Asian Social Science
www.ccsenet.org/journal.html
Vol. 4, No. 3
March 2008

Graduates' Use of Spreadsheet Tools in Learning and Applying Financial Mathematics

Timothy Kyng (Corresponding author)
Division of Economic and Financial Studies, Macquarie University
Sydney NSW 2109, Australia
Tel: 61-2-9850-7289 E-mail: tkyng@efs.mq.edu.au
Paul Taylor
Division of Economic and Financial Studies, Macquarie University
Sydney NSW 2109, Australia
Tel: 61-2-9850-4777 E-mail: ptaylor@efs.mq.edu.au

The research is financed by a Learning Excellence and Development (LEAD) grant from the Division of Economics and Financial Studies, Macquarie University, Australia.

Abstract

We investigate, using questionnaires, the use of spreadsheet software in the financial sector workplace by recent graduates and the benefits of spreadsheets in the teaching and learning of actuarial and financial mathematics at postgraduate level. This study investigates the nexus between learning and work in order to modify the university curriculum. We aim to equip graduates with skills applicable in the workplace and to improve the learning of actuarial and financial theory.

The results indicate that the use of spreadsheets in the workplace is ubiquitous and that graduates find them relatively easy to learn, easy to use and very useful for their work. Spreadsheet skills are considered very valuable. Little or no formal training had been provided during their university studies and graduates mostly learned on the job. The surveys of postgraduate students and of employers support the conclusions reached from the graduates' survey. There is considerable justification for university courses to include training in the use of spreadsheets.

Keywords: Actuarial, Financial, Assets, Liabilities, Calculation, Valuation, Spreadsheets, Software

1. Introduction

In industrial practice, many financial and statistical calculations are done using spreadsheets. At university the traditional approach used in teaching financial mathematics is for students to solve problems using pen and paper and then to do any calculations required using a calculator. The traditional approach may be a barrier to the learning of financial theory for many students.

This paper investigates the use of spreadsheets and other software in the workplace by recent graduates, the extent to which these skills were learnt at university or on the job, and the type of software skills required by financial sector employers of recent actuarial science and other graduates. It also investigates the opinions and attitudes of postgraduate coursework students regarding the use of spreadsheets and software in the teaching and learning of actuarial and financial mathematics.

Our purpose is to consider the nexus between learning and work in order to determine whether the university curriculum should be revised – both in order to improve the learning of financial theory and better to equip graduates with applicable skills for use in the workplace.

Financial mathematics is used for various purposes such as: financial decision making; the valuation of financial contracts, assets and liabilities; and the measurement of and reporting on the financial condition of financial institutions. Much of the mathematics and theory was developed before computers were in widespread use. Its teaching reflects this.

In current industrial practice, computers and spreadsheets are usually used to perform calculations to assist with financial decision making. These calculations vary from the straightforward to the complex. Consider the following 2 examples:

Example 1: Repayment Calculations for an Amortizing Loan

Payment $= \dfrac{Pi}{1-(1+i)^{n}}$

Debt at time t $= \dfrac{P\left(1-(1+i)^{-(n-t)}\right)}{1-(1+i)^{-n}}$

Where P = Principal, i = interest rate, n = term of loan, t = time elapsed since loan taken out.

This is a straightforward financial calculation which can feasibly be done on a calculator. Both formulae involve only 3 variables and basic mathematical operations.

Example 2: The valuation formula for a “chooser option”. This is a financial contract where at time S you can choose whether at time T you get the payoff from a call option or a put option. The option is to buy (call) or sell (put) an asset worth V now for price X at time T in the future. At time T you get a payoff of either Max(V–X, 0) or Max(X–V, 0) depending on your choice at time S.

Value $= (Ve^{-yS}N(d_1(S)) - Xe^{-rS}N(d_2(S))) - (Xe^{-rT}N(d_2(T)) - Xe^{-rT}N(d_1(T)))$

$$d_1(S) = \frac{\ln\frac{V}{X} + (r - y + 0.5v^2)S}{v\sqrt{S}}$$

$$d_2(S) = \frac{\ln\frac{V}{X} - (r - y + 0.5v^2)S}{v\sqrt{S}}$$

Where: V = value of asset now, y = dividend yield, r = interest rate, T = maturity date, S = decision date, X = exercise price, v = volatility of asset. $N(x)$ = cumulative density function of standard normal distribution evaluated at x.

This is a more complicated example of a financial formula. It involves several variables, advanced functions, and functions of functions of functions. This is not suited to calculation on a calculator.

Spreadsheet programs are ideally suited to performing these and other financial and insurance calculations. They are also suited for creating tables, graphs and reports and presenting the results. They are used for these purposes in the financial services industry. Using spreadsheets for teaching financial theory may be a better way of preparing students for the workplace than the traditional approach to teaching the theory. It allows student to work on more realistic problems and case studies.

In this paper we review the literature on the use of software in teaching mathematical skills, and we report on the attitudes of three groups: postgraduate finance and actuarial students; graduates working in the financial services industry; and managers who supervise these graduates.

2. Background

There have been no previous studies on the use of spreadsheets (such as Excel) as teaching tools for courses specifically in actuarial studies. However, there has been a good deal of work done on issues that are directly relevant to our study. The following overview will show, for example, that the use of computer algebra systems (CAS) and other software programs has been extensively investigated at university level, both regarding the value of these as teaching tools, and the attitudes of students to their use. From a pedagogical viewpoint, investigators have found value in using computers to do complex calculations that have in the past been done by hand. They argue that this enables students to attend to the way in which different stages of complex problem-solving processes fit together, leaving the student free to concentrate on components or aspects of the process which they would be likely to overlook when preoccupied with time-consuming hand calculations.

A number of studies have focused on the use of software programs (such as computer algebra systems – CAS) for teaching university courses in mathematics, statistics, science and engineering. Some of these studies are concerned with students’ and lecturers’ attitudes to the introduction of unfamiliar software into university courses, while others are concerned with the pedagogical value – the pros and cons – of software programs as teaching tools. Both of these concerns are present in a study by Stewart, Thomas and Hanna (2005), who looked at the use of CAS in teaching a group of first and second year science and engineering majors. They found that students fell into four “types” or groups:

(1) One was “openly opposed” to computer work because they believed that working out problems by hand benefited their education more than relying on computers.

(2) A second had no such qualms, but lacked the ability to use the software to its full advantage and so made limited use of it.

(3) A third had poor mathematical skills and so welcomed the possibility of using computers to do calculations that they had difficulty doing themselves.

The fourth group found that using computers helped them to understand concepts because they were not distracted by the lengthy process of doing calculations by hand and so were better able to understand problem-solving processes as a whole.

Other studies have concentrated on student attitudes to the introduction of computer technology into university courses in mathematics. Cretchley and Galbraith (2002) and Cretchley and Harman (2001) are among those who have looked at students' confidence, attitudes, motivation and engagement with regard to (i) learning mathematics generally, (ii) using technology generally, and (iii) using technology in learning mathematics in particular. They found that confidence and motivation correlated strongly with achievement in mathematics, but those attitudes towards using technology in learning mathematics correlated much more strongly with a positive attitude towards computer technology than with a positive attitude towards mathematics itself. Coupland (2000) looks at students' opinions regarding the use of Mathematica in their first year of study and she found that just over 50% of them had positive or neutral attitudes while almost 50% had a negative attitude. Previous computing experience seemed to correlate with a positive attitude, a conclusion also supported by Galbraith, Pemberton and Cretchley (2001). These results all point to the importance of the level of computing skills in students' attitudes to the use of computers in studying mathematics, since negative attitudes may arise not because computers impede learning or are simply not useful, but because students have insufficient computer skills to feel comfortable with computers, or lack the skills to benefit from the educational advantages they might offer.

Forster (2006) is concerned not only with the educational value of computer use including spreadsheet programs, but also the technical understanding required. Reviewing a wide range of literature, he argues that passing mathematics processing to a technology allows students to focus on mathematics properties and relationships, provided that technical expertise is in place. Regarding spreadsheet software programs in particular, he says that their capabilities are better than with those on graphics calculators and CAS. The limited screen area on hand-held graphics and CAS technologies means that results are often accessed on different screens to the one on which information is entered, which prevents direct comparison of input and output. He argues that learning in statistics, too, is aided by the use of spreadsheets. Forster emphasises, however, that the use of technology in teaching requires careful attention to the students' computer-specific understanding. He warns that the status of students' technical understanding under three different headings – input of information, procedures in activating the technology, and the interpretation of outputs – should be assessed before exposing them to computer-based activities.

In terms of research specifically on spreadsheets, several studies point to their effectiveness for student learning. Johnson (2006) sets out to demonstrate the educational value for mathematics teaching of Excel in particular, but also other spreadsheet software, arguing that it facilitates hypothesis testing, the investigation of variants and algebraic reasoning. Wagner (2006) is also concerned with demonstrating the pedagogical uses of Excel and similar spreadsheet programs – in this case in the context of engineering – and observes that across a number of relevant numerical tasks and problems students show significant improvement in their skills. Kademan (2005) argues, similarly, that Excel and other spreadsheet software are highly useful in science teaching, because of their data manipulation capacities.

3. Method

Questionnaires were designed to obtain the opinions of three groups of people: students (postgraduate commerce students including actuarial science, accounting and finance and other business students); recent graduates working in the financial services industry; and the managers/supervisors of those recent graduates. The questionnaires were distributed in class for the postgraduate students and by email for the graduates and employers. Participation in the surveys was both voluntary and anonymous.

3.1 The student survey

The student questionnaire uses a 5-point Likert scale (Appendix C). All but two of the questions fall into one of the three following groups:

(a) those inquiring into attitudes to the use of software programs in the classroom, without comparing this approach with traditional teaching methods (questions 1 and 9),

(b) those asking the student to compare the merits of traditional and computer-based learning methods as ways of learning and mastering university work (questions 2, 3 & 4);

(c) those inquiring into student perceptions of the value of using computers in the classroom as preparation for the workplace (questions 5, 6 and 7).

Ninety-three (93) postgraduate students participated in the student survey. The cohort of students was comprised of about equal proportions of actuarial students and accounting/finance students. The survey was conducted at the end of semester. By this time, some but not all of the students in the cohort had been exposed to the use of spreadsheets for performing financial calculations during the semester, some had experience in using it from before then and some were complete novices. During their undergraduate studies, these students would have been taught financial mathematics in the traditional way.

3.2 The survey of recently hired graduates

Seventy (70) graduates who were working in the financial services industry participated in the graduate's survey. The survey (Appendix B) asked questions about:

(1) The demographic characteristics of the respondents, such as age, gender and length of time in the current job.

(2) The software they use at work, how much time they spend at work using spreadsheets, and for what purposes they use spreadsheet software.

(3) The training they have had in using spreadsheets, the importance of spreadsheet skills in the workforce, and the advantages and disadvantages of spreadsheets.

3.3 The survey of employers / managers / supervisors of recently hired graduates

Ten managers responded. The survey (Appendix A) asked questions about:

(a) The type of graduates they employ, what software these graduates use at work

(b) The importance of spreadsheet and macro/visual basic skills in graduates

(c) The spreadsheet skills training they provide to graduates and their views on their training needs

4. Results

The results of the three surveys are set out in Appendix A, along with a statistical analysis and relevant graphs.

4.1 Survey of Postgraduate Students

Figure 1 shows the average score by question. A score of 3 indicates neutral on the proposition expressed in the question, a score of 4 indicates agreement and a score of 5 indicates strong agreement. It is apparent from the graph that the students are in agreement with the propositions in the questions, except for question 1.

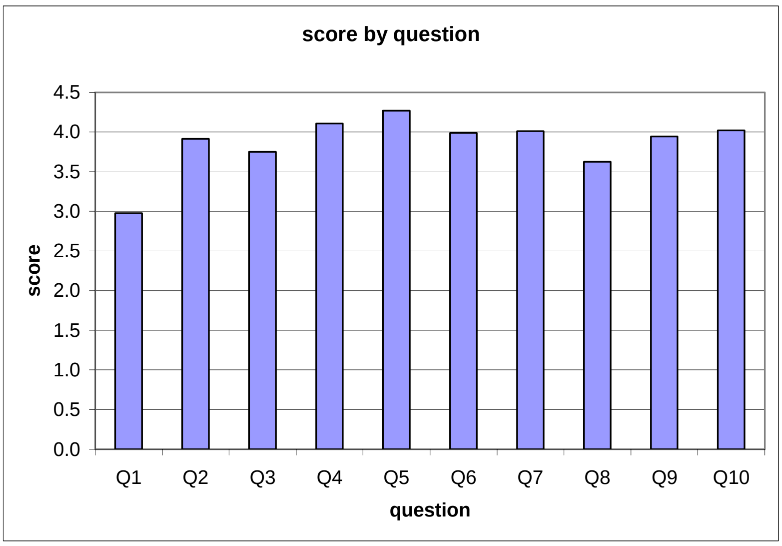

Figure 1.

In Figure 2 we collapse the "agree/strongly" agree categories into a single category and we do the same for "disagree/strongly" disagree categories. This results in three categories of "agree or strongly agree", neutral, and "disagree or strongly disagree". This graph shows the relative proportions of responses in these three categories for each question. It demonstrates visually that for question 1 opinion was polarised whereas for all the other questions the "agree" category dominated the other two categories of response.

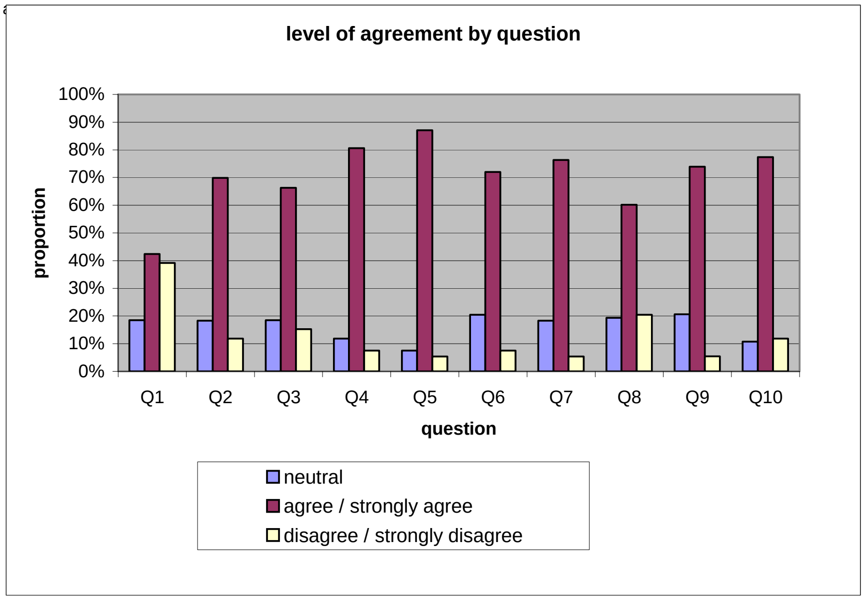

Figure 2.

Thus the response to question 1 stands out as the only one of our questions where there was not a positive answer. This question – from group (a) of the groupings listed under 3.1 above – asks whether "complex formulae and tedious calculations are a barrier to learning". From the literature review it is apparent that in general students tend to be divided in their attitude to hand calculation and complex formulae, with some actually liking them, some finding they present no barrier, and some finding them difficult (Stewart, Thomas & Hanna, 2005; Coupland, 2000). In this context it is interesting that the student responses for question 1 were polarised – much more so than with any other question – with roughly equal numbers of students accepting and rejecting the proposition. This could reflect the divide between actuarial studies students in the cohort (comprising about half the group) and those studying other subjects. High achievement in mathematics is an entrance requirement for actuarial students, they have regular exposure to very complex formulae throughout their university studies, and would therefore be unlikely to be daunted by difficult mathematical calculations.

Students' largely affirmative answers to Question 10, which asked them to respond to the proposition that "it can be an intellectual challenge to solve financial/mathematical/actuarial problems using computers and spreadsheets", show that our cohort of students did not view the classroom use of computers simply as a means of "letting the computer do the work" but found using spreadsheets to solve complex problems to be an intellectually interesting process. This supports the proposition that computers can enhance a student's understanding of complex problem-solving techniques – a benefit of the classroom use of computers remarked upon by a number of the researchers surveyed in our literature review (Johnson, 2006; Wagner, 2006; Kademan, 2005; Thomas, Monaghan & Pierce, 2004; and Forster, 2006).

The answers to questions 2, 3 and 4 – the questions making up group (b) – were all positive and clearly show that our students preferred computers to calculators for their studies. Their answers to question 3 in particular support what we have inferred from their answers to question 10 – that computers are a valuable learning tool.

The students answers to questions 5, 6 and 7 – our group (c) questions – were also all positive, showing that the cohort saw the classroom use of computers as an important part of their professional training for the workplace.

The general view of the classroom use of computers expressed by our students was more positive than the views commonly reported in the literature. A number of researchers (Coupland, 2000; Cretchley & Harman, 2001; Galbraith, Pemberton & Cretchley, 2001; Cretchley & Galbraith, 2002) suggest that a lack of experience in the use of sophisticated software is a common source of resistance to the use of computers as a teaching tool. Since the majority of students in our cohort had had a good deal of prior experience in the use of such software, this may partly explain their generally positive attitude to the classroom use of computers.

4.2 Survey of recent graduate entrants to the workforce

Seventy graduates who have recently joined the workforce participated in the survey. Details of the survey results are set out in Appendix B.

The cohort was 27% female and 73% male. The age distribution was: 71% aged 18-25, 24% aged 25-30, and 4% aged over 30. Regarding their degree majors, 90% of them had an actuarial science major, 41% had accounting/finance majors, and 16% had a mathematics/statistics/computer science major (note students are able to complete more than one major). Regarding their duration in their current job, 43% of them have been in their current job for up to one year, 44% of them for one to three years, and 13% for more than three years. These people work in a wide range of jobs in the financial services industry.

Almost all of the respondents (99%) use spreadsheets in their work. About 90% of them use word processing software and 47% use specialised statistical software. About 30% of them use high-level programming languages. Almost all of them spend a significant proportion of their time at work using spreadsheets. More than 60% of them spend more than half of their time at work using spreadsheets, and 85% of them spend more than 20% of their time at work using spreadsheets. Spreadsheets are used for a wide range of purposes from ad hoc straightforward calculations to highly complex calculations and statistical modelling and simulation.

In our sample none of them had received any training in spreadsheets at university and only 19% had been given a training course by their employer. The rest had learned it from colleagues on the job or by themselves. The majority (81%) of them are of the view that some level of training in spreadsheet skills should be provided at university. Almost all of them (99%) rate themselves as being experienced spreadsheet users.

We asked them about their perceptions of the advantages and disadvantages of spreadsheets. Overall their attitude to spreadsheets is very positive. A clear majority agree on the major pros and cons, as follows:

Pros: It is possible to develop a spreadsheet quickly for all sorts of calculations, both simple and complex (95% of the sample agreed on this point). Spreadsheets are widely used in industry (86% agreed). Spreadsheets are easy to learn and easy to use (71% agreed). They have a wide range of tools and functions that make them useful for work (71% agreed).

Cons: Spreadsheets are often inadequately documented (76% agreed). It is difficult to audit spreadsheets and verify that they work as intended (71% agreed).

Other disadvantages that were identified were the risk that a user can modify the way the spreadsheet works; that spreadsheets have a slow execution speed; that it can be difficult to explain them to new users; and that it is cumbersome to have both code and data in the same file. It is noteworthy that none agreed with the proposition that spreadsheets can be difficult to understand and difficult to modify.

We asked them about the importance of spreadsheet skills for entry-level staff and 80% of them rated spreadsheet skills as fairly important to essential. 77% also thought that employers rate them this way. Skills in Visual Basic (Macros) were seen as less important than basic spreadsheet skills.

4.3 Survey of managers / supervisors of recent graduate entrants to the workforce

We sent the survey to a sample of 50 employers / managers / supervisors, of whom ten responded. Though this is a small sample, the results are similar to those in the survey of recently hired graduates:

(1) Software used in the workplace: All (100%) of the graduates use spreadsheets at work, 80% of them use word processing software and 70% use statistical software.

(2) The importance of spreadsheet skills in graduates: All of them rated these skills as at least fairly important and 80% rated them as very important to essential. Visual basic skills were not seen as quite as important.

(3) The type of graduates employed: Actuarial science (100% employed actuarial science graduates), accounting / finance (30%), economics (30%), mathematics / statistics / econometrics (50%), computer science (20%).

(4) Training in spreadsheets: Only 30% provided a basic training course. The rest expect staff to learn on the job from colleagues or to already have these skills before joining the organisation.

(5) Spreadsheet training needs of entry-level staff: A big majority of the sample (80%) agreed that at least some of the training should be provided in university courses.

5. Implications for learning and teaching

Both recently hired graduates and employers overwhelmingly think that university courses should provide some training in spreadsheet skills. The extent to which training courses are provided for new graduates in the workforce is low. Spreadsheet skills are seen by both employees and managers as very important skills. Basic spreadsheet skills are more important than visual basic (VB) or “macro” skills.

Ninety-nine percent of the graduate employees and 100% of the employers reported that spreadsheets are used in the workplace by graduates. Spreadsheets are used for a significant proportion of the time by most graduate employees. They are used for a wide range of tasks from simple to complex. Over 60% of graduates reported using spreadsheets for more than 50% of their time at work. While spreadsheet, word processing and statistical software skills are evidently required in the workplace, not much training in these skills is provided by university courses.

Among the various studies done on the use of software in teaching at university level, both regarding the value of these as teaching tools and the attitudes of staff and students to their use, a number of investigators have found pedagogical value in using computers to do complex calculations that have in the past been done by hand. Our inquiry offers general support for these conclusions.

The main disadvantages of spreadsheets brought to light by our inquiry were a perceived lack of documentation provided for most spreadsheets, and the difficulty in auditing them and verifying that they work as intended. It is likely that the reason why our inquiry was able to bring out this problem was the high proportion of postgraduates in our student sample – in other words, students sufficiently advanced to identify a problem of this kind. The generally positive attitude in our student cohort to the use of computers as a study tool contrasts with the mixed response often encountered by other researchers. A number of those researchers have suggested that negative responses may be explained by students' lack of experience with sophisticated software. If so, it is plausible that the relatively positive attitude of the students in our cohort can be explained by the fact that a high proportion of them had extensive experience in the use of advanced computer software.

Our student survey indicates that the use of spreadsheets in university training is likely to be welcomed by students. That such training will better prepare them for the workforce is evidenced by our survey of recently hired graduates, who generally find spreadsheets very useful in their work. In this context it is worth mentioning that in industry practice it is important to be able to do the numerical calculations efficiently and accurately, and this means using computers and software to do it. For example, in statistics most of the formulae used for model fitting and hypothesis testing are too complex and tedious to do by hand. No practicing statistician does this sort of calculation by hand. The focus is on using and interpreting the results and not on the calculation process. The same applies to actuarial science and financial mathematics. It is important to understand the mathematical theory, but it is just as important to be able to apply it and this requires computer skills. Both a theoretical understanding and the ability to apply it are required. Having one skill without the other is inadequate in today's workforce.

There is definitely a need for training in the use of spreadsheets to be included in university courses in actuarial science, financial mathematics and finance. This will enhance students' learning and also better equip them for the workforce. It is recommended that university training in financial mathematics and actuarial mathematics should be updated to provide students with training in spreadsheets and other software, and in how to apply these in practical problem solving. Such training would ideally include instruction in how to document and audit spreadsheet models, how to write them, and how to convert a mathematical solution into a spreadsheet model.

References

Coupland, M. (2000). First experiences with a computer algebra system, In J. Bana & A. Chapman (Eds.), *Mathematics Education beyond 2000* (Proceedings of the 23rd annual conference of the Mathematics Education Research Group of Australasia, pp. 204–211). Sydney: MERGA.

Cretchley, P. (2001). Technology and hand calculations in the new e-maths generation: how do they learn and how should we teach? *Quaestiones Mathematicae* (Suppl. 1), 159–167.

Cretchley, P., & Harman, C. (2001). Balancing the scales of confidence–computers in early undergraduate mathematics learning. *Quaestiones Mathematicae* (Suppl. 1), 17–25.

Cretchley, P., & Galbraith, P. (2003). Mathematics, computers and umbilical cords. *New Zealand Journal of Mathematics*, 32 (S), 37-46.

Forster, P. A. (2004). Assessing technology-based approaches for teaching and learning mathematics. *International Journal of Mathematical Education in Science and Technology*, 37 (2), 145-164.

Galbraith, P., Pemberton, M., & Cretchley, P. (2001). Computers, mathematics and undergraduates: What is going on? In J. Bobis, B. Perry & M. Mitchelmore (Eds.), *Numeracy and Beyond: Proceedings of the 24th Annual Conference of MERGA (MERGA-24)* (pp. 233–240). Sydney: MERGA.

Holton, D. (2005). Tertiary mathematics education for 2024. *International Journal of Mathematical Education in Science and Technology*, 36 (2-3), 303-313.

Johnson, E. (2006). A sequence of cylinders. *Mathematics Teaching* 198. [Online] Available: www.atm.org.uk/mt/archive/mt198.html (August 24, 2007).

Kademan, R. (2005). Out of the Stone Age. *Science Scope*, 29 (2), 58-9.

Stewart, S, Thomas, M.O.J., & Hannah, J. (2005). Towards student instrumentation of computer-based algebra systems in university courses. *International Journal of Mathematical Education in Science and Technology*, Special issue, 36 (7), 741-749.

Thomas, M.O.J., Monaghan, J., & Pierce, R. (2004). Computer Algebra Systems and algebra: Curriculum, assessment, teaching, and learning. In K. Stacey, H. Chick, & M. Kendal (Eds.) *The future of the teaching and learning of algebra:*

The 12th ICMI Study (pp. 154-186). Boston: Kluwer Academic Publishers.

Wagner, G. (2006). Excel exercises for first-year engineering students. *Teaching Mathematics and Its Applications*, 25 (3), 109-119.

APPENDIX A: Results of survey of managers / supervisors of recent graduates

What type of graduates do you hire?

Actuarial Studies	100%
Accounting / Finance	30%
Economics	30%
Maths / Statistics / Econometrics	50%
Computer Science	20%
Other	10%

What software do these recently hired graduates use in their jobs?

Spreadsheet software	100%
Word processing software	80%
Statistical software (S+, SAS, etc)	70%
High level languages (C, C++, Fortran)	30%
Other (e.g. in house valuation software)	40%

How do you rate the importance of spreadsheet skills for graduate staff:

(a) not important at all	0%
(b) somewhat important	0%
(c) fairly important	20%
(d) very important	20%
(e) essential	60%

How do you rate the importance of visual basic (spreadsheet macro) skills for graduate staff:

(a) not important at all	20%
(b) somewhat important	20%
(c) fairly important	20%
(d) very important	30%
(e) essential	10%

Does your organisation provide staff with any training in spreadsheets?

(a) We provide a basic training course	30%
(b) On the job training from their colleagues	30%
(c) We expect staff to have skills before they join us	40%
(d) Staff learn by self study in their spare time	0%

What is your view of the spreadsheet training needs of recent entrants into the workforce:

(a) should be included in university training	20%
(b) it should be "on the job training"	20%
(c) both (a) and (b) apply to some extent	60%
(d) expect staff to already have a basic level of competence	0%

APPENDIX B: Results of survey of recent graduate entrants to the workforce

Demographic profile of respondents

gender		Age		Time in current job		Degree major		Type of work they do	
Female	27%	18-25	71%	0-1 year	43%	Actuarial Science	90%	Life Insurance	26%
Male	73%	25-30	24%	1-3 years	44%	Accounting, Finance	41%	General Insurance	30%
		Over 30	4%	3-5 years	10%	Maths, Stats / Computing	16%	Superannuation / Pension Funds	3%
				Over 5 years	3%	Other	6%	Investment / Finance	37%
								Other	14%

Software used at work

Software used at work		Proportion of time using spreadsheets at work		Purposes spreadsheets are used for		Ability as a spreadsheet developer / writer	
Spreadsheets	99%	Nil	1%	Ad hoc straightforward calculations written by me	77%	Novice	1%
Word processing	90%	0%-20% of the time	13%	Routine calculations and other tasks using already developed spreadsheets	70%	Experienced at spreadsheets but not vb / macros	43%
Statistical software (SAS, S Plus, R etc)	47%	20%-50% of the time	24%	Ad hoc highly complex calculations written by me	70%	Experienced at spreadsheets and vb / macros	22%
High level languages (C, C++, Fortran etc)	30%	Over 50% of the time	61%	Statistical model fitting and simulation	23%	Expert in all aspects of spreadsheets	34%
Other	13%						

Advantages and disadvantages of spreadsheets

What are the advantages of spreadsheet software?		What are the disadvantages of spreadsheet software?	
Easy to use and easy to learn	71%	They can be difficult to understand and difficult to modify	0%
Can develop a spreadsheet quickly to perform all sorts of calculations, both simple and complex	95%	It can be difficult to audit & verify that they correctly do what they are designed to do	71%
Spreadsheets are widely used in industry practice and many staff use them	86%	They are often inadequately documented	76%
They have a wide range of capabilities and built in functions and tools that make them useful for calculations and the production of tables and graphs	71%	A user can modify the code and alter how they work. It is difficult to protect them from this risk	38%
Tedious and repetitive calculations or other tasks can be automated using “macros” or visual basic	24%	Other (e.g. slow speed, difficult to explain to others, cumbersome to have code and data in the same file)	19%

Importance of spreadsheet skills

Importance of spreadsheet skills for entry level staff		Importance to the employer of spreadsheet skills in entry level staff		Importance of VB / Macro skills for entry level staff	
Not important at all	1%	Not important at all	1%	Not important at all	10%
Somewhat important	29%	Somewhat important	22%	Somewhat important	44%
Fairly Important	15%	Fairly Important	37%	Fairly Important	32%
Very important	18%	Very important	21%	Very important	9%
Essential	37%	Essential	19%	Essential	4%

Training

What training did you receive in spreadsheet skills		What is your view of the spreadsheet and other software training needs of recent entrants into the workforce?	
None at all	29%	It should be included in university training	1%
I was sent on a training course by my current or a former employer	19%	It should be “on the job training” depending on the specific requirements of the job	43%
I learned from my colleagues / supervisor	14%	Both of the above apply to some extent	22%
I learned from university studies	0%	Expert in all aspects of spreadsheets	34%
I taught myself about it on the job / in my spare time	38%	Employers expect new staff to have a basic level of competence in the software we use in the workplace.	

Appendix C: Questionnaire for postgraduate students

		S D	D	N	A	S A
Q1	There are many complex formulae and tedious calculations involved in learning and studying finance/financial mathematics/actuarial mathematics. This can be a barrier to learning the material.	1	2	3	4	5
Q2	In **learning** finance theory/financial mathematics/actuarial mathematics, using a computer and spreadsheets is preferable to using a calculator for performing the calculations involved in problem solving and answering assignments questions.	1	2	3	4	5
Q3	Using a computer and spreadsheets for the calculations in finance/financial mathematics/actuarial mathematics makes it easier to learn the material.	1	2	3	4	5
Q4	In the **practical application** of finance theory/financial mathematics/actuarial mathematics, using a computer and spreadsheets is preferable to using a calculator for performing the calculations involved.	1	2	3	4	5
Q5	Using a computer and spreadsheets for problem solving in and learning of finance/financial mathematics/actuarial mathematics **makes me better prepared for the workforce**.	1	2	3	4	5
Q6	It is important to receive additional training by the university in the use of spreadsheets so that I am better prepared for the workforce.	1	2	3	4	5
Q7	The training in spreadsheet programming that I received in my university course will prove to be useful when I enter the workforce.	1	2	3	4	5
Q8	Using computers and spreadsheet software to solve financial/mathematical/actuarial problems is an important aspect of my university course.	1	2	3	4	5
Q9	Students should be allowed to use computers and spreadsheets in the final exam instead of a calculator if they wish to.	1	2	3	4	5
Q10	It can be an intellectual challenge to solve financial/mathematical/actuarial problems using computers and spreadsheets.	1	2	3	4	5

Appendix D: Statistical analysis of results of student survey

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Proportion who are neutral	18%	18%	18%	12%	8%	20%	18%	19%	21%	11%
Proportion who agree / strongly agree	42%	70%	66%	81%	87%	72%	76%	60%	74%	77%
Proportion who disagree / strongly disagree	39%	12%	15%	8%	5%	8%	5%	20%	5%	12%
Level of agreement (average score)	3.0	3.9	3.8	4.1	4.3	4.0	4.0	3.6	3.9	4.0
P-value for Hypothesis that score is 3 (neutral)l	85.90%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
P-value for Hypothesis that score is 4 (agreement)	0.00%	21.91%	1.66%	13.42%	0.33%	45.72%	45.31%	0.23%	28.22%	42.40%

To compute the average score / level of agreement, we assign numerical scores as follows:

Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly agree = 5. The level of agreement with each question was computed by averaging these scores.

From the last 2 rows, showing the p-values we can reach the following conclusions:

(1) The scores are all statistically significantly bigger than 3 except for question 1. For question 1 the score was 3.0 indicating neutrality on the proposition in the question.

(2) For questions 2 to 10 the scores are all close to 4.0 (agreement). For question 5 the score is statistically significantly higher than 4.0. For questions 3 and 7 the scores are statistically significantly lower than 4 but for the other questions the scores are not statistically significantly different from 4.0.

Statistical analysis of the average scores is only one way of analysing the results. Alternatively we can look at the proportions who agree or strongly agree versus the proportions who disagree / strongly disagree or who are neutral. We see that for all questions except the first the proportion who agree or strongly agree clearly dominates the proportions who are either disagree or strongly disagree or are neutral.