

Diverse Students – Diverse Solutions?

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Extended Abstract

Introduction

In this extended abstract of my keynote for Δ '99 I will follow the current trend in the U.K. of 'sound-byte' politics. For example, the response of Tony Blair ('New Labour, New Britain') to a question about his priorities if elected was *Education, education, education*. As this is a conference mainly of university educators I guess perhaps one of the main problems we face is "How to put more butts on seats without being caught dumbing-down?" But of course we have greater integrity than that – so maybe, less vulgarly, we would prefer to express our dilemma as: "How to maintain standards while increasing throughput." This is exactly what a group drawn mainly from the London Mathematical Society (LMS), and chaired by Geoffrey Howson, set out to do¹. Their proposed solution was to attempt to reduce the diversity in students' mathematical backgrounds by concentrating attention on school teaching, syllabuses and examinations. My belief is that, while such an approach may lead to improved homogeneity in the student body, it is likely to have a negative effect on making mathematics an attractive subject for students contemplating a commitment of three or more years of study. I propose that we need to take a more radical look at what we do, and why we do it. In doing so I can only draw on experience gained in UK higher education – so you must forgive me if some of the issues raised are not yet relevant in Australia.

Some problems in discussing ideas in education are:

- (a) that everyone has experience of education
- (b) that everyone has strong views on it and
- (c) that each individual's experience of education
is usually very limited and untypical of the whole!

So I will try not to let my experience as a mathematics undergraduate in Oxford in the 1960's cloud my judgement. But there in lies the rub – many of those in senior administrative positions, are products of such an elite system where fierce competition was both accepted and provided pretty well the only driving force. When Sir Hermann Bondi became President of the *Institute of Mathematics and Its Applications* (IMA) in the early 1970's, he pointed out the folly of the then current university mathematics courses and their examination system. In his analysis the shared view by university staff of undergraduate mathematics was one of a process by which the best 15%-20% of students could be selected for entry to Masters and Doctoral programmes and hence enter training to become the next generation of academics. But by that time the rapid expansion of the University sector in the 1960's, post-Robbins, had taken place and the new mathematics posts had been filled. So the 'system' then only had need for

¹*Tackling the Mathematics Problem*, London Mathematical Society, 1995

enough academics to replace those currently in posts who were retiring, dying or emigrating – which actually required less than 5% of the numbers graduating.

So I propose that to come to grips with the problems of diversity, we need to be prepared to abandon, or at least re-assess, some of our cherished assumptions about the nature and purpose of undergraduate mathematics. We need also to consider the expectations of the other players in the system, such as students, employers, politicians, and university administrators.

The Students

Let's start with the students. We all know what a wonderfully challenging, rewarding and beautiful subject mathematics is – but how do our students perceive it, what do they experience and what do they want out of it? Well, one problem in the UK is that far too few good students actually choose to study mathematics after age 16. About 25% of 16-year olds get the higher grades (*A**, *A* or *B*) in the national examination for 16-year olds, the General Certificate of Secondary Education (GCSE) which would normally guarantee entry to the national academic examination for 18-year olds: the *Advanced levels* (*A-levels*) course. But only 35% of those so qualified actually go on to take *A-level* mathematics. *Why?*

Recent research by both the National Foundation for Educational Research and King's College London shows that one reason is that it is perceived by students as being a course harder than those in growth areas such as business studies, media studies, sports science *etc.* Research by Howson on *A-level* results supports this claim. Another reason given by students for their decision to quit studying mathematics is its lack of relevance to the real-world. As well as student choice, there is also school pressure. Performance tables of schools' examination results are published by the government – so the school would prefer to advise a candidate to get a high grade in a useless subject rather than a modest grade in 'hard' subjects like mathematics and physics. The UK is by no means the only country to be experiencing a fall-off in the number of students wishing to specialise in mathematics and science. The LMS proposal to increase the rigour of *A-level* mathematics hardly likely to increase take-up.

In the UK there is a system of so-called 'beacon' schools which receive extra funding from the government and have to work closely with local communities and employers. Their parent body is the Technology Colleges Trust, and they recently commissioned me to produce a report on strategies to increase the uptake of mathematics in secondary schools² for students aged 11-19. Work for that report has revealed that about 60% of those entering *A-level* mathematics pass with a grade of *A*, *B* or *C* – which would normally be sufficient to gain a place to read mathematics – and over 25% get a grade of *A*. Yet only just about 7% of entrants to mathematics *A-level* actually go on to study a mathematics related degree. So no wonder we struggle to fill up our places with so-called 'non-standard entry' students! Another new feature of post-16 education currently is a concentration on so-called Key Skills: Communication, Application of Number and ICT (information and communication technology), together with group-work and problem solving. Currently university mathematics courses can be crudely divided between the so-called 'traditional universities' and the 'new universities' – which were created from the former Polytechnics when Mrs. Thatcher destroyed the old 'binary divide.' A gross, but not inaccurate, generalisation is that courses in the 'trad' sector ignore such key skills, while those in the 'new' sector already try to build on them.

So here we can propose some sound-bytes for our less enlightened fellow academics, such as:

²*Engaging Mathematics*, Oldknow, A & Taylor R, Technology Colleges Trust, 1999

'Don't knock the teachers – they're doing their best.', 'Work with those *developing* school mathematics, not against them.' and 'Be prepared – to adjust your courses to meet the skills and expectations of the students.'

Cynically we all know that what most students are after is 'The best possible degree for the least possible work' – and realistically we also know that most of them are forced to work 'on the side' to pay their way through university. Nonetheless we should be able to devise a fulfilling learning experience which, at worst, doesn't dim any enthusiasm for the subject they may already have and at best provides an excellent framework both for further study and for entering decent careers outside education. On a local basis the research project Flexible Learning and Mathematics in Higher Education (FLAMHE), directed by Afzal Ahmed, has been studying developments in such approaches in a number of institutions.

As the Cockcroft report³ revealed in the UK, all but a tiny percentage of people end up falling away from mathematical study without achieving any tangible success in their ability to do something interesting or worthwhile with it. In fact, the attrition rate in mathematics in higher education is among the highest of all subjects at over 20%. It's like the kid who gets fed up with practising scales and gives up the piano without ever playing a good tune – or, in my case, like ending three years of fencing lessons without ever fighting a bout. Another analogy I like to use is the packet of dried vegetable soup. The picture on the outside shows a copious, steaming, nourishing, attractive and desirable product, whereas the actual contents are a handful of dry-as-dust particles. Of course, we have learned the mathematical equivalent of adding the boiling water and lovingly stirring – but I guess that only a very few of our students will achieve this.

The Employers

Now let's turn to the employers. Currently we have a severe crisis in the UK (not for the first time) in the shortage of new entrants to secondary school mathematics teaching. This is partly accounted for by our failure to recruit more mathematics undergraduates as a whole and partly by the insatiable demands from industry and commerce for our graduates. We are virtually back to full employment, and sectors such as finance and information technology are expanding continually. The remuneration, side benefits, prospects and conditions of service in the private sector are such that only a very few dedicated people even consider teaching as a career. What's more, the 'people skills' that these employers seek are just those we would also seek in a good teacher – yet in neither case are they ones which are explicitly developed in many of our mathematics degree courses. That's the irony – we put great store by the mathematical content and rigour of our courses, yet for the overwhelming majority of our students these will be actually irrelevant in their future careers. If the content is represented by 'bricks', then it is the associated modes of thinking and working which constitute the 'mortar' which turns out to be the more transferable of the building materials.

So we need to learn more about what the major consumers of our 'product' are looking for, and to ensure that, where possible, our courses explicitly promote those qualities. A current exercise in the UK is to try to define 'degree-worthiness' in the various subjects – a process called 'benchmarking', in which the major professional associations are involved. In mathematics there is already a widening gulf between the views of the more purist academic community as represented by the LMS, and those of the users and appliers of mathematics as represented

³*Mathematics Counts* (Report of the Committee of Inquiry into the Teaching of Mathematics in Schools, chaired by W.H. Cockcroft), HMSO, London 1982.

by the IMA. It is highly unlikely that a single view of degree-worthiness in mathematics will emerge. The logical next step, though, is that each degree course in mathematics should have a clearly argued rationale stating its purpose – and that units or modules within it should have aims, objectives, teaching and learning strategies, assessment schemes *etc.*, which are consistent with the rationale. Hence another very important step towards coping with diversity is to encourage diversity between courses so that students could be guided towards courses which best match their qualifications, their learning style and their expectations. I survived Oxford – but I certainly did not encourage my son to go down the same route.

That it is, of course, to assume that there is some underlying coherent structure within our degree courses! Until recently I don't believe that was the norm, at least within the 'traditional sector' (and nor was it the case with *A*-levels). The discipline of peer-review imposed by the Council for National Academic Awards (CNAA) on public sector higher education before the end of the divide was both rigorous and enabling. In documenting courses for validation and review everything had to be made explicit from market research, through audits of supporting resources and staff expertise, to employment opportunities. But the freedom was there for you to structure your courses any way you liked, provided you could argue cogently for them. Although CNAA did its job too well, and was displaced from degree course validation by Mrs. Thatcher, it is reborn and thriving as the Quality Assurance Agency which has been undertaking Teaching Quality Reviews throughout higher education over the past few years. So the culture of accountability and peer review has survived and been extended across the whole of higher education. So another very important element in coping with diversity is to restructure and plan courses with explicit rationale, aims and objectives. The imperative for this can be aided externally by a change in culture which returns teaching to a central, respected and valued role in higher education on a par with research.

Following the Dearing review into higher education a number of significant changes are being phased in. A major change is the recognition that staff in higher education should be trained how to teach, should undergo continued professional development throughout their careers, and should have material resources to support their teaching. At the time of writing the new Institute of Learning and Teaching for higher education is being established with a system of lead centres for each subject. In mathematics one major issue is the role of information and communication technology (ICT) in supporting teaching and learning - and that is the subject of a separate contribution to this conference⁴

The Politicians

Where do the politicians come into the picture? Well, at the top Tony Blair is on record as saying that the country's future economic prosperity depends upon the skills of its workforce. This isn't a party political line, since Mrs. Thatcher expressed the same views. One of the driving forces here is the Confederation of British Industry which published an influential report 'Towards a skills revolution' by a group chaired by Sir Christopher Ball. This claimed a need for a far greater proportion of the population to be educated to degree level – and caused Mrs. Thatcher to set in train the system which saw the UK undergraduate system virtually double its numbers over three years with no added resources! The trick was to abolish the binary divide. The former polytechnics were locally controlled, under severe budgetary restrictions, and responsive to the needs of local employers. But while the Westminster Parliament had a

⁴*ICT in coping with diversity in UK Higher Education*, Challis, N. & Oldknow, A.

Conservative majority, the town and county councils were mostly in Labour or Liberal control. Thus she was able at a stroke to abolish the costly University Grants Commission, 'liberate' public sector higher education from local control and unify higher education under a single funding body, the Higher Education Funding Council (HEFC) and drive unit costs downwards (and staff-student ratios upwards). But there were limits to growth. While it was relatively easy to accommodate the large number of students seeking places in English, History and other liberal arts subjects, there just were not enough students to go round in mathematics and physical sciences. Which brings us back to one of the causes of diversity.

The politicians have made the policy – it is for the university administrators to implement it. The pressure is on to increase supply, at a decreased cost while maintaining standards. One response is to get rid of costly, older staff and replace them with younger, cheaper ones (mainly on short term contracts) – which is how I come to be available for travel in November! Another is to change the core business from education to hotel and catering. Hence our move to semesters and shorter teaching years – freeing accommodation for letting to conferences, outside groups *etc.* Another is to close or merge courses which are under-recruiting. That is how the unthinkable has happened – we now have several universities and higher education institutions which have closed their mathematics departments, or merged them within other departments, such as Computing or Business Studies.

If we are not prepared to radically rethink the purpose, nature and structure of our courses then we will continue to struggle to recruit, and to have to devise means of coping with an increasingly diverse student population with ever constrained resources. My thesis is that while there are strategies which can help alleviate this in the short-term (such as those used by the Open University) we need to be thinking about designing new courses to attract good students who are currently deterred from applying to study mathematics at university. Rather than compete among ourselves for students I suggest that we should be competing with our colleagues in subjects such as psychology, economics, business *etc.* We are losing large numbers of students with the potential to study mathematics further. We would be doing them a good turn by enhancing their career prospects. We would be doing a service to the nation by increasing the supply of skilled personnel. But most important of all, we would be helping to ensure the survival of mathematics as a subject of study in higher education (and, let's face it, our jobs). The price to pay is to take a hard, critical look at what we do now, and to work with schools and employers to define new routes in mathematics which are challenging, exciting and relevant to both teacher and learner. We are in an era of increasing external pressure. We can go Dutch and try to put a finger in the dyke. Or, to paraphrase Laurie Buxton - the former chief inspector for mathematics of the Inner London Education Authority

We've come under a lot of pressure recently – and it's our policy always to give in to pressure

I believe our challenge is to adapt ourselves and to meet diversity with diversity.