

*'The effect on learning outcomes of using online learning modules in a principles of macroeconomics subject*

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## Abstract

**This paper reports on the findings of an evaluation of computer aided learning modules used in a principles economics subject over a two year period. The subject has an average enrolment of 1200 students who are drawn from the top band of high school graduates in the State. Two CAL modules are used. They address areas of the subject that student examination results indicate they have found particularly difficult. The modules are interactive and delivered via the Internet to allow for maximum student access. One has a multiple-choice format while the other requires responses that are more discursive.**

**One element of the evaluation strategy has been to monitor student access to the modules and to compare the frequency of access to student performance on examination questions that are related to the modules. It is difficult to control for all factors that affect student learning outcomes as measured by examination. Bearing this in mind we conducted multiple regressions on the examination results. We looked for relationships between student use of the two different modules with student performance on relevant examination questions and the examination paper as a whole. The student mark in Introductory Microeconomics that was a pre-requisite and had been taught in the previous semester was chosen as an indicator of the student's ability in economics. For this reason it was used as one of the explanatory variables in regression equations designed to test the hypothesis that access to the computer aided learning modules affects examination performance. However using the previous micro exam mark in the equations also has the advantage of allowing us to consider whether or not the computer modules have "added value". Preliminary results indicate that students who access the computer aided learning modules improved their learning outcomes as measured by their performance on examination questions.**

**In addition to the regression analysis we have conducted exit surveys to monitor student perceptions of the usefulness of the modules to their understanding of the subject and the ease of navigation. These results indicate a high level of satisfaction with the modules and also indicated areas where the navigation through the modules could be improved.**

## **INTRODUCTION**

Economics teaching has recently received criticism for lagging behind the rate of innovation in other disciplines (Becker 1997, Becker and Watts 1996). There are signs, however, that economics educators have begun a significant phase of exploration into the ways in which electronic technologies can be marshalled to transform teaching and improve student learning. The Internet has become the focus of much interest and attention, possibly because it offers the most exciting prospects for revolutionising conventional approaches to economics teaching. The use of the Internet in teaching economics has been described as the third generation of computer aided instruction, Daniel (1999). It provides the opportunity for inexpensive and widely available applications that can combine text, graphics, audio, video, data and programming within a familiar interface.

The Department of Economics at the University of Melbourne has trialed the use of the Internet as a learning resource in Introductory Macroeconomics. The initiative requires students, outside of scheduled class time, to use two computer assisted instruction (CAI) modules and to undertake syndicate-based inquiries into the economies of selected Asian countries, using a subject homepage for access to various relevant information sites. This paper focuses on the evaluation of the CAI modules in terms of their impact on student learning outcomes. An evaluation of the Internet syndicated case studies is the subject of another paper.

### **THE IMPETUS FOR THE MACROECONOMICS INTERNET PROJECT**

The project was an attempt to see how Internet-based learning can be integrated into a traditional teaching and learning environment and whether this improves learning outcomes.

Like their counterparts in other disciplines, economics educators are utilising the Internet's capacity for information transfer in three broad ways. First, the Internet is being used to provide students with access to notes and supplementary course materials of various kinds; in general, pre-packaged learning resources that are similar to those that can be provided in print (for example, see Stone 1998). The perceived advantages of using the Internet are lower costs (possibly) and improved time/place accessibility (usually). The second use of the Internet is to enhance student-student and staff-student communication, through synchronous and asynchronous computer-mediated discussion, thus improving the frequency and timeliness of feedback. The third approach involves the development of new multimedia software to provide on-line interactive learning experiences which usually have few parallels with traditional teaching and learning and which may offer the prospect of quite new pedagogical outcomes (for example, Daniel 1998; McCain 1998; McBride 1998).

Generally these innovations are costly, at least in the development stages, and yet the evidence on their effectiveness in improving student learning is inconclusive. Despite a growing number of interesting applications and proposals (Simkins 1998) there is little systematic evaluation of learning outcomes and many claims of educational advances lack adequate empirical support.

Although most developments in the discipline are still in their early stages, two clear patterns of student usage are emerging. Most frequently, Internet-based materials are designed primarily with solo, self-paced learning in mind, from home or through on-

campus computer access. Less commonly, computer-based learning resources are being developed for group learning, being deployed in computer laboratories in which students attend class at a scheduled time and receive on-the-spot guidance and support from professors or teaching assistants.

The Melbourne project has included and extended the earlier approaches that focused on individual and in-class use of the Internet. Firstly, we wished to incorporate new opportunities for collaboration and communication between students, both inside and outside normal class contact time, in recognition of the ample evidence that student collaboration is rewarded in academic results (Becker 1997). The project was part of an on-going program to transform undergraduate teaching and learning in the Department of Economics. The most significant earlier innovation had been the introduction of collaborative, problem-solving approaches to learning in tutorials. This project was supported by federal funding. As reported elsewhere (Johnston, James, Lye, McDonald 2000) the collaborative, problem-solving technique has been found to improve grades for weaker students in economics, particularly weaker economics students from Asian countries who have chosen to study in Australia. In addition this technique was found to improve student attitudes towards their tutors. Significantly, in one subject the effects on student learning were very favourable (Johnston, James, Olekahns and Wilkins, 1999). In the current project, we sought to explore the possibilities for encouraging students to participate in collaborative and individual problem solving *outside* of class time.

Secondly, our interest was in the potential of existing Internet-based resources and the capacity of the Internet for pulling together disparate yet related primary information sources. We believed the Internet should be used to offer students up-to-the-minute insights into real economies in action. The project we conceived created a Internet-site accessible from home, computer laboratory or the library, which would provide students, individually or in groups, access two CAI modules and primary source material and, as appropriate, original material developed for the project. The project's use of technology was therefore simple in conception and inexpensive in development. Few technological hurdles needed to be overcome, allowing energies to be focused on designing and developing sound educational tasks.

Thirdly, we wanted to address specific student needs. The two Internet delivered CAI modules led students through particularly difficult elements of the subject. We identified the areas of the subject that student found most difficult by looking at past student examination scripts and assignments and by talking to the tutors who had marked them. This analysis and discussion allowed us to identify principle areas in which our students required extra assistance. They ranged from simply not knowing the order in which algebraic operations were to be undertaken, to not understanding the role of and the necessity for assumptions in the various economic models that they were expected to be able to use.

CAI modules embody an explicit teaching strategy and are based on the assumption that it is possible for a computer program to emulate a teacher. "The basic design of a CAL module that would come closest to emulating the teacher is one that "1) specifies the learning objective 2) offers a brief introduction to the topic 3) sets a task according to a strategy for achieving that objective 4) interprets the students performance on that task 5) uses this to select the appropriate feedback 6) uses the student performance so far to select the next task" Laurillard 1993, p.148

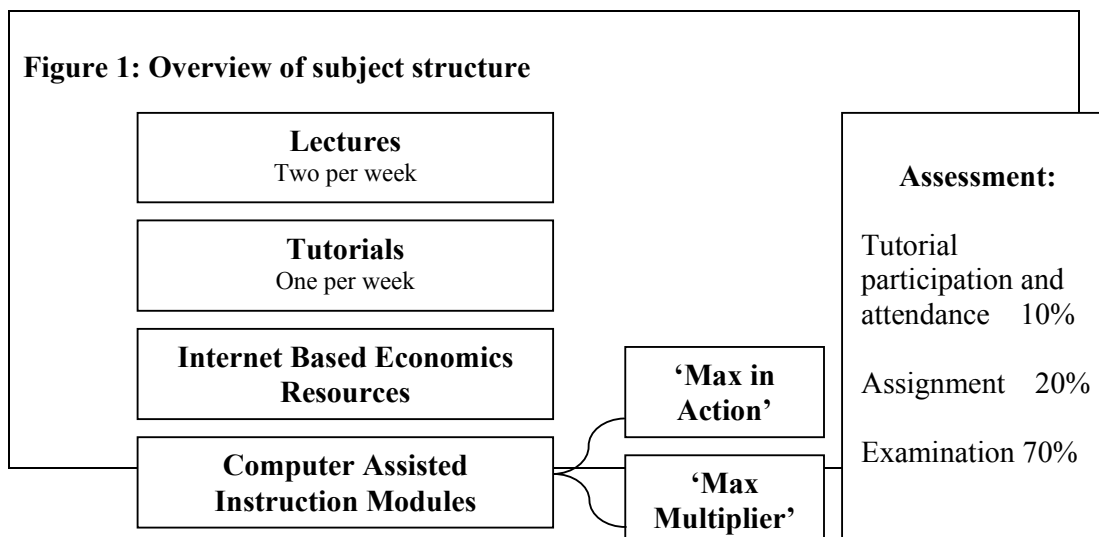
We developed our CAI modules (Max in Action and Max Multiplier) with Laurillard's checklist in mind and also drew on the work of Ramsden who suggests that modelling of the approaches to solving problems is an effective teaching strategy. "The prudent use of model answers taken either from the students own work or specially written by the lecturer is an excellent form of feedback" Ramsden (1992 p.194) and again "Discussion of sample answers in class or a dialogue focussed on your meaning of such terms as 'discuss', 'evaluate' and express your answer quantitatively ' are useful means of making expectations clear, helping students to learn how to do their best in assessments, encouraging independence and reducing the debilitating anxiety that assessment too often imposes". Ramsden (1992, p197)

In addition student quality of teaching questionnaires indicated that first year students wanted early feedback on their understanding. The provision of CAI modules appeared to be one way of providing this efficiently.

Finally, we chose not to discard the basic structure of the existing lecture and tutorial format. At the University of Melbourne, the high quality lecture is still viewed as an important device for student learning, particularly as the traditional 'chalk and talk' lecture has been replaced by sophisticated presentation techniques and new ways of actively engaging students. This project wished to retain and build on the best aspects of the lecture and the collaborative problem solving tutorial format.

#### THE STRUCTURE OF THE PROJECT

Introductory Microeconomics is a prerequisite for Introductory Macroeconomics. Introductory Macroeconomics is offered in both Semester 1 and 2, however most student take it in the second semester of first year. This arrangement is designed to allow greater flexibility to students who enter the course in the mid-year in take or who are taking joint degrees. In addition the repetition allows those students who fail Introductory Macroeconomics the chance to catch up earlier. Coincidentally, the arrangement also allows for the piloting of teaching innovations in the smaller subject prior to their introduction into the larger subject. Both the large second semester Introductory Macroeconomics subject (1174 students in 1998) and the small first semester subject (114 students in 1998) cover the same economics material but are taught by different lecturers and the assignment set may be different.



We wanted to provide students with interactive learning modules such that the material would be introduced in a sequential way and they would get effective feedback on their understanding.

To address these issues we set up two CAI modules. Our approach in both modules was the same. We set up questions in the modules so that if the student misunderstood the material they would make a mistake. In both modules they are provided with instant and helpful feedback (including encouraging feedback to those who were not making mistakes). In addition, students are taken through the material in such a way that they would themselves see their mistakes and realise that the mistake reflected a lack of knowledge of relevant economic theory or a mistaken application of arithmetic technique. The nature of the mistake is identified and remedial 'instruction' given. At a later point in the sequence they are quizzed again and their new learning reinforced.

Documents were prepared which contained material designed to motivate them to use the modules as well as giving them information on how to physically access the modules via the WWW.<sup>1</sup> We have found that about 60% of the log-ins are from off-campus and that students log-in at all hours of the day and night (including just 1 hour before the start of the final exam in the subject!).

The 'Max Multiplier'<sup>2</sup> module takes students through the various multipliers using a multiple-choice format coupled with extensive explanation of each alternative student choice. The Max Multiplier module covered an area of the course that many students were having trouble with (Keynesian multiplier theory). It consists of 36 multiple-choice questions organised into groups (eg those dealing with a closed economy, those dealing with taxation, exports and imports etc). The questions in each set progress from easiest and least complex to hardest and most complex. As students move from set to set more and more items are built on to the economic model. Amongst the choices as answers to each question are the incorrect answers we most often find in exam papers. Students also receive hints and prompts throughout the module.<sup>3</sup>

The 'Max in Action'<sup>4</sup> module takes essay format examination questions based on the open economy model and provides actual student exam answers that have been annotated to demonstrate how the examiner arrived at the grade awarded to the answer. The purpose of this module was, in part, to demonstrate the importance of assumptions to economic modelling. This module addresses two past exam questions.

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<sup>1</sup> Experience has shown that these documents both look more attractive and are more informative if they include images of 'screen shots' such as the log-in screen, the main menu etc.

<sup>2</sup> Max's Multiplier module may be found at the URL <http://www.ecom.unimelb.edu.au/ecowww/cjohnston/101/nmultiplier/index.html>. To log in type 1234567 as the "Student ID" and your first name as the 'Student Name'.

<sup>3</sup> Max is the name of a Tiger that we have adopted as part of a World Wildlife Fund program. His name figures throughout the subject as the 'Professor' who is always in the background with helpful resources or responses to Emails.

<sup>4</sup> The Max in Action module may be found at <http://www.ecom.unimelb.edu.au/ecowww/max/index.html>. Log-in in the same manner as for the Max Multiplier module.

One deals with monetary policy and one with fiscal policy. A search of student scripts was undertaken to find ones that exemplified common mistakes as well as appropriate approaches to the problem posed in the question. For each question there are five different student responses to the question. The five have been chosen as exemplars of both good and bad work. Students using the module construct their own response to the question and then read, annotate and score one of the past student answers it. They are then taken through a version of that answer that has a series of prompts or questions inserted in it by 'the examiners'. After they work through this they can access a version of that answer which has not only the prompts provide by the examiners but suggestions by the examiners as to how they would deal with those prompts or questions. Some suggestions are about the economic analysis but some are about exam technique. Students will then work through each of the five answers in turn in this fashion.

Both modules have (a) Internet links to electronic textbooks where relevant; (b) a feedback form where, as they exit the module, students are asked to fill in a very simple email questionnaire; (c) a 'log-in' protocol which enables us to record who used the module and how long they spent on each component; (d) a method by which they could ask questions by e-mail of a 'professor', obtain individual replies, and (e) a facility where by they could read the questions that other students asked and the replies to those questions. No individual student was identified in the public 'Frequently Asked Questions' (FAQ) pages in order to encourage students to ask a wide range of questions. The FAQ pages were also used on occasion by the lecturer to 'plant' questions, especially questions that would attract the attention of the best students and to suggest further reading for them.

### **THE EVALUATION STRATEGY**

There is a tension involved in undertaking research that attempts to measure learning outcomes. There is a need to obtain evidence of the effect the teaching innovation on student learning while at the same time not impinging too much on lecture/tutorial time and student patience in order to obtain this evidence. In designing the evaluation of this subject care was taken that the learning environment for students was protected while at the same time sufficient data was obtained to evaluate the program properly. In addition there is a need to recognise that student performance on examinations is a relatively blunt instrument with which to measure the subtle and individual process of learning. Examinations necessarily measure student understanding of a relatively narrow range of knowledge. In addition it is sometimes the case that the examination questions themselves are not sufficiently congruent with the desired learning objectives of the innovation.

Four evaluation strategies were used in this study.

- Examination performance was evaluated. A multiple regression analysis was conducted to see if accessing the 'Max Multiplier' module and the 'Max in Action' module had any effect on student learning outcomes using two key questions on the examination that covered similar material to that covered in these modules. In this study Max Modules were designed to replicate the understanding that the examination questions aimed to measure.
- The student use of the 'Max in Action' and 'Max Multiplier' modules were recorded in terms of the number of times they were accessed by each student. Students had to enter their student enrolment number and name before they were

allowed access to each of the modules. This meant that individual student access was automatically recorded with the date, time and duration of their use of each modules.

- When students had finished using the Max Modules they were asked to complete an exit survey that addressed their perceptions of the modules.
- The quality of teaching end-of-semester questionnaire, which is one part of the university-wide quality assurance strategy, was also considered in the evaluation. The aim here was to see if student perceptions of the subject were better or worse than the Department mean for all first year subjects. When an innovation is first introduced there is a tendency for student perceptions of the subject to deteriorate.

## **EVALUATION RESULTS**

Student performance on the end of semester examinations as it related to student use of the learning modules (Max Multiplier and Max in Action) and student access and exit survey data are examined in this section. Results are reported for both semester 1 (107 students and semester 2 (1073 students).

### **Performance on the end of semester 1 examination**

One way of measuring student learning is to look at simple means on examination questions. The data in Table 1 indicate that on average students who accessed the 'Max' learning modules in semester 1 and 2 performed better than those who did not. However we should not conclude too much from this simple comparison since all students are unlikely to have started the subject with equal ability in economics.

It is difficult to control for all factors that affect student learning outcomes as measured by examination. It may be that some students have efficient study habits or have a better work environment than other students. Bearing this in mind, we nevertheless considered it worthwhile to conduct multiple regressions on the examination results. We looked for relationships between student use of the 'Max in Action', 'Max Multiplier' modules with student performance on relevant examination questions and the examination paper as a whole.

The student mark in the prerequisite subject, Introductory Microeconomics, that had been taught in the previous semester was chosen as an indicator of the student's prior ability in economics for students attempting the subject for the first time. However in first semester there were a number of students who were repeating the subject as they had failed it in Semester 2 1997. Repeating students' previous Introductory Macroeconomics mark is used as an indication of their prior ability in Macroeconomics. This mark was used as one of the explanatory variables in regression equations designed to test the hypothesis that access to the 'Max' computer aided learning modules affects examination performance. Using the previous Introductory Macroeconomics 1997 semester 2 exam mark for repeating semester 1 1998 students in the equation also has the advantage of allowing us to consider whether or not the computer modules have 'added value' from one semester to the next.

There was evidence, after adjusting for ability as indicated by the repeating student's 1997 Introductory Macroeconomics mark, that there was a positive relationship between each of the two modules and student learning outcomes as measured by examination performance. The first equation reported below shows, for repeating

students, the relationship between their mark on the Introductory Macroeconomics 1998 semester 1 exam question 6 (this tested student understanding of the open economy) their total Introductory Macroeconomics 1997 semester 1 exam mark (A) and a variable measuring the number of times the student had accessed the 'Max in Action' module (B) in 1998. The estimated equation is given below

$$\text{MacroExamQ6} = 4.677 + 0.242A + 2.060B$$

$$(2.108) + (2.538) + (2.777)$$

The figures in parenthesis under the estimated values of the coefficients are the t-values. The number of observations is 50. The variables A and B are significantly different from zero at the 5% level. This shows that, for repeating students, there is a significant positive relationship between their mark on Introductory Macroeconomics examination question 6 and their previous past exam performance and their access to the Max in Action module.

The next equation shows, for repeating students, the relationship between their mark on the Introductory Macroeconomics 1998 Semester 1 exam question 1 (this tested student understanding of the Multiplier) their total Introductory Macroeconomics 1997 semester 2 exam mark (A) and a variable measuring the number of times the student had accessed the 'Max Multiplier' module (C) in 1998. The estimated equation is given below

$$\text{MacroExamQ1} = 1.719 + 0.120A + 0.407C$$

$$(1.721) + (2.846) + (2.656)$$

The figures in parenthesis under the estimated value of the coefficient are the t-values. The number of observations is 50. The variables A and C are significantly different from zero at the 1% level. This shows that, there is a significant positive relationship between the mark of repeating students on Introductory Macroeconomics examination question 1 and their previous Introductory Macroeconomics 1997 semester 2 examination performance and their access to the 'Max Multiplier' module.

The above equations were estimated using ordinary least squares. In both cases a logit formulation was used to test the hypothesis that accessing the 'Max' learning modules significantly improved examination performance. Virtually identical results were obtained. We experimented with other control variables such as their mark in quantitative methods subjects but again essentially the same results were obtained.

<b>Student use of the 'Max' modules</b>	<b>Number of Students</b>	<b>Mean Q 1 1998 (%)</b>	<b>Mean Q 1 1997 (%)</b>
<b>Max Multiplier 1998 Semester 1*</b>			
Repeating students who accessed Max Multiplier.	26	89	12.5
Repeating students who did not access Max Multiplier.	29	67	15
First attempt students who accessed Max Multiplier.	37	93	na
First attempt students who did <u>not</u> access Max Multiplier.	15	66	na
<b>Max Multiplier 1998 Semester 2**</b>			

First attempt students who accessed Max Multiplier.	597	55.7	na
First attempt students who did <u>not</u> access Max Multiplier	476	52.6	na
<b>Max in Action 1998 Semester 1***</b>		<b>Mean Q 6 1998</b>	<b>Mean Q 3 1997</b>
Repeating students who accessed Max In Action	11	62	27
Repeating students who did not access Max in Action.	44	49	26
First attempt students who accessed Max in Action.	25	68	na
First attempt students who did not access Max in Action.	27	55	na

\* While 114 students were enrolled in the subject at the start of semester 7 students did not attend lectures, tutorials or complete syndicate work. These students have not been included in the analysis.

\*\* While 1174 students were enrolled in semester 2, 101 students had not completed Introductory Microeconomics in semester 1 and were therefore not included in the analysis. There were no repeating students in the cohort that was used for analysis.

\*\*\* Student use data on the Max in Action module in semester 2 was not kept due to a technical error.

We have found that accessing the 'Max' modules improved performance on the part of repeating students, however, similar equations fitted to data for the (much smaller group) of students who had not taken Introductory Macroeconomics before did not result in the same outcome. For these students we used Introductory Microeconomics as an indicator of prior ability. In no case where first-attempt students were concerned could a significant relationship between exam performance and accessing the 'Max' modules be detected. However this is in itself instructive. When we ran the first regression equation for all of the students in the subject (that is both repeating and first-attempt students combined) access to the 'Max in Action' modules was statistically significant. Yet we know that for approximately one third of the students (that is the non-repeating students) who are an important and identifiable subgroup that there is no significant relationship. When we ran the second regression equation for all of the students in the subject (that is both repeating and first attempt students combined) access to the 'Max Multiplier' module was statistically insignificant. Yet we know that for approximately two thirds of the students (that is the repeating students) who are an important and identifiable subgroup that there is a significant relationship. We conclude that we must be wary of making decisions as to the use of computerised modules (decisions that involve considerable resource costs) on the basis of single equations fitted to a non-homogeneous group of students.

In summary in semester 1 1998:

- Students who accessed the 'Max Multiplier' module performed better on the pertinent examination question than those who did not. However, when we use regression analysis to control for prior knowledge, this effect, while significant at the 1% level for repeating students was not significant for the non-repeating students.
- Students who accessed the 'Max in Action' module performed better on the pertinent examination question than those who did not. Again, however, when we use regression analysis to control for prior knowledge this effect, while significant at the 5% level for repeating students was not significant for the non-repeating students.

While the simple means data indicates that there had been an improvement in all students performance on examination questions the regression analysis indicated that

only in the case of repeating students was the effect of the learning modules significant in semester 1 1998.

### **Performance on the end of semester 2 examination.**

While 1174 students were enrolled in second semester 1998 101 of these had not done Introductory Microeconomics in the immediately preceding semester and therefore were not included in this analysis. This left us with a total of 1073 students. All of these students were attempting Introductory Macroeconomics for the first time in Semester 2 1998. We used the Introductory Microeconomics 1998 Semester 1 examination results as an indicator of the students ability in Macroeconomics. Question 1 on the Introductory Macroeconomics semester 2 examination tested student understanding of the Multiplier. Unfortunately due to a technical failure data recording student access to the Max in Action module was lost in semester 2 and therefore this section reports on the Max Multiplier module alone.

There is only moderate correlation between performance on question 1 of the Introductory Macroeconomics 1998 semester 2 examination or on the total Introductory Macroeconomics semester 2 examination score and the total score on the Introductory Microeconomics 1998 semester 1 examination(D). The correlation coefficients are ( $r =$ ) 0.37 and 0.44 respectively

When we look at the score on question 1 and (only) a dummy variable which records 1 if they accessed the Max Multiplier module and 0 if they did not, the explanatory power of the equations is low ( $r = 0.07$ ) but the coefficient on the dummy variable (use of the Max Multiplier module) is significant at the 5% level and positive. When we look at the score on question 1 and student use or non-use of the Max Multiplier module(E) and if we fit an ordinary least squares regression we find

$$\text{MacroExamQ1} = 2.079 + 0.049(D) + 0.190(E)$$

(12.25)      (13.49)      ( 1.96)

The figures in parenthesis under the estimated values of the coefficients are the t-values. Introductory Microeconomics 1998 semester 1 examination is significant at the 1% level and the Max Multiplier dummy is significant and positive at the 5% level.

As students cannot score below 0 or above 8 it is wise to use an equation that is non-linear and which only covers the range 0 to 8. A logistic equation is the simplest to use in this case. If the logistic model is ‘forced’ on the data and we regress Logarithm of (score/(8 – score)) on Introductory Microeconomics 1998 semester 1 and the Max Multiplier dummy (dropping observations where the score is 0 or 8 (the maximum) the dummy becomes insignificant (but Introductory Microeconomics remains significant).

However if we make the dependent variable a binary variable which records whether or not students scored H1 on question 1 ie they obtained 7/8 or 8/8, and we fit either a binary logit model or an ordinary least squares model the results suggest that the probability of obtaining a high mark (7 or 8) on the question is positively related to the Introductory Microeconomics 1998 semester 1 mark and to the use of the ‘Max Multiplier’ model. In the logit the Introductory Microeconomics 1998 semester 1 mark has a positive coefficient and is significant at 1% while the Max Multiplier dummy has a positive coefficient (of 0.35) and is significant at 8%. The coefficient of

0.35 is indicative that the odds of obtaining a high mark increase by a factor of 1.4 if a student uses the Max Multiplier module. That is a student's chance of achieving a high mark increased by 40% if they had used the multiplier module.

Performance as a whole appears to be related in a statistically significant way to the mark in microeconomics and to the use of the Max multiplier module. For example a simple regression of mark on the whole Introductory Macroeconomics 1998 semester 2 examination on Introductory Microeconomics 1998 semester 1 examination (D) and the Max Multiplier dummy (E) gives

$$\text{Intro Macro examination} = 23.46 + 0.41D + 2.40E$$

(19.8)                      (16.        (3.6)

The figures in parenthesis under the estimated values of the coefficients are the t-values.

The r-square even here is 'low' (0.21) emphasising the enormous variability across students and possibly markers. Marker variability is likely to be lower on this relatively numeric question than it would be on a more open question type.

These findings remain whether we use logistic regression or a linear probability model. However the findings may indicate that it is the more 'macro-able' or 'macro interested' who are accessing the module. Whether ability in microeconomics has any influence on ability in macroeconomics is possibly open to debate however a positive relationship has been assumed in this study.

In summary in semester 2 1998

- When we look at the score on question 1 and student use or non-use of the 'Max Multiplier' module we find that the module was significant and positive at the 5% level.
- Students who accessed the 'Max Multiplier' module had a 40% greater chance of achieving a high mark if they had accessed the Max module.
- Performance on the examination as a whole is related in a statistically significant way to the use of the 'Max Multiplier' module

#### **Exit surveys and student use of the modules**

A record was kept of the number of times each student opened the 'Max' modules. This data indicated that 60% (n = 69) of students enrolled in the subject accessed the 'Max Multiplier' module at least once during semester 1 while 54% (n = 597) of students accessed the module in semester 2. Of these, 25% (n = 17) in semester 1 completed an exit survey when they had finished using the module and 50% (n = 296) completed the survey in semester 2 (Table 2). The exit survey was designed to be short so as to avoid trying the patience of students. The range of questions that could be asked was thereby limited. We also wished to avoid falling into the trap of simply providing data that suggested that students 'liked' the modules, we wanted to know if they perceived them as useful to their studies. The low response rate in semester 1 indicates that the semester 1 exit data should be viewed with caution.

In semester 2 over 70% of students agreed that the module was easy to use, was a useful learning tool, helped them to understand the mathematics of the multiplier and the comments provided were sufficiently extensive.

In each of the modules students were able to direct questions to a virtual 'Professor Max' tutor. The individual student received an answer directly from the Professor. However, if the same question was asked often, both the question and answer were posted on a Frequently Asked Questions page that preceded student access to the Professor Max e-mail facility. Student agreement with the positive statement relating to these aspects of the module were not as high as with other aspects. The lower rating may be more a reflection of lack of use than dissatisfaction with the facility as indicated by the higher percentage of students who checked the 'uncertain' category in Table 2.

**Table 2 1998 'Max Multiplier' Exit Survey .**

Statement	Strongly agree %		Agree %		Uncertain %		Disagree %		Strongly disagree %	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Max's Multiplier module is easy to use.	47	67	27	17	7	5	7	2	13	9
Max's Multiplier is a useful learning tool.	56	52	19	26	6	9	0	4	13	9
The module helped me to understand the mathematics.	44	45	38	25	6	13	0	7	13	10
The comments provided are extensive enough.	19	40	44	34	25	11	0	10	13	7
The FAQ's were useful.	20	21	40	22	27	40	0	10	13	8
The Ask Professor Max e-mail facility was useful.	27	19	27	15	33	48	7	9	13	9
Minutes in spent in each set	<b>0-10mins</b>		<b>11-20mins</b>		<b>21-30mins</b>		<b>31-40mins</b>		<b>41-50mins</b>	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Time spent on Set A	0	79	69	12	25	3	7	3	0	4
Time spent on Set B	0	62	46	28	46	5	6	3	0	2
Time spent on Set C	0	53	50	33	43	8	7	2	0	4
Time spent on Open Economy Set	0	51	46	32	38	9	15	4	0	4

Most students spent between 10 and 20 mins working in each of the sets in the 'Max Multiplier' module (Table 2). As the mathematics in the module is relatively simple this seems appropriate. The module is intended to help students to understand the basics and for many students the module would act only as a revision tool. An open ended question at the end of the survey indicated that this was the case.

Exit survey data for the 'Max in Action' module was not collected in first semester 1998 however it was collected in semester 2 1997 and semester 2 1998. The results are reported in Table 3.

**Table 3: 1997 and 1998 'Max in Action' Exit Survey**

Statement	Strongly Agree %		Agree		Neither agree nor disagree		Disagree		Strongly disagree		Total Students	
	98	97	98	97	98	97	98	97	98	97	98	97
1. Max in Action is easy to use	58	53	11	29	4	5	8	6	18	7	186	241
2. Max in Action is a useful revision tool	57	43	16	36	2	10	6	7	20	4	185	238
3. Max in Action helped me to formulate appropriate assumptions	43	33	27	42	4	15	6	6	19	3	180	235
4. The examiners comments	37	27	29	44	8	15	12	8	14	3	180	237

are extensive enough												
5. The key concepts facility was useful	23	19	23	42	25	24	17	11	11	4	175	229
The textbook/workbook facility useful	20	na	25	Na	32	na	17	na	6	na	165	na
The FAQ facility was useful	20	na	25	Na	40	na	8	na	7	na	130	na
The Ask Professor Max facility was useful	23	na	21	Na	40	na	8.	na	8	na	157	na
		<10 mins	11-20mins		21-30mins		31-40mins		>40mins			
Time spent in the module	3	na	14	Na	27	na	18	na	39	na	153	na

We do not have records of how many students accessed 'Max in Action' in total due to a technical problem. However 185 students did complete all or part of the exit survey. Of particular interest is the much increased amount of time students spent in this module compared to the 'Max Multiplier' module. The greater length of time students spent was anticipated as the interaction required more reflection. It indicates that students worked through the module with care. The higher degree of disagreement in relation to statements 1 to 5 in 1998 than in 1997 is difficult to explain. The module is undoubtedly more complex to use than the multiple choice format of the 'Max Multiplier' module. In addition the module indicates that there is more than one way in which to answer the problem posed depending on the assumptions that the students make. Some students may have found this disconcerting but it is hard to see why this would be more of a problem in 98 than in 97

In relation to the **quality of teaching questionnaire** that is distributed as part of the University's annual quality assurance program, both the tutors and the lecturer scored well above the department average in semester 1 1998. Our experience in the Department is that if students find particular elements of a subject displeasing this tends to influence their comments on all aspects of the subject. For example if students had felt particularly negative about the Max modules this may have been reflected in poorer ratings for the lecturer and tutors. This was not the case and indicates that students were generally satisfied with the subject's delivery and structural arrangements.

Statement	Lecturer	Tutor 1	Tutor 2	Department mean
The subject was well taught	4.10	4.20	4.28	3.40 <sup>1</sup>
The lecturer/tutor is enthusiastic about this subject	4.20	4.08	4.21	3.80 <sup>1</sup>
In this subject teaching staff showed an interest in the academic needs of students	4.01	na	na	3.40 <sup>1</sup>
The tutor respects student ideas and opinions	na	4.20	4.41	3.97 <sup>2</sup>
I regularly made use of the information and materials made available by the teaching staff on the Internet	3.80			2.36 <sup>2</sup>
The multimedia based technology helped me to learn effectively	3.70			3.29 <sup>2</sup>

\*Item means recorded on the following scale: 5 = very valuable, 1 = not valuable at all.

<sup>1</sup> Mean for first and second year subjects

<sup>2</sup> Mean for all Department subjects

## SUMMARY

The evaluation of the project has indicated the following outcomes:

- Student learning as measured by examination is improved for students by their access to the computer aided learning modules.
- Student rating of the subject on quality assurance questionnaires was higher than department average indicating that students liked working in the manner fostered by the syndicate group method.

There were a number of practical advantages in using the Internet in the manner of this project.

- *Low-cost* No costly software development was required. The project brought together readily available resources of the Internet and supplementary materials developed by the project team, linked by an explanatory framework that guided student access. To achieve this, the project needed only to use the simple software tools available for preparing Internet sites.
- *Flexible delivery* Students were able to access the modules at any time and from off campus sites. This is important since the University of Melbourne is not a residential university. Students were found to access the modules on a 24 hour, seven day a week basis.

## CONCLUSION

One of the important aims in higher education is to introduce students to the process of inquiry and contemporary tools used to access information. It is important for students to examine, question and apply the best available information easily and quickly. The case study approach is an ideal vehicle for developing these skills.

As the student cohort becomes more adept at using the Internet as a learning tool the demand for this type of subject delivery is likely to rise dramatically. Student use of the Internet was high in this project and subsequent evaluation has indicated that the participation rate has increased further in second semester 1998. Students attest to thinking that they better understand economic theory covered in lectures through having to apply it to real world situations. In terms of stimulating student's interest in economics we were fortunate in that students completed this work in the midst of the Asian economic crisis that was reported daily in the news. Nevertheless we were unable to capture through the evaluation methods that we used a change in critical thinking skills.

In order to address some of the valid concerns that students raised in relation to this project a number of new initiatives will be put in place in the future. There is a need to encourage all students to gain confidence in accessing the Internet. A surprising number of students seem never to have used this source of information. In future one tutorial will be devoted to explaining how the on-line Internet modules are integrated into the structure of the subject, to demonstrating how to access and search the Internet and to explore how to generate effective group work. Students will be given more direction through links to relevant sites in the country home pages in the 'Cyber Tigers' module. In order to facilitate communication between students, asynchronous message or discussion boards will be introduced for each tutorial group of 20

students. It is expected that this will ease communication between syndicate group members and avoid the frustration experienced by a few syndicate groups in setting up meeting times. The 'Max' computer aided learning modules will be extended to cover a wider range of difficult topics in the subject. The evaluation program will be continued in order to obtain data from a larger cohort of students.

This project represents a novel approach to teaching and learning in first year Introductory Macroeconomics that could be replicated elsewhere at low cost. The initiative recognises major factors influencing higher education internationally, including the need to integrate effectively the new digital information sources with traditional forms of on-campus staff and student interaction, and the objective of internationalising the curriculum in order to prepare economics graduates for life and work in a global economic environment. The approach developed by this project is complementary to the goal of developing lifelong learners, an objective now given a clear priority in Australian higher education.

## References

Becker, W. 1997. Teaching Economics to Undergraduates, *Journal of Economic Literature* 35, 1347 - 1373.

Becker, W. and Watts, M. 1995. Teaching Methods in Undergraduate Economics, *Economic Inquiry* 33, 692-700.

Becker, W. and Watts, M. 1996. Chalk and Talk: A National Survey on Teaching Undergraduate Economics, *American Economic Review, Papers and Proceedings* 86(2), 448-453.

Chizmar, J. and Walbert, M. 1998. Internet-based learning environments: Issues of best teaching practice. Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30, 1998.

Coates, D. and Humpreys, B. 1998. Assessing the Effectiveness of On-line Materials in Principles of Economics Classes. Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30, 1998.

Daniel, J. 1998. Using the Internet to improve computer aided instructions in economics. Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30, 1998.

Johnston, C., James, R., Lye, J., McDonald, I. 2000, (Forthcoming). An Evaluation of the Introduction of Collaborative Problem-solving for Learning in Economics. *Journal of Economic Education* Winter

Johnston C., Olekalns N., Wilkins, N., James, R. 1999, (Forthcoming). Collaborative Problem-solving in Tutorials for Improving Student Learning in a Statistics Subject:

An Evaluation Report. *Educational Innovation in Economics and Business IV: Learning in a changing environment*. (eds) J. Troy, M. Pettigrew, J. Hommes and P. Keizer Kluwer Academic Publications.

Laurillard D.,1993. Rethinking University teaching: A framework for the effective use of educational technology. Routledge. London, reprinted 1997

McBride, M. 1998. Using Asynchronous and Synchronous Experiments via the WWW in Teaching Economics. Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30.

McCain, R. 1998. Socratic Teaching of Principles of Economics on the World-Wide-Internet". Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30, 1998.

Ramsden, P. 1992. Learning to teach in higher education. Routledge London, reprinted 1998.

Siegfried, J., Bartlett, R. et al. 1991. The Economic Major: Can We Do Better than a B-?, *American Economic Review, Papers and Proceedings* 81(2), 20-25.

Simkins, S. 1998. Promoting active-student learning using the World Wide Internet in economics courses: Theory and Practice, with examples for teaching and learning. Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30, 1998.

Stone, L. 1998. A Methodology for Multimedia Instruction. Paper presented at the Conference on Integrating New Teaching Technologies in the Undergraduate Teaching of Economics, Pittsburgh, PA, May 28-30, 1998.

### **Web addresses**

- Introductory Economics Home Page  
<http://www.ecom.unimelb.edu.au/ecowww/cjohnston/101/101home.html>
- Max Multiplier Module  
<http://www.ecom.unimelb.edu.au/ecowww/cjohnston/101//nmultiplier/index.html>
- Max in Action Module  
<http://www.ecom.unimelb.edu.au/ecowww/max/index.html>
- Cyber Tigers Syndicate Module  
<http://www.ecom.unimelb.edu.au/ecowww/cjohnston/maxine/index.html>