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The extent and uptake of mathematics support in higher education: results from the 2018 survey

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Abstract

In response to the well-documented challenges associated with the 'mathematics problem' in UK higher education, many institutions have implemented a programme of mathematics support. Previous surveys within the UK, undertaken in 2001, 2004 and, most recently, 2012, have shown growth in the number of institutions offering such support and indicate that the dominant form of provision is through a drop-in model. Here we report on a 2018 survey of higher education providers in England and Wales undertaken to establish not only the extent of current provision but also understand the scale of its delivery. We find that overall the proportion of higher education institutions offering mathematics support remains broadly the same, but there is considerable variation in how this support is delivered within institutions. Whilst the drop-in model remains most common, we see evidence that the methods used to provide mathematics support are expanding and that the range of levels and subjects-studied of targeted student cohorts is widening. For the first time we are able to report on the volume of use of mathematics support by students across England and Wales, and although dependent upon the institutional context, we see clear evidence of the extensive use being made of it by learners.

1. Introduction and Background

For almost 25 years there has existed compelling evidence of the challenges experienced by engineering, physics and mathematics undergraduates as a result of their lack of preparedness for the mathematical components of their university studies (Sutherland & Pozzi, 1995; LMS, 1995; Hawkes & Savage, 2000). Whilst this so called 'mathematics problem' may have had its origins in the science, technology, engineering and mathematics disciplines, more recent reports have highlighted that many other students are arriving in higher education underqualified mathematically for their studies (ACME, 2011). Specific issues have now been noted in a wide range of disciplines including the biological sciences (ABPI, 2008) and the social sciences and humanities (British Academy, 2012).

One response to help mitigate the mathematical issues and challenges experienced by students in higher education has been the establishment of mathematics support

(throughout we use the term 'mathematics support' as shorthand for the more correct 'mathematics and statistics learning support'). As noted by Lawson, Croft & Halpin (2003) mathematics support is a "*facility offered to students…which is in addition to their regular programme of teaching, lectures, tutorials, seminars, problems classes, personal tutorials, etc.*" It may be offered to students in a range of forms including on a drop-in or appointment basis in small groups or one-to-one (Marr & Grove, 2010). There now exists an increasing body of evidence of its effectiveness on student retention and progression (Symonds, Lawson, & Robinson, 2007; Matthews et al., 2013; O'Sullivan et al., 2014).

The growth seen in mathematics support within UK higher education has been charted through several surveys. In 2001, Lawson, Croft & Halpin (2003) conducted the first survey to determine the extent of provision. They found that 46 out of 95 responding institutions offered some form of mathematics support provision, with the key element identified most often by respondents being the one-to-one support that is made available to students. A subsequent survey in 2004 (Perkin & Croft, 2004) showed that this had increased to 66 out of 101 responding institutions, and the most recent survey, until now, in 2012 (Perkin, Croft & Lawson, 2013) identified that 88 out of 103 responding institutions were offering some form of mathematics support. Whilst, as its headline, the 2012 survey noted a clear increase in the number of institutions offering some form of mathematics support, it did find that within a small number provision had either ceased to exist or had been reduced in scale. The reasons for this were identified to relate to a "*lack of available funds or lack of strategic leadership rather than because the need for such support has disappeared*" (Perkin et al., 2013).

Tolley & Mackenzie (2015) however, found that by 2015, the attitudes of universities at a senior level were positive towards mathematics support and its role as part of the student learning experience. In reporting on 23 semi-structured interviews from a sample of senior management within UK universities they noted that all who were interviewed now recognised that "*unless they provide appropriate forms of learning support for mathematics and statistics, it is inevitable that there will be an adverse impact on their students' satisfaction, retention, achievement and employability*". Further, they go on to conclude that "*mathematics support is now more visible and high-profile within HEIs and is seen as important for enhancing the student experience and aiding success*." Grove et al. (2018) reinforce these findings as they note in their study that "*there is evidence that the way in which mathematics support provision is 'positioned' within an institution is becoming increasingly strategic; in many cases there is alignment with other student-focused services.*"

Surveys exploring the extent of mathematics support provision have not only been undertaken across the UK, but also within Australia and across the island of Ireland. Reporting on the results of her 2007 survey in Australia, MacGillivray (2009) notes that 32 out of Australia's 39 universities had some form of mathematics support. In the most recent

survey of mathematics support provision from the island of Ireland, Cronin et al. (2016) determined that mathematics support was provided in 25 of the 30 responding higher education institutions. In their 2017 survey of the extent of mathematics support, Ahmed et al. (2018) identified that 13 of Scotland's 17 higher education institutions offer mathematics support. Whilst the survey of Perkin et al. (2013) began to explore how mathematics support is delivered, and in doing so identified the prevalence of the drop-in model within the UK, the more recent surveys of Cronin et al. (2016) and Ahmed et al. (2018) have sought to explore national trends in how mathematics support operates within institutions with data also available on how it is delivered, who provides the support (that is, who does the tutoring), and the extent of its availability to learners.

Since 2005, there has been significant work to assist institutions across England and Wales with the establishment of their mathematics support provision and provide a national network for those working in this area. The **sigma** Network, which emerged from the **sigma** Centre for Excellence in Learning and Teaching at Loughborough and Coventry Universities with the support of the Higher Education Funding Council for England (HEFCE) (2005-2010), the National HE STEM Programme (2009-2012) and once again HEFCE (2013-2016), led, and provided a focus for, the national activities in this area. The survey of Perkin et al. (2013) provided an overview of the extent of mathematics support towards the end of the second period of **sigma's** funding. External funding of the **sigma** Network ended in 2016 and it has continued since then as a self-supporting community of practice. The authors therefore deemed it timely to revisit this survey to explore how the mathematics support landscape in the UK has changed since 2012. Here we report on a 2018 survey that was undertaken with the aim of not only determining the extent of current mathematics support provision, but, by incorporating aspects of the sustainability review of Grove et al. (2018, 2019a), also offering further national insight into how it is delivered, who is involved in providing the support, and for the first time, the volume of use of it made by learners.

2. Research Methodology

The previous survey of mathematics support considered the whole of the UK (Perkin et al., 2013). Given the existence of recent, and comprehensive, surveys of mathematics support across the island of Ireland (Cronin et al., 2016) and within Scotland (Ahmed et al., 2018), the decision was taken not to duplicate these. As such, the survey we describe here chooses to focus upon mathematics support only within England and Wales. We discuss comparative findings with Scotland and Ireland in Section 4.

Since the last extent of provision survey in 2012 there have been changes to the higher education sector within England and Wales. Several new universities were created when a number of existing specialist institutions and university colleges were awarded university status in late 2012 and, since then, a further small number of new universities, including those that have formed from private colleges, have been established since. Across both

England and Wales, there have also been university mergers, and as a result the Higher Education Statistics Agency now lists a total of 145 'higher education providers' based within England and Wales. Excluding private universities, those not offering undergraduate-level provision, and specialist institutions focused upon arts and medicine-based subjects, a total of 111 higher education providers were identified and invited to participate in this survey (HESA, 2018).

The survey, consisting of a total of 13 questions, was first promoted through a national mathematics support mailing list which generated a number of initial responses. Work then took place to identify, from the website of each institution, whether there existed evidence of mathematics support, and if so an appropriate contact for that support. Where evidence was not found, or a response not received from the identified contact, a member of academic staff or professional services staff was selected and contacted. Finally, where this did not yield a response, senior management within the institution were approached and asked to identify a colleague who would complete the survey.

Once all data had been received, it was collated and prepared for analysis. In total 14 partially completed, duplicate, or responses from outside of England and Wales were removed leaving the 88 responses that were subsequently analysed. Cross-correlation of responses between questions was undertaken to ensure the consistency and accuracy of the data, and in a small number of instances some re-classification of the data based upon free-text responses was undertaken.

Ethical clearance for this study was granted by the University of Birmingham and the study was conducted in line with appropriate ethical guidelines (BERA, 2014). To maintain the anonymity of those individuals who responded, and their institutions, any information that might allow them to be identified has been removed in the analysis that follows.

3. Results

3.1. Response rate and sector spread

A total of 88 responses were received to the survey and they are shown within Table 1 broken down by university 'mission group'. The mission groups represent groupings of universities with common interests, and as such they are helpful for classifying responses although some institutions are unaligned with any group. We choose to consider responses by these institutional groupings since they allow us to analyse the spread of mathematics support across the sector and explore whether, for example, it is less prevalent in research-intensive institutions. The common mission groups have been used: the Russell Group (representing the large research-intensive universities); University Alliance (a group formed of universities based in cities and regions); MillionPlus (an association for modern universities); and, Cathedrals Group (an association for universities and university colleges with Church foundations and which are usually former teacher training institutions). Several

institutions were identified as belonging to both the MillionPlus and Cathedrals Groups; here they have been categorised as belonging to the MillionPlus Group so as to avoid duplicate results in the analysis that follows.

Until 2013 there also existed the 1994 Group which represented the smaller research-intensive universities. After a number of universities left the 1994 Group to join the Russell Group in 2012, it eventually dissolved with its remaining university members becoming unaligned (i.e. members of no mission group). However, we have chosen here to adopt an additional classification of Unaligned* for these remaining 1994 Group universities since they are smaller research-intensive institutions. A number of other universities across the sector do not belong to any mission group (referred to as Unaligned in Table 1); typically such institutions could seek membership of the MillionPlus and/or University Alliance Groups but have chosen not to do so.

	Cathedrals Group	MillionPlus	Russell Group	University Alliance	Unaligned*	Unaligned		Totals
Responded	5	11	18	14	11	29		**88**
No response	7	4	3	2	1	6		**23**
Has mathematics support	2	11	16	14	10	25		**78**

Table 1: Institutional responses (or otherwise) to the survey categorised by university mission group (n = 111).

Considering the 88 responses received from the 111 institutions that were invited to participate in this survey, we see a response rate of 79%. Whilst a response rate of 79% for an optional survey can be considered very high, it is nevertheless lower than the 95% and 87% achieved in the 2004 and 2012 surveys respectively (Perkin & Croft, 2004; Perkin et al., 2013). However, it is difficult to compare response rates between the different surveys as the population of institutions considered differs; here, only higher education providers in England and Wales were included whereas previous surveys have considered the whole of the UK.

A key finding which is clearly seen from Table 1 is that provision of mathematics support is spread across the full range of HE mission groups in England and Wales. The vast majority of Russell Group and Unaligned* universities, typically the universities with the highest entry requirements, provide mathematics support.

3.2. Extent and age of mathematics support provision within institutions

Amongst those institutions responding to the survey (Table 2), 89% offer some form of mathematics support. By combining the responses made to the survey with the results of our search of university webpages for evidence of mathematics support provision, we have determined that 83 of the 111 institutions (75%) we approached to participate in this survey

offered mathematics support by some means (Table 3). In all but one case, a response to the survey that reported the institution concerned provided mathematics support via online resources only, the support available within institutions involves some form of direct contact between learners and tutors.

Year of survey	Number surveyed	Number responding	Number of institutions offering support	Percentage offering support (as a % of those responding)
2000 (Lawson et al., 2001, 2002)	-	95	46	48
2004 (Perkin & Croft, 2004)	106	101	66	65
2012 (Perkin et al., 2013)	119	103	88	85
2018	111	88	78	89

Table 2: Percentage of responding institutions offering mathematics support when compared to previous (UK-wide) surveys.

	Has mathematics support	Has never had mathematics support	Used to have mathematics support but no longer does so	Evidence of face-to-face support listed on university website	No evidence
Responded to survey	78	7	3		
Did not respond				5	18

Table 3. Whether institutions offer mathematics support (n=111).

Respondents who indicated that their institution offered mathematics support were asked to provide an indication of approximately how long it had done so. The results are shown in Table 4. Whilst three respondents indicated that their institutions used to offer mathematics support but no longer do so, four institutions have established new provision within the last year. What we observe is that within institutions mathematics support is becoming increasingly established. Almost 70% (54 out of 78) of institutions offering mathematics support have been doing so for more than five years, and some 53% (41 out of 78) have now been doing so for over 10 years. Given the relative sizes of the groups there appears to be no discernible differences by university mission group, which is consistent with the findings of Perkin et al. (2013) from the previous 2012 survey and the work of Tolley & Mackenzie (2015).

	Less than a year	1-3 years	3-5 years	5-10 years	10+ years	Used to offer	Never offered
Number of institutions	4	4	16	13	41	3	7

Table 4. Length of time for which the institution has offered mathematics and/or statistics support (n=88).

The 24 respondents who indicated that their mathematics support was established within the last five years were asked to articulate their reasons for doing so. Overwhelmingly (18 references) provision was established in relation to a clearly identified need for such support due to issues associated with progression, performance or student requests for such a service:

> *Students' poor progression from year 1 to year 2 in quantitative subjects*
>
> *The Study skills department at…had seen an increasing number of students who required numerical or statistical support.*
>
> *A range of factors, but our primary concern currently is that BTEC[1] students tend to struggle with maths and stats elements of the curriculum…*

And in several cases this need for support was recognised across the institution and supported at a senior level:

> *…institutional awareness that it was a good thing; a Faculty PVC who was prepared to fund it initially…*
>
> *The service required a new strong central structure. In Autumn 2014 the management executive realised the need and importance to establish such structure.*

The findings within Table 4 show the establishment of new mathematics support provision on a regular basis with eight institutions creating provision within the last three years. In addition, mathematics support provision was established in a further 16 institutions within the last three to five years. This period coincides with a programme of nationally-funded activity through the **sigma** Network (the end of the National HE STEM programme and the subsequent period of HEFCE funding) which championed mathematics support in higher education. During the final phase of the National HE STEM programme, **sigma** assisted in the creation of new mathematics support provision at nine institutions and a further nine more during the subsequent HEFCE funding. Within the survey responses, there were five specific references that the opportunity to access support through this national network was a clear factor in their eventual establishment of mathematics support provision within the institution:

> *Growing student need for help and seed funding from sigma.*

[1] BTEC (Business and Technology Education Council) qualifications are vocational qualifications taken in the final stages of pre-university education and are an alternative to the more academic A-levels.

An initial pilot showed that there is a need for maths support, and after that the service was established with a 2-year funding support from sigma.

When responding to the question about how long the institution has offered some mathematics and statistics support provision, it is possible that some respondents indicated the length of time the current provision has been operating rather than the length of time that the institution has offered any kind of support. The authors are aware of at least one case where a respondent indicated that their provision (which is a central institutional provision) had been established within the last year although a localised departmental provision had existed for many years before that. This institution would have been included in the 2012 survey as an institution with some mathematics and statistics support provision and also included in Table 4 as an institution whose provision had been established in the last year.

3.3 Nature and availability of the mathematics support provision

Institutions offering mathematics support were asked to indicate which types of support they offered and the typical number of hours per week that it is accessible to learners during term time.

As the results of Table 5 show, it is overwhelmingly the case (75 out of 78 (96%)) that the vast majority of institutions with mathematics support offer provision that includes either, or both of, one-to-one bookable appointments and drop-in. These are forms of support that allow students direct contact with a tutor to discuss their mathematical queries and concerns. Typically, support is provided by more than one means, and it is interesting to note that 55% (43 out of 78) of institutions with mathematics support are now offering a combination of both drop-in and one-to-one bookable appointments.

	Number of institutions
Offering 1-1 Bookable Appointments only	11
Offering Drop-in only	21
Offering both Bookable and Drop-in provision	43
Offering neither 1-1 Bookable Appointments or Drop-in but offers some form of mathematics support	3

Table 5: Number of institutions offering some form of face-face mathematics and/or statistics support provision (n=78).

The survey also allows us to explore the extent to which both one-to-one bookable appointments and drop-in sessions are available to learners (Table 6). We see that amongst those institutions offering one-to-one bookable appointments and providing details 42% (21 out of 50) offer their provision for between 5 and 15 hours per week, and 30% (15 out of 50) for more than 15 hours per week during term time. Similar trends are seen for the drop-in provision where 32% (19 out of 60) of institutions offering this form of mathematics support

and again providing details, make the provision available to learners for between 5 and 15 hours per week; a further 33% (20 out of 60) make drop-in support available for more than 15 hours per week.

	1-1 Bookable appointments	**Drop-in**
Using and specified hours (see below)	50	60
Using but did not specify hours	4	4
Does not offer	24	14
Specified hours		
$0 < t \leq 5$ hours per week	14	21
$5 < t \leq 10$ hours per week	13	11
$10 < t \leq 15$ hours per week	8	8
>15 hours per week	15	20

Table 6: Number of responding institutions offering bookable appointments and drop-in support (n=78).

Respondents were also asked whether they offered mathematics support via organised lectures or workshops; 68% (53 out of 78) of institutions responded that they did. Within the free text comments a small number of references were made to examples of where mathematics support provision is now embedded within mainstream teaching:

> *Workshops are embedded in programmes and curricula*
>
> *Attending faculty lectures and providing additional maths/stats/numeracy support within the session. Providing or helping with preparation of materials, for faculty staff to deliver/provide for students.*
>
> *Advice at curriculum development stage on inclusive approach to meet the needs of BTEC students. Development and delivery of subject-specific maths modules for 1st year students in Business and some Science subjects (e.g. Engineering).*

	Online (real-time) tutorials	**Online resources**
Using and specified hours (see below)	15	60
Using but did not specify hours	3	
Does not offer	60	18
Specified hours		
$0 < t \leq 1$ hours per week	12	
$1 < t \leq 3$ hours per week	2	
>3 hours per week	1	

Table 7: Number of responding institutions offering online support (n=78).

Table 7 shows that, of the responding institutions with mathematics support, only 23% (18 out of 78) were using technology to offer online real-time support to learners. Further,

there is evidence that the extent of this current provision is very limited with at least 66% (12 out of 18) of institutions offering it doing so for less than an hour per week. It was typically the case that where online real-time support was available this was an additional offering. However, in a small number of institutions there were indications that if this was taken up, it would replace some of the hours available for more traditional provision:

> *The time allocated to 1-1 bookable is the same as that allocated to Online. They are interchangeable but there is almost no take-up on the online.*

This lack of uptake of online real-time support by learners was a theme echoed by two other respondents who provide this means of support:

> *Available on demand but not generally requested.*
>
> *Up to 3 hours of 1:1 Skype appointments would be available. Not often taken up.*

In many cases, complementing the support that involved direct interaction with learners was the provision of online resources. Whilst these were made available by a large number of institutions, their availability was by no means universal. Of those institutions responding to the survey 23% (18 out of 78) do not provide online resources to learners. For one HEI however, this was the only means by which they offered mathematics support with staff involved in signposting students to these resources:

> [Staff] *signpost students to general maths and stats support resources but do not offer one-to-one advice.*

In addition to online provision (tutorials and resources), 28% (22 out of 78) of respondents reported that their institutions were using further alternative approaches to delivering mathematics support. These approaches all indicate ways in which mathematics support has been tailored to support particular institutional needs. From an analysis of the free text responses to the survey, some of the common themes or approaches to emerge in this regard were: facilitating group or peer support activities (5 references); email and telephone support (5 references); diagnostic testing (3 references); and, supporting widening access or those with mathematics anxiety (3 references). The following are specific examples to highlight the range and flexibility of the provision offered:

> *Drop-in workshops for first year maths students run by older maths undergraduates; Group study skills supported for referred mathematics students; Group or 1:1 support for entrants with BTEC or Access qualifications to some subjects.*

Diagnostic testing in collaboration with academics in different departments to identify struggling students and put in place collaborative and appropriate subject-specific support.

There are some telephone statistics appointments for distance learners as and when needed.

Host a monthly widening participation interactive seminar series.

3.4. Permitted users of mathematics support

As we noted earlier, the 'mathematics problem', the predominant response to which has been the establishment of mathematics support, had its origins in the STEM disciplines. However, it is now clear that many other groups of students including mathematics specialists, require support at the transition to university, and in many cases throughout their studies. There is also evidence that postgraduates and staff themselves are in need of support and are benefitting from mathematics support. The groups to which mathematics support is made available within institutions was explored within the survey. As Table 8 demonstrates, whilst it is the case that in just over 80% (64 out of 78) of institutions mathematics support is noted as being available to all undergraduates, in some institutions there are restrictions placed upon the undergraduate cohorts that can access it. Details of these restrictions were not provided by many respondents who indicated that they existed, but in one case this was noted to be specialist (that is single or joint honours) mathematics students:

"Some undergraduates" was highlighted because UGs actually studying Maths and Stats can't use [the mathematics support service]*. It's for UGs from all other Schools.*

In almost 75% (58 out of 78) of institutions providing mathematics support, the provision is available to postgraduate taught students, that is those studying Level 7 qualifications and above including master's degrees and postgraduate certificates. In almost 60% (46 out of 78), it is also available to postgraduate research students. Some 32% (25 out of 78) of responding institutions also make their mathematics support available to members of staff from within the institution.

	All UGs	Some UGs	PGR Students	PGT Students	Staff	Other
Number of institutions	64	14	46	58	25	7

Table 8. Who mathematics support is available to within responding institutions (n=78).

Seven respondents to the survey indicated their provision was available to other groups. These responses again provided examples of how mathematics support has been tailored by institutions to meet their specific needs and circumstances. Whilst one referenced their

alumni, three respondents specifically referenced students studying within associated partners of the institution and three potential applicants to courses within their institutions:

> *We do see other staff and students from our Associate College Partners...*
>
> *Applicants to PCGE courses for their numeracy tests*
>
> *Others include: Students from the International College in* [the region]*, that study in programmes linked to the University.* [Also] *Distance and work-based learners.*

3.5. Who delivers mathematics support?

Grove et al. (2019a) explored who was involved in the delivery of mathematics support on a day-to-day basis within institutions. Here we choose to extend their approach to not only identify that a range of different groups of individuals are involved in delivering mathematics support within institutions (Table 9), but also to ascertain details of the number of individuals (headcount) involved in the delivery of mathematics support to students within institutions (Table 10).

	Percentage of responding institutions
Full-time or part-time mathematics and/or statistics support staff	63
Postgraduate students or PGTAs	42
Hourly paid or sessional staff	35
Academic staff from departments	33
Undergraduate students	26

Table 9. How mathematics support is provided within responding institutions (n=78). Note, this does not sum to 100% due to many institutions using several different types of staff.

It is the case within the responding institutions that full-time and part-time staff, appointed with a specific remit within their roles of providing mathematics support, are responsible for the delivery of provision in 63% (49 out of 78) of institutions. Although not shown in Table 10, the Russell Group differs from the rest of the sector here. Only 38% (6 out of 16) of Russell Group institutions report having such specialist staff compared to 69% (43 out of 62) of all other institutions. Amongst the 49 institutions who reported they had specific full-time or part-time staff employed to deliver mathematics support, in 16 institutions (33%) these individuals were identified to be the sole providers of the provision; further, in six of these institutions (12%) there was a single member of staff delivering the entire mathematics support provision; we will return to this point during the discussion. This is in contrast to institutions where academic staff were identified to be involved in the delivery of mathematics support; in such institutions, only 12% (3 out of 26) used academic staff as the sole providers of mathematics support. Whilst hourly paid or sessional staff have a role in

the provision of mathematics support, the proportions here are lower with only around 35% of institutions making use of such individuals.

Number of individuals (headcount)	0	1	2-3	4-5	6-10	11+	Total responding	No response
Full-time or part-time mathematics and/or statistics support staff	8	23	22	3	1	0	57	21
Hourly paid or sessional staff	15	11	9	4	2	1	42	36
Academic staff from departments	15	10	3	4	4	5	41	37

Table 10: Number of individual staff (headcount) involved in delivering mathematics support to learners (n=78). Note: No response is different from a response of 0.

Table 11 shows the involvement of students, both postgraduate and undergraduate, in the delivery of mathematics support. Since the figures from Russell Group institutions are quite different from other institutions these are shown separately.

Number of individuals (headcount)	0	1-2	3-10	11-20	21+	Total responding	No response
Postgraduate students (Russell Group universities)	0	2	7	4	2	15	1
Postgraduate students (other universities)	17	8	9	0	1	35	27
	0	**1-5**	**6-10**	**10-25**	**26+**		
Undergraduate students (Russell Group universities)	1	2	2	1	1	7	9
Undergraduate students (other universities)	16	10	2	1	1	30	32

Table 11: Number of individual students (headcount) involved in delivering mathematics support to learners (n=78). Note: No response is different from a response of 0.

Postgraduates were used to provide mathematics support in 42% (33 out of 78) of all responding institutions (Table 9). Within the Russell Group institutions, much more use is made of postgraduate students (or postgraduate teaching assistants as they are sometimes called) to deliver mathematics support. Indeed, all but one Russell Group institution indicated that they use them as tutors; however, this particular centre had been open for less than a year and so is likely to have still been in its set-up or development phase. In fact, the Russell Group accounts for 45% (15 out of 33) of all institutions using postgraduate students for mathematics support despite Russell Group institutions forming just over 20% of the institutional responses to the survey. In total there were seven institutions, six of

whom who were in the Russell Group, where mathematics support was provided solely by postgraduate teaching assistants.

Whilst 26% (20 out of 78) of institutions reported using undergraduate students as tutors, including one institution which was solely reliant upon them, generally the overall number of undergraduate students involved in tutoring within any one institution is small.

3.6. Extent of engagement with mathematics support

Respondents were asked to indicate the approximate number of engagements with mathematics support by students within their institutions over an academic year. Whilst some figures were precise, others were clearly estimated. The results are summarised in Table 12. Of those responding with data, 41% (28 out of 68) reported that there were in excess of 1,000 student engagements with their service over an academic year, and 56% (38 out of 68) reported more than 500 engagements. It is worth noting that two of the institutions who reported fewer than 100 student engagements had been established for less than 12 months and so were unlikely to have had data spanning a full academic year available. Considering all 68 institutions who provided data, the total number of reported student engagements with mathematics support across England and Wales totals just over 85,000 in an academic year, with the largest centre alone reporting some 15,000 engagements with their service by learners.

	No data provided	1 ≤ N < 100	100 ≤ N < 250	250 ≤ N < 500	500 ≤ N < 1000	1000 ≤ N < 2000	2000 ≤ N < 3500	N>3500
Number of institutions	10	7	7	16	10	15	10	3

Table 12: Number of engagements (N) with mathematics support over a typical academic year (n=78).

When respondents were asked to indicate the number of individual students engaging with mathematics support at least once over an academic year, the data provided indicated a greater level of uncertainty. In a number of cases, figures were estimated, and several respondents noted that this level of data was either not collected, or if it was, it would take significant time to analyse.

Nevertheless, whilst the results in Table 13 should be interpreted with a degree of caution, they do offer interesting insight into the engagement by individual students with mathematics support.

	No data provided	1 ≤ X < 100	100 ≤ X < 200	200 ≤ X < 350	350 ≤ X < 500	500≤ X < 750	750 ≤ X < 1250	X>1250
Number of institutions	14	10	11	16	8	5	7	7

Table 13: Number of individual students (X) who engage at least once with mathematics support over a typical academic year (n=78).

Amongst those institutions who returned data, 42% (27 out of 64) reported engagement by a minimum of 350 different students with mathematics support in an academic year; 67% (43 out of 64) reported engagement by at least 200 students a year. There were extensive levels of student engagement with mathematics support within a number of institutions: 22% (14 out of 64) reported over 750 students individual students engaged with their service and 11% (7 out of 64) reported engagement from over 1250 distinct students. Whilst it is important to remember the uncertainty noted by respondents in their reported figures, considering all 64 institutions across England and Wales who provided data, the total number of individual students reported as engaging with mathematics support at least once during an academic year totals just under 34,000.

4. International Comparisons

With surveys exploring mathematics support within Ireland and Scotland having been recently completed, we now look to collate the results from these in order to provide a comprehensive 'snapshot' of the extent of mathematics support within the UK and Ireland. Given there exist differences in the nature of the questions within the three surveys, we limit our comparisons to the aspects where there is direct equivalence in questioning. The results of this are shown in Table 14.

		England & Wales	Ireland	Scotland	Aggregated: UK & Ireland
Date undertaken		2018	2015	2016	**-**
Source reference		-	Cronin et al. (2016)	Ahmed et al. (2018)	**-**
Percentage of contacted institutions responding		79% (88/111)	97% (30/31)	89% (17/19)	**84% (135/161)**
Percentage of all <u>contacted</u> institutions with mathematics support		75% (83/111)	81% (25/31)	68% (13/19)	**75% (121/161)**
Percentage of all <u>responding</u> institutions with mathematics support		89% (78/88)	83% (25/30)	76% (13/17)	**86% (116/135)**
Type of mathematics support provision	**Drop-in**	82% (64/78)	88% (22/25)	77% (10/13)	**83% (96/116)**
	(Bookable) one-to-one appointments	69% (54/78)	44% (11/25)	77% (10/13)	**65% (75/116)**
	Workshops	68% (53/78)	64% (16/25)	54% (7/13)	**66% (76/116)**
	Online resources	77% (60/78)	48% (12/25)	62% (8/13)	**69% (80/116)**
Tutors within mathematics	**Full-time or part-time staff**	81% (63/78)	72% (18/25)	69% (9/13)	**78% (90/116)**

support	**Postgraduate students (PGTAs)**	42% (33/78)	48% (12/25)	62% (8/13)	**46% (53/116)**
	Undergraduate students	26% (20/78)	36% (9/25)	8% (1/13)	**26% (30/116)**

Table 14. Comparison of most recent surveys of mathematics support provision in England & Wales, Ireland and Scotland. In all cases percentages are the percentage of institutions.

When seeking to make comparisons between the results from the different surveys it should be remembered that in England and Wales, contact was made with over double the number of institutions of the Scotland and Ireland surveys combined. Nevertheless, the data are broadly similar in terms of the proportions of institutions (contacted or otherwise) with mathematics support. In all cases, drop-in provision is the most common means of support, but fewer institutions offer bookable one-to-one appointments in Ireland. Whilst the proportions are slightly lower in Scotland, a comparable number of institutions within England and Wales and Ireland are offering support through workshops. This further reinforces how the delivery of mathematics support is extending beyond the traditional model of one-to-one appointments and drop-in within institutions.

As in Table 7 'Online Resources' in Table 14 refers to items like links to websites or the use of online virtual learning environments within mathematics support and does not include online real-time tutorials. No data is available in relation to institutions using technology to deliver online real-time tutorials within Scotland. Only one institution in Ireland reported using Skype appointments (Cronin et al., 2016) whereas Table 7 shows that 23% of responding institutions across England and Wales report offering these. However, as noted earlier, there is generally limited student uptake of this provision.

The surveys collectively show a large proportion of institutions are using substantive staff (by which we mean full-time or part-time mathematics and or statistics support staff and academic staff from departments, see Table 9). Here, the results from England and Wales include both those with specifically appointed roles within mathematics support and academic staff from departments; this is to ensure consistency in the presentation of results with those from Scotland (see Ahmed et al. (2018), Table 6) and Ireland (see Cronin et al. (2016), Table 6). Again in all three surveys there is evidence of the role of postgraduate students as tutors within mathematics support in many institutions. Significantly, within England and Wales and across Ireland, undergraduates also have a role as tutors within a number of institutions; although figures are shown for Scotland, it is important to note that this survey did not explicitly seek details of undergraduates working as tutors in mathematics support and so the reported figure is likely to be an underestimate.

5. Discussion and conclusions

The survey described here, although focusing for the first time upon mathematics support within only England and Wales, offers greater insight into how this support operates within the higher education sector than the previous surveys in 2000, 2004 and 2012. With a response rate of 79% we have been able to obtain a comprehensive overview of mathematics support within higher education providers and explore how it is delivered, who works as its tutors and its longevity. Perhaps most significantly for the first time we have been able to identify, at a national level, the extent to which students engage with mathematics support within their institutions.

As a headline, we see evidence within at least 75% of the institutions approached to participate in this survey of mathematics support provision. Amongst those institutions responding directly to the survey, 89% reported offering some form of mathematics support. It is important to note the differences in the survey populations between the two surveys, however, our findings for the extent of mathematics support provision are broadly similar to those from the 2012 survey of Perkin et al. (2013). Whilst three institutions reported that they used to offer mathematics support, but no longer do so, four institutions have established such provision in the last 12 months. As Table 3 demonstrates, significant growth in mathematics support provision was seen between 2000 and 2004, and again between 2004 and 2012; growth at this rate is impossible to sustain given the high proportion of institutions now offering some form of provision. There are now relatively few institutions not offering mathematics support and most (if not all of these) will have deemed that there is not sufficient need in their institution for such support.

There also exists evidence of the increasing longevity of mathematics support within institutions. Almost 70% of responding institutions have provision that has been established for at least five years, and 53% have provision that has been established for more than 10 years. Coupled with this longevity, there is evidence that how mathematics support is being provided, and to whom, has changed. Whilst the drop-in model remains the most common method of support, this is being increasingly combined with one-to-one appointments with 55% of institutions reporting this to be the case. Both forms of support allow students to interact face-to-face with, as Lawson et al. (2003) note, a tutor "*who is willing to take time to explain things to them"*, and it is this aspect that is known to be particularly valued by learners. Whilst not widespread, with only some 25% of responding institutions reporting doing so, technology is now being utilised to deliver mathematics support through online real-time tutorials. Uptake of this form of support amongst students does however appear to be low, and this is a trend that has also been noted by others. For example, when Rice & O'Hare (2012) piloted online one-to-one tutorials, no students accessed them, however at the same time they did observe an increase in the uptake of face-to-face support. On the other hand, a pilot of a shared online statistics advisory service (Owen et al., 2011) reported a good level of usage by students from institutions that did not provide their own statistics support. Taken together, these findings perhaps indicate that students highly value one-to-

one support and would prefer it to be in person, but if in person support is not available then they will use online one-to-one support.

Organised lectures and workshops are being increasingly used as a means of providing mathematics support; here, 68% of institutions responding to the survey indicated that they offered this form of provision. In addition, a number of examples were cited by respondents to the survey of how their institutions were working with those involved in more mainstream teaching activities to embed ideas and approaches from mathematics support to enhance delivery.

We have previously noted the definition of mathematics support given Lawson, Croft and Halpin (2003) as a "*facility offered to students…which is **in addition*** [our emphasis] *to their regular programme of teaching…"*. These new embedded forms of mathematics support challenge this definition in as much as they may be regarded as part of the "*regular programme of teaching*" and so in one sense are not additional. These forms of support have the potential to reach more students since they do not rely on students opting in but their nature is such that they cannot deliver some of the well documented benefits of traditional mathematics support (Solomon, Croft and Lawson, 2010).

In addition, a number of respondents reported that their institutions delivered mathematics support in new ways extending beyond drop-in, one-to-one appointments, organised lectures and workshops, and online tutorials and resources. These alternative modes of delivery demonstrate the ability of mathematics support to be tailored to better meet the needs of learners and the priorities of institutions.

More broadly, there has been an expansion in terms of the student cohorts targeted by mathematics support. Whilst it remains universally accessible to undergraduate students, albeit with some restrictions in 18% of institutions, it is now widely available to postgraduate students, and in 32% of institutions, it is also available to staff members. In some institutions, there are restrictions upon whether specialist mathematics students can access mathematics support; this in itself is an interesting development as it is known that within some institutions, where such students are able to access mathematics support, they do so in large numbers (Grove, Guiry & Croft, 2019b). The observed increased availability of mathematics support to postgraduate students is also consistent with the findings of Tolley & Mackenzie (2015) who not only reported the concerns of senior management in relation to the statistical skills of postgraduate students, but also how institutions were using mathematics support as a response to this issue. More significantly, the evidence of mathematics support being available to staff members may indicate a response to a finding of the British Academy (2012) which linked the poor mathematical skills of undergraduates with "*the dearth of academic staff able to teach quantitative metho*ds"; staff may be using the service to enhance their own mathematical knowledge and skills. Although smaller in

number, examples were also noted by respondents of how their institutions are making mathematics support available to learners within partner institutions, perhaps as a means of encouraging progression to higher education, or as a potential recruitment mechanism.

This broadening in who can access mathematics support does, however, pose real challenges for those who deliver it. With a more varied user base, queries can extend well beyond the level of those asked by engineering students making the transition to university study which is where mathematics support had its origins (Croft, 2000). Postgraduate students have an important role in supporting its delivery in some 42% of institutions. In fact, in 9% of institutions responding to the survey, postgraduate students were solely responsible for the provision of mathematics support as tutors, and in nearly 40% of Russell Group institutions this was the case. There has been much work across the sector to support postgraduate students involved in mathematics support (see for example Croft & Grove, 2016), but there has been little focus upon undergraduate students who work as tutors in mathematics support. It may have been previously assumed that they had only a limited involvement, if any, however as we have found here, it is now the case that they do have a significant role as just over a quarter of responding institutions reported that they used undergraduates as tutors.

Working in mathematics support is known to be quite different from other forms of university teaching (Croft & Grove, 2016) and so in addition to ensuring that all those working in this area receive some form of introductory training, there is real value in those involved in its delivery coming together periodically to share experiences and discuss issues and challenges encountered. The experience of such a community of tutors has recently been explored within one institution (Grove & Croft, 2019). Whilst some institutions have a number of individuals involved in the provision of mathematics support, and as such can facilitate this interaction internally, in others, the provision of mathematics support is a more isolated endeavour. In six of the responding institutions, a single member of full-time or part-time mathematics support staff was the sole deliverer of the provision. As such, how these potentially isolated individuals can continue to be supported and engaged as part of a national network or community remains an important issue for consideration.

The widening seen in mathematics support is occurring at the same time as it is becoming increasingly embedded within the core provision and practices of institutions. It is not only being delivered in different ways, but its availability within institutions is becoming extensive. Just over 55% of institutions responding to the survey are offering either drop-in or one-to-one appointments for more than ten hours per week, and 38% are offering either of them for more than 15 hours per week, during term time. Tolley & Mackenzie (2015) identified, through their interviews with university senior management, that institutions are increasingly putting in place measures to address the issues they encounter associated with the mathematics problem. Further, Grove et al. (2018) identified that there exists increasing

alignment of mathematics support with other student-focused services within institutions, and in their follow-on work (Grove et al., 2019a) that many institutions now have dedicated staff roles associated with the provision of mathematics support.

Perhaps the most compelling evidence of mathematics support becoming embedded within institutions is the use of it that is now made by learners. Whilst it was apparent that there exist challenges around the collection and analysis of data on student engagement with mathematics support, a fact noted previously by Matthews et al. (2013) in their review of the literature, it is nevertheless the case that the data do show the extensive engagement made by students across the higher education sector with mathematics support. Amongst those responding institutions who reported student visits across an academic year, 55% saw more than 500 engagements and 41% more than 1,000, with one institution reporting more than 15,000 engagements. Clearly such results must be interpreted within the context of the institution itself, for example its size, who the support is available to, mode of delivery, and the number of hours for which it is available. Across the sector as a whole, a total of around 85,000 engagements with mathematics support in an academic year were reported.

Whilst such headline figures demonstrate extensive student engagement, they cannot be used as a measure of the quality of mathematics support or the ultimate benefit that it offers to learners. As Lawson et al. (2003) have noted, students are known to greatly value the individual interactions with a tutor that mathematics support offers. As such an institution reporting a smaller number of these face-to-face engagements may see a far greater impact on the student experience than one reporting a figure many times this number but where the mathematics support is delivered by entirely different means.

From the results of this survey, we have been able to identify a number of areas where further research would offer benefits to the higher education sector:

1. We have presented evidence on how the delivery of mathematics support by institutions has expanded. Whilst there exist evaluations of drop-in support, or similar (see for example O'Sullivan et al. (2014) for a comprehensive evaluation), more work is needed to understand the impact of mathematics support in its new and different forms. Related to this, is the need for research to explore how these different forms of support are delivered, and in particular, how well they guide students towards becoming more independent learners.
2. In an increasingly technological society, the limited engagement by students with online real-time support is interesting and worthy of further study. It may be that this lack of uptake further reinforces the great value that students are known to place upon the person-to-person contact of mathematics support (Lawson et al., 2003). Equally, it may be that even though such opportunities for support are not

utilised by learners, they nevertheless have a wider role in raising awareness of the mathematics support provision that is available within an institution.

3. It is now the case that a wide range of different individuals (for example specialist staff, academic staff, postgraduate students, undergraduates, etc.) are working as tutors in mathematics support across the sector. This raises the valid question of who are the best individuals to tutor the wide range of users who now access mathematics support within institutions.
4. Mathematics support is now widely available to a range of different individuals, but, at the same time at least within a small number of institutions, restrictions are placed upon the undergraduate cohorts who can access it. Understanding just who is using the available provision, how they are using it to aid their learning, and whether there are differences between these groups, could have implications for how mathematics support operates more widely. Significantly, it should also not be forgotten that whilst we have shown extensive engagement by students with mathematics support, there still exist many students who choose not to avail themselves of the support when they would most likely benefit from doing so. As such, understanding this lack of engagement remains very important.

Finally, by collating the most recent results of the surveys of mathematics support across England and Wales, Ireland, and Scotland, we are able to present the most comprehensive overview of the extent of mathematics support undertaken to date. Considering 160 higher education providers, of which 135 responded to the survey requests, we see 75% of contacted institutions offering mathematics support, and 86% of responding institutions offering mathematics support. Whilst intuitively we expect the 'true' overall figure to be closer to 75% than 86%, since institutions are more likely to respond to survey requests if they have provision than if they do not, regardless it shows that mathematics support is extensively available within higher education providers across the UK and Ireland. Further, there exists no evidence in any survey (Ahmed et al., 2018; Cronin et al., 2016) that the provision of mathematics support within institutions is declining. As such mathematics support is now a widely available, accessible and extensively used service within institutions to support students with the challenges that they may face with the mathematical components of their higher education studies.

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