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Author(s)	Dongsheng Zhao, Keng Cheng Ang, Gerald Cheang, Rosalind Phang and Wee Kee Tang
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Learning Mathematics Through Exploration and Connection

Dongsheng Zhao, Keng Cheng Ang, Gerald Cheang, Rosalind Phang and Wee Kee Tang

The Learning Mathematics Through Exploration and Connection project was approved by NIE Research Fund Allocation Committee on 5 August 1998 and completed in March 2001. There were nine colleagues from Mathematics and Mathematics Education Academic Group who participated in this research project.

Objectives

There were two main objectives for this project.

i to provide a good set of standardized teaching materials on the internet which could be used by lecturers and students. These materials will be integrated with other useful materials;

ii to create a good environment for the use of computer algebra system that would enable students to better appreciate mathematics through simulations and exploratory examples and exercises.

Background

During the period of 1997 to 2001, at the National Institute of Education (NIE), there were six different Mathematics content modules taught to first and second year B.A./B.Sc. students. These modules provided students with the basic definitions, theorems, algorithms and skills for proof and computation. Basic commands for Maple were also taught at the very beginning. Most of the more advanced modules have these basic modules as pre-requisites. Although there was a prescribed syllabus far each module, there could be considerable differences between what is taught by different lecturers. Furthermore, a lecturer could possibly repeat what was taught in an earlier module. It is also not uncommon for students at advanced levels to claim that they were not taught certain topics or concepts that were supposed to have been taught in the pre-requisite modules.

Many such problems arise because of a lack of a set of reasonably detailed and standardized notes that are easily accessible. We believe that an ideal solution is to put these notes onto a website, so that both lecturers and students can access them at any time. Furthermore, advanced students may need to refer to the many definitions, theorems or algorithms introduced in the fundamental modules. It would be very time consuming for students to look up several books simply to understand one concept or theorem. Having such linked websites will help these students retrieve past year notes more easily and quickly.

In the last couple of years, a Computer Algebra System (CAS), namely Maple, was used in the teaching of some fundamental and advanced modules. We found that the use of Maple enhanced the students' understanding of the concepts. A well-designed sample Maple worksheet provides students with new opportunities to explore the mathematics on their own. One way to facilitate such explorations is to attach related Maple worksheets to the notes on the website, so that the users can open the worksheets immediately after reading about the concepts or theorems.

The Project

In the light of the above-mentioned benefits, we embarked on a project to establish a system that contains sets of first and second year undergraduate mathematics notes in reasonable detail. These notes were linked within each individual module as well as between different modules. Maple worksheets were also attached to notes wherever appropriate. One of the major decisions that we made concerned the platform to be used to present the notes online. While HTML might seem the most logical, popular and convenient choice for publishing text and graphics

material on the web, it may not be the most appropriate for mathematical documents. In mathematical documents or lecture notes, one would expect many mathematical formulae and equations. Unfortunately, HTML does not handle mathematical formulae and equations very well. The team eventually decided on writing the notes in PDF (portable document format) files that can be read using the freely available Acrobat Reader. The choice of using PDF files was made because: 1) PDF files are very small, 2) converting MS Word files to PDF files is a trivial process, 3) links between parts of the documents may be made fairly easily, and 4) PDF files can be downloaded very quickly.

Main Achievements

A collection of lecture notes for modules Algebra I, Algebra II, Calculus I, Calculus II, Statistics I and Discrete Mathematics I are now linked to each other and available on a web site. The notes for each module are internally linked. One can search for and move to any other part from every page. The system we have constructed is the only one we know of that contains coherent lecture notes, tutorials as well as Maple worksheets for so many different modules. Six lecturers who have taught the modules far several years prepared the notes. The students can now access this system through the Internet to search all definitions, theorems, examples and algorithms in Year 1 and Year 2 Mathematics modules and preview what is to be taught in new semesters. They can also explore various mathematical 'ideas and concepts by using the sample Maple worksheets. The system provides a framework that makes further expansion much easier. Another benefit was that all team members learnt a great deal about producing online documents, especially PDF files. The project has also promoted the systematic use of Maple V, a very powerful computer algebra system for the teaching and learning undergraduate mathematics.

Future Development

The conversion of the notes into PDF format has its limitations, although this format is the most appropriate for our requirements at this time. We will be reviewing this mode of presentation in light of better ways of presenting mathematical material on the web. The Maple worksheets are not used within the browser. When a worksheet is launched, it appears in a separate window. This may create some difficulty for some users. We need to address this problem in the future. Also more sample Maple worksheets will be put into the system. The system will be expanded to include teaching materials of Year 3 and Year 4 modules. With the implementation of new syllabus we also need to update all the notes. In future, this system could be developed into a system for remote learning.

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