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network for excellence in mathematics and statistics support

The oversight of mathematics, statistics and numeracy support provision at university level

A guide for Pro-Vice-Chancellors

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for the **sigma** Network

HIGHER EDUCATION FUNDING COUNCIL hefce FOR ENGLAND

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Preface

The seminal report, *Measuring the Mathematics Problem* (Hawkes & Savage, 2000), recommended that: *"prompt and effective support should be available to [higher education] students whose mathematical background is found wanting."*

Over the last 20 years, mathematics support has developed significantly as a response to this recommendation and now forms a respected part of the provision in many higher education institutions: *"Mathematics and statistics support is an essential part of any university. It is critical to a wide range of social sciences as well as professions such as nursing, an obvious benefit across all the STEM subjects and a boon to mathematics…Mathematics and statistics support has now attained a critical mass and overcome the significant hurdle where universities worry whether offering such support is an indication of modest aspirations. The accepted position is now that it is a student's right to receive support with the mathematical content of their degree. The question for all HEIs should now be 'How can universities provide a full range of qualifications and advance the widening participation agenda without maths support?'"* (David Youdan, Executive Director of the Institute of Mathematics and Its Applications quoted in Fletcher, 2013).

For more than a decade, **sigma** has produced numerous publications to support the work of practitioners and researchers within the mathematics support community. This guide is written for Pro-Vice-Chancellors who have responsibility for overseeing the quality of learning and teaching and the student experience.

Throughout this guide, the phrase 'mathematics support' will be used as a short-hand for the more correct (but longer) 'mathematics and statistics support'. Further, the term includes more basic numeracy support, particularly where this is relevant to students' ability to gain access to graduate level employment.

We hope that you find the distilled wisdom within this guide to be of value as you oversee, champion, develop and strive for excellence in student support within your own institution.

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August 2016

Chapter 1.
Why offer mathematics support?

- Significant numbers of students are entering higher education lacking the mathematical skills they require to deal competently with the mathematical content of their courses: *"We estimate that, of those entering higher education in any year, some 330,000 would benefit from recent experience of studying some mathematics (including statistics) at a level beyond GCSE. At the moment fewer than 125,000 have done so."* (ACME, 2011).
- This affects a very broad range of disciplines including, increasingly, the biological and social sciences: *"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).
- This *'mathematics problem'* (LMS, IMA & RSS, 1995, Hawkes & Savage, 2000) remains a major issue despite being extensively researched, being the basis of several inquiries and being reported on for many years (Croft et al., 2015).
- It is widely accepted that universities have a responsibility to try to deal with the mathematical needs of their incoming students: *"Higher education has little option but to accommodate to the students emerging from the current GCE process"* (Smith, 2004) *and "One reason why students leave higher education without completing their qualification, or fail, is that they are not well prepared in key skills before they start. Higher education institutions therefore have to identify knowledge and skills gaps and provide support to students, for example remedial or catch up courses in mathematics in the first year."* (NAO, 2007).
- There is evidence that many academic staff lack the skills to deal with the increasing quantisation of their disciplines: *"English universities are side-lining quantitative and mathematical content because students and staff lack the requisite confidence and ability."* (RSA, 2012).
- Mathematics support has grown substantially in the past 20 years as an effective and popular vehicle through which many students can address mathematical shortcomings and improve their confidence (Perkin, Croft & Lawson 2013).
- Even students with the highest grades on entry to mathematically intensive courses encounter difficulties with their studies: *"…undergraduate students in the Russell Group universities also experience problems with mathematics and statistics, despite the fact that in the main such 'high tariff providers' are capable of recruiting students with very good academic qualifications…"* (Tolley & Mackenzie, 2015).
- Issues are not only restricted to undergraduate level: *"Postgraduate courses, which are often more quantitative than their undergraduate counterparts, give rise to further challenges."* (Tolley & Mackenzie, 2015).
- For many students, employer numeracy tests are an increasingly important part of the employment process: *"…after leaving university many graduates will find themselves faced with numerical reasoning tests when competing for jobs. Yet only 16 per cent of undergraduates studying subjects other than maths have an A-level in maths under their belt. Often they will have forgotten much of what they once knew, and even if they haven't, their confidence in their own abilities may be low."* (Willetts, 2013).
- Far too many students are entering higher education with a negative perception of mathematics: *"My GCSE maths experience has put me off it for life."* (Brown, Brown & Bibby, 2008).

Chapter 2.
What is mathematics support?

- The term *mathematics support* should be interpreted to mean a facility offered to students which is **in addition** to their regular programme of teaching. The term should be regarded as an umbrella term encompassing a wide range of provision.
- The most common provision is the mathematics support centre which typically offers one-to-one support to students on a drop-in basis (Lawson, 2012). Other models of support are used effectively by universities (Marr & Grove, 2010).
- The key feature of a successful mathematics support centre is having a tutor with whom students can discuss their mathematical issues and problems on a one-to-one basis. In addition to addressing technical knowledge, it is important for the tutor to address the student's confidence.
- A mathematics support centre provides a safe learning environment where students can access a range of resources and interact with other students as well as drawing on input from a tutor when needed.
- Research evidence demonstrates that students value the change in power dynamic in a maths support centre as opposed to a member of staff's office. *"When they [staff] are in maths support, you know they're there to help people and you're not bothering them. If you go to their office, you've got your stuff in your bag, there's nowhere to get it out to show them, you know there's a queue of people behind you, they were doing something before you arrived if there wasn't anyone in the queue ahead of you, so you feel like you're bothering them, it's their space as well and you're going into their office, whereas maths support is neutral ground for everybody … it doesn't belong to anybody, you've got your stuff out and they will work their way round the table to come to you, you have your work out ready even if you've put it to one side, so you can flip back to it and say 'can you just help me with this'"* (Solomon, Croft & Lawson, 2010).
- Tutors in mathematics support centres can offer alternative explanations to aid student learning.
- Mathematics support centres complement other initiatives aimed at addressing the *'mathematics problem'* such as bridging courses, summer schools, online resources, diagnostic testing and curriculum re-development.
- The key purpose of mathematics support centres is to assist students to achieve their full potential. For some, this will mean gaining the few extra marks needed to turn a good result into an excellent one. For others, it may be that a fail becomes a pass.
- The exact form of support offered may vary from institution to institution, but the ends are the same: to build students' confidence in mathematics and thereby to enable them to be more successful in the study of their primary discipline.
- Mathematics support centres often assist students in the preparation for employer numeracy testing.

Chapter 3.
Establishing mathematics support provision: delivery and evaluation

Delivery of mathematics support

- Mathematics support can encompass a variety of forms: from small-scale, departmental and subject based initiatives, to multi-site drop-in centres accessible to learners from a range of programmes (Lawson, 2012; Marr & Grove, 2010).
- A mathematics support centre can be based in a range of locations across a university campus. In some institutions the mathematics support centre is based within the library or central study skills unit; in others, the centre can be departmentally based or even peripatetic.
- Crucial to mathematics support is the role of the tutor. Working in a mathematics support centre is challenging, and as such, tutors need to have a particular set of skills that means not everyone is suitable.
- It is essential tutors are selected for their ability to work within a mathematics support centre environment. Essential skills include: ability to recognise students' individual needs; comfortable working on a one-to-one basis; patient; able to explain mathematical ideas in multiple ways; excellent interpersonal skills; able to work (and communicate) with students of a range of abilities and from different disciplinary areas.
- Across the country, mathematics support centres use a range of staff as tutors including academic staff, hourly paid staff (often former teachers) and postgraduate students.
- All tutors need to receive training before commencing work in a mathematics support centre as this is quite different to in-course teaching, tutoring or demonstrating (Croft & Grove, 2011). This should be complemented by ongoing mentoring.
- Those working in mathematics support should be afforded the same development and recognition opportunities as those undertaking more traditional forms of teaching. In recent years, several staff involved in the delivery of mathematics support have been awarded National Teaching Fellowships.
- Since statistics support is often related to extended pieces of project work, it requires the tutor to gain an appreciation of the project as whole. As such, statistics support requires statistics specialists and frequently uses bookable appointments as opposed to drop-in.
- A successful mathematics support centre requires day-to-day oversight and management to ensure the quality and continuity of provision.
- Additionally, buy-in from a senior management 'champion' is needed; someone who not only secures financial support for the provision, but also brokers linkages, raises awareness, and enables departmental and central service buy-in.
- Many universities are identifying their funding of mathematics support in their Office For Fair Access (OFFA) agreements, citing the key role of such support in promoting widening access, particularly at the transition to university.
- A large number of freely accessible mathematics and statistics support resources are available for institutions to use in a range of ways with their students and there is much good practice upon which to build and develop provision. The **sigma** Network continues to develop this resource base.

Evaluation of mathematics support

- Evaluation is necessary to ensure the continued enhancement of mathematics support provision.
- There may be three key foci for the evaluation of a mathematics support centre: Measuring **usage** of facilities, resources and services; gathering **feedback** from students on their perceptions of the quality of the service; and, measuring **effectiveness** in terms of improvements in performance of students who use the service.
- Gathering data and feedback from students who use the mathematics support centre is relatively straightforward to determine usage patterns and quality of service (Green, 2012).
- Evaluation of the *effectiveness* of a mathematics support centre as a retention mechanism is challenging due to the many independent factors which impact upon a student's ability to succeed (Matthews et al., 2013).
- Evidence shows that a persistent minority of students who would benefit from mathematics support fail to access and take advantage of it despite multi-faceted strategies to encourage them to do so (Symonds, Lawson & Robinson, 2008). As such, careful consideration needs to be given as to how to promote mathematics support to all potential student users.

Chapter 4.
Institutional coherence: maximising the benefits

Institutional coherence

- Significant external or 'top-down' factors have been responsible for changes affecting the whole HE system in England. These systemic changes include the move away from an elite to a mass system of tertiary education, widening participation, 'marketisation' through the introduction of student tuition fees, the emphasis given to the quality of the students' experience, the importance attached to their recruitment, retention, achievement and employability, and the publication of league tables.
- The importance of mathematics support not only in improving retention rates but also in attracting students, addressing issues of inequality and diversity and improving employability is now being recognised. Mathematics support is thus increasingly seen as one element of a wider brief to enhance the student academic experience.
- Prompted largely by the above cited external factors, university senior management is increasingly exercising oversight of mathematics and statistics support.
- Mathematics support should be regarded as enhancement provision for all students rather than remedial work for weak students, and so should be of interest to those responsible for enhancing quality in the institution including programme leaders, Heads of Department, Deans, PVCs (Learning and Teaching), Learning Development Managers, Careers advisors and many others.
- In 2014, a joint report to the Department for Business, Innovation and Skills (BIS) from OFFA and HEFCE (BIS, 2014) set out a shared national strategy for combining fair access to HE with student success. It advanced the view that the adoption of a broader, coherent whole lifecycle approach would benefit all students attending the full spectrum of HE providers across the whole sector. Mathematics and statistics support clearly has a vital role in this whole lifecycle approach.
- In most institutions mathematics support is one of a range of academic support services provided. Senior management oversight of all these services can enhance their effectiveness and coherence.

Feedback into the curriculum

- There is great potential for mathematics support provision to make a broader contribution to an institution than simply its work with students. Many structural issues come to light in mathematics support centres (such as significant numbers of students having the same gap in expected knowledge, or mismatches between what is taught in the first two years and the demands of the final year of a degree programme). Consideration should be given as to how this information can be best fed back into curriculum development.
- The effectiveness of mathematics support can be enhanced by close co-operation between mathematics support tutors and academic staff teaching mathematically rich modules.
- In order to achieve this broader impact, it is necessary for mathematics support and those who deliver it to be seen as a key part of the academic provision of the institution. Appropriate and effective channels of communication should be in place to facilitate exchange of information across the institution.
- Consideration should be given as to how the experience of mathematics support can feed into delivery, training and support for those in mainstream teaching.

Chapter 5.
Mathematics Support and the Teaching Excellence Framework

- At the time of writing, the Teaching Excellence Framework (TEF) is still developing; however several elements of the Framework have been established. The impact of the TEF on the higher education sector is, at this point in time, unknown. However, if the impact of the Research Excellence Framework (REF) is a guide, it is likely to have a major effect over the coming years.
- One of the elements of the TEF that has been determined is that higher education providers (HEPs) who choose to submit to the TEF will be assessed against three main aspects:
  - Teaching Quality
  - Learning Environment
  - Student Outcomes and Learning Gain.
- A common set of metrics will be used to measure HEP performance in these aspects and HEPs will also submit a 15 page evidence-based contextual statement describing their approach to teaching and student outcomes.
- A strong mathematics support provision will be powerful evidence of the importance a provider attributes to a supportive learning environment. The investment of funding to assist students to achieve their full potential is a clear sign of a provider's commitment to teaching in the broad sense being used in the TEF.
- If the mathematics support provision is being properly evaluated (see Chapter 3), there should be both quantitative and qualitative evidence available to demonstrate how this element of the Learning Environment is providing effective support to students.
- Additionally, one of the metrics that will be used to measure the Learning Environment aspect is the Academic Support set of questions from the National Student Survey (NSS) (questions 10 to 12). Provision of high quality mathematics support in addition to students' regular teaching is likely to increase the student satisfaction in the areas covered by these questions.
- The other metric in the Learning Environment aspect is the HESA Retention data. There is research evidence of the effectiveness of mathematics support in increasing retention rates; a major whole national study in Ireland reported that *"22% of respondents who had availed of MLS [mathematics learning support] had considered dropping out of their course due to mathematical difficulties and almost two thirds of these students stated that availing of MLS had a positive impact on their retention on their course."* (O'Sullivan et al., 2014).
- At present there are no robust measures of learning gain. For the first few years of TEF, at least, the focus in the aspect Student Outcomes and Learning Gain will be on employment data and, in particular, the percentage of graduates in employment or further study (as measured by the Destinations of Leavers from Higher Education (DLHE) survey). As has been illustrated in Chapters 1 and 2, mathematics support has an important key role to play in this area.
- An increasing number of graduate employers are using numerical reasoning tests as part of their selection processes. Many graduates have not explicitly studied mathematics since their GCSEs (at least 5 years previously). The role of mathematics support in preparing them for these tests is vital in helping them to secure employment.
- It has also been made clear that the TEF will use 'splitting' to compare the performance of students with different characteristics (for example, those from lower POLAR (Participation Of Local AReas) quintiles compared with those from higher POLAR quintiles or those with disabilities compared to those with no disability). The role that mathematics support plays in addressing issues relating to student confidence, notably through the one-to-one support and the tutor-student relationships that are developed, can be particularly relevant to many of these students and so help to reduce any 'performance gap'.
- TEF Year 3 (2017/18) will pilot assessment at discipline level with a view to complete discipline level assessment in TEF Year 4 (2018/19). In many disciplines which have a growing dependence upon mathematical and quantitative skills, the absence of mathematics support is likely to be viewed as a serious deficiency.

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Tony Croft and **Duncan Lawson** were each awarded an IMA Gold Medal in 2016 for Outstanding Contribution to the Improvement of the Teaching of Mathematics.

The authors and the **sigma** Network gratefully acknowledge the funding received from HEFCE.

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