

Case Studies for HEFCE Report
Use of TLTP Materials in UK Higher Education
Haywood, Anderson, Day, Land, Macleod & Haywood 1999

Mathwise

A consistent picture emerges from our surveys of departments, courses and C&IT community support representatives that materials from the Mathwise project have a high position in a ranking of reported usage by project. The case study is divided into two sections. The first section provides a general description of the project and its products, and highlights project activities and product features which may have had a key influence on dissemination and usage. It also reports the views of lecturers, (identified from our courses survey), on features of Mathwise materials; and the reasons which they cited for adopting or rejecting Mathwise modules. The second section examines and reflects on the dissemination activities of the Mathwise project.

General Background

Mathwise has had a comparatively long life as a project. It was set up in 1992 as one of the first phase TLTP projects, and is still in existence, with continuation funding that will keep the project active until December of 1998. Funding for the project has not been continuous over this period, however; and gaps in funding over the two phases of TLTP have caused difficulties, resulting in the loss of software developers and other core staff and a 'stop/start scenario'. During the last six years the momentum and focus of the project have been sustained by an executive committee which could draw on the commitment and interest of a core group of CAL enthusiasts ; and the support of the CTI Maths & Statistics centre has also been of key importance during periods when there was a funding gap.

Development strategy and aspects of design

The particular strategy that Mathwise used for developing materials may also have contributed to the project's ability to sustain itself during periods when there were gaps in its funding. The project has produced a fairly large number of different modules and rather than have the work of development concentrated in a central, 'professional' team; it has been distributed to individual authors drawn from academic departments throughout the UK. In all, there have been 42 Mathwise authors. Distributing the task in this way has had the beneficial effect of keeping expertise and knowledge within the project, compensating somewhat for discontinuities in funded staffing. Support has been provided for the work of these individual authors; and in the earlier stages of the project's life, this support was provided by a number of separate regional centres. Involving authors from a large number of universities in the construction of Mathwise materials can also be seen to have the advantage of encouraging ownership of these materials by the academic community; and it is possible that this development strategy may have been one of the factors which has contributed to the dissemination and fairly widespread use of Mathwise modules.

Any project which involves a large authoring team faces the challenge of ensuring that there is overall coherence in the instructional design and visual presentation of individual modules. Inspection of the current version of the Mathwise materials suggests that the authors have been fairly successful in achieving a common 'look and feel' across the different modules. As another aspect of coherence and a concern for extensibility, instructional text, such as definitions, proofs, examples contained within "leaflets" in any Mathwise "learning unit" is potentially available to other learning units created within Mathwise. Mathwise modules can be customised by their users. For example, additional material can be added as "leaflets". Both PC modules and Mac modules have been produced by the project. Initially it was planned that all materials would run on both platforms; but this aim proved to be too ambitious and there are now more modules available for the PC than for the Mac. (The main

development tools for the PC version have been Toolbook and Authorware and for the Mac, HyperCard and Authorware.) The modules are designed to allow for networked use.

The Mathwise modules in use

With Numerical Algorithms Group (NAG) as partners, Mathwise produced a Demonstration CD in 1996. This was followed by the release in December 1997 of a CD which contains 48 modules. Copies ordered through NAG cost £60.00 to staff in UK Higher Education institutions. Users of the CD have been asked to report on any difficulties they experience. Over the course of this year a list of bugs has been compiled. These will be removed and a 'final' version of the Mathwise TLTP CD will be produced later this year. This revised CD-ROM will be available at no cost to current users who have sent back questionnaires asking about how Mathwise has been used and for evaluations of the current CD-ROM to the Mathwise project. (It has also been possible, during a period of the project's life, to download individual modules from an FTP site.)

The 48 modules cover a wide range of mathematical topics taught in first year at university and "a number of key topics in second-year university courses", together with pre-university material. The subjects covered in the Mathwise modules fit well with the mathematics curriculum that engineering students are expected to follow in their first two years at university. The courseware on the Mathwise CD-ROM is divided into two categories of "mathematical modules" and "application modules". The application category includes topics such as: applied differential equations, "mathematical modelling in sport", mathematical biographies, and a very extensive module on mathematical applications in astronomy.

The Mathwise project sees these mathematical and application modules as having a number of different possible functions in the learning of mathematics. They can be used as: stand-alone student-learning activities around particular topics, a means of providing tutorial support and a 'remedial' aid to individual students who are encountering difficulties in their mathematics learning. Modules mostly include self-assessment exercises which allow students to monitor their own progress; and a number provide for more formal assessment of learning. (On the matter of more formal assessment of students' learning activities, Mathwise are collaborating with the SUMSMAN project (Scottish Universities Mathematics and Statistics across the MANs) which is developing and using assessment material.)

Support materials related to the modules on the Mathwise TLTP CD-ROM are available to members of the Mathwise User Group from a password protected web directory. Among the materials available at this web directory are case studies of use and student worksheets and booklets that authors have developed for use with Mathwise.

Moving on to consider factors which have may have influenced the extent of the penetration of these Mathwise modules, it appeared from the interviews conducted with members of academic staff and from evidence gathered in our surveys that there was considerable awareness of Mathwise within the higher education sector and that, unlike the materials produced by some other projects, Mathwise was clearly identified as a TLTP project. At the same time, both users and non-users, tended to be aware of the existence of other courseware for first year mathematics, so Mathwise can be seen to be competing for attention, rather than having a monopoly position. Users had found Mathwise easy to obtain and those who had sought technical support from the project were satisfied with this service. The fact that Mathwise has been available cheaply to the academic community would seem to have been a major 'selling point' for the materials. Particularly in comparison to certain other courseware products for first year mathematics teaching, Mathwise was viewed as technically robust, and more importantly free from errors in the exposition and illustration of mathematical concepts. Ease of student use was seen as another positive feature of Mathwise materials.

Turning to possible barriers on the uptake of Mathwise, one 'non-user' of Mathwise stated that as a TLTP product it was likely to be more suited to lower-level teaching/student

learning activities, and therefore not appropriate for his department which he characterised as having a high-level, intensively taught, "traditional pure mathematics programme". Such preconceptions about the nature of TLTP products may, as in this case, prevent departments from considering their use. A different scenario was revealed by the lecturer who had carefully examined Mathwise materials at a workshop and was impressed by their general quality and style. However, she felt that the level of these materials was not appropriate to the high achieving students who entered her department. In this case the judgement not to use Mathwise materials was made in very measured terms and would seem to highlight the problem of creating a set of courseware materials that will be viewed as relevant to all sections of the diverse higher education student body. This is likely to be a particularly acute difficulty in an area such as mathematics, where large service courses have to be taught and the range of ability to be catered for may be wider than in many other subjects. Another informant commented on the difficulty of deciding exactly which constituency to 'aim at' and that it may not be possible to cater for everyone when marketing an HE wide product.

These individual voices do point up general challenges faced by a project that is trying to achieve distribution of its products across the whole of the higher education sector: to cope with the diversity in teaching and the type of students recruited by different courses, to attempt to dispel preconceptions about its products that may not be helpful. The evidence of our survey returns, which show fairly equal proportions of departments from old and from new universities reporting use of Mathwise materials, would suggest that the Mathwise project is having some success in meeting these challenges.

A few informants indicated that they saw Mathwise as including a limited range of learning activities and as tending to lead to more "passive" use by students. For these reasons, they had made limited or no use of Mathwise materials. Clearly such comments can be read straightforwardly as criticisms of Mathwise materials, or interpreted as revealing the need to give careful thought to how a 'traditional' piece of courseware is integrated into a course to ensure that more interactive, deep learning is achieved.

The contrasting experiences of students from two different engineering departments using Mathwise on a maths service course serves as a reminder of the well established finding from research on CAL that the manner in which students' learning with a particular piece of software is structured has a central effect on the processes and outcomes of learning.

One of the two departments gave its students the opportunity of optional attendance at a Mathwise session for an hour each week. These sessions were supervised by a member of staff, but there was no direction given to students who were learning with the software. In this case, where Mathwise was very much used as a 'bolt-on' to the course, the number of students attending Mathwise sessions declined and feedback from the students was not enthusiastic.

In the other department by contrast all students were given encouragement to make use of Mathwise; and a computer lab was made available for three hours each week for its use. Where appropriate individual students were also loaned copies of Mathwise to use at home. This second department also supplied additional teaching support to the ten students on the course whose mathematics performance was weakest. The supplementary course for these students consisted of a "traditional tutorial", which was followed by an hour's use of Mathwise. The Mathwise sessions were carefully directed, with the students being set clear objectives to achieve with the software. In this second department, the use of Mathwise materials was viewed to have been fairly successful and student feedback was largely positive. On the basis of results in their final exam, students who attended the supplementary course also showed a considerable improvement in performance.

This first section of the case study has reviewed the challenges faced by the Mathwise project, the factors that made for comparative success and the possible barriers that existed to wider penetration of its products. Many of the matters examined in this section have also

emerged as salient issues in the other case studies of projects. One area where the Mathwise project has taken a somewhat different direction from some of the projects considered in the other case studies is in its attempts to ensure a future for its materials by making active attempts to build up a formal user community. It seemed appropriate, therefore, to focus in some detail in the next section on the dissemination activities of the Mathwise project and its creation of a user group.

Dissemination activities and the User Group

In the last few years the Mathwise project has focused considerable attention and effort on the task of publicising its materials and developing a constituency of users. The members of the Mathwise steering group recognised that there was a need to avoid the danger of penetration being limited to isolated enthusiasts using individual modules. They wished to encourage individual departments to use a fairly large number of modules and believed that "getting together a group of some peers" would make both more intensive and wider use possible. Their proposal for continuation funding included a fair sized budget to support the creation of a user group; and indeed gaining monies for this purpose was viewed as essential for the future health of the project. Once this funding was secured, the Mathwise project set to work on this task of building a base of 'peers' within the UK academic community, establishing a sub-group of its executive to direct the development of the Mathwise User Group.

Two activities have featured largely in this drive to build up a user base. One has been the production of a widely distributed termly newsletter, 'Be Mathwise!'. The CTI Mathematics Centre has provided assistance with this and other Mathwise publicity efforts. The other chief means of bringing attention to Mathwise materials has been a series of workshops that have been held this year throughout the UK in Nottingham, Southampton, Bangor, Edinburgh, Belfast and Birmingham. These workshops have allowed participants to: have hands-on experience of Mathwise, get technical questions answered and hear accounts of how Mathwise has been and can be used in teaching and learning. They have served as a good point of contact for encouraging lecturers to sign up as members of the Mathwise User Group. The user group has its own web-site and an electronic discussion facility, as well as the password-protected collection of support materials that has been referred to earlier. A conference will be held in September of this year, at which control will be 'passed over' to the users themselves and decisions made concerning its future activities and organisation.

Pointers to general issues concerning dissemination

Given that the User Group is still in an early phase of its development, it is not yet possible to pronounce on whether this attempt to build a solid, vigorous user base is likely to achieve long-term success, or not. However, a promising beginning has been made with over 100 members registered in the User Group at the end of June 1998. Whatever its future may hold, this effort to build a user base by the Mathwise project does bring into focus matters concerning the dissemination and support of C&IT developments within the UK higher education sector that are often unduly neglected. As an initial point, within the C&IT world, particularly since the arrival of the Web, it is customary to think of users groups as being created by a distinctly 'bottom-up' process, driven by the self-organising and sustaining activities of energetic enthusiasts. However, the example provided by the Mathwise project suggests that it may be worthwhile on occasion to consider adopting a more 'top-down' approach to fostering networks that share interest and expertise in specific uses of C&IT for teaching and learning. Top-down support and direction may play a vital role until a group gains the critical mass to be self-sustaining.

Turning to another general issue which emerges from this case, the efforts of Mathwise to build a user base imply a concern not only with the immediate penetration of their products into departments but also an orientation towards the future survival of these products. In adopting such an orientation Mathwise provides a revealing contrast with much of the thinking and practice concerning the dissemination of courseware within British universities

and colleges. Given the imperatives that short-term funded projects face to achieve wide coverage quickly, the limitations on their resources and the uncertainties produced by technological change, it is understandable a) that publicity efforts are often focused within a relatively narrow band of time and that b) developing a longer-term strategy for dissemination is not always a priority.

Delivering products by means of short-term funded projects also in itself militates against the design and implementation of a longer-term publicity strategy. However, if (possibly regularly updated) versions of a courseware product are to be securely integrated within courses it would seem unwise to concentrate on a 'one-shot' delivery and assume that the quality of courseware will in itself establish its place within the higher education sector. Achieving a more sustained approach to publicising and creating a constituency for courseware within British higher education would not be a trivial task. It might require rethinking matters such as how, and for how long, projects are funded, and how the publicity efforts of individual development projects are co-ordinated.

On a more general matter, the considerable investment of energy and resources that has been made by Mathwise to establish a community of users can be viewed as demonstrating, at the very least, a tacit understanding of the importance of a felt sense of being part of a collective effort. Commitment to the use of a particular type of courseware may well be enhanced if one feels that this activity is 'validated' by a group of peers and treated by them as a routine aspect of day-to-day teaching practices.