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RESEARCH ARTICLE

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The importance of mathematics and statistics support in English universities: an analysis of institutionally-written regulatory documents

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ABSTRACT

Increasing focus worldwide on accountability and quality assurance in universities has forced senior management to develop policies to address academic support at institutional-level. One such area is the mathematical and statistical skills that students in many disciplines need to succeed. In common with many countries, large numbers of students at English universities arrive inadequately prepared for their courses' quantitative demands. University-wide mathematics and statistics support provision has been developed to mitigate this problem. We explore such provision from the perspective of institutional accountability and quality assurance, researching the extent to which such support is referenced in institutionally-written regulatory documents. The documents reveal that mathematics and statistics support is stated as contributing to retention, achievement, employability and widening participation. The paper closes with implications and recommendations drawn from the analysis of these documents and therefore is of relevance to those responsible for development and implementation of institutional teaching and learning strategies.

KEYWORDS

Mathematics and statistics support; academic support; institutional change; TEF; access and participation plans; access agreements

Introduction

Higher education accountability

According to Macheridis and Paulsson (2021), 'There are strong demands in increasing accountability in the area of higher education'. Their survey article, reviewing 350 papers, explores some of the implications of their assertion. The ways in which universities are held accountable differ from country to country (see, for example, Eurydice (2021a)).

In England, regulation and quality assurance is complex and has many actors (evidenced by the length of its entry in Eurydice (2021b)). The principal body with legal responsibility is the Office for Students. Previously the Higher Education Funding Council for England and the Office for Fair Access have played significant roles.

In a number of areas of activity, universities are required to write documents describing their actions at institutional level. Several of these focus on the provision of institution-wide academic support (i.e., going beyond that provided within courses of study). Following the recommendation of Yorke et al. (2005), that institutional datasets are often

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under-exploited and can contain evidence that is potentially of high value for planning and decision making, we have chosen to take some of these regulatory documents as the data corpus for this study.

Mathematics and statistics support

In England (and elsewhere), there is concern about the quantitative skills of students. A consequence of the recent data revolution is that disciplines that in the past made little use of quantitative methods are becoming increasingly reliant on them. Many authoritative organisations have expressed the need to improve capabilities; for example, in biosciences (BBSRC, 2010) and social sciences and humanities (British Academy, 2012).

Furthermore, the availability of huge amounts of data is changing the skills needed by industry. Dubbed Industry 4.0 (DBEIS, 2019), this has created a need for most employees to have sound numerical reasoning skills. Ahrens and Spöttl (2015) (translated in Pfeiffer, 2015) have identified data analysis and interpretation as one of the new qualification requirements specific to Industry 4.0.

In England only a small proportion of the population study mathematics beyond age 16 (Hodgen, Pepper, Sturman, & Ruddock, 2010). A consequence of this is that

> Of those entering HE [higher education] in any year, some 330,000 would benefit from recent experience of studying some mathematics (including statistics) at a level beyond GCSE, but fewer than 125,000 have done so. (ACME, 2011, p. 1)

The lack of mathematical preparation of so many students, often referred to as 'the mathematics problem', has consequences on retention, progression, attainment, student satisfaction, and ultimately employability. Indeed, Longden (2006) citing Yorke and Longden (2004) state that one of four reasons influencing a student's decision to leave university is 'failure to cope with the demands of the programme'.

In mitigation, many universities have introduced mathematics and statistics support (for brevity, hereafter referred to as 'mathematics support'). Mathematics support has been defined as 'a facility offered to students (not necessarily of mathematics) which is in addition to their regular programme of teaching, lectures, tutorials, seminars, problems classes, personal tutorials, etc'. (Lawson, Croft, & Halpin, 2003, p. 9). A key element of this definition is 'in addition'. Mathematics support addresses needs that are not met by the standard learning and teaching elements of the curriculum.

There are initiatives, such as the new Core Mathematics qualification in England (Glaister & Baldwin, 2018), aimed at improving the mathematical preparedness of new undergraduates. However these will take time to yield impact. Until these improvements are realised there will remain a need either for mathematics support or for extensive changes to the university curriculum.

Although this paper focuses on the situation in England, mathematics support is an increasingly prominent feature internationally, being widespread in Australia (MacGillivray, 2009), Ireland (Cronin, Cole, Clancy, Breen, & O'Se, 2016) and the USA (Mills, Rickard, & Guest, 2020). Beyond English-speaking nations, mathematics support is being developed in, for example, Germany (Schürmann et al., 2020), Norway and the Czech Republic (Bowers, 2018).

A substantial body of research relates to mathematics support (reviewed in Lawson, Grove, and Croft (2020)). The overwhelming majority of this research is practitioner-focused. As far as the authors are aware, with the exception of the work of Mackenzie, Tolley, Croft, Grove, and Lawson (2016), no research has been undertaken from a policy/management perspective. This paper seeks to contribute to closing this gap by studying documents produced for regulators by English universities to discover what these reveal about institutional-level thinking in relation to mathematics support. Responding to Yorke et al.'s (2005) suggestion, this paper closes with a section detailing implications for both institutional policy-developers and those concerned with national initiatives affecting the sector as a whole.

Methodology

Background, theoretical approach and research questions

The driver for this research has been the authors' efforts to address the aforementioned 'mathematics problem' through establishing, promoting and researching mathematics support. Our previous publication (Mackenzie et al., 2016) reported interviews with senior managers revealing their perspectives on the problem and their institution's offer regarding mathematics support. In that approach, participants were required to discuss mathematics support at their institution. This current work intends to avoid any bias induced by this requirement, by analysing institutional documents for which there is no expectation *whatsoever* that mathematics support will be mentioned.

Knowing that mathematics support provision is now widespread in English higher education (Grove, Croft, & Lawson, 2020), we make the following explicit assumptions: that the provision of mathematics support contributes to addressing institutional priorities and that if this provision is felt to be sufficiently important by senior managers, for whatever reason, it will be referenced in some of the institutional documents being analysed. Particularly in documents with strictly enforced page/word limits, allocating space to mathematics support is, *de facto*, taking space away from referring to other initiatives. These assumptions help define our research questions and influence the search for emerging themes.

This paper therefore explores the extent and nature of mathematics support in English higher education when viewed through the lens of institutionally-written documents required by regulators. For each institution, three different, related, documents are considered:

- Institutional submissions as part of the Teaching Excellence and Student Outcomes Framework process;
- Access Agreements;
- Access and Participation Plans.

These were chosen because, although each university is required by regulatory authorities to produce them, the institutions themselves can choose what information they include. Analysis of these documents was both quantitative and qualitative: basic descriptive statistics relating to the number of institutions referring to mathematics support were

gathered and, following Braun and Clarke (2006), thematic analysis of the descriptive text guided our approach to identifying, analysing and reporting themes within our data. We seek answers to the following research questions:

- RQ1: To what extent is there reference to mathematics support in these institutional documents?
- RQ2: What does analysis of these documents reveal about the importance of mathematics support to senior management and their institution's agenda?
- RQ3: What does analysis of these documents reveal about the positioning and development of mathematics support within English universities?

Although this study is Anglo-centric (because of the evidence base used), this work has broader value since England is an international leader in the provision of mathematics support and developments in England have spread to other parts of the world (e.g., Australia (MacGillivray, 2009) and Ireland (Mac An Bhaird, & Ní Fhloinn, 2010)).

The data corpus, data set, coding choices and themes

In England a variety of organisations provide higher education. We focus on those listed by the Higher Education Statistics Agency excluding private universities, those not offering undergraduate level provision and specialist institutions focused upon arts and medicine-based subjects – a total of 101 institutions. For each, the three documents listed above were interrogated. The totality of these documents for the 101 institutions formed our data corpus comprising 303 documents (3 per institution).

Each document in the data corpus was searched electronically using the search terms 'math' (covering both maths and mathematics), 'stat' (covering both stats and statistics), 'numeracy' and 'quantitative'. The context of each occurrence of a search term was then considered individually to determine whether it referred to mathematics *support* (as opposed to, for example, a 'new financial *mathematics* degree'). In a small number of cases, it was not entirely clear whether the text referred to mathematics support and in these cases the researchers used their experience to decide whether or not to include these in the data set. Reference to mathematics support was found in 105 documents and these documents constitute our data set. The Appendix gives details of the documents in the data set broken down by institution. Our data items consist of the specific passages from these 105 documents where reference is made to mathematics support.

Extracts from these items were coded by looking for words or phrases which captured important elements in relation to the research questions. This process did not take place in a vacuum: the researchers have extensive experience in the field with knowledge of external drivers, institutional priorities and the mathematics problem. So, prior to any analysis, we expected that, if any codes were to emerge, they would concern the relevance of mathematics support to these aspects. In this sense our approach has been deductive or 'top-down'. (Braun & Clarke, 2006)). Rather than focussing on just one aspect (e.g., retention) we aimed to form a richer description by including all data items relevant to our broad research questions.

The data items were then read and re-read individually and collectively and sorted into distinct cognate themes, for example 'employability' and 'diagnostic testing'. We approached the identification of themes at a semantic rather than latent level with no attempt to go beyond reporting them explicitly. Later, during the analysis and reporting we progress from this descriptive approach to making inferences about the importance of mathematics and statistics support to senior management.

That there is no requirement to refer to mathematics support in the regulatory documents is both a strength and a weakness in our research. It is a strength in that when there is reference to it, we can infer that there exists a belief that its inclusion enhances an institution's document. It is a weakness in that the absence of reference to mathematics support does not necessarily mean that the institution does not have such provision, nor that it does not value this provision highly. Consequently, for the thirty-eight institutions (see Appendix) that did not refer to mathematics support in these documents, we are unable to draw any conclusions about their views on mathematics support.

The next section gives details about the nature and purpose of the three types of documents being considered. Then, we answer the research questions, providing a selection of verbatim quotations, chosen from the many possible, to provide a representative sample from across the sector. The discussion section explores the findings emerging from this work, before we conclude by describing their implications for those responsible for policy development within institutions and across the entire sector.

The analysed regulatory documents

The Higher Education and Research Act (2017) introduced the Office for Students as the regulatory authority for higher education in England. Prior to this, some regulatory functions had been vested in different organisations notably, HEFCE and the Office for Fair Access. Although technically these were two separate bodies, they were closely aligned with each other. Each regulator has required universities to produce a range of documents, some of which form the corpus of evidence analysed in this paper.

Teaching excellence and student outcomes framework (TEF) institutional submissions

In 2017, the UK Government introduced the Teaching Excellence and Student Outcomes Framework (TEF) for English universities. (The devolved Governments in parts of the UK other than England have responsibility for education policy in their jurisdictions; the UK Government has responsibility for education policy in England). The specification of the Teaching Excellence and Student Outcomes Framework (DfE, 2017, p. 7) states that it is

> A way of
>
> - Better informing students' choice about what and where to study;
> - Raising esteem for teaching;
> - Recognising and rewarding excellent teaching;
> - Better meeting the needs of employers, business, industry and the professions.

Gradings (gold, silver or bronze) were first awarded in 2017 and were determined by an expert panel using metric information and a submission provided by the institution. Institutions could elect to be re-assessed in 2018 or 2019. For those institutions that did so, and so have more than one institutional submission, this study considered only the most recent one.

There is no template for the institutional submission. Institutions are advised to write documents that address the aspects of quality, assessment criteria and ratings descriptors given in the specification. Although there is no template, a strictly enforced page limit compels institutions to be selective in the material they include. It is reasonable to assume that institutions select the information they believe is most likely to achieve the highest rating.

Access agreements

The Higher Education Act (2004) introduced a basic level of tuition fees of £1,200 but permitted English universities to charge tuition fees up to £3,000. Institutions were only permitted to charge fees in excess of the basic level (then £1,200) if the Office for Fair Access (which was created by the Act) approved their Access Agreement (AA). The Access Agreements set out 'access measures they [the institution] intend to put in place such as outreach work and financial support' (OFFA, 2021).

Access Agreements were renewed and approved annually. The final Access Agreements covered the academic year 2018–19. These are the ones that have been examined here.

Access and participation plans

In 2018, the Office for Students took over responsibility for fair access to higher education. The Office for Students must approve an institution's Access and Participation Plan if an institution is to charge the highest permitted level of tuition fees (which most universities do), currently £9,250. Although this process is similar to the previous one, it is more robust and considerably more data-driven with an access and participation data dashboard available on their website (OfS, 2020a). Furthermore, the scope of Access and Participation Plans is wider including continuation, attainment and progression as well as access which was the primary focus of the predecessor Access Agreements.

Initially institutions were required to produce an Access and Participation Plan for the academic year 2019–20 then, the following year, a five-year plan covering 2020–21 to 2024–25 was needed. It is these plans that have been studied in this paper (except for one institution where, at the time the analysis was carried out, the five-year plan had not been approved – for this institution the one-year Access and Participation Plan for 2019–20 was used).

Answering the research questions

In answering the research questions, we provide a selection of representative quotes from various of the documents studied. When we do this, we will indicate the institution, the type of document (TEF, AA or APP) and page number. We do not, however, include

these documents in our reference list. The full set of documents are publicly available at Office for Students (OfS, 2020c) for TEF Institutional Submissions and Office for Students (OfS, 2020b) for Access Agreements and Access & Participation Plans.

RQ1: To what extent is there reference to mathematics support in these institutional documents?

The frequency with which mathematics support is mentioned in these documents indicates that it is established across a wide range of English universities. Of the 101 institutions considered, 63 mentioned some form of mathematics support in at least one of the three documents, with 44 institutions referring to it in their Teaching Excellence and Student Outcomes Framework submission, 39 in their Access Agreement and 22 in their Access and Participation Plan. Several institutions mention it in more than one document, with nine institutions doing so in all three documents, as illustrated in the Venn diagram in Figure 1. Since the total number of institutions considered is 101, the values in Figure 1 are also the percentage (rounded to the nearest whole number) in each category. The Tables in Appendix 1 show an institution-by-institution comparison.

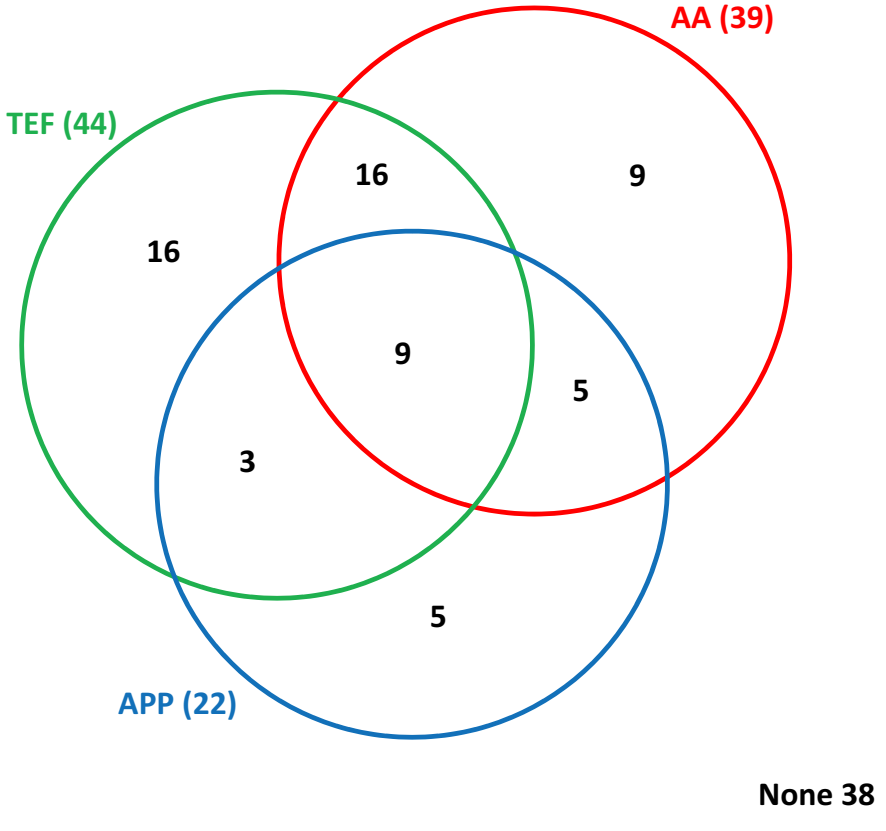

Figure 1. Venn diagram illustrating the number of institutions (out of 101) referring to mathematics and statistics support in the different documents.

It is not surprising that mathematics support is mentioned most often in Teaching Excellence and Student Outcomes Framework institutional statements. As mentioned above, mathematics support is usually provision 'in addition' to standard teaching. Therefore, institutions may see mathematics support provision as evidence of the extra learning opportunities provided and thereby evidence of their teaching excellence.

Many institutions have presented mathematics support as part of their fair access provision. The reasoning here is that widening participation initiatives may lead to institutions accepting students from under-represented backgrounds with lower qualifications than normal. Such students will benefit from the provision of mathematics support. Fletcher (2013) reported that 14 universities referred to mathematics support in their Access Agreements. As noted above, this number had increased to 39 by the 2018–19 Access Agreements.

In contrast, there is a drop from this total of 39 to 22 for the current five-year Access and Participation Plans. Other studies have shown that there has not been a reduction in the number of institutions providing support (Grove et al., 2020). It is possible that some institutions have been wary about citing mathematics support as contributing to fair access because of the Office for Students focus on data-based evidence. Although it is reasonable to surmise that students from under-represented backgrounds benefit from mathematics support, there is a lack of data-based studies to demonstrate this.

The documents provide evidence from across the spectrum of institutions. For example, 16 of the 20 English members of the Russell Group, an organisation of research-intensive (and predominantly long-established) universities, refer to mathematics support in at least one of their documents. However, only three of the 14 English members of the Cathedrals Group, an organisation of church-founded, former teacher training colleges (which have only recently become universities) refer to mathematics support.

Comments in the documents indicate that many institutions perceive that the need for mathematics support is likely to increase because of the increasingly quantitative nature of many disciplines:

> Given … the ever-increasing importance of quantitative skills in social sciences and humanities … we believe that this service [Mathematics and Statistics Support] is essential in aiding retention and progression for many of our students. (Coventry, TEF, 10)

The cumulative evidence from our dataset is that mathematics support is present in a majority of English universities. Since mathematics support is a relatively recent addition to the range of institutional academic support services, it may be inferred from the extent to which it is reported in these documents that mathematics support has become a highly regarded part of the student support infrastructure.

RQ2: What does analysis of these documents reveal about the importance of mathematics support to senior management and their institution's agenda?

What becomes apparent from the analysis is that the provision of mathematics support is a valuable tool for institutional management in addressing a wide-range of strategic challenges such as recruitment and retention, widening participation, diversity and

inclusivity, and employability. Moreover, there is a recognition at institutional level that the requirement to use quantitative skills is taxing for many students across the whole institution. It is evident from the documentation that senior management recognise that lack of competence and confidence in mathematics has consequences for many students and has the potential to impact the institution adversely in respect of the above-listed challenges. Conversely, provision of mathematics support is seen as a mitigating development of sufficient value to highlight its presence in the documents. In some institutions such provision forms part of an explicit strategic approach overseen by very senior staff. Below we give further details of how institutions express the value of mathematics support in addressing these issues.

Taking a strategic approach

Some institutions either explicitly name a strategy or describe a strategic approach to which mathematics support contributes. Strategic approaches can be inferred at other institutions.

> Our comprehensive Academic Skills Strategy, overseen by the DVC-A, ... [includes] targeted support for Mathematics and English. (Greenwich, TEF, 12)

Recruitment, particularly of under-represented groups

The contribution of mathematics support to student recruitment as part of institutional widening-participation agendas is evident. There is recognition that many of these students will need support during their courses. The role of mathematics support in supporting BAME (Black, Asian and minority ethnic) students and students with disabilities are specifically highlighted, with evidence that such students are disproportionately positively represented amongst mathematics support users.

For example, De Montfort University quantifies its support of such groups:

> Analysis of usage data indicates that a greater proportion of students from WP [widening participation] backgrounds use this support service (70% of students accessing this service are classified as BAME). (De Montfort, AA)

Supporting retention, progression and achievement generally

Students from a wide range of disciplines (including science, engineering, medicine, biology, social sciences, humanities, pharmacy, nursing, midwifery, sport and exercise science, health studies and teacher education) are explicitly mentioned as beneficiaries of mathematics support:

> ... a package of teaching and support measures [was] put in place to ensure that students develop the mathematical skills they need to study Biology (Cambridge, TEF, 14)

Several institutions simply indicate the value to all students:

> One in five students who completed mathematical and statistical skills training reported that it helped to keep them on courses they would otherwise have seriously considered leaving. (Durham, TEF, 12)

The value of mathematics support for particular student groups

The extent of types of student groups impacted by mathematics support is much broader than might first be imagined. Some institutions refer to the support of part-time and distance learners. Others refer specifically to its role in the support of mature students. At some institutions, mathematics support is extended to applicants and/or alumni:

> 'Connect Live' provides students with on-line problem-solving for tasks in subjects such as maths and statistics .... available 24/7 and feedback is provided within 24 hours. This form of support is particularly relevant to our student body, who may well be working during the day and studying late at night when it can be difficult to access support. (Birkbeck, APP, 21)

The importance of providing general learning support to students who have learning differences is well-established. However, the analysis here reveals the extension of general support to include mathematics and statistics, for example for those students who are maths anxious:

> Maths and Statistics Help (MASH) provide workshops on Maths Anxiety which aim to help students to self-identify challenges around numeracy and mathematical ability and to develop techniques and strategies to overcome them. (Sheffield, AA, 49).

Employability

There is recognition of the need to provide support for those about to graduate, in the form of preparation for numerical reasoning tests, in order to improve employment prospects. It is apparent that this support is particularly valuable for aspiring health care professionals and school teachers:

> ... targeted sessions on such topics as numerical reasoning, statistics and SPSS to enhance students' employability. Numerical reasoning tests are provided as preparation for interviews, internships and for PGCE applications ... (Coventry, APP, 26)

In summary, institutions make clear the contribution of mathematics support to a wide range of priorities and by inference its importance to senior management.

RQ3: What does analysis of these documents reveal about the positioning and development of mathematics support within English universities?

A number of themes relating to ongoing development of mathematics support are evident. These concern increasing institutional alignment of mathematics support services with other student support activity; the widespread use of diagnostic testing upon entry to identify students who might benefit from mathematics support; evidence that institutions are evolving the delivery of provision to meet changing student needs; and, the analysis and reporting of data confirming the positive impact of mathematics support on student satisfaction, retention and success.

Institutional alignment with other student-focused services

Almost half of the institutions who referenced mathematics support showed that this provision is aligned with other services or is benefitting from an ongoing institutional commitment. In several cases, there is reference to the creation of specialist mathematics

support posts. Sometimes these are situated within a larger central service, for example an academic skills centre or library; others are in a dedicated stand-alone mathematics support centre. This alignment is a dynamic process where the positioning of mathematics support is continuing to evolve:

> Research students contribute to teaching and supporting student learning in academic departments and as tutors in central services such as the Maths Skills Centre and the Writing Centre. . . .. (University of York, TEF, 6)

Diagnostic testing upon entry to identify students who might benefit from additional mathematics support

Diagnostic testing is used by institutions as a means of identifying those who might benefit from mathematics support early in their learning experience and as a mechanism for then encouraging their engagement with the available provision:

> A major feature . . . is our Academic Skill Diagnostic Tests . . . Students scoring below specified thresholds in these academic skills diagnostic tests (including English literacy and numeracy) get bespoke support . . . (Bolton, TEF, 10)

Innovations in delivery of mathematics support

Several documents record innovations in the delivery of mathematics support in an attempt to encourage a broader range of students to engage, with almost half of the institutions providing details. Whilst there were many examples given of 'traditional' forms of mathematics support such as drop-in provision, a range of innovative approaches were also cited demonstrating how mathematics support is diversifying. Particularly evident were examples of how ideas from mathematics support are influencing more mainstream practice through changes to the curriculum and the development of resources:

> . . . development of an intensive three-week pre-sessional course for students who narrowly miss their required grade in A-level Mathematics for degrees in engineering, science and social sciences. (Bath, APP, 11)

> In the Department of Life Sciences, where students' levels of prior attainment in mathematics can be lower, a compulsory Essential Mathematics module is taught. (Imperial College, TEF, 13)

Another feature evident was recognition of the importance of professional development:

> . . . we trained tutors to support the numeracy and literacy skills BTEC Health students need to successfully pass Nursing admissions tests. (City, University of London, AA, 8)

Evidence of institutions analysing impact data and citing this in the documents

Some institutions provided data about the impact of mathematics support. Occasionally this was based upon student perceptions:

> 75% of students said that attending maths support had made a significant difference to their performance in coursework or examinations. (Greenwich, TEF, 12)

But more frequently, data were presented citing how engagement with mathematics support has resulted in positive impacts upon student success, retention and performance:

> The 'Numbers for Nurses' session 2014-15 saw a 100% pass rate for the nursing students who attended workshop [sic], and a higher than average pass mark (94%) compared to the rest of the cohort (average pass mark 85%). (Manchester Metropolitan, TEF, 10)

Discussion

Herein, three different sets of documents which higher education regulators require universities to submit, have been examined to answer three research questions relating to mathematics support provision in English universities. These questions relate to the extent of reference to mathematics support, its importance to the institutions and its positioning and development.

The analysis has revealed that mathematics support is highly embedded across the sector, with over 60% of institutions referring to their mathematics support provision in at least one of the three regulatory documents. For some institutions, the reference to mathematics support is relatively extensive; in others the reference is little more than acknowledgement that such provision exists. It is not necessarily the case that those institutions which make only brief reference to mathematics support do not think it important. Rather, these institutions may feel that mathematics support provision is now such an established part of the higher education infra-structure that such provision can almost be taken for granted.

It is clear that in many institutions, a strategic approach is now taken to the provision of mathematics support. This represents a significant change from previous descriptions of mathematics support as 'a form of cottage industry' (Kyle, 2010, p. 103). In some instances, this has resulted in mathematics support being physically and/or hierarchically located with other central services. In other institutions, responsibility for delivery of mathematics support services may reside with the mathematics department or a specialist unit, but with direct accountability to institutional management.

The evidence in the documents shows that there are a variety of approaches to the provision of mathematics support. Institutions are developing mathematics support services that are appropriate to the needs and nature of their students. A key feature is that mathematics support provision is dynamic. As the external challenges change, so different ways of meeting them are required. As the scale of demand for mathematics support increases, traditional approaches based around drop-in centres and individual appointments are being supplemented by increased use of online facilities and embedded support.

Those institutions that chose to give relatively extensive reference to their mathematics support provision usually do so to report evidence of its effectiveness, as exemplified by this excerpt which follows a lengthy description of the mathematics support services provided:

> Students engaging with the MLC have improved retention and success rates, with 98.7% retention of users in 2015/16 compared to 93.7% for all undergraduates. Analysis of usage data indicates that a greater proportion of students from widening participation backgrounds access the MLC support service: for example, 70% are classified as BAME and

> 24% identify as having a disability. This compares to an average of 45% BAME and 18% disabled students within the student body. This increased rate of access highlights that this service is providing valuable support and contributing to closing the attainment gap. (TEF, De Montfort, 5)

Implications and conclusions

We turn now to implications drawn from our analysis of the regulatory documents.

Implications

The increasingly quantitative nature of many disciplines and the shortage of suitably-mathematically qualified students is frequently acknowledged. All institutions should consider using their periodical review processes to examine the impact of these dual challenges. Where necessary, institutions should consider developing strategic oversight to ensure that appropriate supportive measures are in place to enable all students to develop the required quantitative skills. Mathematics support provision can play a strategic role within re-developed 'standard' curricula through what some institutions call embedded support.

Several institutions mention investing in and recruiting new staff to work as tutors in support centres. Research shows that students regard the quality of tutors as being the most important factor influencing the effectiveness of the support they receive (Lawson et al., 2003). However, often these staff occupy non-standard academic or academic support roles, which may make these roles less attractive. Appropriate career paths are essential for retention of high-quality staff who would like to make a career in this field.

Changes to practices and content within mainstream teaching could alleviate some of the difficulties students present with in mathematics support. There is a need to ensure that intelligence gathered from mathematics support provision informs curriculum change, development of resources and staff. Establishing fora to facilitate this would be useful. Targeting teaching and learning development funding to individuals who can innovate and evidence changes in practice within mainstream teaching or mathematics support provision may also help.

Related research has highlighted the growth in the number of support centres across England and Wales (Grove et al., 2020). This paper offers further evidence in this respect, showing that 63 out of 101 institutions made reference to their mathematics support provision in at least one of the regulatory documents analysed. The fact that a majority of institutions now offer mathematics support creates a market incentive (even imperative) for others to do so too in order to support their recruitment.

There is evidence of good practice in mathematics support in the documents studied. This good practice warrants being shared more widely so that it might be adopted in other institutions. Cross-sector professional groups such as the **sigma** Network (**sigma**, 2021) have a valuable role to play in ensuring dissemination of good practice and provision of staff development. One such area is tutor training, where **sigma** delivered regional tutor training events have been effective (Grove, Mac An Bhaird, & O'Sullivan, 2019).

Conclusion

That many university students across a wide range of disciplines need and benefit from additional support with the mathematical requirements of their courses is now well-established. The provision of such support is widespread and contributes to a diverse range of institutional priorities. Findings presented here show that many institutions regard evidence of their mathematics support provision as an indicator of quality and this, alongside the increasing challenges in relation to developing the quantitative skills of a huge proportion of their students, indicates that mathematics support has become, and is likely to remain, an integral part of the higher education infra-structure. Future research into the benefits accruing to specific student groups would be helpful in determining ongoing priorities.

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Appendix: References to Mathematics and Statistics Support

The tables below show which institutions refer to mathematics and statistics support in which of the three documents studied. Due to the particular nature of institutions belonging to the Russell Group (an organisation of 24 research-intensive UK universities, of which 20 are in England), universities from this group are shown in **bold** in the tables.

Table A.1: Institutions referring to mathematics and statistics support in all three documents

Birkbeck College
Birmingham City University
Coventry University
Loughborough University
University of Bath
University of Birmingham
University of Chester
University of Newcastle
University of York

Table A.2: Institutions referring to mathematics and statistics support in two of the three documents

TEF & AA	TEF & APP	AA & APP
Aston University	Liverpool John Moores University	The University of West London
De Montfort University	University of Kent	**University of Exeter**
Kingston University	University of Sussex	University of Lancaster
London School of Economics & Political Science		University of Leicester
London South Bank University		University of Surrey
Nottingham Trent University		
Oxford Brookes University		
Roehampton University		
The Manchester Metropolitan University		
The University of Bolton		
University of Greenwich		
University of Hertfordshire		
University of Lincoln		
University of Plymouth		
University of Portsmouth		
University of Sheffield		

Table A.3: Institutions referring to mathematics and statistics support in one of the three documents

TEF only	AA only	APP only
Brunel University	City, University of London	Middlesex University
Buckinghamshire New University	Harper Adams University	Staffordshire University
Imperial College of Science, Technology & Medicine	**King's College London**	**University of Leeds**
Royal Holloway College and Bedford New College	Leeds Trinity University	**University of Liverpool**
Southampton Solent University	London Metropolitan University	**University of Southampton**
The University of Manchester	Sheffield Hallam University	
University of Bedfordshire	The University of Northampton	
University of Brighton	**University of Nottingham**	
University of Bristol	Writtle University College	
University of Cambridge		
University of Durham		
University of East London		
University of Essex		
University of Huddersfield		
University of Reading		
University of the West of England, Bristol		

The 38 institutions not referring to mathematics and statistics support in any of their three submitted documents are:

Anglia Ruskin University, Bath Spa University, Bishop Grosseteste University, Bournemouth University, Canterbury Christ Church University, Edge Hill University, Falmouth University, Goldsmiths College, Leeds Beckett University, Liverpool Hope University, Newman University, **Queen Mary University of London**, St Mary's University Twickenham, Teesside University, The University of Chichester, The University of Cumbria, The University of Westminster, University College Birmingham, **University College London**, University of Bradford, University of Central Lancashire, University of Derby, University of East Anglia, University of Gloucestershire, University of Hull, University of Keele, University of Northumbria, **University of Oxford**, University of Salford, University of St Mark & St John, University of Suffolk, University of Sunderland, University of the Arts London, **University of Warwick**, University of Winchester, University of Wolverhampton, University of Worcester, York St John University.