	2.4

From the high scores on items 3, 8, 13, 14, 15 and17 we conclude that students respond positively to HELM workbooks as an aid to learning.

The statement 'I *am better able to understand mathematics topics because of the Helm workbooks*' was tempered by three of students who gave 1s. These particular students exhibited a similar response to other resources including Mathscope and rated their own mathematics ability with 5s. The modal average for this question was a very positive 4. The three outlier students did however give very positive responses to the high scoring statement '*I would like access to HELM workbooks covering more advanced topics at later stages of the degree programme*' reflecting a near unanimous recognition of the potential value of the workbooks.

The statement *'Lecture sessions that closely following topics in the workbooks are appropriate'* had a particularly positive response from students suggesting the practice of writing power-point slides that mirrored the explanations and examples in the workbooks was appreciated by the students who were clearly happy to see HELM play a central role in their learning. Although it is tempting for mathematics tutors to stick to previous lesson plans and slides and thus offer HELM workbooks as a supplement; the author would instead strongly recommend an overhaul of Mathematics delivery to make HELM the central component.

Interestingly the students agreed strongly with the statement *'I believe at degree level learning is the responsibility of the student*' yet disagreed with the statement *'I dedicate much of my own time to working through workbooks'*. Suggesting they buy into the expectation of student centred learning but admit they aren't doing it. Only

15% of students gave 4s or 5s to the latter statement which was a surprise given the workbooks are ideal for revision and self learning.

It's also worth pointing out the statement with the highest agreement '*I think a number of assessments throughout the year more appropriate than a single exam*' reflected a positive response to continuous assessment. Another statement '*I have found HELM online practice tests useful'* also exhibited a positive response showing the value of HELM computer aided assessment as a mechanism for formative feedback. The students however had reservations for this to be used for summative assessment.

Results

More difficult to assess than student opinion is the objective mathematical attainment resulting from the adoption of HELM resources given there were a number of changes made to address high failure rates for level one maths modules. These included changes to the syllabus (without dumbing down), changes to assessment, new module coordinators, new timetabling, class streaming, group projects and a better integration with the university's maths support unit. However given the central role of the HELM workbooks in module delivery and the use CAA for formative feedback it is worth crediting these in part for the much higher pass rates we have now been able to achieve.

In the year 2006 after the collation of phase test and exam marks 12% failed the module outright hence requiring re-sits. It should be noted the 57% passed all phase tests outright and bulk of the remaining students were able demonstrate required achievement in the end of module exam. For comparison in the year 2003 prior to module changes there was a 52% failure rate with significant impact on retention despite the offer of re-sits.
Although students have clearly benefited from changes to the structure of assessment one can still infer significant improvements due to mathematics delivery and the role of HELM.

Although one could argue changes to assessment and subsequent higher pass rates don't necessary reflect an substantial improvement in the math prerequisite for later modules there is some anecdotal evidence coming back from module coordinators of level two and three modules that the recent cohorts are better able to cope with the mathematics and better able to engage with student centred learning than in recent previous years.

Staff

HELM resources have proved especially attractive as means of delivering mathematics modules within science and engineering programmes and since their adoption in acoustics programmes module coordinators from other discipline areas in C.S.E. at Salford (notably computing and civil / mechanical engineering) have expressed an interest. Clearly some discipline areas have well established and tailored resources for mathematics delivery and even in acoustics it was deemed necessary to work in some specific acoustic examples to better justify the mathematic content to the students.

Dissemination of higher level workbooks within level 2 and 3 acoustics modules has proved difficult given staff have well established lesson plans and perhaps fear the greater mathematical depth and lack of specific application might limit HELM's role in their lessons. However as extra support materials the resources are welcomed by both staff and students. The author has found it necessary to create password protected online access to resources for level 2, 3 and M with time dedicated to promotion of their use. Future policy may well include setting aside school funds and time to printing a selected set of advanced topic workbooks and assigning different module coordinators to distribute in classes that have clear relevance (e.g. z-transforms in D.S.P.).

Conclusion

HELM resources have played a central role in the delivery of mathematics to students doing acoustic related degree programmes in the department of Computing, Science and Engineering at the University of Salford. We can verify that the inclusion of HELM resources has been popular with students and has made a significant contribution to 'Level 1' pass rates, student mathematics attainment and more generally student learning skills. It should be noted that we suggest that to optimise the effectiveness and popularity of HELM workbooks and CAA module coordinators should consider restructuring lessons plans to make HELM central as opposed to supplementary to student learning of mathematics.