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## GRADUATES' INITIAL EXPERIENCES OF WORK

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*Abstract. : What do our students do with their mathematics degrees? How do they make the transition to the professional workforce? This study reports results from in-depth interviews with 18 graduates who have moved into a range of industries. The study is from the perspective of graduates who have graduated within the past five years from five universities. We investigate how they perceive their university study has helped them move into the workforce.*

*Graduates find the move to the workforce difficult and many have not found an appropriate niche for their skills. This paper describes, in narrative style, the experiences of recent graduates.*

### **Introduction**

There have been numerous studies on the transition from secondary school to university mathematics study (summarised in Wood, 2001). There are also studies of graduates and graduate attributes, such as Scott (2002). The transition to university mathematics and its challenges are well recognised. What is less understood is the transition to professional work; how people move from being students to developing a professional identity and professional skills and attitudes. This later transition is the basis of this study.

### **Background**

Australia needs the mathematical sciences. The report, *Mathematical Sciences: Adding to Australia* commissioned by the Australian Academy of Sciences (National Committee for Mathematics, 1996) asserts:

*The mathematical sciences are critical to Australia's economic competitiveness and quality of life, and will become more so. The mathematical sciences are generic and enabling technologies. They are essential to the prosperity of many value-adding industries in Australia. ... Individuals and groups pursuing research in the mathematical sciences constitute a human and intellectual resource of the utmost national significance. (Executive summary, p x).*

However, researchers in mathematics education worldwide (such as Krantz, 1999) have identified a serious problem: despite the importance of the mathematical sciences, few students are enrolling for degrees in mathematics and those that graduate are having difficulty getting appropriate jobs. The Australian government graduate destination surveys of 2004 show that of those graduates who are seeking

full time employment, 64.4% on mathematics graduates are in full time employment and 35.6% are seeking full time employment. This is at a time of high employment and skill shortages. In all the graduate fields surveyed, it is the second lowest full time rate for students graduating in 2004 (the lowest is Visual and Performing Arts with 57%, (Graduate Careers Council of Australia, 2005)). The good news is that the starting salaries for those in employment are high.

The job of “mathematician” or “mathematical scientist” is not obvious, visible or well defined. Rather, it encompasses a wide range of careers that are related through using the tools and ideas of mathematics. For most students, the nature of mathematical work is not at all clear, and hence it is not easy for them to make a connection between what they are learning at university and what they will be doing as a mathematician. It seems that this is true also for employers who do not appreciate the insights that a mathematics graduate can bring to their business and industry.

### **The study**

We investigate how mathematics graduates move from their mathematical studies into the workforce by following the stories of 18 recent graduates using in-depth interviews. This paper tracks the process of acquiring a job, adjusting to the work situation and their use of mathematics. We also consider some of the discourse concerns that graduates have identified. We do this in narrative form following the graduates’ stories.

These graduates have become ‘mathematicians’; they see their work and life in terms of mathematics even if they are not working as a mathematician. All exhibit Level 3 conceptions of mathematics (Reid *et al.*, 2003). They have taken their learning experiences at university and it has changed their way of looking at the world – their studies have mostly found them a ‘foot in the door’, a start to their careers. Their jobs have given them a different perspective. Their comments here are set within their experiences of employment.

The participants for the study were recruited from advertisements sent to graduates who had finished their studies in the past five years. They had a range of employment situations, age, ethnicity and academic backgrounds. Some graduates had laboured through their degrees with many failures and others had high grades. Some had done well (by their own reckoning) in the workplace; others had struggled. Participants had graduated from five universities and had a range of degrees with mathematics majors. Most of the participants were in their early to mid twenties. There were three people who had studied mathematics as their second degree and one had come to university as a mature-aged student. There were 10 males and 8 females and 8 spoke languages other than English as their home language. The commonality between these participants is that they all regarded themselves as qualified mathematicians. A full list is given in Table 1.

The quotes in this paper are as the graduates have spoken with some deletion of ums and other repetitions. Spoken English is full of grammatical errors and these have not been corrected. Quotes have been shortened and sections that are not relevant to the particular context have been omitted – these are shown by the use of an ellipsis (...). At all times care has been taken not to change the sense of what a participant is saying. The quotes have been shortened for ease of reading.

ID	Sex	Majors	Job description	Work area
Angie	F	Maths, Finance	Loan advisor	Banking
Boris	M	Pure, applied	Cryptographer	Security research
Christine	F	Pure, applied	Police constable	Police
David	M	Maths, Finance	Dealer bank treasury	Banking
Evan	M	Maths, Finance	IT	Banking
Fredrik	M	Maths, Physics	Technical officer	Hospital research
Gavin	M	Applied	Climate modelling	University
Heloise	F	Stats, OR	Logistics analyst	Industrial
James	M	Maths, Finance	Corporate treasury	Insurance
Kay	F	Statistics	Statistician, tutor	University
Leah	F	Statistics	Clerk	Government
Melanie	F	Applied	Musician	Entertainment
Nathan	M	Applied, IT	IT development	Self-employed, Industry
Paul	M	Maths, Finance	Trading risk management	Banking
Roger	M	Pure, applied	Modeller, programmer	Geological survey
Sally	F	Statistics	Statistician	Insurance
Thi	F	Engineering, Maths	Loan support	Self-employed, bank services
William	M	Actuarial	Instructional designer	University

**Table 1: Description of participants**

## Getting a job

The experience of our graduates shows that the transition to work is difficult. Each graduate has a story and it is valuable to consider a few accounts here to appreciate the experience of the process of moving to work.

*Nathan: I pretty much got a job straight out of uni, full-time and I started as a programmer for a web-development company and after about fourteen months, or so, a bit over a year, the market sort of did a bit of a downturn and the company retrenched nearly half its staff and I was one of those, so I was out of a job for about three months or so and then they took me back as a contractor so I started just working for them maybe ten to twenty hours a week ...*

*Heloise: when you do go into interviews you gotta sell the degree because... especially talking just with an agency who has no knowledge of maths and how far you can go with it, you've gotta really prove to them what you can do with it. Because it's not like an accounting degree where, 'o.k., you're an accountant'. It's not as straightforward as that. You've gotta say, 'well, with what I've done, I can do this, I can do that, I can do that'. And then they'll go... you'll see how people just go, 'Really? You can do that?' People don't realize how much you can do with a maths degree.*

*Thi: ... there's not that much work out there and when I came out, in 2002, the telecommunications industry was hitting rock-bottom, was hitting absolute rock-bottom, that is why I'm where I am now because of the lack of work. ...One of my goals in life was to start my own business, anyway. It just accelerated the choice and it's a huge risk.*

*Sally: I knew what I wanted, and I wasn't gonna settle for anything less so I was always searching and stuff. But I think they will maybe, cos you do feel, you do get down on yourself after like, a few months without getting any work and you're at home, and you know, and you're like, ooh.*

*Angie: I've got the skills. Given the opportunity I'm more than capable of doing the job. However, having the piece of paper itself hasn't helped me get a job. So, that's a negative problem. Once I get the job I've got plenty of theory and knowledge and skills to go ahead and do it but it has been a very real hurdle trying to get the (?) position.*

*Leah: I don't think that my studies prepared me for a subsequent career in statistics at all well. As a matter of fact I think it was very poor and I think it had... my getting this job here had a lot more to do with me just using my initiative than having anything... than applying anything I've learnt at university. ... it's actually really easy to see areas in industry where you think you could make a difference, it's extraordinarily difficult to get past that recruitment filter and to actually find yourself in one of those jobs.*

So some graduates fell into work but had to reappraise their situations due to changes in the workforce, others were struggling at the entry stage to get a job that they felt was commensurate with their knowledge. They believed that they had skills and knowledge that would make a difference in industry – and could see how to apply their knowledge – but could not get into those positions where they could make a difference. There is a clear need for training about applying for jobs, as Leah suggests *I think it would be humane for somebody, ... to have some kind of in-your-face train... I don't know if training's the word, just exposure to what happens when you go for a job.*

### **Initial work experiences**

Getting the job is one objective, adapting to the situation is another. Graduates had a range of initial work experiences and it is often mediated by the people that they work with, particularly their managers.

*Heloise: I think the biggest help was the people I work with. When you're comfortable, especially with your manager, the person you report to, you're comfortable with that person, it makes a big difference, I think. I just... I've taken a step back and had a look sometimes and, if I'd had a different manager I don't think I could have gotten as far as I have and I've only been there seven months.*

*William: I ended up leaving after a year ... when I sort of started my cadetship because that was when I first entered an office and worked in an office and I'd expected there to be much more ... I wasn't prepared for the environment.*

*Paul: when you first come out of uni and you try to explain, you're really keen, oh I've got this great idea and here, blah blah blah, and your boss just looks at you blankly and says that's too technical, I don't understand.*

*Evan: The underlying thing of coming out of uni is not ... you're not going to be CEO in 3 years' time! It's something we had to beat out of me in the first 3 months! I guess one of the main things is the responsibility is just given very much in piecemeal, and built up over time, ... you might have got HDs in everything, but you've still gotta prove yourself in a particular context. And that's not uni any more.*

Initial work experiences, particularly a graduates' relationships with their boss and their workmates have a strong influence on their transition to the workforce.

## Use of mathematics

How do these graduates use mathematics in their early careers? The responses range from 'bugger all' through 'the most simple mathematics equations' to sophisticated mathematical modelling. All graduates felt that they knew more mathematics than was required for their positions though most used their textbooks when they had forgotten details of the mathematics or needed to develop new work.

*Christine: I can tell you how many wheels there are in a train, for example. It's mostly just the way that I look at it ... because I'm a logical person and the logic applies in the work that I do. As far as mathematics itself is concerned, I'm not using my degree in any way, shape or form.*

*Leah: it [statistics] just gives you a lot of points of view to start looking at problems, whereas statistics is very much about, 'who says?' 'Where's the evidence?' "What are you basing that on?" 'Is there a real trend?' 'Is it just a one-off?' 'Back it up'.*

*Roger: I think the hardest thing that I ever had to actually use, in my job was second year maths, these Riemann sums, that was about the hardest. But it really helped to know a lot more, because you can more freely work with the things.*

*James: ...when I have a particular project or something I like to go and refresh my memory on it things around, for example, I had to use the t-distribution the other week and I wanted to go back and read and make sure I was using the correct distribution. I should have been using chi-squares, in my head I went this is what I should use, I just wanted to check.*

*Paul: A couple of weeks ago I was given a new swaption, this weird derivative to price, and how do you do it? And I kind of sat down and had a think about it and worked through, pulled out an old derivatives securities textbook and worked through it like a problem, that was it.*

*Gavin: [I'm] working with a climate modelling group on, what they call data assimilation, which is ways of incorporating observations, real observations to better kind of models, I guess, so, using neural networks, using multi-dimensional calculus stuff, using, so it's sort of applied maths really. But a lot of other stuff that's not really maths, that's sort of, plant physiology has to get in there as well and, that kind of stuff.*

*Boris: I'm actually doing ... cipher design, to be able to design that you need the mathematical theory to prove security bounds.*

These graduates are using mathematics in different ways. The ones who are not explicitly using the mathematical procedures that they learnt at university nevertheless believe that they have taken on the characteristics of a 'mathematical person' such as logical thinking and being more aware of numerical and logical situations around them.

## Working as a mathematician

Many mathematics graduates are isolated in their workplaces in that they are the only ones with a mathematical background. There is a degree of loneliness with being the sole member of your work team who is the mathematician. Often you are unable to discuss details with any of your colleagues or supervisors. Other issues about working as a mathematician emerged in that their bosses may be demanding results that are simply not possible from the mathematics or the data available. Roger, in particular,

expressed serious frustration with the way mathematics was used in his workplace and had to change his ideas of working as a mathematician. He was incredulous about the demands made on him (and mathematics) and the way he was expected to work.

*James: I was really fortunate up until about 12 months ago I had a guy who did honours degree in stats and so that was great I used to bounce ideas of each other quite a lot and became good friends so probably no one else in that I work with in my work area has a maths degree ...*

*Gavin: None of my supervisors are particularly well informed in that respect, which makes it quite difficult sometimes, because a lot of what I'm doing, probably most of it, isn't really supervised I guess. I'm working by myself, ...*

*Roger: So, basically, there were many absurdities of this nature where they expected you from minimal data to extract more information than the data could provide. So that was quite irritating. And there was no stopping them, demanding it. If they think that they're paying you enough, and that's it.*

*David: [Talking about his boss] That's right. And he's an intelligent man, but he's not, he doesn't have, his background's not quantitative, but he's quite comfortable with quantitative ideas. But I don't think I'd be able to take him to the [...] calculus, that's not his cup of tea.*

*Roger: Yes. There was one other thing that I was going to say. Oh yes, one problem for people with pure maths, well that I certainly had, is it is quite a shock to them in the real world to see how maths is used in this strange way where assumptions are made left and right, whereas in pure maths one dare not. But it is very important to accept that, if you are going to go and work in the real world so to speak, one has to be able to just allow oneself to make assumptions and so on, and even though it is completely against what one is trained to do, in pure maths, which is everything is to be verified, perfectly, so you must then get rid of that idea*

*Boris: No, no. Actually generally I don't talk about mathematics at all with my friends. With exception for one or two friends that is [...] all know nothing mathematics. That's actually because they see mathematics as this hard and difficult, and when you talk you almost, it's like a door that is closing, so that's the main reason why I not talking about mathematics.*

### **Lack of communication skills**

While not directly asked, several participants commented on the consequences of poor communication skills in the workplace. Nathan not only talks about the personal problems with advancement but the problems to the whole organisation when the technical people and management are not able to discuss work practices.

*Evan: At work, you'd be out the door quicker than anything, doesn't matter how good you are, if you are not tactful, or don't know how to talk to someone, you can't have a, provide a client-style consultative relationship with, with people you work with, doesn't matter how good you are.*

*Nathan: Often people in I.T., I've found, that are very technically savvy and they're brilliant at what they do, they often don't advance, career-wise, or don't get the opportunities they deserve because they lack certain vital communication skills*

*Nathan: The people that are in a position to make a decision on, you know, who to spend with so much money because they have a budget and, they're high up, you know, (?) government, educational, corporate institute, none of them are technical study and often the ones that are within the degree, or within their department, the people that know, that have the skills, they don't have the decision-making abilities. So, all of a sudden (?) you'd be in a meeting where you have two people who are in a position of power, they are talking about a concept they don't really understand it yet they're the ones making the decisions on what to promise, how much money to spend and that always causes problems because once they've made the decision they then push the project down the, you know, various chains of command and eventually it falls into the hands of the technical people who do the project and so often it's out of scope, or there's problems, because the people who made the decisions in the first place never really understood the technologies. But, that's the perfect example of those people getting to where they are because they have good business and communication and negotiation skills.*

*Leah: I've often thought well at least I wasn't one of those poor kids from the Western Suburbs with atrocious, you know, verbal communication skills and I often wondered what happened to them and I don't know whether... I mean I really do. I wonder what happened to them.*

### **Changes to university programs**

Participants made suggestions as to changes to university programs that would have assisted their transition to the workplace. There were suggestions about content, computer skills and personal skills. Some ideas were the obvious domain of academics (that is academic content) and other suggestions were concerned actually getting a job such as; interview skills and knowledge of the employment market. There was appreciation of the diversity of jobs that universities are preparing students for and that the role of universities is not necessarily vocational; that the broad aim is learning. Nevertheless there was robust criticism of teaching and the way content is delivered at university, in particular the lack of overall coherence and a failure to link areas of knowledge. Especially strong was the perceived failure to link areas of knowledge to real situations. Good teaching, as always, makes a difference. When talking about why he studied mathematics Gavin says: *It was a good lecturer. And I wasn't doing as well in maths as I was doing in physics, but, a good teacher makes it much more exciting.*

### **Changes to content**

There were several suggestions about content. The majority of these were to do with specific computer products, such as Excel, Visual Basic or SAS (a statistical package). The following quote is typical.

*James: As far as transition for work, everywhere uses standard products like Excel, and if you come out of a maths degree, I wasn't really taught to use Excel all that much here [at university] and I think its really a tool of the trade.*

In general, graduates felt that they knew far more mathematics than was needed for their jobs. This was not seen as a negative as Roger says: *It is always much better to know a great deal more than what you actually use: It is a kind of confidence and experience that you don't feel bound by rules.* Others were frustrated about having so much knowledge that they were not using.



There is a clear need here for universities to be constantly updating their computing tools to fit in with the needs of industry. The amount of mathematics studied in a degree seems to be more than what is needed for most employment. There is space in the mathematics curriculum to develop other skills that graduates need and to bring in real world experience.

### **Changes to teaching**

Group tasks were strongly recommended by graduates as an important way to prepare for the workforce. Graduates who had studied in other disciplines where a greater range of teaching methods were used felt that this was an advantage in the workplace. Thi (and others) believe that you really learn a topic if you teach others and they recommended that opportunities for teaching be incorporated into learning tasks. This resonates with the work done on peer teaching by Ken Houston at the University of Ulster (Houston, ...)

*Christine: I hate group work, and I hate to encourage group work, but probably group work'd actually, because being mathematics you can do an assignment the night before it's due if you have to, and you can not go to bed if you have to, but if you've got group work then you've got people that are counting on you which is probably more realistic.*

*Kay: I think that the more group-work that we're doing we're forcing people to learn to communicate*

*Nathan: ...the maths studies that I did were a lot more, what's the word, individualized. So you get a project or and assignment and you work on it on your own, pretty much, and that's it and then you do your exams and you pass or you fail. So, its very much an individual's sport, if you like. Whereas, doing something like psychology or business studies is a bit more of a team sport.*

*Nathan: maybe do more presentations or group assignments, something that's going to give them more confidence and be able to... step up (?) to explaining in a group. ... I mean most of them would be so scared to do that but I think it would do them a world of good if you had that as part of the study*

*Thi: I think we should be able to know how to communicate our knowledge to others so that they can comprehend it in a way that's easy and I don't think we know how to do that yet.*

Many of the changes suggested by graduates were structural. Some believed that the lecture situation is not conducive to learning, others suggested formal work experience as part of their degree and James suggested a third year subject on transition. Laboratory learning for statistics and computing received positive recommendations.

*Nathan: Sitting down and listening to someone talk where, in most situations, your attention-span drops off further into the lecture, not to say that that is a comment on the lecturer's skills, I think most of the ones that I had were good, some were excellent. I just think the whole way that people are taught, it's not the best way of learning.*

*Heloise: Maybe an option, to do a six-month formal work experience but if you didn't want to do a full six months of it, maybe a few weeks... the difficulties of setting something like that up... but just a bit of hands-on... I just found it [university study] very theoretical.*

*James: Maybe like a transition to employment, like a third year subject, whether it's a subject or something else*

*David: And lab is vital, I think, having the labs is absolutely vital in statistics. I certainly think that one of the more valuable learning experiences I did have, was labs in statistics, and computing.*

*Paul: Probably more putting it in a professional context, ... so making something more work relevant would be useful so maybe a report writing course or something like that but for business rather than for academics.*

There was a constant theme about subjects not being related to each other and students having to make connections themselves. In joint programs, such as mathematics and finance (which is a set degree with half mathematics and half finance) students expected integration between the subject areas but this did not happen. Even for those who did straight mathematics degrees, the graduates perceived that the subjects were not linked. What is clear from this study is that, for this group of graduates, links between subject areas were not made explicit.

*Gavin: That's the problem with most university courses is that you're not introduced to the philosophy of the course, you know, you're not introduced to the motivation of the course, you just go straight onto the content.*

*Boris: Actually, I'm take [?] it for courses a bit more integrated with each other, I realise. In my honours year, there were honours subjects and in the beginning you get the idea that they are starting to deal with each other, and at the end of him it's actually have idea why they have something to do with each other, I think that in the middle of the next semester you actually realise why they have actually something to do with each other.*

*Evan: Ah, I guess at uni the thing that was hard for me was um, and that may have changed since I did it, but there is the maths stream and there is the finance stream, and there's not a lot of crossover. ... you have to marry them up yourself.*

*Melanie: [...] this is a left field idea as well, but like if the very first lecture of any course was given by somebody who wasn't actually going to be the lecturer of that course, but just somebody who had good communication skills and could actually put the whole course in context.*

Students are often isolated in mathematics classes. Graduates made a plea for more interaction in class and less content driven curriculum.

*Christine: the classes aren't big, you've got maybe 20 students in a class, but I couldn't have told you a single name of someone in some of those classes. I've just, there was no interaction with other students, for a lot of the time, ... so perhaps if you start up with a bit of the touchy-feely stuff, and just getting to know everyone, and I don't know if other people do that sort of thing, but that perhaps would have been a bit nicer. Just to make, encourage more discussion in the class, cos I think there's so much to get through in the course that it's just, Day 1, right, this is my name, this is my contact details and all that sort of thing, right let's begin. And then it's just scrambling through it for the rest of the semester.*

Graduates wanted more exposure to real world situations as part of their learning.

*William: ... a graduated approach, where you might start by learning some theory, then be working a bit with, say, a lecturer in a mock team situation on a realistic project, then having industry experts come and work with you to maybe do real project, ... So, I suppose, if university was able to forge stronger co-operative project-base (sic) work with industry, that would be a really helpful thing to make that transition.*

*Nathan: I think that you could probably, if you had a lot more exposure to the 'real world' as part of your learning process, I think you can't go wrong.*

## **Managing expectations**

Graduates were often given career advice by their lecturers and this can lead to grief!

*Paul: To be honest in first year we were told that this course is designed to send everyone into dealing rooms and that stuff. What I have found is that maybe 2 or 3 people in each year will get a job in a dealing room so managing the expectations of everyone in the course could be done more effectively. Probably by not overselling things early. Trying to be more realistic early. Like its good to get everyone excited about what they are studying but not so excited that they expect that when they graduate they are going to be this, because a lot of people will end up disappointed or frustrated that they don't get to do that.*

*Sally: Yeah, you should give an accurate idea of what potential jobs are out there, instead of finding out at the end.*

## **Conclusion**

In an in-depth study like this one, we are examining the perceptions of a small group of graduates. Their experiences are important and can inform curriculum development. For example, even if lecturers believe that the curriculum is integrated and subjects are connected, that is not the experience of this group. The connections were not sufficiently explicit.

The work situations that the graduates entered taxed their resilience and some did not make it in the environment. Many have changed careers and others are frustrated with their circumstances, as Leah said: *if I haven't found a niche in the next couple of years then I'll start to get really shitty.* Most believed that university changed them and their expectations, David: *It made me appreciate the bigger picture. It sort of opened up avenues of my career that I never would have ever imagined could have existed.*

The study revealed serious areas of under preparedness for the workforce. Graduates were unprepared for the office environment or to deal with colleagues and managers. Their first experience, particularly with their manager, set the scene for their adjustment. Many of the mathematicians were alone with their area of expertise and had to adjust to the language of those around them – with no training for this from university. Most were unprepared for the job seeking process itself and had to educate employers on their skill set. Graduates were unaware of language choices and how to communicate at different levels.

Many of these problems could be alleviated by changes in curriculum that would be cheap and effective to implement. Firstly, course designers and lecturers should make connections between subject areas explicit – explicit to the students. Group work in subjects needs thought but is relatively easy to implement and will not add cost to the

course. Other teaching and learning suggestions should be seriously considered. A well designed third year *Transition to the Workforce* subject could lead to the study of a project, consulting or peer teaching and develop many of the generic team and communication skills needed for the workforce as well as consolidating mathematical skills. This could be complemented by smaller 'real' projects in previous subjects. Universities can coordinate opportunities for work experience in the university vacations. There is need for all agencies of the universities to work together to assist in the transition to the workforce.

Given that graduates are not using all the mathematics that they learnt at university, there is opportunity to reduce the amount of content and increase the development of generic capabilities and general learning skills.

## References

- Graduate Careers Council of Australia. [www.gradlink.edu.au](http://www.gradlink.edu.au) (accessed on 29 May, 2005)
- Houston (2000). Peer Teaching
- Krantz S (1999). *How to Teach Mathematics*. 2<sup>nd</sup> edition. American Mathematical Society, Providence, Rhode Island.
- National Committee for Mathematics (1996). *Mathematical Sciences: Adding to Australia*. National Board of Employment, Education and Training and Australian Research Council, Canberra.
- Reid, A., Petocz, P. Smith, G.H. Wood, L.N., & Dortins, E. (2003) Mathematics students' conception of mathematics. *NZ J Math*, 32,S,163-172.
- Scott, G. (2003). Attributes of successful graduates. *ATN Conference*, January 30
- Wood, L.N. (2001). Transition to tertiary mathematics. In Holton, D. (ed) *ICMI Study on Teaching and Learning of Mathematics at University Level*. Dordrecht:Kluwer.