
Older and Mathwiser?

Neil Pitcher
University of Paisley

neil.pitcher@paisley.ac.uk



Acknowledgements

I am very grateful to the Leverhulme Trust for its funding, allowing me to continue research into the use of Mathwise during the session 2001-2. This has enabled me, among other things, to conduct class observations and student focus groups, so that the observations and conclusions given in this article are based on actual observation of students using Mathwise. It is intended to write up the research in the form of academic papers in due course.

I would also like to thank colleagues at Paisley, Napier and Heriot-Watt universities for allowing me to observe some of their Mathwise classes.

Many readers will be familiar with Mathwise [1]. This project, which began about ten years ago, set out to automate the delivery of learning materials in undergraduate Mathematics. The aim was to provide multimedia text-based modules covering service Mathematics for Science and Engineering students. Computer-based assessment sections were added mainly through the SUMSMAN project [2]. The commercial quality-assured version was produced by NAG [3], based on the initial TLTP version. Although the uptake of Mathwise was quite widespread through the mid to late nineties, this subsequently tended to fall away, particularly with the advent of the Internet. Mathwise is a CD product, so that accessibility can be a problem for students, compared to Web-based materials.

In this article I shall outline some conclusions derived from recent research and evaluation I have carried out on Mathwise. I shall outline a case for the development of a new Web-based “offspring” of Mathwise. A new Mathwise should not simply be a clone of the current version, but should be structured differently, to take account of what we have discovered about how students have used the materials. After ten years we are certainly older, but we should also be a little (Math)wiser!

Comparison of Different Methods of Using Mathwise

Mathwise contains a large amount of information and can in fact be used in different ways with students. I have looked at three approaches:-

- Computer-based assessment
- Information gathering from Mathwise modules and reporting back
- Interactive experimentation

Issues of computer-based assessment are addressed in a recent article of mine, contributing to the “Maths CAA Series” [4]. There I argue that, although there are problems and limitations with Mathwise assessment, these are outweighed by its advantages. Mathwise assessment benefits students by providing a structured environment for meaningful practice, based on instant feedback.

Information Gathering and Reporting Back

In computer-based assessment, what is expected of the student is fairly clear. Using the text-based Mathwise learning units is however more complex and open-ended as an activity. There is a tendency for some students to skim through the material superficially, without engaging deeply enough with the content. In order to examine this issue more closely I set a coursework in which students had to investigate a topic, namely Complex Numbers, in depth, and write a report describing its main ideas, applications and relevance. One of the aims of the exercise was to encourage students to interact meaningfully with the text-based learning units in Mathwise.

I made observations of students working through Mathwise pages in computer laboratory classes. I found that they interacted with the content in different ways. The most common method was to progress painstakingly through step-by-step, reading all the text information and completing the interactive exercises in the sequence presented. There were however other students who were more holistic in their approach and went straight for an overview first before coming into particulars. Some students could interpret written mathematical instructions and information quite fluently and easily. They

would scan the words and grasp the ideas quickly. They were able to digress usefully into tangential areas of the Mathwise modules, without becoming unduly sidetracked. However some of the less confident students tended to focus on the text and the mathematical symbols as such, rather than on their meaning. As a result they often tended to miss the point of what they were reading. These two tendencies are perhaps typical of the deep and surface attitudes to learning that have been noted [5].

Based on my observations I would conclude that it is best not to set this kind of exercise to students at their first use of Mathwise, but only after they have gained some experience, and perhaps later in their university course, when they have advanced in mathematical and general maturity. For more experienced students the main Mathwise learning units can be useful for revision, or extra reading, to study a topic more extensively and deeply than time permits within timetabled lectures and other classes. However, it does require a fair level of maturity for a student to read and assimilate mathematical information independently, without direct input from a lecturer.

Since the initial aim of the Mathwise project was to provide materials for students in their early years of university study, it is therefore unfortunate that so much weight was placed on text-based learning units from the outset. It would have been better to have given a greater prominence to more interactive features, such as computer-based assessment. In any subsequent version of Mathwise this should be carefully borne in mind.

Interactive Experimentation

In a Calculus course I have used Mathwise to review the topic of Riemann Sums with the same set of students. In the Mathwise module "Introduction to Integration" they were directed to study page 14 of the first learning unit. This page contains a set of experiments based on Riemann Estimates (see Fig 1). By moving the slider the user is able to select the number of vertical strips and the machine then produces the corresponding diagram and calculations. The student can compare his/her own diagram and calculations with the computer's. The student can also experiment to see how the Riemann sums approach the exact integral in the limit.

When I asked students for their views on this usage of Mathwise, all their comments were positive and favourable. The opportunity to engage interactively with mathematical graphs, investigating different variations and their effects, is a powerful conceptual tool. The exercise seems to have been useful for all students, including those who were less mature in their attitudes. These more "surface" students took longer to work through the tasks, but in the end they did seem to be successful in grasping the Riemann integral concept to a fair extent.

Mathwise and Students

Students who have used Mathwise seem generally to have a positive view of it. They find it easier to use and more enjoyable than books or lectures, and feel that they learn more thoroughly with Mathwise. What attracts students to Mathwise appears to be not so much the material itself, in terms of interest or clarity, but rather the flexibility it provides for self-paced study.

When asked to rank the three kinds of Mathwise usage in order of usefulness, the students in my focus group at the University of Paisley placed interactive experimentation and computer-based assessment at equal first, with information-gathering in third place. This may well reflect the fact that the information-gathering exercise is the most demanding in terms of the maturity required. When using Mathwise with students in the early stages of their university career therefore, I would recommend that they should begin with interactive experiments, of the kind provided by the Riemann Sums page, and with some computer-based tests,

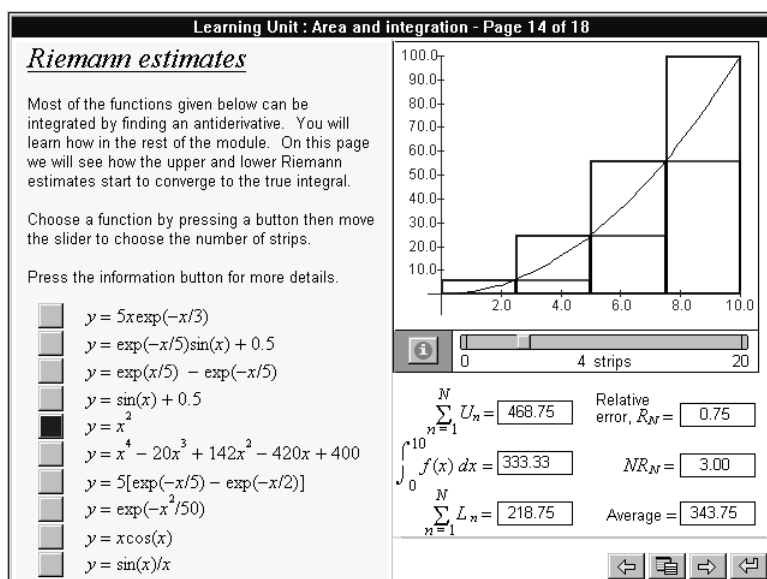


Fig 1 Mathwise page with experimentation based on Riemann Sums

for example the Mathwise test provided in the “Rules of Differentiation” module.

It is best to start students off with exercises of an experimental nature, to engage their interest in and enjoyment of the system. In parallel with this students can also be introduced to the assessment activities for specific parts of their courses. Later on, once they have gained experience in the use of Mathwise, they can be given the opportunity to study selected mathematical topics independently using Mathwise. This could be done as a “mini-project”, in which the student is expected to study a selected topic in depth and to write a report for assessment. Such an exercise, based on Mathwise, could give students a positive experience of using computer-based resources to obtain information. This could be of value to students in developing as independent learners.

A Web Version of Mathwise?

There has been a problem with the under-utilisation of Mathwise, as with textbooks and library facilities. Students often limit themselves to lecture notes. With Mathwise a Web-based version is an obvious solution to this. There is evidence to suggest that, when relevant materials are made readily available via the Internet, students will use them, not only on university computers, but also from home. My students have commented favourably on Mathwise, compared to many materials currently available via the Web. Mathwise has all relevant information readily accessible at a single location. In an activity where the student is seeking information on a specific mathematical topic, this saves a lot of time, as compared to doing a general search on the Internet.

However, in producing a Web version, we would need to learn from the Mathwise experience of recent years. I would recommend that any offspring of Mathwise should be structured differently. When Mathwise began, the modules were all text-based, with interactive parts placed within the pages. Unfortunately, in order to find the more interactive parts of Mathwise, the student or tutor has to spend quite a lot of time searching for them, so that these sections are not as accessible as they really need to be for the first-time user. With the benefit of hindsight, it was perhaps a mistake to construct the Mathwise system in the way it was.

Text-based learning units should be made less prominent. The first-time user should have ready access to experimentation exercises and to assessment sections. The latter have great potential for development beyond what is currently provided in Mathwise, particularly in

terms of larger question banks and facilities to set tests of different grades of difficulty. One very useful facility would be one by which Mathwise tests could be set, using questions from different topics, so that effectively they form a Mathwise examination.

An attractive and useful format for the next version of Mathwise could be as follows:

- Experimentation activities (2 or 3 from each main topic) readily accessible and visible
- Assessments (for each topic, but also with the facility to combine topics within a test)
- Learning Units (containing exercises, leaflets and experiments as at present) more in the background

Such a structure, mounted on the World Wide Web, would provide a set of software resources that were accessible, attractive and eminently usable by students.

We would also need to build student feedback much more carefully into the software development process. In the original Mathwise we produced too much material without testing it sufficiently on students to find out what actually “worked”. It would be much more sensible to begin with a smaller set of materials and find out how students get on with them, so as to agree a general format, before pressing on with writing more and more software.

A Web-based version produced along these lines would build on the early success of Mathwise, and would enable the initial momentum of interest generated in the project to be usefully continued.

References

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