OPINION

Celebrating our past: once upon a time there was a cottage industry. Personal reflections on the development of mathematics support

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Abstract

Back in the early 1990's mathematics support was small-scale and loosely organised. Now, in 2021, it is to be found in the full range of university mission groups including those with the highest entry requirements. Today it is undoubtedly true that support centres are part of the landscape of higher education. They have evolved from offering local, drop-in support to first-year engineers to university-wide centres offering help to students in all disciplines and at all levels including postgraduates and sometimes staff. They contribute to university-wide priorities including recruitment, progression, retention, satisfaction, quality enhancement and employability. They have succeeded in raising issues such as the mathematics support of students with additional needs higher up institutional agendas and have firmly put the activities of those who work in this field on the radar of senior management of universities. This paper charts key milestones and events from the trajectory of mathematics support from 1990 to 2020 which have resulted in the thriving support services and community of practitioners that are evident today. It is based on a keynote presentation given by the author at CETL MSOR 2021.

Keywords: mathematics support.

1. Introduction

Over the last thirty years what has become known as *Mathematics and Statistics Support* has evolved from loosely organized, peripheral, and small-scale activities into a more collaborative and co-operative venture. Nowadays it is often embedded within university structures and with university oversight. There are now strong networks of practitioners freely giving their advice, resources, and time, with a common purpose of improving the student experience of mathematics and statistics.

This paper will provide a personal reflection of how we got from then to now. I start with an apology: I will mention some people by name, and either because of time limitations, or my memory or my ignorance, miss other key players. Please don't take this personally. Very many people have brought us to where we are today.

For those readers too young to be around at the start of this journey, I hope this paper will provide some historical background and perspective to the careers you are following today. For those of us who have toiled on this chalk-face for a lifetime, I hope it will provide elements of nostalgia and allow us to reminisce about 'the golden era' - the days before 'the mathematics problem' 'blighted' higher education!

I'll begin with a quotation from the report *Measuring the mathematics problem (*Hawkes, T. and Savage, M. (2000)). This report was, in my opinion, a watershed moment for mathematics support, as I will explain. Referring to A-level mathematics in the 1960s,

"... the 'golden age' of mathematics in which able sixth formers, aiming for university, were inspired and stretched by a very talented teaching force. Students acquired all-important study skills together

with sound mathematical knowledge and understanding which prepared them well for Higher Education."

(Savage, Kitchen, Sutherland, Porkess (2000) in Hawkes, T. and Savage, M. (2000))

Was it ever really like that? Is this unfair? Perhaps a point for discussion over a coffee! But to provide at least some balance, here are a couple more quotes:

"The standard of mathematical ability of entrants to [ ] courses is often very low ... Experience shows that a large proportion of entrants have forgotten how to deal with simple vulgar and decimal fractions, have very hazy ideas on some easy arithmetical processes, and retain no trace of knowledge of algebra, graphs or geometry, if, in fact, they ever did possess any."

(Mathematical Association Report, 1954)

"Many who are in a position to criticise the capacity of young people have experienced some uneasiness about the condition of arithmetical knowledge and teaching at the present time. Accuracy in the manipulation of figures does not reach the same standard which was reached twenty years ago. Some employers express surprise and concern at the inability of young persons to perform simple numerical operations involved in business."

(Board of Education Report of 1925)

These are cited in the Cockcroft Report (1982). So, the first take-away message is that the 'mathematics problem' is certainly not new! However, there are significant differences today: widening of access to higher education, an increasing focus on quality assurance and accountability, substantial fee levels, and societal need for a more mathematically and statistically competent workforce and a more numerate society. These factors provide a rationale for academia to work harder to ensure that students have a worthwhile experience of mathematics whilst at university.

2. The arrival of mathematics support

The term 'cottage industry' in the title of the paper is one which has been cited frequently in the mathematics support literature. Dictionary definitions include: 'a small, loosely organized, decentralized industry' and 'a limited but enthusiastically-pursued activity'. These are apt descriptions for much of the work in the early days of mathematics support (c1990). Work was certainly decentralised with little or no oversight save by the one or two enthusiasts who took it on as almost individual pursuits. Within the literature of mathematics support we attribute the original reference to Joe Kyle, University of Birmingham, who wrote that he regarded mathematics support as *"a form of cottage industry practised by a few well meaning, possibly eccentric individuals"* (in Marr, C, and Grove, M., (Eds) (2010)). I really can't imagine who he was referring to!

Pioneering work in Australia by Milton Fuller led to the establishment of the Mathematics Learning Centre at Central Queensland University (c1984). Fuller was influential in Glyn James' application to the BP Education Fund to establish support at Coventry (1991) and thereafter developed by Duncan Lawson and colleagues to become the outstanding services at Coventry today. Early pioneers were Ian Beveridge and Rakesh Bhanot at the University of Luton (c1993) who organised the first *National Conference on Supporting Mathematics in Further and Higher Education*. One of the delegates there indicated that support was delivered by "*dedicated enthusiasts struggling to cope with a desperate situation which is getting worse each year, usually with inadequate resources*" (Beveridge, 1999). In an early attempt to gather a community of like-minded individuals, the Mathematics Support

Association (MSA) was formed. MSA newsletters were published until 1999. Copies are archived on the **sigma** Network website.

The Loughborough University Mathematics Support Centre was established in 1996, in the Department of Mathematical Sciences, primarily to serve the large engineering cohorts many of whom were struggling with mathematics. I was appointed to both tutor and to develop the service which rapidly expanded to offer help to any student in the university. Dedicated statistics help followed and other staff in the Department offered additional hours of drop-in support. Clare Trott was appointed as a tutor. Later, she would go on to specialise in the support of students with neuro-diversities and to pioneer this nationally. The help leaflets we developed at Loughborough attracted the attention of Professor John Blake, Director of the MSOR Network (University of Birmingham), which funded the printing, distribution and development of the series known as *Facts and Formulae*. In the following years hundreds of thousands of these leaflets helped students and resource centres around the UK.

3. Reasons for the establishment of mathematics support

Broadly speaking, whatever provision had been in place prior to the 1990's, there was a sea-change following the introduction of the GCSE examinations, which replaced O-levels, in 1986. The first GCSE examinations took place in 1988 and the first cohorts entered university in 1990. It was widely accepted that the GCSE *"brought a decline in students' concept of proof and in their technical fluency and understanding of algebra."* (Hawkes, T. and Savage, M. (2000)). One consequence was a dramatic fall in the number of students taking A-level mathematics from >80,000 (total Mathematics and Further Mathematics entries) to around 50,000. A-level mathematics was perceived as too hard for too many. A knock-on effect was felt by engineering departments many of which found themselves unable to recruit sufficient numbers of undergraduates with A-level mathematics and resorted, at worst, to requiring only a pass at GCSE. Clearly this qualification provided an insufficient mathematical background for success in traditional engineering courses. Provision of mathematics support was an attempt to alleviate this situation. The demographics of the university student population had changed significantly too. In the 1960's only around 5% of 17–30-year-olds studied at university. By 2013 this figure had reached 38% and is now around 50%. It is therefore not surprising that the level of academic support provided for students to succeed needed to change.

In 1999, a Gatsby Seminar (funded by the Gatsby Charitable Foundation) was held at the Møller Centre in Cambridge. This brought together practitioners from universities with the aim of evidencing the decline in preparedness of incoming students for the demands of university. Several delegates, including Lawson, provided detailed quantitative analyses following diagnostic testing which confirmed this decline. His ongoing research published afterwards demonstrated that: incoming undergraduates tested in 2001, having achieved a grade B in mathematics A-level, scored an average mark of 33.8 (out of 50), compared with students entering in 1991 who had achieved a grade N (a fail grade), 34.4/50 on the same questions (Lawson, 2003). A later study (Lawson, 2004) showed that those entering with A-level mathematics grade D in 1991 had an average score of 37.3 whilst students entering in 2001 with the same qualification scored only 29.1. Using the diagnostic test as a 'fixed metric', it appeared that there was roughly a decline of one A-level grade per two years during the 1990s.

The report *Measuring the mathematics problem* (Hawkes, T. and Savage, M. (2000)) followed from the seminar. It was seminal in that many of the anecdotal complaints about the challenges of teaching mathematics were evidenced and legitimised. Due to the wide diversity of types of university represented, no longer could a university claim that *"we don't have students like that in our university*". Two of the recommendations in that report were that (i) students embarking on mathematics-based degree courses should have a diagnostic test on entry, and (ii) prompt and effective support should be available to students whose mathematical background is found wanting.

4. A movement gaining traction

A delegation led by Sir Alan Williams (VC, Leeds) and Professor Mike Savage (Leeds) secured a meeting with government ministers to raise awareness of the challenges. The delegation met the Universities Minister, Margaret Hodge, and the Schools Minister, Stephen Timms, himself a mathematics graduate. The Secretary of State for Education and Skills at the time was Charles Clarke, also a mathematics graduate. The message delivered did not fall on stony ground. Clarke asked Professor Sir Adrian Smith to lead an inquiry into post-14 mathematics education. The resulting report *Making Mathematics Count* (Smith 2004) contained wide-ranging recommendations including the establishment of the National Centre for Excellence in the Teaching of Mathematics (2006) which continues today. The curriculum development body Mathematics in Education and Industry (MEI) was funded to set up and manage national initiatives to encourage and enable more students to study Further Mathematics (and later worked much more broadly). Importantly for universities the Smith Report noted *"Higher education has little option but to accommodate to the students emerging from the current GCE process*" (Smith, 2004, p 95). The need for mathematics support had been legitimized and effectively mandated from the highest levels.

Incidentally, Charles Clarke went on to edit the book *The 'Too Difficult' Box: The Big Issues Politicians Can't Crack* (2014), explaining why politicians find some issues too difficult to deal with, notably,

- difficulty identifying the problem;
- difficulty identifying the solution;
- difficulty working out how to implement a solution;
- difficulty overcoming vested interests;
- existing legal constraints;
- the lengthy process required to bring in legislation;
- a lack of political energy.

Perhaps many of us will see parallels with the mathematics problem and how this persists today!

By now a fair wind was behind those activists trying to develop solutions. In 2002, with funding from LTSN (the Learning and Teaching Support Network - later part of the Higher Education Academy, now Advance HE), HEFCE (Higher Education Funding Council for England) and the Gatsby Charitable Foundation, the websites **math**centre and **math**tutor were established (Figure 1). The former, intended to replicate a drop-in centre, was open-access, required no registration, and was populated with resources on key topics. **math**tutor was much more structured and was intended to mimic a personal tutor taking the student through all required material in a structured way. For the younger members of the readership, it is relevant to point out that technology has developed at a very rapid pace since 2000, and when **math**tutor was established it was not possible to stream the video resources - they were made available to all universities on a set of DVDs. This might seem strange to those who have grown up with fast broadband and the ability to make and watch videos on a variety of platforms. This was not the case as recently as 20 years ago and making videos necessitated hours in a TV studio with technical professionals. In 2010, **stats**tutor was launched largely due to the pioneering efforts of Alun Owen, Ellen Marshall and colleagues.

Figure 1. Screenshots of **math**centre, **math**tutor and a Facts & Formulae leaflet.

5. The sigma years

From 2005-2010 **sigma,** as a Centre for Excellence in Teaching and Learning (CETL), was awarded £4.85m as part of HEFCE's CETL programme. Led from Loughborough and Coventry, **sigma** (unlike many CETLs) was always outward-facing. Mathematics support was inspired, directly funded or supported at dozens of universities. Further funding followed when **sigma** was asked to lead the mathematics support strand of the National HE STEM Programme. In 2013 HEFCE was keen for **sigma**'s work to continue and an additional injection of funding was made until 2016. The Universities Minister, David Willetts wrote: *"Another important initiative is **sigma** - it is establishing approachable mathematics support services at institutions across the country. Thanks to their work, politics students suddenly confronted with a regression analysis have someone to turn to. STEM undergraduates too are receiving expert support to bring their maths skills up to speed."* (Willetts, 2013). By the end of HEFCE funding, **sigma** had directly facilitated the establishment of 36 centres across England and Wales.

From 2012, the work of **sigma** was upheld by the **sigma** Network, managed by voluntary members. A re-branded website, and a new JISCMail mailing list enabled the Network to champion the cause and provide developmental activities and mentoring for practitioners. Strong links with all parts of the UK and Ireland were developed and encouraged the formation of the Irish Mathematics Learning Support Network and the Scottish Mathematics Support Network. Welsh language versions of the *Facts & Formulae* were produced in collaboration with partners in Wales. Colleagues beyond the UK were inspired to develop centres, notably in Norway, the Czech Republic and Switzerland. Those working in these centres have become significant contributors to the growing international community of leaders, teachers and scholars of mathematics support.

After the end of external funding, the **sigma** Network continued to thrive with David Bowers working tirelessly to establish it more formally, now bound by a constitution and answerable to an AGM. It has since been responsible for producing newsletters, establishing Special Interest Groups, offering workshops, training of postgraduates, providing advice for those working with students who have various additional needs, and encouraging student partnership projects. The field has provided fertile ground for pedagogic research projects, masters and PhD students. **math**centre is being gradually updated and made more accessible not least through the efforts of Emma Cliffe at Bath.

An aim of the CETL programme was to recognise, reward and celebrate good teaching. **sigma** contributed to this aim through the **sigma** prize programme. Many colleagues from the UK and Ireland have had their contributions recognised in this way. In 2011, **sigma**'s own contribution was highlighted by it winning the Times Higher Award for Outstanding Support for Students.

6. The mathematics problem persists 2010-2020

Despite these efforts, sadly the problem persists and, in some ways, has worsened. In 2011, a report from the Advisory Committee on Mathematics Education (ACME) noted:

"We estimate that, of those entering higher education in any year, some 330,000 would benefit from recent experience of studying some mathematics at a level beyond GCSE, but fewer than 125,000 have done so".

(ACME Mathematical Needs 2011)

Disciplines, which were traditionally not so mathematical, are relying more on mathematics and statistics. The Biotechnology & Biological Sciences Research Council (BBSRC) in its Strategic Plan 2010-2015 - *The Age of Bioscience* - noted:

"As bioscience becomes increasingly quantitative, there is also an urgent need to raise the mathematical and computational skills of biologists at all levels."

(BBSRC 2010)

The Social Sciences and Humanities are now also generating work for mathematics support practitioners:

"The UK is weak in quantitative skills, in particular but not exclusively in the social sciences and humanities…. another reason for the poor skills of undergraduates is the dearth of academic staff able to teach quantitative methods"

(British Academy 2012)

7. Concluding remarks

Mathematics support has come a long way since its early days as a cottage industry. Joe Kyle went on to write:

> *"…. Now only a few years on, we see that the concept of mathematics support has not only become firmly embedded in UK Higher Education, but colleagues have moved on to gather data on the way students use such resources and look for optimal strategies for the delivery of this support, and this is perhaps the most convincing evidence of acceptance. Mathematics support came of age in the first decade of the 21st century. What might once have been described as a cottage industry now plays a respected and widely adopted role in Higher Education*."

(Kyle, J, in Marr & Grove, 2010)

Clearly there is much for the community to celebrate despite the mathematics problem persisting. Perhaps the issue of mathematical preparedness might well be in the 'too-difficult box' (Figure 2) but nevertheless there are many of you still trying hard to crack the problem.

Figure 2. The 'too-difficult box'.

Thank you to everyone who has played a part in taking us from the cottage industry to our healthy community, evidently thriving today. The challenges are still there but the people in this room and with us online are amongst those who will face them head-on, and make a difference.

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