

**INTEGRATING MAPLE™ IN THE TEACHING AND LEARNING OF
MATHEMATICS FOR BUSINESS AND ECONOMICS**

By

LATIFAH BINTI MD ARIFFIN



PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the Requirement for the Degree of Master of Science**

July 2006

Dedicated to,

My beloved parents, family and friends...



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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master Science

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Chairman: Associate Professor Adem Kiliçman, PhD

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MAPLE™ technology has been trusted as an advanced mathematical and technical tool for over 25 years. In that time, millions of users all around the world have used and relied on the power of MAPLE™ for their research, testing, analysis, design, teaching and schoolwork. MAPLE™ is seen as easy to be incorporated into any undergraduate mathematical course. In this study, MAPLE™ based materials were introduced into MTH 3004 (Applied Mathematics for Business and Economics) classrooms. Before the MAPLE™ based material was developed, the analysis of student achievement during tests and final examination was done based on the previous semester's performances. This analyses was conducted to identify the difficult topics that student's could not understand the most. Based on the analyses, non-linear inequalities, inverse of three by three matrix, integrations, limits and set operation are the topics that report a high number of failures in all the examinations. The analysis was done with manual calculation and the graph was plotted using Microsoft EXCEL. Some MAPLE™ based materials had been used in tutorial classes and had demonstrated MAPLE™ as problem

solver. Positives feedback was then received from the student's since they claim that they could understand the particular topics clearly and could answer most of the questions given in quizzes and tutorials very well. However, there are still weaknesses in this MAPLE™ based materials that had been identified during the demonstration which can be improved. Some students suggested revising the MAPLE™ -based materials in the technical aspects. These aspects include the type of font, color of text and the size of worksheet. Thus, the efforts to integrate MAPLE™ into teaching and learning MTH 3004 environment are hope to increase the understanding levels amongst student's and to increase their achievements in all assessments throughout the semester. However, it is to be emphasized that MAPLE™ was not to replace the teacher's role in the classroom but to help them to become more efficient and effective in their teaching.



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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**INTEGRASI MAPLE™ KEPADA PENGAJARAN DAN PEMBELAJARAN
MATEMATIK EKONOMI DAN PERNIAGAAN**

Oleh

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Teknologi MAPLE™ telah dipercayai sebagai alat matematik dan teknikal termaju sudah 25 tahun. Pada ketika itu, berjuta-juta pengguna dari seluruh dunia telah menggunakan dan bergantung kepada kuasa MAPLE™ dalam penyelidikan, pengujian, analisis, merekabentuk, pengajaran dan tugas akademik. Oleh sebab itu, MAPLE™ juga mudah digabungkan kepada kursus matematik ekonomi bagi pelajar peringkat ijazah. Dalam kajian ini, kami memperkenalkan penggunaan MAPLE™ dalam MTH 3004 (Pengenalan kepada Matematik Ekonomi dan Perniagaan). Sebelum penggunaan MAPLE™ dalam bahan pengajaran dibentuk, analisis pencapaian pelajar dijalankan berdasarkan ujian dan peperiksaan pada semester sebelumnya. Analisis ini dijalankan bertujuan untuk mengenalpasti topik-topik yang sukar dimana pelajar sering tidak faham. Daripada analisis, didapati ketaksamaan linear, matrik 3×3 songsang, pengamiran, had dan operasi set merupakan antara topik yang sukar. Analisis dilakukan dengan menggunakan Microsoft EXCEL. Penggunaan MAPLE™ dilakukan di dalam

kelas tutorial dan mendemonstrasikan MAPLE™ sebagai penyelesaian masalah bagi kebanyakan masalah-masalah di dalam tutorial. Maklum balas positif diterima daripada para pelajar kerana mereka boleh memahami topik dengan jelas dan mudah serta boleh menjawab soalan-soalan melalui kuiz dan tutorial dengan baik. Walau bagaimanapun masih terdapat beberapa kelemahan dalam aplikasi MAPLE™ di dalam kelas ini yang boleh dipertingkatkan seperti jenis tulisan, warna teks dan saiz lembaran. Oleh demikian, dengan pengintegrasian MAPLE™ dalam persekitaran pengajaran dan pembelajaran MTH 3004, adalah diharap agar tahap kefahaman dan pencapaian pelajar dalam peperiksaan akan dapat dipertingkatkan. Walau bagaimanapun, ditekankan di sini bahawa MAPLE™ bukan untuk menggantikan tugas pengajar tetapi membantu mereka dalam meningkatkan keberkesanan pengajaran mereka.



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I certify that an Examination Committee has met on 7th July 2006 to conduct the final examination of Latifah Binti Md Ariffin on her Master of Science thesis entitled “Integrating MAPLE™ in the Teaching and Learning of Mathematics for Business and Economics” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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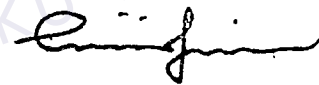
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DECLARATION

I hereby declare that the thesis is based on my original work except for quotation and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



LATIFAH BINTI MD ARIFFIN

Date: 28 AUGUST 2006



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LIST OF ABBREVIATION

%	percentage
CAI	Computer-Assisted Instruction
CMI	Computer-Managed Instruction
CAL	Computer-Aided Learning
CAS	Computer Aided System
KFUPM	King Fahd University of Petroleum and Minerals
KUiTTHO	Kolej Universiti Teknologi Tun Hussein Onn
UPM	Universiti Putra Malaysia
HTML	Hyper Text Markup Language
RTF	Rich Text Format
RGB	Red Green Blue



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CHAPTER 1

INTRODUCTION

Computer Aided System (CAS) has been used as an aid to computations for decades. It is common nowadays to include CAS as part of the teaching and learning approaches in classrooms. CAS plays the role to assists in the learning process. Furthermore it also acts as a medium of instruction and supplements in the classrooms. With CAS, the drudgery of numerical calculations can be removing leaving students to concentrate more on concepts and techniques involved in the solution of problems.

Today we have a variety of CAS available in our market. *Mathematica*, MATLAB, Mathcad, Maple™, etc. are examples of CAS that are usually used as tools in teaching and learning mathematics. For this research, we decided to work with Maple™ as we believed that Maple™ has what it takes to help us achieves our objectives and goals. Maple™ was used to demonstrate most of the hard topics with simple Maple™ program (Majewski, 2002). There are no restrictions in identifying the most suitable CAS with our needs. Maple™ is chosen as its availability in our PC system. Thus Maple™'s vast functionality provides vibrant atmosphere for mathematical computation and graphical visualization. We'll also able to create interactive technical documents with Maple™.

The Department of Mathematics, Faculty of Science at Universiti Putra Malaysia (UPM) offers several basic Mathematics Courses for undergraduate students from other departments and faculties in UPM. Some of the courses are Introduction to Algebra (MTH3001), Introduction to Calculus (MTH3002), Statistics for Applied Science (MTH3003), and Introduction to Applied Mathematics for Business and Economics (MTH3004). These courses are offered for students from other departments and faculties in UPM.

We select MTH3004 as our means of research as MTH3004 offers a selection of basic topics from calculus and algebra including its applications in business and economics. What is MTH3004? MTH3004 is a course that introduces fundamental concepts of mathematics in calculus and algebra for economics and business undergraduate students. Topics discussed include Introduction to the Basic Concepts, Set Theory, Linear Equations, Non Linear Equations and Functions, Matrices and Vectors, Differential Calculus, Integral Calculus, Differential and Integral Techniques and Sequences and Series. The application of these mathematical techniques in analyzing and solving economics and business problem is also the focus of the course.

Apart from the course outlines mentioned above, this research is conducted with reference to Kilicman [2001] manuscript in his book, Applied Mathematics for Business and Economics published in year 2001 by Penerbit Universiti Putra Malaysia, Serdang. This is because MTH3004 course content and the book contents are parallel. The contents are Set Theory, Introduction to Basic Concepts, Equations and Inequalities, Cartesian Coordinates and Lines, Matrices, Functions

and Graphs, Non Linear Functions, Differential Calculus, Integral Calculus and Sequences and Series. Furthermore this book is used in lectures as the textbook. It had been an advantage to the students as they did not need to copy the lecture notes from the transparencies and they could give extra attention to the lecture given by the lecturer. Furthermore there are several examples that students could try to solve as tutorial. This is one of the efforts taken by lecturers as to help the students to increase their level of understanding in this course.

Ruberu J. describes the Psychological Nature of Mathematics in his paper on the Psychological Basis of Learning Mathematics. Says he:

‘Mathematics, considered in a psychological sense, is a curious subject. It is not a mere collection of ‘facts’, although such factual knowledge is there in it, in great abundance. It is not an elaboration of a number of techniques, although such techniques are clearly essential for the effective use of mathematics.’(Ruberu, 1981)

Learning of mathematics is certainly need a high intellectual and creative thinking. As for those who are in this field, it is not a problem to be at the highest level of creativity. But for those who use mathematics only as part of their daily life, it is such a burden to understanding it and to applying it in their routine. They seem to be unable to understand the basic mathematical concepts even though they are not forced to work with the pure mathematical theorems or lemmas. Due to lack of understanding in the concepts, they also found it difficult to integrate the

mathematics in economics and business. Perhaps they are not clear enough to the essentials for them to sit for this course (Latifah et al., 2005).

At Universiti Putra Malaysia, our experience has been that the mathematical background of students is varied. Some of them come from arts stream and have less mathematical knowledge while others come directly from Sijil Tinggi Pelajaran Malaysia (STPM) and have been exposed to additional mathematics (Kilicman, 2001). As for MTH3004, students who registered for this course mainly are from the Faculty of Economics. This course is part of their degree program. It is a pre-requisite for their major courses. The expectations of this course are students should familiar with the basic concepts in calculus and algebra and its application in business and economics. They should be able to apply their mathematical skills in related fields when it is needed.

There are a few areas that we had identified earlier which student faces problems the most. To gain information about this matter, we had conducted 3 hour tutorial sessions for 3 different groups every week for about 14 weeks. Each group consists of 25-27 students. The idea of being a demonstrator is to become familiar with the learning environment and also to understand the way that learning process is being done. At the beginning, it is hard to differentiate between easy and difficult topic in this course. We classified the topics as easy or hard referring to responses that we gained from students at the tutorial sessions. Every students gives different comment towards topics that had been discussed every particular tutorial session. Most of the students felt that this course is one of their greatest fears, Mathematics. Many of them muttering each time when they are asked to

solve problems. Some of them even complaint that they have no basic additional mathematics, pure mathematics and etc., but there are a few of them who took this opportunity to explore and deepen their knowledge by doing extra revision and extra homework. After a few weeks, their mood of study had changed. We observed that they had given full concentration towards understanding theories and concepts of what they are learning. They have started to asked questions and gave more responses each time they were asked to.

There are 9 chapters that being taught during the semester. For the first 3 chapters, they are introduced to basic knowledge of Mathematics. Beginning with Chapter 4 until Chapter 9, they are exposed to the usage of every component in those chapters with the real life activities that is in the economics and businesses field. Majority of the students does not have any problems on the applications of economics part. This might due to the reason that they are majoring either in economics, business or accountancies. Otherwise, they are having problems with theoretical part of this course. Based on our observations, there are two major problems that had been identified. These problems are Matrices and Limits. They find that it is confusing to determined limit of a function. They could not understand the basic concept of limit itself. There isn't enough illustration material for them to visualize how limit actually works. As for matrices, the most difficult part is to find the inverse of square matrices given that the matrices are in dimension 3×3 . There are a few methods in finding the inverse. These methods are Row Elementary Operations, Gaussian Reduction Method, Gauss-Jordan Reduction Method and Cramer's Rule. Unfortunately these methods require a lot of numerical calculations and they could not determine steps they should take to

perform the operations. They also often make mistake such as inaccurate calculation during operations.

Therefore we decided to alter method of teaching and learning process being done. The main objective for this study is to integrate symbolic computing and computer graphics into MTH3004 learning environment in order to facilitate the understanding of concepts and applications in related fields. In addition, the scopes of this study are to identify the most difficult topics in MTH3004 based on student's performances in assessments which are conducted as evaluations of the course. Based on the analyses and observations made during the semester, new materials for learning and teaching this course will be develop appropriately using the Maple™ version 9 and above.

Besides the objectives mentioned above, our goals also are to improve mathematics education with the use of CAS. These CAS is identified to assist our learning and teaching process in higher education level. It is emphasized that our means is to improve our methodology but not to replace the teacher's role in classroom. Teachers are now as instructor and with CAS teachers could become more efficient and effective in teaching (Shinohara, 1981).

The effectiveness of using Maple™ is later demonstrated through test results that will be analyze. The analysis will be done to measure the usefulness on using Maple™ in teaching and learning mathematics.

CHAPTER 2

LITERATURE REVIEW

2.1 What is Maple™?

Maple™ is a comprehensive CAS for advanced mathematics. It includes facilities for interactive algebra, calculus, discrete mathematics, graphics, numerical computation and many other areas of mathematics. It also provides a unique environment for rapid development of mathematical programs using its vast library of built-in functions and operations. Maple™ has numerous built-in services and routines that enable us to extend its capabilities. We can use it not only to manipulate and calculate numeric values, but also to operate on a wide variety of mathematical and computational structures. These structures include: Equations and expressions, Arrays, Sets, Groups, Graph structures, Sequences, Tables, Lists, Strings, Procedures, etc.

2.2 Etiology

Maple™ was first introduced in 1980 with its earliest version. It was an introduction to the first research concept. It was then expanded through a few years with Maple™ 3 series in the research versions. Finally in 1985 Maple™ 4.0 was launched for its commercial version. Two years later, Maple™ 4.2 was released as an extension to the previous version.

and first in Mac™ version. It also introduced plotting element. Then in 1989 the first personal computer (PC) version was released in Maple™ 4.3.

Maple™ then offer interactive 3D plots function in its fifth version, Maple™ V released in 1990. The Maple™ V version was then rapidly developed with new and vast functionality with five new releases from Maple™ V Release 2 to Maple™ V Release 5.1. Maple™ V series provides true mathematical output, major innovations for Differential Equation solving, enhanced technical documents, context-sensitive menus and web publishing.

In year 2000, Maple™ 6 was released for the first time in its history with numeric that can compete with numerical tools like MATLAB and C. It was no longer a purely symbolic environment. Thus, it's provided with NAG-Based Numerics for Efficient Numerical Linear Algebra. Maple™ 6 provides external calling from FORTRAN and C where by implementation of the same algorithm in two different environments are no longer needed.

Maple™ 7 then introduced a year after Maple™ 6 with new features included such as units and scientific constants and also provided with more tools for research mathematicians. In this version Maple™ vastly improved in its differential equation solvers. Along with this Maple™ 7 offer real domain package where teachers can restrict computations to the real numbers, making Maple™'s outputs more understandable to students in elementary math classes.

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