Modern Undergraduate Mathematics

symposium officially opened by

Professor Tony Pettitt

Head, School of Mathematical Sciences,
Queensland University of Technology

8:15 a.m. Monday, 24 November, 1997
Room S403

Schedule of Events

Time	Monday		Tuesday		Wednesday		Time
8.30-8.55	KEYNOTE ADDRESS		Jayne	Engelbrecht	Smith	Meiring	**8.30-8.55**
9.00-9.25	Deb. Hughes-Hallett		Harman	Coupland	Carter	Varsavsky	**9.00-9.25**
9.30-9.55	McCoy	Roberts	KEYNOTE ADDRESS		KEYNOTE ADDRESS		**9.30-9.55**
10.00-.10.30	Sugden	Kageston	Jerry Uhl		Brian Stone		**10.00-10.30**
10.30-11.00	*Morning*	*Tea*	*Morning*	*Tea*	*Morning*	*Tea*	**10.30-11.00**
11.00-11.25	Barling	McIntyre	Hubbard	Norton	Coutis	Judd	**11.00-11.25**
11.30-11.55	Deakin	Anderson B	Boustead	Brooks	Morton	Keynes	**11.30-11.55**
12.00-12.25	Bokor	Ruxton	Wood	Kirunda	Rowland	Kneebone	**12.00-12.25**
12.30-12.55	Swedosh	Kannemeyer	Melton	Barry	Dansie	Thornley	**12.30-12.55**
1.00-2.00	*Lunch*		*Lunch*		*Lunch*		**1.00-2.00**
2.00-3.30	WORKSHOPS		WORKSHOPS		WORKSHOP : Stevenson		**2.00-3.30**
2.00-2.25	Hughes-Hallett/Uhl/Bulmer		Hughes-Hallett/Uhl/Scott		Henderson	Joiner	**2.00-2.25**
2.30-2.55	Hughes-Hallett/Uhl/Bulmer		Hughes-Hallett/Uhl/Scott		Smith	Cretchley	**2.30-2.55**
3.00-3.25	Hughes-Hallett/Uhl/Bulmer		Hughes-Hallett/Uhl/Scott		Angell	O'Keeffe	**3.00-3.25**
3.30-4.00	*Afternoon*	*Tea*	*Afternoon*	*Tea*	*Afternoon*	*Tea*	**3.30-4.00**
4.00-4.25	Dekkers	Snyders	Britton	Blyth	**OPEN FORUM**		**4.00-4.25**
4.30-4.55	Mueller	Flanders	Pierce	Aldis			**4.30-4.55**
5.00-5.25	Colgan	Taylor	Anderson M	Louis			**5.00-5.25**
Evening	*Cafe San Marco*		*Conference Dinner*		*Wine & Cheese*		***Evening***

Organizing Committee

Patricia Cretchley Walter Spunde
(*University of Southern Queensland***)**
Ruth Hubbard Jack Wrigley
(*Queensland University of Technology*)
Milton Fuller David Ruxton
(*Central Queensland University*)
Neville de Mestre
(*Bond University*)

Contributing Authors

with page references

Monday	Room	KEYNOTE	Chair:
24 November, '97	**S403**	ADDRESS	Patricia Cretchley

8.30 – 9.30

THE TEACHING OF UNDERGRADUATE MATHEMATICS IN THE 21ST CENTURY

Deborah Hughes-Hallett

Harvard University
U.S.A.

As the century draws to a close, mathematicians in many countries are re-evaluating their teaching practices. This talk will discuss the forces behind the movement to refocus the teaching of calculus in the U.S. and will consider some of the issues we will face in the future. It will describe what has been achieved, what remains to be achieved, and what international cooperation may contribute.

	Room	Chair
	Z303	Jack Wrigley

9.30 – 9.55

SPREADSHEETS: AN ALTERNATIVE MEDIUM FOR THE TEACHING OF BUSINESS MATHEMATICS

Gary McCoy
Neville de Mestre

Bond University

Teaching and learning mathematics at the undergraduate level often remains within the bounds of algorithm-based procedures, and lacks focus on the exploration, extension and application of fundamental and useful concepts. This paper addresses the role of spreadsheeting as a vehicle for pedagogical development and its use by Business Mathematics students as an exploratory tool, which stimulates the learning experience and provides an alternative medium in which to develop positive attitudes. Examples will be examined, which highlight the spreadsheet's usefulness with linear programming and calculus-related problems and it's relevance to concepts such as limit, continuity, discretisation, convergence and accuracy. The analysis of problems in Business Mathematics and other mathematics service courses often involved trivial solutions and simplification of concepts caused by a lack of speed in calculation and mode of presentation. The successful student is often the one who can manipulate (or derive) an algorithm correctly rather then interpret or extend results. However, if the power of a spreadsheet is projected into a problem-solving lesson, the nature of discussion takes on a quite different, more flexible and stimulating perspective. Spreadsheets are easily adaptable and yet are a very powerful tool in the problem-solving process. Currently underutilized, the application of this technology reveals an avenue to mathematical enlightenment for students and lecturers alike.

10.00 – 10.25

THE USE OF SPREADSHEET SOFTWARE TO SUPPORT THE TEACHING OF DISCRETE MATHEMATICS

Steve Sugden

Bond University

In this paper, we report experience in using a modern spreadsheet, namely, Microsoft's Excel, to support the teaching of an elementary discrete mathematics subject at Bond University. The subject *Discrete Mathematics & Algorithms* is a rather typical compulsory first-semester foundation subject for an IT bachelor degree. It is designed to establish basic mathematical principles and an to introduce associated elementary algorithms which will be used in later information technology subjects. It is argued here that the modern, graphical spreadsheet is a very useful and powerful vehicle for the illustration and investigation of many concepts of discrete mathematics relevant to a modern IT degree. Topics to be discussed will be chosen from propositional calculus, linear and nonlinear recurrences, set theory, induction, binomial theorem, number representations and Horner's algorithm for base conversion.

Monday
24 November, '97

KEYNOTE SPEAKER

Deborah Hughes-Hallett

Harvard University

Deb Hughes-Hallett is widely recognised as a leader in the field of innovation in undergraduate mathematics teaching. In particular she has emerged as a leading figure in the Calculus Reform movement in the United States. Her team of innovators, the Harvard Consortium, has explored new approaches in calculus curricula, and developed a range of texts and support materials which continue to grow in popularity.

Knowledgeable also in the areas of bridging and service teaching, Deb has a gentle and sensitive approach to the associated difficulties. Accustomed to breaking new ground, Deb has presented her ideas and the work of the Consortium in many countries. She is an active presenter and organiser of workshops and conferences.

Room **Z304**

Chair Leigh Wood

9.30 – 9.55

CONSTRUCTIVE ALIGNMENT: THEORY INTO PRACTICE

Malcolm Roberts

University of Newcastle

One possible educational framework on which to base the development or the refinement of an undergraduate mathematics course is that of *constructive alignment*. This philosophy is actually the marriage of two educational ideas. Put crudely, the first idea is that students actively construct new knowledge for themselves, while the second idea is that within a course the aims and objectives, the teaching/learning activities and the assessment all need to be aligned.

A course in Numerical Analysis (for a small class of secondary teachers) that I have developed guided by this philosophy will be presented. The discussion will cover the development of the course, the implementation of the course and an evaluation of the course. Some interesting features of the course include:

- the course is based on a series of projects,
- only about 20% of the class time is used in lectures,
- assessment is by folios, there are no exams (and the students write essays!),
- the use of technology is encouraged throughout the course. The students have given a very positive response to the course.

10.00 – 10.25

LEARNING THROUGH A GREAT VARIETY OF LEARNING AND ASSESSMENT METHODS

Owe Kågesten

University of Linköping, Sweden

The aim of this talk is to describe the result of a project at University of Linköping "Learning Mathematics Through Assessment" and how I, through changing assessment methods, had to change my role as teacher. My role became more of an organiser, with lecturers used for introduction, overview and summarising the different part of the subject, but I was also the assessor. Students were given a range of assessment tasks with assistance available in tutorials, library and one-to-one. Every student had a laptop supplied by the university. In other word I didn't have lecturers in the traditional way.

The reason that I changed my teaching methods through the assessment is that most of the student are studying to pass the exams (actually I think that most of us think in that way if we are studying to get any kind of formal competence) and have the passing as their first aim. I tried to use this to my advantage.

Another reason to change our teaching methods is that I think that I as teacher, have to create the necessary conditions to develop the whole human.

11.00 – 11.25

TOWARDS A NEW CURRICULUM: THE CHALLENGE OF TECHNOLOGY

Chris Barling

Swinburne University
of Technology

Technologies such as graphical calculators and computer algebra systems are changing forever the sort of knowledge and behaviour that will constitute the common knowledge of future mathematicians, and demographic changes are forcing into senior mathematics classes students for whom the traditional curriculum is both unrealistic and irrelevant. We need to engage urgently in a debate as to what skills and ideas we will regard as essential for the future, and how they are to be learned; what levels of mastery and of understanding we will expect of different categories of students; and indeed what we mean by "understanding" in the context of these changes. The temptation has always been to take the existing curriculum and modify it, with cosmetic additions and deletions, supposedly to accommodate the new technologies; but this will not be sufficient for the thorough ongoing revolution that is now taking place. Already the curriculum is littered with relics of ideas and methods that should have been obsolete since electronic calculators became common currency, but our thinking has yet to catch up. The author will describe some of these apparent anomalies, and suggest several important questions that need to be debated thoroughly in the coming months and years.

11.30 – 11.55

HOW THE HISTORY AND THE PEDAGOGY OF MATHEMATICS INTERACT

Michael Deakin

Monash University / RMIT

It is widely accepted, indeed often assumed to be axiomatic, that the History of Mathematics is closely linked to its Pedagogy. Students, for example, often ask “How could someone come up with *that* idea?” and imagine that the motivation is to be found in some reconstruction of the mindset of the mathematician who first *did* “come up with” the idea in question. The true story is actually much more complicated; for a start the motivation that actually worked for some mathematician from the past, is often totally unsuited to classroom use. On the other hand, there are useful links between History and Pedagogy in the study of Mathematics. There is a strong motivational thread to be found in the History of Mathematics, well adapted to the development of Positive Attitudes to Learning, and easily adopted in the Undergraduate Classroom, if the instructor pays sufficient attention to historical detail. For example, it can supply a “human face” to Mathematics, making it an aspect of human thought and culture, rather than a Platonic structure of challenging and forbidding mien. Beyond this, there *are* lessons to be learned *within* Mathematics, from its History. A number of these will be explored in this talk.T

12.00 – 12.25

WHAT IS MODERN IN MODERN MATHEMATICS AND HOW SHOULD MODERN TEACHING REFLECT THIS?

Imre Bokor

University of New England

The paper looks at changes in mathematical culture since the time of Euler and Gauss, with particular emphasis on the changes in the last few decades and dicsusses how these changes should be reflected in tertiary mathemaitcs syllabuses.

The Fundamental Theorem of Calculus is used to illustrate how these changes have altered our view and understanding of standard results, as well as our recognition of their significance. Several alternative interpretations of it are presented

11.00 – 11.25

THE EVOLUTION OF CALCULUS REFORM AT ADFA

Peter McIntyre

Australian Defence Force Academy

Over the last five or six years, various elements of Calculus Reform have been successively introduced into the first-year calculus course at ADFA. These include graphics calculators, the use of the Harvard Calculus text and weekly two-hour maths labs for Science majors.

I will talk about our experiences in implementing this program, our successes and failures as the program has evolved and our plans for further implementation.

The labs, graphics calculator programs (TI-82/83) and other course materials are available on the School of Mathematics and Statistics Web page at http://www.ma.adfa.oz.au.

11.30 – 11.55

TEACHING IN SMALL CLASSES: THE REAL REFORM?

Barbara Anderson

Australian Defence Force Academy

In conjunction with the Calculus and Maple trial held during the last six weeks of the first-year calculus course this year at ADFA, a group of nineteen students was taught in a small class (section), as a control group and as a trial in itself.

In undertaking this type of teaching, we saw an opportunity to try some of the ideas we had discussed over a number of years, but had not been able to implement. We aimed to have the students more actively involved in the class than was usually possible in the large lecture theatres, where they are mostly passive observers. In planning this for the last six weeks of the course, we understood that we would be fighting against an established *observer* culture, and that there may well be some resistance on the part of students to changing their comfortable routine.

We will discuss our expectations, experiences, evaluation and future plans for this type of teaching in first-year mathematics.

12.00 – 12.25

REFORM CALCULUS AT CENTRAL QUEENSLAND UNIVERSITY

David Ruxton

Central Queensland University

Central Queensland University was one of the first Australian institutions to implement the Harvard Calculus reform programme. In 1995 the programme was tested on a group of first year engineering students and since 1996 it has been a core requirement for both our first year mathematics degree students as well as for the engineers. We offer the programme in internal and external modes - the latter both within Australia and overseas.

The talk will briefly summarise our experiences to date. After some discussion of implementation, evaluation and articulation issues, particular attention will be paid to modes of assessment and the mechanics of offering the programme to distance students. Our experience so far has been encouraging in that, although as yet there is little clear evidence of improved mathematical performance in later years, student surveys clearly indicate the development of an ongoing positive attitude to learning mathematics for most respondents. Students as well as their lecturers and tutors appear to enjoy the approach and that in itself engenders a positive learning outcome.

12.30 – 12.55

IN DEFENCE OF MATHEMATICS

Philip Swedosh

University of Melbourne

Mathematics is under siege. Over recent years mathematics has been under attack on a number of fronts. Far less time is now allocated to mathematics in schools. This has caused a significant deterioration in the skill levels of mathematics students. About 50% of all Year 7 and 8 mathematics classes are taught by individuals who have never studied a single mathematics subject at tertiary level. The proportion for Years 9 and 10 is about 20%. Fewer students are studying mathematics at upper secondary and tertiary levels. Mathematics is an invisible achiever. Mathematics underpins virtually every scientific pursuit, large areas of medical research and the financial sector, but often its contribution goes unnoticed.

Due to concerns about the health of mathematics, the Australian Mathematical Society has decided to promote mathematics and the author has been seconded as Mathematics Publicity Officer. Duties include liaising with the secondary and tertiary education sectors highlighting the advantages of studying mathematics, providing career information for mathematics teachers, and preparing publicity material, data and statistics. Developments will be discussed. The situation with regard to the health of mathematics is serious, but actions can be taken to rehabilitate it if we fight for its life *together.*

WORKSHOP Room Z303

2.00 – 3.30

TEACHING CALCULUS INTERACTIVELY USING CHALLENGING PROBLEMS

Deborah Hughes-Hallett

Harvard University
U.S.A.

The workshop will provide hands-on experience with materials from the Calculus Consortium Based at Harvard. It will include a discussion of changes in emphasis in calculus courses, and the uses of group work and projects

WORKSHOP Room S1030

2.00 – 3.30

MATH WITH MATHEMATICA

Jerry Uhl

University of Illinois
at Champaign-Urbana
U.S.A.

Participants can play with the courseware behind *Matrices, Geometry & Mathematica* currently in preliminary service at Illinois and Davidson and in internet distance education. This is the first course to be based from the start on the geometry behind the singular value decomposition using a visual approach through computer graphics. (*C&M* and *Diffeq* material will also be available to those who want to play with it.)

Matrix multiplication is studied through the inherent geometry embedded in a matrix, e.g. students will find that if A is a matrix with a positive determinant then multiplication by A is a rotation, followed by a stretch, followed by another rotation. Each facet of matrix theory is approached in a similar geometric fashion. Some applications highlighted in the course: Ray tracing in two and three dimensions; Adjusting for measurement error ; Continuous dynamical systems such as systems of differential equations; Discrete dynamical systems such as Mendelian genetics; 3D pictures of surfaces in higher dimensions; Image compression; Roundoff errors.

This is *fair dinkum* different approach to linear algebra.

Monday	Room	Chair
24 November, '97	**Z304**	Bill Blyth

12.30 – 12.55

REFORMED CALCULUS TEACHING: THE UWC EXPERIENCE

Larry Kannemeyer

University of the Western Cape
South Africa

Many students accepted to study science related courses at UWC are poorly prepared for first year mathematics. It has been necessary to provide these students with an empowering learning experience, helping them to surmount their scholastic inadequacies. An alternative first year mainstream course was implemented at UWC in 1993. With the continued development of this course the coordinator gradually implemeted some of the principles and strategies of the *calculus reform* initiative begun in 1986 in the USA. The nature of the issues raised by the reformers resonates with the position of the coordinator that *doing* mathematics is fundamental to the enhancement of students' learning of mathematics. Based on the results and appraisals of the students' who attended, the course has successfully given more students the opportunity to achieve a credit for first year mathematics as well as raising their affinity for the study of mathematics. There is no one magical method - workshop lectures, or use of technology, or writing, or lab sessions. It is the integrated use of these things that we have to evaluate. Curriculum changes such as spiralling the curriculum and adopting the principle that *less is more* also played a significant role in enhancing students' learning

WORKSHOP Room V208

2.00 – 3.30

CALCULUS CONNECTION

Michael Bulmer
Diane Donovan
Catherine Holmes
Bevan Thompson

University of Queensland

Calculus Connection is a CD package, developed by Quinney, Harding and IntelliPro Inc, dealing with the theory and application of calculus. There are two compact discs, that are divided into 8 modules, covering topics from simple functions, through differentiation and integration to sequence and series and differential equations. One exciting feature of this package is the inclusion of interesting applied examples that have non-trivial solutions.

During this presentation we discuss the scope of this package and present the advantages and disadvantages of using *Calculus Connection* at a tertiary level. We will take each CD separately and document our experiences using this package in the classroom. Here we will use specific examples to demonstrate the versatility of this package. As part of this workshop participants will work through carefully selected exsecises which empahsise this versatility.

We will conclude our presentation by discussing the necessary environment in which to gain the maximum benefit from using *Calculus Connection* as a teaching tool.

Ferry across the river

to

Cafe San Marco

after
the evening session
of contributed papers

4.00 – 4.25

THE GRAPHICS CALCULATOR AND THE STIMULATION OF LEARNING IN SERVICE MATHEMATICS

Antony Dekkers
Milton Fuller

Central Queensland University

Graphics calculators have become an important component of the learning process in mathematics. Due to its versatility as a learning aid and marked cost reduction in the price of individual calculators students are embracing this technology. Many textbooks are now written with the assumption that students not only have access to, but also have basic skills in the use of this hand held technology. There is a need to support students to utilise the exploratory and investigative features of the calculator to stimulate mathematical thinking skills.

This paper will discuss and demonstrate a program of workshop activities which have been developed to provide a range of learning experiences in mathematics for first year engineering students. The emphasis is to use the enthusiasm of the student to generate positive learning outcomes.

The activities are based on the HP38G and HP48G graphics calculators and relate to essential concepts in algebra, matrix algebra and the differential and integral calculus.

4.30 – 4.55

IMPLEMENTATION OF THE USE OF A GRAPHICS CALCULATOR IN UNDERGRADUATE LINEAR ALGEBRA COURSES

U.Mueller, P.Pedler,
M.Anderson L.Bloom

Edith Cowan University

In this paper we first describe the implementation of the use of the HP48Ggraphics calculator as a teaching and learning aid in an intermediate linear algebra course at the undergraduate level. We outline the approach we have taken in this and discuss some of the problems that arose in relation to the calculator use. We detail the strategies adopted to address these problems and discuss changes in the assessment that became necessary because of the use of graphics calculators. We look at students' perceptions of the calculators and discuss the calculator techniques actually used by students in the final examination. Finally we consider the implications for a successful implementation in a larger first year unit.

5.00 – 5.25

MATLAB IN FIRST YEAR MATHEMATICS

Len Colgan

University of South Australia

In 1996 the Faculty of Engineering at the University of South Australia completely redesigned its undergraduate degrees. In particular the courses were structured so that graduates would be expected to possess specific qualities determined by both the university and the Institute of Engineers. This had ramifications for the teaching of mathematics. During the first year, we needed to include the following:. a knowledge of MATLAB, opportunities for problem-based group work opportunities for self-learning of material not covered in lectures. The central concept in achieving these goals was the production of a guide *A Focussed Introduction to MATLAB*. A complimentary copy was given to all first-year students. The first version had an introduction of 33 pages followed by more than 120 pages of examples illustrating MATLAB approaches and solutions to problems selected from the calculus and linear algebra textbooks. This special feature of creating a bridge between MATLAB and the textbooks had the bonus of motivating students to refer to those books more often. Many students also purchased the book *MATLAB 5.0 Student Edition* to install the disc on their home computers. The brief presentation will show a couple of examples from the guide and a problem (judged difficult from previous experiences for an individual assignment question) that was set as one group exercise.

4.00 – 4.25

IMPROVING LEARNING OF MATHEMATICS IN A MULTI-CULTURAL SOCIETY

A Snyders

University of Port Elizabeth
South Africa

How does one teach the basic concepts of calculus like limits or continuity to students who cannot factorize a quadratic trinomial; who struggle to simplify algebraic fractions; whose comprehension of the language of instruction is less than adequate and who think that to achieve success it is sufficient to pay attention during lectures and to understand the concepts - no hard work is necessary. Such students are clearly underprepared or even totally unprepared for studying Mathematics at tertiary level. Most university lecturers would simply say it is an impossible task and these students should never be allowed to enrol at universities. The practical reality is, however, that for political and other reasons, mathematics departments at universities in South Africa are forced to work with students similar to those described above. In this paper the author discusses some of the programmes being run by the University of Port Elizabeth in order to improve learning of mathematics on first year university level, particularly for unprepared students from the so-called disadvantaged communities in South Africa. These programmes include extended curricula, small group tutoring, language, lifeskill and computer literacy programmes as well as peer group teaching through Supplemental Instruction and Video Supplemental Instruction. Data reflecting success achieved with some of these programs will be given.

4.30 – 4.55

A FIRST STEP TO UNDERGRADUATE MATHEMATICS FOR ADULT LEARNERS

Margaret Flanders
Lynne Campbell

Central Queensland University

Government policy in the areas of access and social justice has provided the major impetus for the widespread develop-ment of preparatory and bridging programs offered at Australian universities over the last decade. In 1986, Central Queensland University applied for and received funding to run such a course: Skills for Tertiary Education Preparation Studies (STEPS). Demand for places within the course has progressively increased. This paper describes how the mathematical component of this course is structured to accommodate and motivate adult learners who exhibit varying degrees of mathematical preparation prior to undergraduate entry. The course specifically aims to provide opportunities for the learning of concepts and techniques, fundamental to any course at tertiary level involving mathematics and statistics. Students are given the opportunity to participate in a flexible learning environ-ment which combines technology, self paced text materials, customised instruction and regular feedback to generate positive learning outcomes. Two fundamental issues explored in the paper are the recognition that the students involved are adult learners and that the creation of a suitable learning environment is a key factor in offering a successful math-ematics programme. If mathematics units can be offered to students in an environment similar to that of the STEPS programme, improvements in learning may well occur.

5.00 – 5.25

A FOUNDATION COURSE IN GENERAL MATHEMATICS : AN EXPERIMENT IN FLEXIBLE LEARNING FOR ON AND OFF CAMPUS STUDENTS.

Janet Taylor
David Mander

University of Southern Queensland

As increasing student diversity becomes a part of higher education, across the world universities are concerned about the preparedness of first year students. This paper describes stage 1 of the development and evaluation of a multistage project designed to increase the flexibility and change the focus of a first year general mathematics course which caters for a broad range of disciplines across the university (engineering, science, business, education). The curriculum for the unit is student centred and is characterised by the use of self paced instruction strategies, mastery learning, and the integration of a bridging course with the core first year maths unit to provide at least 3 possible pathways to successful completion of the objectives. This new design allows students to complete the unit at a level and pace to suit their entry skills with exit points available throughout the two semesters of offer. Preliminary results on the implementation of the 1997 trial with 170 on campus and 320 off campus students are detailed and indicate the necessity and success of such a program. Successes and difficulties of the development are discussed including future directions and implications.

Tuesday	Room	Chair
25 November, '97	**Z303**	Helen Chick

8.30 – 8.55

SELF-PACED AND EXTERNAL MATHEMATICS AT SOUTHERN CROSS UNIVERSITY

Nicola Jayne
Jamie Walton

Southern Cross University

Over the past 6 years the first year units Business Mathematics, Statistics I and Discrete Mathematics have moved from a traditional lecture/tutorial delivery to a self-paced mode. Furthermore, as these units are now being offered externally as well as internally, the self-paced mode has been easily adapted to external study.

The self-paced mode allows the teaching staff to effectively meet the varying needs of the first year students who have a wide range of mathematical experience and ability. This is achieved by optional workshop attendance, the use of comprehensive study guides with related textbooks and/or readings and by regular testing.

The self-paced methods that have been developed work well in both the internal and external delivery modes.

This paper will examine the methods and resources developed for both internal and external students, the problems encountered, the modifications made and the problems that still remain

9.00 – 9.25

A MODEL FOR TEACHING AND LEARNING MATHEMATICS AT A DISTANCE WITH DESKTOP VIDEO CONFERENCING

C. Harman, W. Tan, M. Dorman,

University of Southern Queensland

O. Jegede

Open University of Hong Kong

An interactive teaching/learning model has been developed and trialled for creating a virtual face-to-face environment using a Desktop Video Conferencing (DVC) system. This model was developed at USQ and was used with a subgroup of students studying a 1997 Semester 2 unit in calculus and linear algebra. Regular weekly sessions were held with this subgroup as a supplement to their normal distance education studies. The technology used included PictureTel DVC systems, Smart2000 electronic whiteboards, applications software and video tapes. Various measures were used during the project to provide objective information for analysis of (i) the complexity of the teaching/learning environment, (ii) the effectiveness of the methodology in providing a medium for conveying mathematical ideas, and (iii) the improvement in student understandings and skills. A description of the model and the outcomes of the project are presented here together with a discussion of the many advantages to be gained by using such a DVC model for distance education in mathematics. A commentary is also given on the perspective from a teacher's viewpoint, together with the balance of associated benefits, costs, and problems.

KEYNOTE ADDRESS	Room	Chair
	S403	Walter Spunde

9.30 – 10.30

WHAT CAN BE DONE TO IMPROVE THE LEARNING OF UNDERGRADUATE MATHEMATICS STUDENTS ?

J. J. Uhl

University of Illinois
at Champaign-Urbana
U.S.A.

- Communicate new ideas visually and experimentally; get an idea across before putting language on it; motivate students to want to learn by serving up problems whose importance is recognized by the students.
- Approach mathematics as a science, not as a language or as a liturgy. Eliminate introductory lectures; make students masters of their own active learning. Keep the language in the vernacular. Give the students a chance to organize their thoughts by explaining themselves in writing. Give the students the opportunity to learn the mathematics and the technology in context. Ask students for explanations, not proofs. Give the students professional tools.

Illustrations of these principles will be drawn from the courses *Calculus & Mathematica*, *DiffEq & Mathematica* and *Matrices, Geometry & Mathematica* now in service both on campus and through internet distance education via the NetMath Coalition.

8.30 – 8.55

DO WE SEE WHAT WE DO OR JUST DO WHAT WE DO?

Johann Engelbrecht

University of Pretoria /
University of Venda
South Africa

This talk is about visual mathematics. For most students (myself included), understanding of most mathematical concepts is impossible without a geometrical/visual picture. We have grown accustomed to use geometrical mathematical terminology like "square", "cube", "geometrical series" in an entirely non-geometrical context, without ever thinking of the geometric meaning and background of this terminology. This has the effect that mathematics is often conducted (or played?) as a self-contained activity (or game?), almost with contempt of reality.

The use of technology opens up the possibility of, not only seeing what we are doing, but also being able to supply convincing arguments (or proofs) for many mathematical facts and ideas.

In this talk a sample of (existing) geometrical interpretations and/or "proofs" for some mathematical ideas and facts ranging from elementary algebra to multivariable calculus, will be discussed.

9.00 – 9.25

WHY DOES IT MOVE LIKE THAT? USING ANIMATION TO EXPLORE SOME BASIC MATHEMATICAL CONCEPTS

Mary Coupland

University of Technology

Sydney

In this presentation I will describe several animations and still pictures that can be easily programmed in Mathematica. They could be used for demonstrating concepts in the topics complex numbers, three-dimensional geometry, and eigenvectors. While demonstrations in lectures are useful and attention-grabbing, I believe that if our aim is student learning, a more powerful use of the technology is to engage students in their own explorations, preferably in small groups or pairs. They can be given an animation and asked to explain why it does what it does, or asked to extend an idea to investigate related topics. Some of the work done by students in this way will be described, and feedback from students will be discussed.

KEYNOTE SPEAKER

J. J. Uhl

University of Illinois
at Champaign-Urbana

Jerry Uhl is well known to the mathematical community as managing editor of the Proceedings of the American Mathematical Society and as a member of the Council of the A.M.S. He is co-author of the research monograph, *Vector Measures*, (with J. Diestel), an advanced undergraduate textbook, *The Mathematics of Nonlinear Programming* (with A.L. Peressini and Francis Sullivan) and has written some fifty research papers and supervised ten doctoral theses.

With Bill Davis of Ohio State and Horacio Porta of Illinois, he has been the developer of the outstanding *Calculus & Mathematica* program, which is truly a program rather than a textbook. Subsequent programs *DiffEq & Mathematica* now in class testing at Illinois and Ohio State, and *Matrices, Geometry and Mathematica* being tested at Illinois and Davidson College, North Carolina, demonstrate the richness of his approach. Jerry has demonstrated *Calculus & Mathematica* throughout the United States and in Switzerland, Singapore, Egypt, South Africa, Puerto Rico and, now, in Australia.

11.00 – 11.25

WHY DO STUDENTS ATTEND LECTURES AND WHAT DO THEY LEARN?

Ruth Hubbard

Queensland University
of Technology

Several years ago there were heated discussions in the higher education literature about whether lectures were or were not an effective medium for promoting learning. I was firmly of the view that lectures were not effective, although my view was based on my own impressions and not on any data. Today cooperative and collaborative learning styles are in vogue, but do we know that these approaches are better than lectures?

Since I was allocated to lecture to large groups of Engineering students this year I decided to try to find out why they came to lectures and what they learned from them. The results of my investigations surprised me. Briefly, the students said that they came to lectures to learn and they demonstrated that they did learn.

11.30 – 11.55

EXPOSITORY READING FOR LEARNING IN UNDERGRADUATE MATHEMATICS: TECHNOLOGY VS TEXTBOOK

T.M. Boustead

University of Canterbury
New Zealand

Independent study is an essential part of tertiary learning. The reading of expository hard-copy material in undergraduate mathematics, whether via textbooks, lecture notes or handouts, currently plays a major role in the construction and development of student understanding. Although hard-copy text reading is still a cheaper and more accessible option than computers, the future is changing. In this paper a comparison is made between expository reading and learning of the same 'new' topic via a textbook, an interactive textbook on CD ROM and a multimedia package. The study is a preliminary investigation using 14 first year mainstream mathematics students during one and a half hours of taped interviews, pre-tests, post-tests and observations of reading and study behaviour. The aim of the study was to assess the most effective medium for independent undergraduate mathematics student learning. Students using the CD text obtained the highest post-test scores for recall of concepts, procedures and knowledge of applications. The lowest post-test scores, especially for knowledge of concepts and procedures, were obtained by students using the multimedia package. Pair sharing of texts achieved higher post-test scores than individual text reading. Further investigations to confirm these findings for larger samples are currently in progress.

12.00 – 12.25

TEACHING COMMUNICATION SKILLS IN MATHEMATICS

Leigh Wood
Geoff Smith

University of Technology
Sydney

Mathematics teaching, learning and assessment is changing. As we move to more varied assessment tasks and require students to express their ideas and results, both orally and in writing, we need to be explicit as to our expectations. Students are required to explain their ideas, report on computer explorations and make conjectures from their experiments, but we often only explicitly teach the mathematical concepts and skills and expect students to learn communication by osmosis.
We have developed an approach to teaching communication skills that combines developments in mathematics education with developments in language teaching. We use subject-specific content that highlights the relationship between the symbolic and the natural languages of mathematics and shows students how the style of the natural language used to describe mathematical concepts must vary depending upon who is being communicated with. At the same time we extend students' knowledge of mathematics and its applications, and give them opportunities to practise communicating with each other about these.

This session will address these ideas, with concentration on the design of curriculum and assessment tasks to develop skills and concepts in mathematics and communication.

11.00 – 11.25

MAKING THE TRANSITION

Pam Norton

Monash University

Carol Ashton

Croydon Secondary College

The Department of Mathematics at Monash University has had two high school mathematics teachers join them for short periods over the last two years, with the aim of identifying and solving transition issues, so as to improve student learning in undergraduate courses. The biggest problem to address is that of the learning environment - students come from an environment that fosters collaborative learning, co-operative investigation, close personal relationships, closely monitors work output and conceptual understanding, has a (complete ?) lack of rigour in mathematics teaching, focuses on concrete examples, real-world applications and visual learning experiences, has a fairly even gender balance and places an increasing importance on technology and its use. This is pretty much the opposite of what happens in the traditional university. The most important recommendation from this work is that universities must help the students acquire independent learning skills, by giving assistance when needed, having staff who are personable and approachable and encourage and reward active participation by the students.

11.30 – 11.55

TRANSITION TO TERTIARY MATHEMATICS - AN INTEGRATED APPROACH

Malcolm Brooks
Mary Hewett

University of Canberra

Our teaching in first year mathematics officially assumes that students already possess a range of mathematical knowledge and skills. However with no formal prerequisites demanded by our Faculty and our experience has been that more and more students come to us with a great diversity of strengths and weaknesses in their mathematical backgrounds and with as many reasons explaining this diversity. To help students to overcome this potential handicap, take responsibility for their learning at the outset and enhance their likelihood of success in first year mathematics and beyond, we have devoted the first four weeks of first semester to a comprehensive and compulsory program of prescribed readings, sample materials and mastery tests on fifteen essential 'prerequisite' topics. To allow for different learning styles and paces we have incorporated flexibility into the program both in the time provided to complete the program and in the delivery (fledgling). The program has run in 1996 and 1997. This paper describes the 'mastery' program, presents comparative results showing students final performance in relation to their mastery performance, to their TER and to their pre-tertiary maths score. We also compare the TER and students' actual maths score. Finally we look at student outcomes in first year mathematics before the mastery program was in place and since, enabling us to comment on the success or otherwise of this program.

12.00 – 12.25

CHALLENGES IN UNDERGRADUATE MATHEMATICS TEACHING IN A LESS DEVELOPED INSTITUTION IN SOUTH AFRICA.

Ezra Kirunda

University of Venda
South Africa

A variety of students are admitted into undergraduate mathematics courses at the University of Venda. This include students with varying exposure and background to school mathematics. A retrospective study was conducted to analyze the performance of undergraduate mathematics students, and various factors that could affect their performance for the period (1992-1996) explored. Over the five-year period, 649 students registered for the first year mathematics major course, 5123 for the service courses and 7694 for the Bridging courses. Of these, 324 in the first year mathematics major course, 3388 in the service courses and 4781 in the Bridging courses wrote examinations. The success rates were 68.2%, 68.5% and 71% respectively. The lack of basic mathematical concepts and large class sizes were identified as some of the major factors affecting overall performance and contributing significantly to the drop out rate. Methods used to improve the learning of mathematics in this environment are discussed. Future trends envisaged for this university include among methods the introduction of Computer Based Mathematics learning and staff recruitment drive to reduce student-lecturer ratio.

12.30 – 12.55

PREPARING FUTURE EMPLOYEES VIA MATHEMATICS CLASSES

Austin Melton
Beverly Reed
Thaddeus Shura

Kent State University
U.S.A.

Industries and businesses need well trained employees. However, an important part of the training which these future employees need is not commonly found in universities or even in trade schools. By taking with employers and listening to them on panels, one learns that employees with the following traits are desperately needed. Employees need to be able to work in empowered groups in which the members have diverse backgrounds and different areas of expertise, communicate with others in and out of the group, and work on problems which are only partially specified or partially understood.

A mathematics class is a natural setting in which students can experience situations in which the above traits can be observed and learned. In this presentation we'll examine mathematics learning situations in which using the above traits is natural and needed for completing the assigned projects. In particular, we'll discuss this learning environment for an elementary data analysis class.

WORKSHOP Room Z303

2.00 – 3.30

TEACHING CALCULUS INTERACTIVELY USING CHALLENGING PROBLEMS

Deborah Hughes-Hallett

Harvard University
U.S.A.

The workshop will provide hands-on experience with materials from the Calculus Consortium Based at Harvard. It will include a discussion of changes in emphasis in calculus courses, and the uses of group work and projects

WORKSHOP Room S1030

2.00 – 3.30

MATH WITH MATHEMATICA

Jerry Uhl

University of Illinois
at Champaign-Urbana
U.S.A.

Participants can play with the courseware behind *Matrices, Geometry & Mathematica* currently in preliminary service at Illinois and Davidson and in internet distance education. This is the first course to be based from the start on the geometry behind the singular value decomposition using a visual approach through computer graphics. (*C&M* and *Diffeq* material will also be available to those who want to play with it.)

Matrix multiplication is studied through the inherent geometry embedded in a matrix, e.g. students will find that if A is a matrix with a positive determinant then multiplication by A is a rotation, followed by a stretch, followed by another rotation. Each facet of matrix theory is approached in a similar geometric fashion. Some applications highlighted in the course: Ray tracing in two and three dimensions; Adjusting for measurement error ; Continuous dynamical systems such as systems of differential equations; Discrete dynamical systems such as Mendelian genetics; 3D pictures of surfaces in higher dimensions; Image compression; Roundoff errors.

This is *fair dinkum* different approach to linear algebra.

Tuesday 25 November, '97	Room **Z304**	Chair Janet Taylor

12.30 – 12.55

DEFINING AND ASSESSING ESSENTIAL MATHEMATICAL SKILLS

Steven Barry
Stephen Davis

Australian Defence Force Academy

Ever marked an exam with a statement like 1/y+1/x=1/c -> y+x=c in it? We have. And not just once. And not just from first year students. The decline of our student's ability to do skills we consider {\em essential} is of current concern nationally and internationally. In 1995 we set up the Essential Mathematics Scheme to help remedy this problem. This scheme is loosely related to the Gateway Testing Schemes used in some American Universities.

This scheme *defines* clearly to students in *all* years which material we consider essential for them to have completely mastered - from fractions and calculus through to differential equations. The scheme is based around a clear set of notes and a series of tests which the students must pass (with 80% a pass mark). In our talk we will discuss the operation of the scheme and its results (such as the strengths and weaknesses of the students - some which will surprise you). We will also call for discussion on what skills should be considered essential for a mathematics undergraduate degree and the best way of testing and training our students in these skills.

WORKSHOP Room Z304

2.00 – 3.30

EXPLORING CALCULUS: AN EXPERIMENT IN COMPUTER AIDED LEARNING

Paul Scott

University of Adelaide

This year I have been working on a HyperStudio program designed particularly for those of our Level I Mathematics students who come to University with weaker backgrounds. The program is designed for tutorial or individual use, to reinforce material given in lectures. I have tried to make it an attractive, interactive, fun package. Although the project is by no means complete, there has already been a very positive student reaction. Problems, particularly with notation and graphs, and their solutions, will be discussed, and the program demonstrated.

The workshop would be an opportunity for people to try out the package, and I will answer questions.

Conference Dinner at

The Lyrebird Restaurant *

tonight at 7pm !

After dinner speaker
Ansie Meiring
Of shoes and ships and sealing wax, of cabbages and calculus . .

* adjoining the *Lyric Theatre* in the *Performing Arts Complex* (across the river) ($35 per person).

4.00 – 4.25

CHANGING THE ASSESSMENT MIX TO IMPROVE LEARNING

Sandra Britton
Jenny Henderson

University of Sydney

At the University of Sydney approximately 400 pass-level engineers study mathematics in second year. Many of them have little interest in mathematics. In first semester all these engineers take two courses -- *Vector Calculus and Complex Variables* and *Matrix Applications.*

Over the past two years we have tried new strategies to encourage more than surface learning by students in these courses. The main thrust has been a change to the assessment procedures. Previously the assessment was based almost entirely on the final exam, with a small assignment component. We have introduced tutorial *participation* marks, and short quizzes. The participation marks were devised as a way of encouraging students to actively engage in some mathematics during tutorials. We hoped that the quizzes would encourage some learning to take place throughout the semester (rather than just before the exam). Both strategies rely for their success on the support and compliance of the large number of tutors involved.

In this talk we will discuss in more detail what we have done, and why; report on the successes and failures of the new strategies; and comment on plans for the future.

4.30 – 4.55

REFLECTIONS ON ASSESSMENT WITH ACCESS TO COMPUTER PACKAGES

Robyn Pierce
Lyn Roberts

University of Ballarat

Given that assessment drives student learning, the role of Computer Algebra Systems and statistical packages in the teaching and learning of mathematics and statistics will be greatly influenced by their place in assessment. In first year undergraduate mathematics our students have been introduced to CAS, either DERIVE or Maple. When use of CAS was not specified for assignments, students seemed to feel that their use was illegitimate, and while they may have used technology to check answers they seldom acknowledged this. For assignments where use of CAS was strongly encouraged, the shift in emphasis from 'getting the answer' to 'explaining the answer' challenged students. Experience with examinations similarly showed that making CAS available shifted the focus towards higher order thinking. Our experience in statistics has been that the use of technology has changed key learning objectives from how to evaluate formulae to application and interpretation. Students are expected to make use of technology for assignments and either are presented with computer output in exams or have access to the data prior to the examination. This paper reflects on the outcomes of some assessment options we have explored which incorporate the use of computer packages.

5.00 – 5.25

THE IMPACT OF THE GRAPHICS CALCULATOR ON THE ASSESSMENT OF CALCULUS AND MODELLING

M. Anderson, L. Bloom, U.Mueller, P.Pedler

Edith Cowan University

In this paper we consider some changes that the use of graphics calculators imposes on the assessment of calculus and mathematical modelling at an undergraduate level. For a student who is proficient in the use of a graphics calculator many standard questions involving differentiation, numerical integration or the graphing of functions do not necessarily test the mathematical skills traditionally regarded as fundamental. Furthermore, the use of a graphics calculator requires new skills to be acquired and employed effectively. Any assessment will therefore need to take into account such items as transcription skills, the limitations of the calculator and the student's ability to frame problems. We indicate some of the ways in which the assessment of mathematical tasks can be modified as the mechanics of calculation become routine and questions of analysis and interpretation assume greater importance. Particular reference will be made to the HP48G graphics calculator.

4.00 – 4.25

LABORATORY BASED NUMERICAL ANALYSIS WITH MATHEMATICA

Bill Blyth

Royal Melbourne Institute of Technology

Mathematica has been used to fundamentally change the teaching, learning and assessment paradigm for numerical analysis from the traditional lecture mode to a lecture + computing laboratory "practical" mode. In 1996, two second year and three third year numerical analysis subjects were changed to laboratory based practical subjects (with the supporting theory). Two lectures per week (for each subject) were replaced (generally) by one lecture and a one hour computing laboratory practical session. The computer laboratory practicals (cf Physics practicals) are supervised sessions where students are assisted to undertake task-oriented programming and computational work. All the *Mathematica* notebooks used have been developed by RMIT staff. *Mathematica* is used to carry out numerical computation, plot graphs and perform exact symbolic manipulations. The "Notebook" interface for *Mathematica* gives a word processor like interface so that computational results, graphs and text can be manipulated very easily. Students are assisted by the lecturer and a tutor, but are encouraged to work cooperatively and to individually produce professional standard write-ups of their assessed laboratory work. Using the computing laboratory as an integral part of their course is new, educationally effective and *enjoyable* for both the students and the staff.

4.30 – 4.55

TEACHING TRIAL OF CALCULUS AND MAPLE

Geoffrey Aldis
Harvinder Sidhu

Australian Defence Force Academy

Calculus and Mathematica is a computer-laboratory-based calculus course written by Davis, Porta and Uhl (1994), and taught at the University of Illinois and elsewhere since 1989. In 1996 the first book of the course, "Derivatives: Measuring Growth", was translated into *Maple*. In September and October 1997, ADFA trialled *Calculus and Maple* on two classes of twenty first-year students. One class were Science majors, the other Engineering majors. For each class the two calculus lectures normally scheduled each week were replaced by two periods in a PC lab. Every second week there was an additional two hours spent in the PC lab. The latter replaced the calculus labs in our current course. Students continued to attend their normal one-hour tutorial each week and the algebra strand of the first-year course continued unchanged. One of the principal motivations for the trial was to investigate ways in which the passive learning environment of a lecture could be replaced by active learning. This talk will show examples of the material the students worked through and describe how they responded to it. Some time will also be spent on how we handled the problem of developing essential pen-and-paper skills in a course which emphasised the use of a computer. Comment will also be made on the amount of staff time required to implement fully such a course.

5.00 – 5.25

INTEGRATION OF MAPLEV WITH THE UNDERGRADUATE MATHEMATICS CURRICULUM

J. Louis
P. Tillman
I. Altas

Charles Sturt University at WaggaWagga

In this talk we present our experiences in teaching a new first year technology based mathematics subject. Three lecturers were involved in presenting this subject to a cohort of mainly computer science majors. In developing the subject we adopted some of the reform calculus teaching methodology. Ten computer laboratory practicals were developed for the course. These practicals were based on the *MapleV* software package and were closely integrated with the lecture and tutorial sessions. For a typical unit of work, students would attend lectures, complete tutorial problems with pencil & paper and then attend a *Maple* practical session on that unit. The structure of the *Maple* practicals included at limited commentary on the topic material, sample worked Maple solutions followed by the student working through problems from the corresponding tutorial session on the unit. We found that using this approach, students quickly learnt the basics of *Maple* syntax, without the need to devote valuable class time specifically to learning *Maple* syntax.

A teaching evaluation, carried out at the end of the subject, indicated that students enjoyed the *Maple* practical sessions and found them educationally worthwhile and motivating. Another sign of the successful integration of *Maple* into the curriculum, was students quickly adopting *Maple* to cross check their answers for assignment work in the subject.

Wednesday	Room	Chair
26 November, '97	**Z303**	David Ruxton

8.30 – 8.55

MATHEMATICS FOR ENGINEERING STUDENTS

G. Smith
G McLelland

University of Technology
Sydney

This paper describes a new first year mathematics subject in single variable calculus to be introduced to engineering students at the University of Technology, Sydney in 1998. The intention is to introduce all mathematics in a context tailored to engineering students, although the principles described apply to other areas. We feel that this is an effective way of introducing students to mathematical concepts. The material is developed by modelling a small number of realistic physical problems, some of which are tied to experiments that students encounter in a concurrent physics course. The rationale is to tie the mathematical methods to particular problems and to provide realistic scenarios where these methods are used and, indeed, necessary. In considering modelling processes, concepts such as functions, continuity and smoothness arise naturally. Consideration of the physical processes yields differential equations for which power series and integrals are used to generate the solution functions. The subject will present almost all of the material from a traditional first year calculus course, but it will appear for different purposes and in a different order to standard presentations. At all stages, the student should be able to connect the mathematical concepts with a particular physical idea or problem.

9.00 – 9.25

DOWN ON THE FARM

Mike Carter

Massey University
New Zealand

Four years ago the Faculty of Agricultural and Horticultural Sciences at Massey University introduced a new Bachelor of Applied Science degree, offering specialisations in such fields as agriculture, forestry, horticulture, animal science, natural resource management, agribusiness and others. It was decided that the degree should include a compulsory paper in elementary mathematics and statistics. Students in the Faculty had a long tradition of hostility towards mathematics, so it was clear that special efforts would have to be made to provide a paper which the students would see as relevant and interesting. It was decided that the paper would be designed around a series of assignments dealing with applications which were as realistic as possible given the often poor mathematical background of the students, and that lectures on the necessary theory would be given in parallel with these assignments. The paper turned out, as expected, to be a challenging one to teach. On the whole, given all the circumstances, I think it can be judged to have been a success, but certainly not an unmitigated success. In this paper I will discuss which ideas worked and which did not, and some of the lessons which have been learned

KEYNOTE ADDRESS	Room	Chair
	S403	Milton Fuller

9.30 – 10.30

TEACHING, TUTORING AND ASSESSMENT ON THE WEB

Brian Stone

University of
Western Australia

Since 1995 a new computer based tutoring and assessment system have been introduced in the teaching of Dynamics at UWA. This has been added to existing teaching material that includes notes and animations. The tutoring and assessment system includes feedback with specific diagnostics on misconceptions and the serving software shows the current state of each student in the class. The system is an extension of a Mac based version. Over 3 years more than 200,000 student solutions have been recorded. The system has reduced tutoring hours to 1/3 of the traditional approach, has gained student approval and increased pass rates. Such improvements did not arise with the earlier teaching materials. It appears that the tutoring and assessment approach could be applied in many disciplines including mathematics.

8.30 – 8.55

LESS EXPLAINING, MORE DOING.

Ansie Meiring

University of Pretoria
South Africa

The new approach to teaching Calculus, made famous by the Harvard consortium, places more emphasis on understanding and applying concepts. Unfortunately it takes time to grasp an idea - it also requires of the students to read, to think, to absorb and to question. A new concept in aiding students in this process is that of a workbook. The idea of a workbook has now become a reality as a supplement to the newly published Brief Calculus textbook of the Harvard group. The idea of a workbook originated at the University of Pretoria and we were first to put the textbook and workbook as a pair to the test during 1997. A discussion of our experiences and recommendations forms the basis of this talk.

9.00 – 9.25

NEW TEACHING AND LEARNING THROUGH NEW MEDIA

Cristina Varsavsky
Alistair Carr

Monash University

Academics are under growing pressure to produce interactive multimedia material for the delivery of their subjects. This is a hard matter for mathematicians, as the current technology is not ready yet for the easy handling of mathematical output and input.

This presentation will provide an example of what is achievable today in multimedia mathematics teaching. *Epsilon* is an interactive electronic book for first year mathematics developed by the presenters to address the different learning styles of our students and to be used in distance education.

This presentation will describe the experience gained during the development of *Epsilon*: the identification of the most important features in constructing an electronic book in mathematics, the handling of equations and mathematics input, the interactive features, the programming, the graphics, the book structure, the principles behind the screen design, etc. The presentation will also outline the effective *modus operandi* developed to minimise production costs.

KEYNOTE SPEAKER

Brian Stone

University of
Western Australia

Brian Stone has been Professor of Mechanical Engineering at the University of Western Australia since 1981. In addition to a research interest in stopping vibration in production processes he has a long standing interest in teaching. He has won three teaching excellence awards from his university and has introduced many innovative teaching approaches. The one that is currently attracting most interest is a tutoring system based on the WWW which includes feedback with specific diagnostics on misconceptions. Professor Stone is recognized as one of the outstanding teachers in his field of engineering in Australia.

11.00 – 11.25

Measuring the Impact of Large Workshop Teaching on Student Learning

Peter Coutis
Leigh Wood

University of Technology Sydney

In this talk we provide details of an enabling teaching program consisting of three large mathematics workshops presented by staff of The Mathematics Study Centre, University of Technology Sydney, to students studying the mainstream first year course, Mathematics 2. Each workshop is of six hours duration and structured to include components of skill acquisition/reinforcement, concept development, revision and examination technique. The workshops are held on Saturdays and spaced evenly throughout the semester. Attendances regularly range from 90 to 150, out of a cohort of approximately 230 students. Data collected during second semester 1996, indicated that the workshop teaching had a positive effect on student performance, particularly on the results of students ranked in the bottom decile of the student body. Students in this group who attended the workshops performed significantly better in each of the three examination components of the course. In addition, class surveys gave clear and specific indications that the classes had assisted in developing positive attitudes to learning. We present a summary of the performance data and student survey responses and outline implications of this work for future trends in undergraduate mathematics teaching and learning.

11.30 – 11.55

Collaborative Tutorials for more than 100 Undergraduates

Margaret Morton

Auckland University
New Zealand

The use of collaborative learning techniques is now fairly well established in Bridging Mathematcs courses (which typucally have a small number of students) and, with the calculus reform movement in the United States, is also gaining popularity in higher level undergraduate courses. Research has shown that collaborative tutorials provide an effective learnign environment and a refreshing alternative to the more traditional lecture/tutorial style of tertiary courses. Advantages include giving students more challenging problems than those asked in the more routine assignments and tests and opportunities to engage in meaningful mathematical dialogue. Issues include the level of resourcing required, providing suitable problems, how to appropriately assess students' work and student perceptions of the usefulness of such tutorials.

This semester a colleague and I have been teaching an undergraduate second year multivariable calculus and linear algebra paper. Despite there being 150 students registered, we decided to try collaborative tutorials. Overall we've been pleased with the results. In this paper I shall describe the mechanics of how the tutorials were actually organized, the resources involved, how the format of the tutorials changed during the semester, student feedback, and how I propose that my department might use tutorials next year.

12.00 – 12.25

Fostering Groupwork In First-Year Mathematics Labs

David Rowland

Australian Defence Force Academy

First-year mathematics labs at ADFA provide students with the opportunity to investigate, in collaborative groups of three or four, problems which are more complex and demanding than what we'd expect them to tackle individually, either for homework or in exams. During a two-hour period, they must both solve the problem(s) and write a report on their findings.

Getting students to work effectively as a group rather than ineffectively as a collection of colocated individuals has been an ongoing challenge. Some new initiatives aimed at helping students work well as a group have been trialled this year with some success. These include periodic self-assessed groupwork evaluations; assigning students to mixed ability groups; and periodically altering the groups in order to give them the opportunity to see how others work as groups.

This talk will go into more details about what we've tried, evidence for claims to some success and problems yet to be resolved.

11.00 – 11.25

MATHEMATICS AND STATISTICS TUTORIALS AND ASSESSMENT VIA THE WEB

Kevin Judd

University of Western Australia

This paper will describe some web-based computer software that has been used in the teaching and assessment of intermediate calculus and statistics. The software was developed in collaboration with Dr. Nathan Scott and Prof. Brian Stone from their original Macintosh based software designed for a first year engineering course in dynamics. The software incorporates many of the features of the engineering software but extends it in important ways.

The most important differences between the mathematics and engineering software is ability to accept mathematical expressions as answers and more sophisticated methods of diagnosing errors in answers. This paper will describe the calculus and statistics material that has been the developed, indicate the range of question types that can be implemented and illustrate the sophistication of the diagnostics.

11.30 – 11.55

RE-ENGINEERING THE SCIENCE CALCULUS SEQUENCE AT A RESEARCH UNIVERSITY

Harvey Keynes

University of Minnesota
U.S.A.

The School of Mathematics at the University of Minnesota has developed a new first and second year calculus sequence for students in mathematics, science, and engineering. The sequence incorporates changes in content, new methods of faculty and graduate student instruction, and student-centered changes such as cooperative learning in both lecture and workshops. One innovative feature involves student exploration of mathematical ideas and complex, open-ended, interdisciplinary applications using interactive features of the World Wide Web. This sequence is about to become institutionalized at the University of Minnesota. This talk describes some of the special features of the sequence, including student attitudes about the usefulness of the pedagogical and curricular components, and how these approaches affect their learning are analyzed for the new sequence. Quantitative data are presented that compare the achievement and retention of students in the new sequence over a several year period with a control group from the standard calculus sequence. Issues about effective ways for institutionalizing these changes, and future directions for refinements in pedagogy and curriculum are also discussed.

12.00 – 12.25

USING CAS TO FACILITATE STUDENT CENTRED LEARNING IN MATHEMATICS

Kay Kneebone
Robyn Pierce

University of Ballarat

A new integrated approach to the use of Computer Algebra Systems has changed the learning styles of first year mathematics students. Since 1989 undergraduate mathematics students at the University of Ballarat have been introduced to the use of CAS (either *Derive* or *Maple*) as a tool to ease the burden of tedious or especially complicated problems. In 1997 some first year courses were changed to make CAS an integral part of teaching, learning and assessment. Worksheets were rewritten to encourage students to explore and record their findings. Student response was initially neutral but became increasingly positive as the semester progressed. While they were most positive about having access to computers during examinations, results reflected students' lack of experience with questions which required explanations as well as calculations. This paper will present the rationale for the changes made, give examples of worksheets, assessment tasks and student work, discuss changes in organisation and provide reflections from both staff and students.

Wednesday	Room	Chair
26 November, '97	**Z303**	Peter McIntyre

12.30 – 12.55

THE EXPERIENCE OF STUDENTS WORKING IN COLLABORATIVE LEARNING GROUPS IN INTRODUCTORY STATISTICS

Brenton Dansie

University of South Australia

In an attempt to create a more active learning environment for a group of 30 students in an introductory statistics class in first year, first semester, an approach based on the use of collaborative learning groups has been trialled. For approximately 8 of the 13 weeks students have a range of materials to work on in small groups. There are no lectures and tutorials scheduled, the groups meet individually with the lecturer for an hour each week to review progress. A variety of methods are used to assess student progress in the individual development of statistical knowledge and computing skill and the performance of the group on both the standard materials and some independent learning exercises.

After describing briefly the details of this approach, this talk will focus on the experience of the students in this class in first semester. With the help of funding from a University Teaching and Learning development grant, some video-taping of the students working in their groups and talking about their experiences has been done. A presentation of some selections from this tape will be made to highlight some of the benefits of this approach.

2.00-3.30	**WORKSHOP** (see page 26)	
	Room	Chair
	Z303	Len Colgan

2.00 – 2.25

REDESIGNING A LINEAR PROGRAMMING COURSE TO IMPROVE MODELLING SKILLS

Jenny Henderson

University of Sydney

Most second year level engineering students at the University of Sydney take a half-semester course in linear programming. Essentially one technique, the simplex algorithm, is taught. Students have find this technique relatively straightforward. More difficult, however, is the formulation of problems presented in written English. Before 1996, this aspect played a relatively minor role in the course compared to the simplex algorithm itself. Last year the course was extensively restructured with two main aims in mind: ti improve students' skills in the mathematical formulation of linear programming problems and to improve the computing environment in which they applied the simplex algorithm. The ratio of lectures to tutorials was substantially reduced. Modelling was given greater emphasis in the tutorials, which became the focus of the course (the lectures being written to support them). The second aim was addressed by using a locally produced computer program in a Matlab environment, with facilities for electronic submission of assignments. This talk will describe the type of modelling problems used, the difficulties students had with the material, students' perceptions of improvement in their own modelling skills and the general operation of the computing aspect of the course.

2.30 – 2.55

DEVELOPING STUDENT SKILLS THROUGH THE USE OF A TAXONOMY

Geoff Smith
Leigh Wood

University of Technology Sydney

In this paper, we briefly describe the MATH taxonomy (for *Mathematical Assessment Task Hierarchy*) which provides a classification of the skills needed to complete a given mathematical task. We have systematically used this taxonomy to design examinations and other assessment tasks for students. However, it is one thing to know what skills a student needs to complete a task—it is quite another thing to guide the student's learning experience to ensure that he or she actually has the required skills. We will describe how an analysis of the skills required for a given task can be used to develop a series of exercises which will help students to acquire these skills. We illustrate our approach by demonstrating how the MATH taxonomy may be used to develop a systematic approach to the development of student skills for a particular problem in linear algebra. We have chosen this area since it is one in which all but the most able students experience considerable difficulty in achieving mastery, despite the fact that linearity pervades much mathematical thought and that linear algebra is a highly organised body of knowledge for which a wide variety of instructional materials have been produced.

Wednesday 26 November, '97	Room **Z304**	Chair Lyn. Bloom

12.30 – 12.55

Introducing Mathematical Software to 200-level Classes

Gillian Thornley

Massey University
New Zealand

In 1995 our department decided to introduce all 200-level students to mathematical software. We were an ordinary mathematics department teaching fairly traditional courses, and many of the staff were not conversant with the software themselves.

This is an account of how the programme has evolved over two years from early discussions of which to use, Maple or Matlab, (we ended up with both) to the the working out of the different perceptions of the role of technology in education. Is it a tool or is it an aid to learning mathematical concepts and techniques?

I will talk particularly about using Maple in 200-level calculus, giving some examples of teaching materials. Student reactions to the programme will also be included.

2.00-3.30	**WORKSHOP** (see overpage)	
	Room **Z304**	Chair Chris Harman

2.00 – 2.25

Educational Evaluation Of Calculus Reform

Keith Joiner

Australian Defence Force Academy
Curtin University of Technology

Calculus reform has followed three stages: the use of graphing calculators, the use of computer algebra systems and, most recently, interactive calculus texts. Each technological advance gives additional visualisation to calculus learning, helps to create a more learner-centred environment, involves students in an active pedagogy and takes advantage of the increased student motivation present when using computer technology. ADFA has integrated graphing calculators into its calculus courses and is considering a computer algebra system. Before making further changes, the College wanted to determine the educational benefits and implementation issues of any change, through a formal educational trial. This paper outlines the establishment of a trial of a computer-based course, *Calculus and Maple*. Control and experimental groups were established, and students baseline tested for personality, calculus achievement, computer attitudes, achievement attitudes and affiliation attitudes. Students were grouped into heterogenous collaborative groupings, determined from the test results. Other measures were a standard classroom environment inventory, observation, interview and, for the computer-based learning class, a post-test of computer attitude to assess the effect of such an intensive computer intervention.

2.30 – 2.55

What factors really do improve learning? Warnings for Undergraduate Mathematics

Patricia Cretchley

University of Southern Queensland

There can be no doubt that the challenges we face as mathematics educators are exciting. Technology and the growing demand for flexible delivery bring new opportunities. Innovators are encouraged to develop programmes that are interesting and novel, and many of these are adopted quite broadly because of their perceived positive effect on learning. But this work is costly and demanding. We must be careful what it is that we claim is genuine and sustainable improvement in learning. Research shows that innovation itself, almost regardless of its nature, has an initially positive effect on learning. Clearly we cannot lean upon that to claim improvement! We must look deeper.

This talk discusses the research of John Hattie and others, meta-analysis which attempts to assign effect-sizes to a range of factors which influence learning, including feedback and technology. It also offers the responses of some undergraduate mathematics students when asked to rate similar factors, raises questions about the implications of such findings, and suggests a path for further research. In conclusion, it suggests directions we should take, as developers and good teachers, so that we can be fair critics of our own work and that of others.

Wednesday	Room	Chair
26 November, '97	**Z303**	Len Colgan

3.00 – 3.25

MASTERING THE BASICS IN PURE MATHEMATICS COURSES

David Angell

University of New South Wales

A method of course organisation and assessment is described which aims to ensure that all students passing the course have thoroughly mastered the fundamental parts of the subject matter, while affording opportunities for the more able students to progress to advanced topics. Students are encouraged by continually reflecting on their study to set themselves appropriate goals and aim at an appropriate level of achievement, and thereby to take upon themselves a greater degree of responsibility for their education.

The scheme to be described rests upon three pillars: a careful and detailed division of subject matter into "core" and "advanced" sections; an insistence upon a high standard of work in the core section; and the provision of repeated assessment opportunities for students who do not initially achieve the required standard. These ideas have been implemented in second and third year pure mathematics courses, and appear to have substantially achieved their aims.

WORKSHOP Room S403

2.00 – 3.30

USING COMPUTER TECHNOLOGY TO VISUALISE STATISTICAL CONCEPTS

Ken Stevenson

Sydney Institute of Technology

There are a number of barriers which prevent students gaining a full understanding of statistical concepts -

- they find the terminology to be unfamiliar and very rich
- they can focus on mechanical calculations alone
- they are often unable to relate the concepts to the practical world.

At the Sydney Institute of Technology students (even from an educationally disadvantaged background) successfully use computer applications to visualise and learn about statistical concepts.

Models'n'Data is one such application which enables students to be almost free of calculations while they "see" the workings of statistical processes such as sampling, model fitting, curves of best fit, confidence interval construction, hypothesis testing.

3.45 – 5.15

OPEN FORUM

Chair

Ruth Hubbard

A Curriculum for the Twenty-first Century

Panel:

Jerry Uhl
Neville de Mestre
Deborah Hughes-Hallett

Wednesday 26 November, '97	Room **Z304**	Chair Chris Harman

3.00 – 3.25

CHANGING THE ATTITUDES OF TRAINEE PRIMARY SCHOOL TEACHERS TOWARDS MATHEMATICS - A SUCCESSFUL EXPERIMENT

Ted O'Keeffe

Macquarie University

Discussion with trainee primary teachers reveals that many of them approach mathematics with a disturbing mixture of fear, dislike, and feelings of incompetence. I've altered our unit, "A View of Mathematics", in an attempt to break the vicious circle by which these students will pass on their negative attitudes to their own pupils.
In a 1993 proposal I wrote: "... The best we can do for such students (and the most important thing we can do for them) is change their attitude to mathematics. To do so we must give them some ap-preciation of mathematical ways of thought, not a mass of mech-anical techniques". Colleagues in my department, and the Director and staff of our Teacher Education Program supported this view.
A major change has been the abolition of the final examination. Instead, students work in groups investigating non-trivial recreational mathematics problems. I continue to be delighted by the positive attitudes developed within one semester by these previously math phobic students, and amazed by the high quality of the work produced by students whose background contains only minimal high school mathematics.

I propose to discuss briefly the structure of the unit and some of the students' mathematics that has excited me so much.

Thursday 27 November, '97 — Informal Sessions

9.00 – 12.30

Deborah Hughes-Hallett

Room: Z303

POSITIVE ATTITUDES AND STIMULATING LEARNING

9.00 – 12.30

Jerry Uhl

Room: S1030/V208/Z304 (t.b.a.)

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Please send responses to Milton Fuller at
m.fuller@janus.cqu.edu.au

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