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SUMSMAN—A Project for the Mathematics Community in Scottish Higher Education*

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The SUMSMAN project is a collaboration between the mathematics and statistics departments of all 13 universities in Scotland. There are three key developmental strands within the project: the enhancement of the Mathwise system (a computer-aided learning package produced within the TLTP Technology in Learning and Teaching Programme initiative), extension of the MathPool system to each of the institutions and piloting the use of high speed videoconference technology for the delivery of shared course modules and materials. The project was funded by SHEFC (Scottish Higher Education Funding Council) under its Use of MANs initiative (Metropolitan Area Network) for the period January 1997 to August 1998. The aim of this paper is to give a brief description of these three essential areas and a discussion of the evaluation of the project and of the student and staff experience.

BACKGROUND

IN 1995, under its Regional Strategic Initiative (RSI), SHEFC funded the MathPool project which ended in the summer of 1997. This project involved the four universities within EaStMAN (Edinburgh and Stirling Metropolitan Area 155Mbaud ATM Network): Edinburgh, Heriot-Watt, Napier and Stirling [3,8]. Its aim was to promote inter-institutional collaboration and the provision of undergraduate and postgraduate courses in the mathematical sciences. The project also investigated the suitability of the local MAN for interactive sessions and joint delivery of the curriculum. At the end of 1996, in response to a further call for bids, under UMI, SHEFC funded a new project entitled SUMSMAN (Scottish Universities Mathematics and Statistics across the MANs network). The principal aim of the new project was to extend the main strands of the RSI project to all of the universities in Scotland.

COMPUTER-AIDED LEARNING MATERIALS

The Mathwise project began in 1992 through the work of the UK Mathematics Courseware Consortium, funded under TLTP [6]. The aim was to produce high quality CAL mathematics modules based on Asymetrix Toolbook and Macromedia Authorware with automatically generated exercises, animations, on-line help and bibliographies. There are currently around 30 modules with more to follow in the second phase, covering topics from trigonometry to multiple integration and applications from astronomy to mechanics. They can be used in both a standalone asynchronous mode, or individual units within each module can be incorporated into a conventional university course. The original system did not include comprehensive assessments, although interactive illustrative exercises are included throughout each module. Nor were there plans in the original project to back up the on-line courseware with related paper-based materials. One of the aims of the SUMSMAN project, as initiated by its predecessor (also funded by SHEFC) was to build on the Mathwise units by filling these gaps. The same enhancements were also required for the corresponding statistical package Statwise, produced by a team within the mathematics department at Napier University [4].

The end-of-module assessments were designed to fit the Authorware template developed within the Mathematics department of Heriot-Watt University [1, 2]. The assessment engine includes a highly useful *input tool* which enables the user to type mathematical expressions while a graphical form is simultaneously displayed. The assessment can be used in both formative and summative modes, and allows the student to break each question down into parts. The marks gained in each test are automatically recorded and these can be used as a reliable and immediate measure of the student's performance. Another important feature of the template is that it incorporates randomisation of both the selection of questions from each bank and of the parameters within each question.

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An early decision of the project team was to produce both a flexible learning study guide and a workbook for each of the modules within Mathwise and Statwise. The study guides contain useful material which complements the content of the corresponding module, and they are designed for use by the student when they are working with the software. The workbook, which is a standalone resource for students to use when they are away from the computer, includes extension material to help consolidate their understanding. Scientific Workplace by TCI Software Research is used for the word processing which produces LaTeX documents. Considerable attention has been given to designing the layout and style of the booklets to facilitate their effective use by students. A template has been generated which will allow other writers to conform to the standard style in a very straightforward way. By the end of the project, it is intended that booklets will be available for each completed module.

THE MATHPOOL SYSTEM

The predecessor to the SUMSMAN project had, as its main aim, the development of a database of teaching materials which would be suitable to share amongst mathematics and statistics departments in Scotland. Several schemes were reviewed and it was decided that a web-based system would be both timely and most useful for future applications. The system was designed and tested in 1996/97 in the East of Scotland universities as part of that project and the further development and implementation of the system was taken over by SUMSMAN [7].

The MathPool system consists of a series of HTML forms driven by Perl cgi scripts which enable users to submit electronic resources such as Word documents, Mathematica worksheets, LaTeX documents, graphics images and many others, either to be placed in a collaborative pool of material held in one university (Edinburgh) or to be held locally on the user's own department's web server for private use within their own institution. Thus, the system serves the dual needs of collating a department's resources and promoting collaborations between departments across universities.

As part of the RSI project, a survey of staff was carried out to gauge the expected usage of such a system. The results of this survey highlighted several important concerns such as security, issues of copyright and quality assurance. To address these concerns a code of conduct was drawn up. It is almost impossible to police such a potentially large system in the same way as one could with purely paper-based materials. One difficulty is that a designated checker (whether looking at copyright or quality issues) may not have access to all of the software necessary to check a particular submission. It is also an important aspect of the philosophy of the World-Wide-Web that censorship should be kept to a minimum. Hence, the code of conduct places the onus of responsibility on the shoulders of the users, with a clause that the MathPool management team reserves the right to remove or review certain materials if complaints are received (indeed, this has already happened).

Turning to more technical aspects, the system is organised as a hierarchical file system of so called *information files*. These contain titles, author names, keywords, file types and comments as well as other information. The data for these files is obtained from the person submitting the resources in an HTML form. The form also includes JavaScript-driven help boxes linked to the documentation pages. Once the form is completed the user submits the data and an extensive Perl script checks the data, downloads the files to the appropriate area (in the case of the pool, this is achieved using a Java-based network socket and private protocol) and creates the information file. The donator can choose the name of the information file and a submission to the same file acts by updating both the information file and the data files. There is also a deletion form to remove a particular information file and its associated data files. To retrieve information a user can simply browse the file system or use a search tool based on the Glimpse engine. Once found, the file can be downloaded to the user's machine in the normal way within their web browser.

For departments without access to web servers, remote customised pages are provided hosted by Edinburgh University. All of the above facilities are available to users in such institutions but donation is limited to links to web files and the data is not transferred to the server. Future versions of the system will have an option to upload such material automatically.

Limited access to the system running in Scotland can be obtained at the web site: http://www.maths.ed.ac.uk/~pool

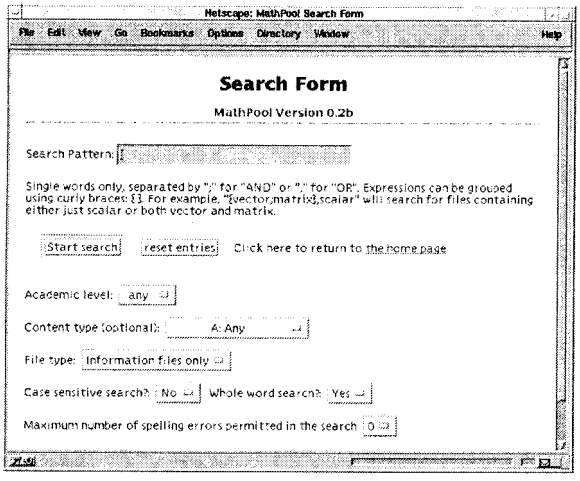

Fig. 1. One of the web forms from the MathPool system.

VIDEOCONFERENCING

One of the main motivations of SHEFC, when it funded projects such as SUMSMAN under its Use of the MANs initiative was to promote the use of this high-speed data network which connects the higher education institutions in Scotland. This network provides Internet functionality as well as sufficient bandwidth to enable high-quality multi-point videoconferencing to take place. As part of the start-up funding to universities, at least one videoconferencing suite has been set up in each university in Scotland. Such facilities are typically television studios or small classrooms. The expectation was that such a network would enable collaborative teaching between two universities, such as sharing courses which would not otherwise be viable in either institution, due perhaps to the small class sizes or to lack of teaching expertise. Another use of the MANs in higher education is the obvious application within medicine, veterinary medicine and other experimental sciences, of sharing demonstrations. Although not so obvious within the mathematics community, this use of videoconferencing has emerged as particularly useful for software demonstrations. As part of the SUMSMAN project (and following on from previous projects), we have undertaken both types of collaborative teaching and have now built up a considerable expertise in the use of such media for the delivery of mathematics. It is worth mentioning here that, in addition, an important use of the videoconferencing facilities by this project and others has been for meetings [9].

The first use of videoconferencing involved a final year group of students at the University of Stirling and a similar group at Napier University. Six lectures on the calculus of variations were delivered by a subject expert at Napier to both groups of students. The course took place over a three-week period, with a local tutor in support at Stirling. The students were supplied with printed notes and tutorial questions in advance. Throughout each of the six sessions, both sets of students had access to a radio microphone, so that discussion could be initiated by any of the participants at any time. The delivery of the sessions by the lecturer was traditional. This allowed us to compare the experiences of the students in this session with their experience of similar length modules delivered without video links. Predictably, the level of feedback during the sessions was low, as might be expected from a traditional lecture. The students may have been put off further by the cameras but it would be reasonable to conclude that videoconferenced lectures are not likely to be a useful way to promote more feedback in lectures. Indeed the whole mode of delivery in the form of a 'talking head' in a single lecture theatre, let alone in two, is never likely to enhance debate. Nevertheless, the course did demonstrate that it was possible to provide honours level courses in a topic which one of the institutions are not able to supply. This is a clear benefit to the students. The experience was sufficiently good that it is likely to be repeated again as a way to extend student choice by making a short course viable when it could not otherwise have been offered.

The second pilot took place in October 1997, involving a group of first-year students at the University of Paisley and a similar group at Heriot-Watt University. A keynote lecture on the use of a particular Mathwise module was delivered by the module author from Paisley. This was followed by a demonstration of the related assessment by the author of the assessment package from Heriot-Watt. This was a very successful session and it demonstrated one of the best uses we can make of videoconferencing in higher education: the keynote address. The mode of delivery was, in many ways, similar to the lecture course but this time the session was shorter and much more focused. The students could also benefit by being addressed by the module author himself. This added a good deal of interest and motivation as well as making efficient use of resources.

EVALUATION

Evaluation has always been an important part of this project, both as a way to assess the project itself and to 'quality assure' the methodologies and materials being used in the teaching environments. Evaluation packs have been issued for use in conjunction with Mathwise and Statwise modules. These packs include sample questionnaires and suggestions for evaluation methods. Such evaluation has been carried out for both Statwise and Mathwise units and the results will be published in a forthcoming article. Among the comments received was the view that the Mathwise and Statwise assessments did not disadvantage the students over paper-based tests. Indeed, the weak students often performed substantially better in the computer-based tests and this boosted their confidence. The students did point out that their preferred use of the resources was as a backup tool to the lectures. For example, the module assessments are particularly effective in the asynchronous mode as they include formative feedback. The main negative point was the ease with which the student could slip into a passive learning mode involving little more than just flicking from page to page. This can be avoided by including more summative assessment linked to the module and to make better use of the supporting paper-based materials.

One highly effective evaluation tool was the use of split screen video. One such session involved a student working his way through the Statwise learning material in the company of one of the authors. Half of the frame showed the student's interaction with the computer as a live screen dump, the other half was a video of the student himself with sound. Another session was carried

out in the same way with two students, both working through the Mathwise assessment. This enabled us to watch the student reactions to problems as they arose and to obtain live feedback as the session progressed. Recordings of all three sessions have been transcribed and the transcriptions will be included in the final evaluation report. However, the use of split screen video is time consuming. For this reason its use is best reserved for the developmental phase of CBL materials.

Evaluation has also been conducted for videoconferenced sessions including the one described above. This evaluation was carried out using a videoconference link with a selection of the students who had participated in the session. The evaluation took the form of a focus group and its findings showed that the students rated the videoconference sessions very highly and were keen to participate further. The students were particularly appreciative of the keynote session mentioned in the previous section between Paisley and Heriot-Watt. This evaluation session has also been videotaped and it is clear from watching the student responses that they were all highly motivated by the session which went beyond the self-selecting nature of the evaluation session.

In addition, staff from the participating universities were sent questionnaires asking about their experiences of using both Mathwise and Statwise in their teaching. The evaluation team was equally interested in people's reasons for not using the software. Reasons given included lack of planning time and inadequate hardware provision. From those who did make use of either package, the overall feedback was positive. For example, the perceived advantages included the saving of time in preparing course materials and providing an alternative learning resource. The project representative at each institution participated in a telephone interview with a member of the evaluation team. The overall feedback was encouraging; for example, there were several comments to the effect that SUMSMAN was highly successful in pulling together the mathematics community in Scotland. One worrying aspect was the difficulty that staff seem to have, mainly due to lack of time, in adapting their approach towards resource-based learning. A fuller analysis of all the data will be published in due course [5].

CONCLUSION

The SUMSMAN project has demonstrated that collaborative teaching between university departments is possible. The modes of such teaching can range from basic sharing of written materials, such as those available from MathPool, multimedia packages such as Mathwise, as well as directly shared teaching using video-conferencing. Careful evaluation of both the mechanisms of the project as well as the student experience is a valuable component of all such projects.

Web site

The project has a web site at http://www.maths.ed.ac.uk/~ama/UMI.

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