Skills in Mathematics and Statistics in Business and Management and tackling transition

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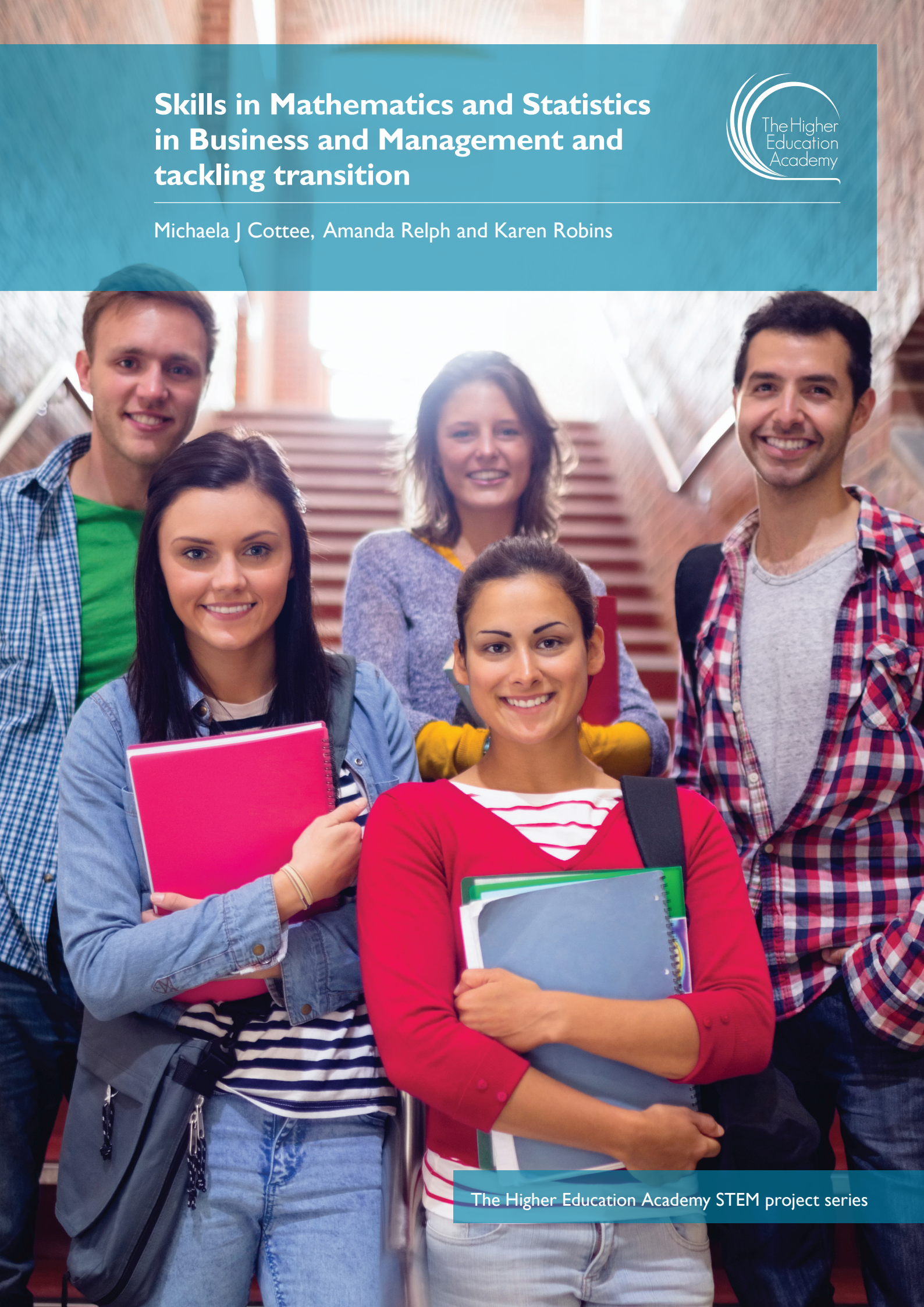

The Higher Education Academy STEM project series

Contents

Foreword

This report is one of a series commissioned by the Higher Education Academy STEM team to look at mathematical and statistical skills in a range of discipline areas. The report seeks to contribute to existing knowledge about this area within the context of Business and Management.

At the start of the project a list of areas for consideration in the study was provided by the Higher Education Academy. These encompassed the way in which mathematical and statistical skills form part of the discipline landscape, the signalling higher education provides about the need for these skills, sector requirements within the discipline (e.g. from accreditors and Quality Assurance Agency subject benchmark statements), the use of diagnostic testing and the support provided for students to improve and develop their mathematical and statistical skills. The methods used in the study in Business and Management consisted of (i) a literature review; (ii) survey work; and (iii) a discussion event.

As indicated in the report, Business and Management is quite a wide field. The level of mathematical or statistical qualification on entry varies widely across the sector. Students approach higher education study in the discipline from a diverse range of mathematical backgrounds. This provides particular challenges for teaching. Despite this fact there has been very little research on this topic. The present study aims to consider the issues and to provide an evidence base to inform future work and discussion, policy developments and teaching practice in the discipline.

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1 Summarised findings and recommendations

1.1 Introduction

Business and Management degree programmes are offered by most universities and are very popular with students. As such the transition from school to undergraduate Business and Management degree programmes at university is an important area for consideration as it may, potentially, affect tens of thousands of students each year.

It is widely believed that large numbers of students entering Business and Management degree programmes are lacking the skills they require to cope with the quantitative methods content of their chosen degree programme. This so-called "Mathematics problem" affects a very wide range of disciplines and is not unique to Business and Management. It provides challenges that have to be addressed.

The work reported here formed part of the Higher Education Academy (HEA) Science, Technology, Engineering and Mathematics (STEM) project: "Skills in Mathematics and Statistics in the Disciplines and Tackling Transition", with emphasis on the Business and Management discipline. Information relating to quantitative methods provision, teaching requirements and support on undergraduate Business and Management degree programmes was gathered from relevant staff and students, to provide an evidence base to inform dialogue between and within the higher education and pre-university sectors. The results presented in this report relate primarily to the experiences of first year undergraduate students within the UK undertaking the transition from school or college to university.

A literature review was undertaken at the start of the study, and three surveys were subsequently developed. One survey was aimed at staff teaching within Business and Management. A second survey was directed at heads of department or those with responsibilities for organising teaching in Business and Management (taken together these form the HEA STEM staff survey). The third survey was for students taking degree programmes within Business and Management. All of the surveys were developed within the full HEA STEM project team to ensure that, as far as possible, a consistent approach was adopted to the work across all disciplines involved in the project. The surveys were circulated in the Spring and early Summer of 2013. The last strand of the work was a set of HEA STEM Tackling Transition events for the various disciplines; the event for Business and Management was held together with Economics in April 2013. It provided an opportunity for staff working in Economics and in Business and Management in higher education to meet and discuss the areas of interest with colleagues in the pre-university sector and other key stakeholders in the discipline. The discussions were recorded and collated with the other data obtained.

1.2 Findings and recommendations

1.2.1 Notable findings †

1. All of the Business and Management degree programmes considered in the staff survey include quantitative methods teaching in the first year, usually through compulsory standalone modules. There is less of an emphasis on quantitative methods teaching in subsequent years, with fewer or no compulsory standalone modules and more embedded quantitative methods teaching.

2. The allocation of staff for the teaching of quantitative methods generally takes into account staff expertise, experience and preferences. Most quantitative methods teaching is undertaken by staff from within the Business and Management department. A high proportion of staff who teach quantitative methods feel "very confident" about their subject knowledge.

3. All Business and Management programmes included in the staff and student surveys contained some element of quantitative methods. However Business and Management degree programmes vary considerably in terms of the amount, level and content of the quantitative methods taught on the programme, and detailed information about content is not always openly available online. This may make it difficult for applicants to find a programme that suits their abilities and preferences with regards to quantitative methods.

4. There appears to be a mismatch between staff and student expectations. For example, less than half of higher education staff surveyed felt that students understood why quantitative methods are included in their degree programme. In contrast most students surveyed claimed to understand why quantitative methods are included in their Business and Management programme and had reasonable expectations about the amount of quantitative methods study involved. Over 85% of students surveyed knew, before they started, that there would be some quantitative methods in their programme. Almost three quarters of students surveyed said they expected to have to extend their knowledge of quantitative methods.

5. The Business and Management programmes considered in the staff and student surveys all included some element of quantitative methods but degree programmes vary widely in content. This is not surprising given that the Quality Assurance Agency (QAA) subject benchmark statement for General Business and Management only refers in vague terms to "appropriate quantitative and qualitative skills" and to "numeracy and quantitative skills, including data analysis, interpretation and extrapolation".

6. Many higher education institutions ask for a minimum of GCSE Mathematics grade C, or equivalent, for entry to Business and Management degree programmes. The specified entry requirement is only a minimum. In practice, there may be considerable diversity with students on the same programme having studied different amounts of Mathematics and Statistics across a range of Mathematics qualifications prior to starting university. Consequently prior knowledge of topics cannot be assumed.

7. Diagnostic testing is used, but not universally. About half of the students surveyed had undergone some form of diagnostic testing, mostly in the form of a written test. Where used, diagnostic testing seems to be used more to inform students' self-awareness and to inform staff of the general skills level of students than to ensure that teaching is at an appropriate level. Some institutions stream students for quantitative methods teaching, but streaming is not widespread and, where used, is more likely to be based on mathematical qualifications upon entry, rather than diagnostic test results.

8. Additional quantitative methods support is widely offered, most commonly in the form of drop-in support at the university level, online resources and/or supplementary workshops, but there are some concerns about the poor take-up of these services by the students who would benefit most from them. Many students did not know if additional support was available to them. All the students who had made use of the additional support had found it helpful.

9. Relatively few students felt that their performance on quantitative methods assessments was worse than in other areas of their degree programme. When students struggle with quantitative methods it is usually attributed, by the students themselves, to anxiety or a lack of confidence about studying Mathematics/Statistics, or because they find working with numbers challenging. It is not because they do not appreciate the relevance of quantitative methods or because they are not motivated to work at quantitative methods.

10. The time elapsed since Mathematics was last studied was considered by more than half of staff respondents to be a factor that inhibits the development of students who struggle with quantitative methods. Such a gap in study was also recognised as a problem in the student survey and by delegates at the Tackling Transition event. Delegates did not, however, believe that study of Mathematics beyond the level of GCSE or equivalent would be essential for Business and Management degree programmes.

† The participants in the HEA STEM surveys and event were self-selecting and the sample sizes were small. Detailed information on sample sizes and the response rates for specific questions is given in Section 4.

1.2.2 Recommendations

1. Staff with responsibility for degree programmes in Business and Management should articulate clearly the quantitative methods content and level in their degree programmes. This information should be made available in promotional and other programme information.

2. Key stakeholders in the Business and Management discipline should provide better signalling to the pre-university sector about the relevance of quantitative methods in Business and Management degree programmes.

3. The QAA subject benchmark statement for General Business and Management should be revised at the earliest opportunity to articulate clearly specific minimum quantitative methods skills and knowledge requirements for Business and Management degree programmes.

4. Key stakeholders in the Business and Management discipline should actively encourage university staff in Business and Management to engage with future studies related to quantitative skills in the discipline. Such engagement would include input to consultations and surveys.

5. Students on university degree programmes in Business and Management should be made aware of the availability of additional support in quantitative methods. University staff in Business and Management should actively encourage students to use the available resources and opportunities to develop their skills in quantitative methods, and engage in activities to increase take-up by those students who would benefit most.

6. Key stakeholders in the Business and Management discipline and university staff with responsibility for managing degree programmes in Business and Management should actively engage with current and future developments in post-16 qualifications in (i) Business Studies (with particular relevance to quantitative methods components) and (ii) Mathematics (e.g. "Core Maths").

2 Background

2.1 The "Mathematics Problem"

It is now widely acknowledged that large numbers of students entering higher education lack the skills they require to cope with the mathematical content of their chosen degree programmes and that this problem affects a wide range of disciplines in many universities (Mac an Bhaird and Lawson, 2012; Croft, 2001). This so-called "Mathematics problem" has been reported on for many years, in numerous learned society, professional body and research reports, yet it remains a major issue and is unlikely to disappear in the foreseeable future (Mac an Bhaird and Lawson, 2012; Pell and Croft, 2008; Vorderman *et al*., 2011). Although the problems that many undergraduates experience with the quantitative content of their chosen degree programmes are frequently attributed to a school Mathematics curriculum that does not appear to be preparing many students adequately (Advisory Committee on Mathematics Education, 2011; Mac an Bhaird and Lawson, 2012), the causes of the "Mathematics problem" are not well-understood and are likely to be complex and multi-dimensional (Croft, 2001).

Croft (2001) points out that there is no obvious single solution and that to tackle the "Mathematics problem" is likely to require a joint long-term effort and a range of strategies by government, funding agencies, schools, universities and others. In the meantime, universities need to recruit what students they can and put mechanisms in place to do the best possible job with the students they have (Lawson *et al.,* 2003; Croft, 2001). Similarly, the Smith Inquiry (2004) concluded that "higher education has little option but to accommodate to the students emerging from the current GCE process."

2.2 Motivation and context

2.2.1 Motivation

The aim of the work described in this report is to provide an evidence base to inform dialogue between the higher education and pre-university sectors about the requirements for mathematical and statistical skills in Business and Management degree programmes and to foster greater understanding between the two sectors about the need for students to be able to develop and apply these skills.

The main concern of this project is the transition from pre-university to university. As such, the work described in this report focuses on the experiences of first year undergraduate students within the United Kingdom (UK), i.e. England, Wales and Northern Ireland together with Scotland, where the education system is substantially different from the rest of the UK.

2.2.2 Context

Many UK Business Schools deliver degree programmes across a wide range of business-related areas, including Business, Management, Accounting, Finance, Economics, Marketing, Human Resources, Hospitality and Tourism. Within the context of the Business and Management discipline, the findings described in this report are concerned primarily with Business and Management degree programmes/courses as defined by the Universities and Colleges Admissions Service (UCAS) codes N100-N109, N200-N209, N1N2 and N2N1 and delivered by UK higher education institutions as recognised by the Higher Education Statistics Agency (HESA). Foundation degree programmes and top-up programmes were not considered.

Based on information obtained from the UCAS website (University and College Admissions Service, 2012) for entry in 2013, there were (at least) 223 undergraduate Business and Management programmes, offered across 164 higher education institutions, that satisfied the specified criteria. The majority of these institutions (131) are in England, with 19 in Scotland, 10 in Wales and 4 in Northern Ireland. Institutions from all of the University coalition groups offer Business and Management degree courses. At the time this information was collated, the 164 institutions included 13 institutions from the 1994 Group, 24 from the Alliance Group, 21 from the Million+ Group, 24 from the Russell Group and 82 others.

Information from the HESA website (Higher Education Statistics Agency, 2014) indicates that there were 38,595 full-time first year undergraduate (first degree) students studying Business Studies or Management Studies courses in 2012/13. This represents over half (54%) of the total for Business and Administrative Studies (which includes Accounting, Finance, Marketing, Human Resources, Hospitality, Leisure, Tourism and Transport) and 8% of the total for all subject areas.

It can be seen, therefore, that the transition from pre-university education to university within Business and Management is a process that affects tens of thousands of students each year and is an area of potential interest and concern for almost all higher education institutions.

2.2.3 Quality Assurance Agency subject benchmark statement

The QAA subject benchmark statement for General Business and Management (Quality Assurance Agency for Higher Education, 2007) states, in the section on skills (Section 3.9), that "Graduates should be able to demonstrate a range of cognitive and intellectual skills together with techniques specific to Business and Management." The list of skills includes:

- "effective problem solving and decision making using appropriate quantitative and qualitative skills including identifying, formulating and solving business problems";

- "numeracy and quantitative skills including data analysis, interpretation and extrapolation. The use of models of business problems and phenomena".

Subject benchmark statements are indicative rather than prescriptive – they are not intended to specify a curriculum, nor are they intended to constrain innovation in programme design – and the QAA recognises that General Business and Management degrees are broadly based and general in their scope, rather than being oriented towards a particular business function or sector.

On the other hand, a subject benchmark statement should provide a means for the academic community to describe the nature and characteristics of a Bachelor's degree with honours in a particular subject area, and represent general expectations about standards for the award of degrees in terms of the attributes and capabilities that those possessing qualifications should have demonstrated. The lack of detail with regards to numeracy and quantitative skills in the subject benchmark statement for General Business and Management permits widely different interpretations in programmes with similar names.

2.2.4 Terminology

There is considerable variation among higher education institutions in how the terms "Business" and "Management" are employed. In some contexts the terms "Business" and "Management" may be used jointly or even interchangeably, yet in other contexts these two terms can be used in quite specific and different ways. Except where a clear distinction is made, throughout this report the term "Business and Management" can be taken to refer to "Business" and/or "Management" as separate disciplines, as well as to "Business and Management" as combined disciplines.

Within Business and Management a variety of terms are employed to describe the mathematical/statistical/quantitative/numerical components of a degree programme. In some cases this is an attempt to capture the multidisciplinary nature of the topics covered, which may also include operational research and management science techniques as well as financial and econometric applications; in other cases this may be an attempt to "sell" Mathematics to non-mathematical students by using a less intimidating label. Throughout this report the term "quantitative methods" will be used to cover the whole variety and range of associated techniques that may be taught on a Business and Management degree programme but alternative terms, such as "Mathematics", "Statistics" and "numeracy", may be used when citing the literature or discussing HEA STEM staff and student survey responses and comments made at the HEA STEM Tackling Transition event.

3 Research objectives and methodology

3.1 Introduction

Information relating to quantitative methods provision, teaching, requirements and support on undergraduate Business and Management degree programmes was collected by means of desk research and from Business and Management staff and students through the HEA STEM staff and student surveys and the HEA STEM Tackling Transition event, as described below.

3.2 Desk research

3.2.1 Web-based research

The websites of UCAS, HESA, the QAA and various professional bodies including the Chartered Management Institute (CMI) were searched for information relating to entry requirements, student profiles and standards for undergraduate Business and Management degree programmes in the UK.

3.2.2 Literature review

Although the Business and Management discipline is the main area of interest, much of the literature considered in this report relates to disciplines other than Business and Management. This is because the so-called "Mathematics problem" was first recognised in traditional STEM disciplines such as Mathematics, Statistics, Physics and Engineering and only more recently have the implications of the problem for other disciplines been recognised – first of all in other science subjects (Hawkes and Savage, 2000) and then, more recently still, in the social sciences (MacInnes, 2009; Mac an Bhaird and Lawson, 2012). Recent developments within the social sciences include the Quantitative Methods Initiative launched jointly by the Economics and Social Research Council (ESRC) and the Higher Education Funding Council for England (HEFCE); the British Academy's position statement on the issue of the quantitative skills deficit in the humanities and social sciences (British Academy, 2012); and the recent Q-Step initiative by the Nuffield Foundation, ESRC and HEFCE (Nuffield Foundation, 2013). The latter initiative includes two Q-Step Centres concerned with Management and Business Studies.

A review of the literature was carried out not only to establish what research had already been done but also to inform the content of the HEA STEM staff and student surveys and the presentation and discussion at the HEA STEM Tackling Transition event described below.

Although there is relatively little published research that relates specifically to Business and Management[1] there is no reason to suppose that this discipline is immune from the issues that have already been identified across a range of disciplines. The issues identified in the wider literature that are described in this report are potentially be relevant to Business and Management.

1 The work described in this report is one of the first UK studies designed to identify issues that relate specifically to the Business and Management discipline.

3.2.3 A-level Business Studies

A-level Business Studies attracts students of varied abilities, some of whom plan to go directly into employment rather than higher education. The current Business Studies A-levels offered by the different awarding organisations all contain some Mathematics (Nuffield Foundation, 2012) and Statistics (Porkess, 2013). However, for most Business and Management degree programmes, admission is not dependent on any particular subjects at A-level, or equivalent. Nevertheless, university staff in the Business and Management discipline have an important role to play in providing input to the way in which pre-university qualifications both in Business Studies and Mathematics (e.g. "Core Maths") are developed for the future.

3.3 HEA STEM surveys

National surveys were conducted to investigate the views and experiences of lecturers involved in the delivery of quantitative methods teaching on Business and Management degree programmes, heads of university Business and Management departments, and undergraduate Business and Management students. Standard survey questions were developed by the HEA STEM project team. The questions used in the Business and Management surveys were tailored to the discipline in terms of language and likely quantitative methods content.

The surveys were administered by an independent research agency (EdComs). Emails containing links to the online surveys were sent to contacts within UK higher education institutions, with a request to circulate the links as appropriate. Respondents were self-selecting. Anonymity was assured.

3.3.1 HEA STEM staff surveys

The HEA STEM staff surveys were directed at heads of UK higher education Business and Management departments and at lecturers in UK higher education Business and Management departments with current or recent experience of teaching quantitative methods on a Business and/or Management undergraduate degree programme. There was considerable overlap between the two survey questionnaires, which were identical except for three questions where heads of department were asked about training of staff and postgraduate students involved in teaching. Lecturers were asked about their own training and confidence in teaching quantitative methods.

Respondents were asked to list all relevant Business and/or Management programmes (single honours or combined) and then answer detailed questions with reference to the Business and/or Management programme with the largest number of students.

3.3.2 HEA STEM student survey

The HEA STEM student survey was aimed at, but not restricted to, first year undergraduate students on Business and/or Management degree programmes (single honours or combined).

Respondents were asked to state the name of their degree programme and place of study, as well as their current year of study, their gender and their age on entry, plus their highest Mathematics qualification on entry. Having checked that they had studied quantitative methods as part of their degree programme, students were then asked a number of detailed questions.

3.4 The HEA STEM Tackling Transition event in Business and Management and Economics

The HEA STEM Tackling Transition event was organised jointly with the Economics discipline to bring together Business Studies and Economics teachers from the pre-university sector and Business and Management and Economics lecturers from higher education, as well as representatives from interested sector bodies such as examination boards. The topic of discussion was the mathematical and statistical skills requirements for the study of Business and Management and Economics with a particular emphasis on the transition to university.

An email was sent to contacts within UK higher education institutions and targeted subject specialists in Business and Management or Economics who either (i) teach mathematical and/or statistical elements of a university Business and Management or Economics degree programme, particularly at first year level, or (ii) have management responsibility for Business and Management or Economics degree programmes.

Following a brief introduction to the HEA STEM project and presentations about Business and Management and Economics, the audience split into focus groups to discuss in detail the mathematical and statistical skills requirements for the study of Business and Management and Economics in higher education and the transition from the pre-university sector to higher education. These discussions were recorded and subsequently transcribed.

4 Main findings

4.1 Respondents

4.1.1 HEA STEM Staff surveys

Responses were received from 17 lecturers and 8 heads of department, representing 22 different institutions, of which 16 are in England, 3 in Scotland and 3 in Wales. Despite making efforts to increase the response rate, which included extending the response period, the number of responses is low relative to the number of UK higher education institutions that offer Business and Management degrees.

Given the relatively low response rate, and the substantial overlap in the questions asked, it was decided to combine the responses from both groups of staff. The group size for this combined set of lecturers and heads of department is 25, except where otherwise stated. Of the 22 different institutions two are represented more than once. The main university coalition groupings are represented in the combined staff survey responses, with five institutions from the Russell Group, four from the Alliance Group, three from the Million+ Group, two from the 1994 Group and eight others.

Staff were asked to specify which of the degree programmes in Business and Management offered by their institution had the largest number of students and to answer the survey questions with reference to this particular programme. Given the relatively small sample size, a broad interpretation of Business and Management was used, and responses relating to programmes in Accountancy and Accounting and Finance were included. The largest programmes identified in the staff survey included, across the 22 institutions, 10 Bachelor of Arts (BA) programmes, nine Bachelor of Science (BSc) programmes and one Bachelor of Accountancy (BAcc) programme, plus two programmes not specified. Figure 1 summarises the programme titles represented in the survey.

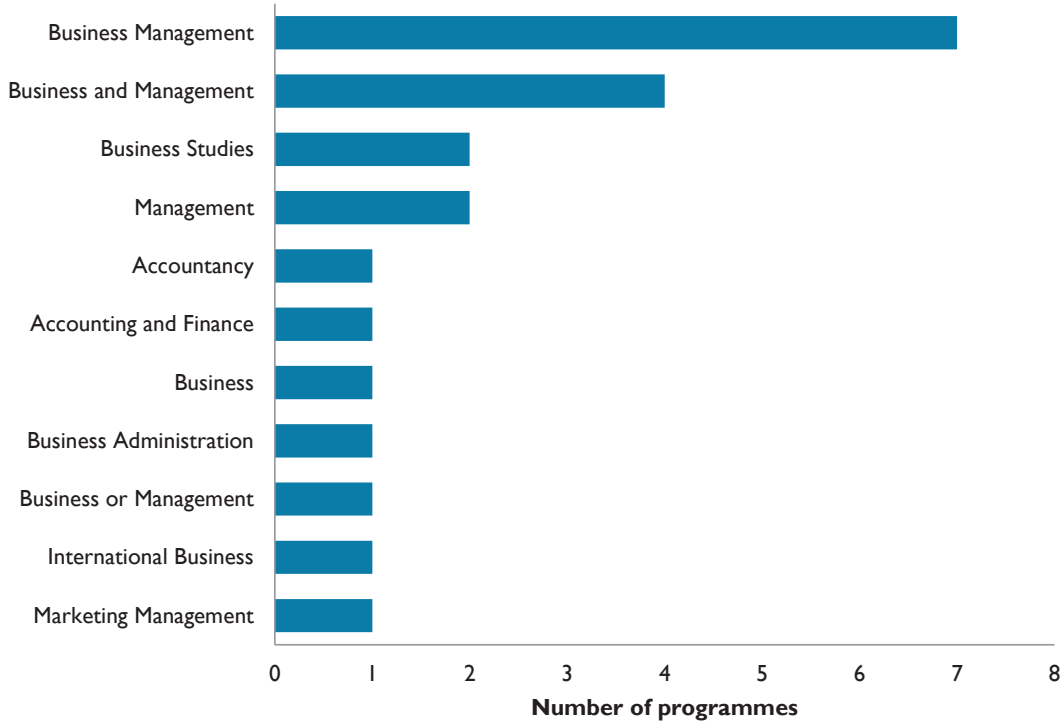

Figure 1: HEA STEM staff survey: Which [of all the Business and/or Management degree programmes that you offer] has the largest number of students? (N=22 institutions).

4.1.2 HEA STEM Student survey

Responses were received from 46 students, representing just eight different institutions. Despite making efforts to increase the response rate, which included extending the response period, the number of responses is low relative to the number of students studying Business and Management degrees at UK higher education institutions. The relatively poor response rate may be due, in part, to the timing of the survey, which was administered towards the end of the 2012/13 academic year, when many students would be sitting examinations or would have already finished for the Summer.

While the main university coalition groups were represented, over half of the student survey respondents (28 out of 46, 61%) were studying at one of just two institutions, and half of the institutions (4 out of 8) accounted for over four-fifths (38 out of 46, 83%) of the student survey respondents. 43 of the 45 students (96%) were studying in England, two were studying in Scotland and one student did not specify their institution. For these reasons the student survey cannot be regarded as representative of the situation across the higher education sector as a whole.

The majority of students who took part in the survey (37 out of 46, 80%) were in, or had just completed, their first year, and the remaining 20% (9 out of 46) were in, or had just completed, their second year. The majority of students (40 out of 46, 87%) had been under 21 when they started their degree programme, with the remaining 13% (6 out of 46) aged 21-30. 70% (32 out of 46) of the students were female[2].

There were 33 students (72%) who said that they were studying on a single honours degree programme. All students were asked to state the name of the degree programme they were studying. A broad interpretation of Business and Management was used, and responses relating to programmes such as Fashion Management, Accounting and Finance, Marketing and Event Management were included. Figure 2 summarises the programme titles represented in the survey. The sample size is N=46 for each question, except where stated.

2 This is a higher proportion than expected, given that HESA data (Higher Education Statistics Agency, 2014) shows that just over 50% of first degrees awarded in Business and Administrative Studies in 2012/13 were awarded to females.

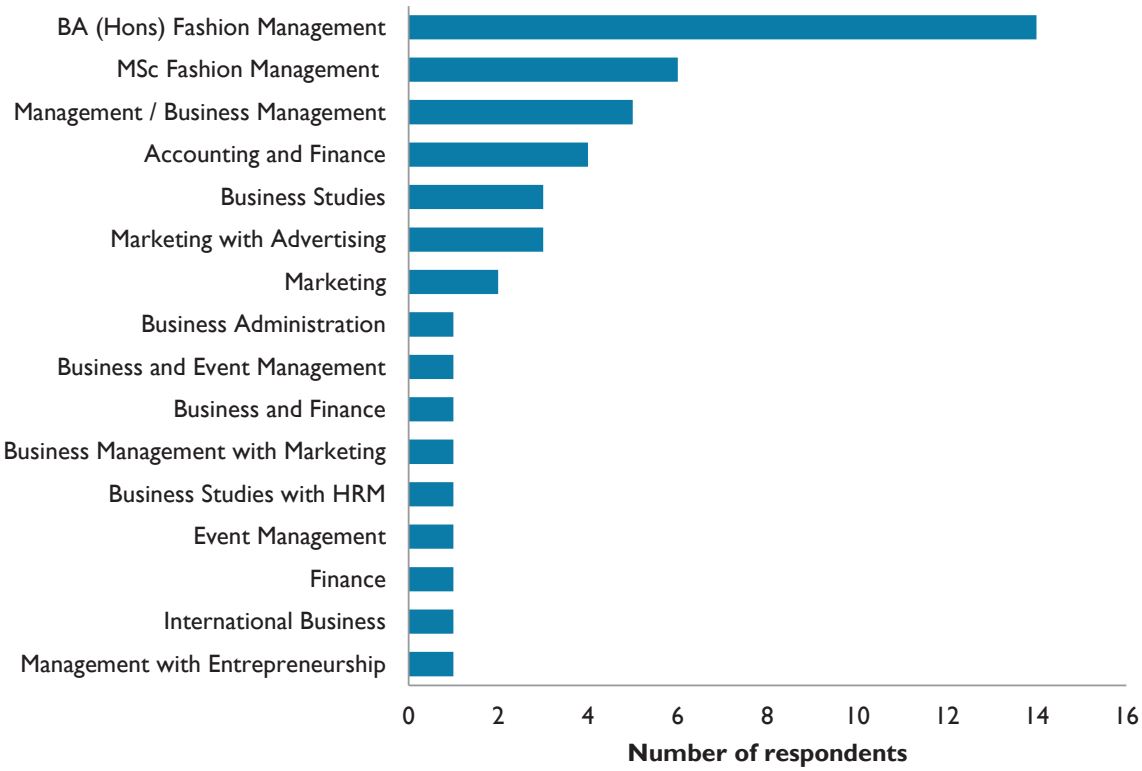

Figure 2: HEA STEM student survey: Please give the name of the degree programme you are studying (N=46 respondents)[3].

As already stated, the results from the student survey cannot be regarded as representative of the situation across the higher education sector as a whole. For example, it can be seen that 20 out of the 46 student respondents (43%) were studying for a BA (Hons) or MSc Fashion Management (MSc Fashion Management is a 4/5 year integrated Masters programme with entry qualifications at the same level as for an undergraduate programme).[4] Unlike the majority of programmes considered in the staff survey, quantitative methods teaching is embedded in these Fashion Management programmes at all levels, the stated entry requirements for which include GCSE Mathematics grade B.

4.1.3 HEA STEM Tackling Transition event

There were 23 delegates present at the HEA STEM Tackling Transition event, including 16 from UK higher education institutions (15 from England and one from Scotland), two from examination boards, one from a secondary school and four from the HEA. The event was held jointly by the Business and Management and Economics disciplines and no attempt has been made here to identify focus group comments as relating specifically to one discipline or the other, except where this is clear from the content or context.

Since it is not possible to quantify the number of people who agreed with views expressed at the Tackling Transition event, or to substantiate some of the claims made, views expressed at the event are only reported where they relate directly to other, more objective, data or to the literature.

3 In Figure 2 HRM denotes Human Resource Management.

4 Such programmes are known to be popular with female students (Which? University, 2014).

4.2 Entry requirements

Of the 131 English higher education institutions offering Business and Management courses, 77 explicitly specified some level of Mathematics as an entry requirement on the UCAS website for entry in 2013 (University and College Admissions Service, 2012). These minimum entry requirements are summarised in Figure 3. Most, but not all, of the institutions that do not explicitly specify a Mathematics entry requirement for a Business and Management programme have a general Mathematics entry requirement that is specified elsewhere (e.g. on the University's website).

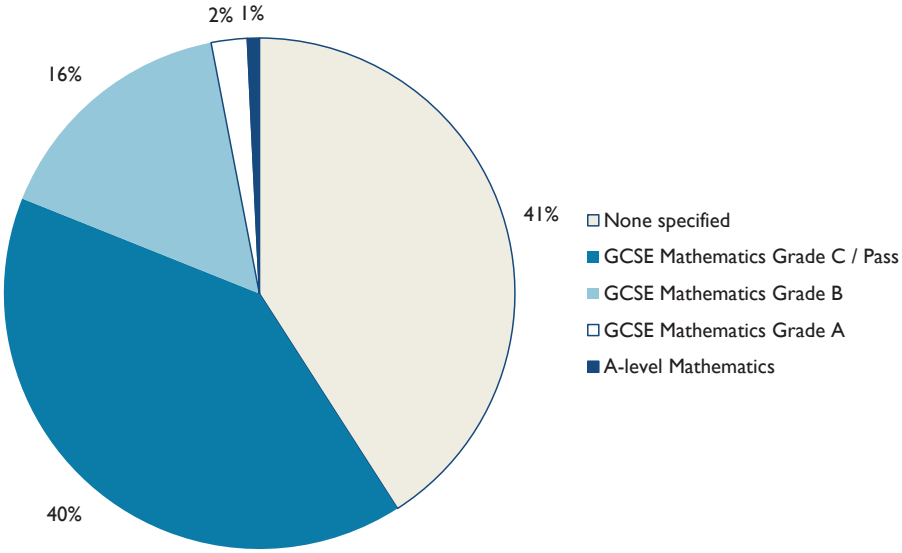

Figure 3: UCAS website: Mathematics entry requirements specified for entry onto Business and Management degree programmes by higher education institutions in England (N=131 institutions).

Some 72% (18 out of 25) of HEA STEM staff survey respondents said that their degree programme specifies a minimum entry requirement in Mathematics. These minimum entry requirements are summarised in Figure 4.

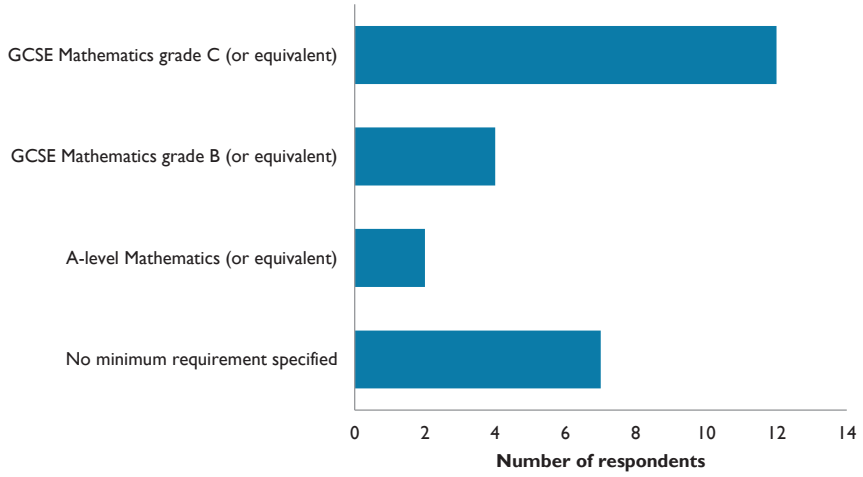

Figure 4: HEA STEM staff survey: Does your degree programme specify a minimum Mathematics entry requirement? If "Yes", please specify (N=25 respondents).

Further investigation of the 7 programmes for which respondents said that no minimum entry requirement is specified reveals that a minimum of GCSE Mathematics grade C (or equivalent) is specified at the institution level for 4 out of these 7 programmes, suggesting that the proportion of programmes with a minimum entry requirement in Mathematics is actually higher than stated.

The highest Mathematics qualification on entry among the respondents to the HEA STEM student survey is shown in Figure 5. When compared with the previous two graphs, it can be seen that many students are likely to exceed the minimum entry requirement for their institution. It is possible, however, that the self-selected sample of students may not have included those with lower qualifications.

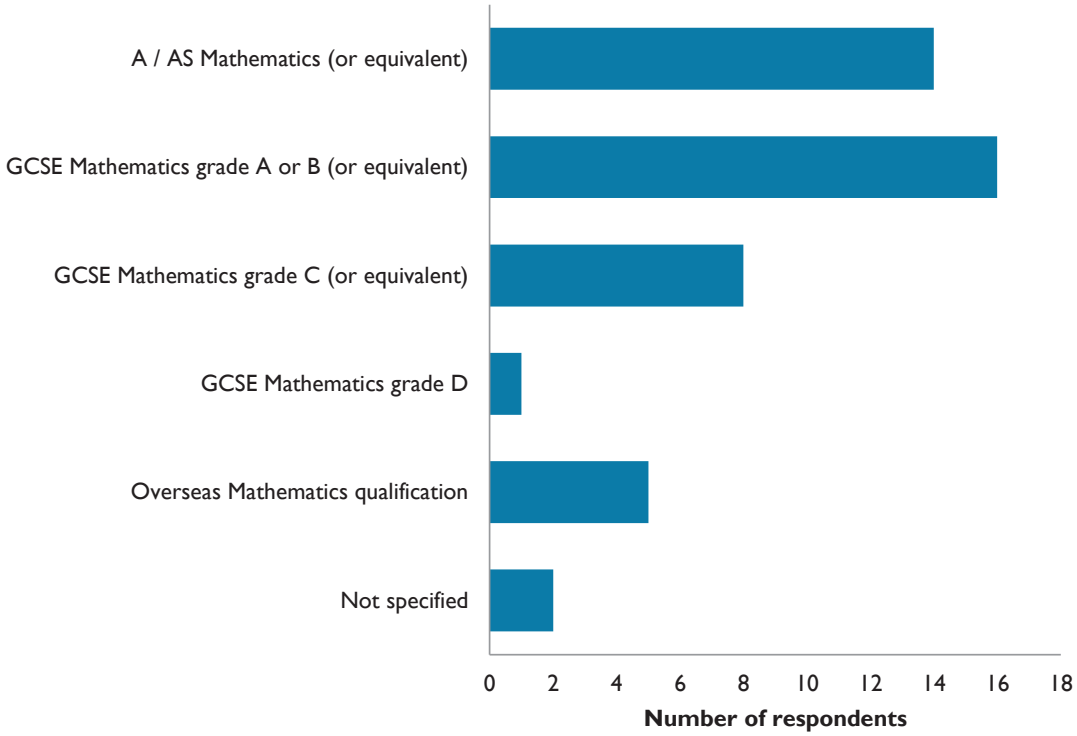

Figure 5: HEA STEM student survey: What is the highest Mathematics qualification you achieved before starting your current degree programme? (N=46 respondents).

4.3 Programme structure

No Business and Management programmes reported on in the HEA STEM staff survey were totally qualitatively based. This would appear to be consistent with the QAA subject benchmark statement for General Business and Management (Quality Assurance Agency for Higher Education, 2007), which specifies numeracy and quantitative skills in the list of cognitive and intellectual skills that Business and Management graduates should be able to demonstrate. However, only lecturers with current or recent experience of teaching quantitative methods on a Business and Management undergraduate degree programme were eligible to participate in the survey, which may have inadvertently excluded some totally qualitatively-based programmes from the survey. Figure 6 summarises the qualitative/quantitative balance adopted in the programmes considered.

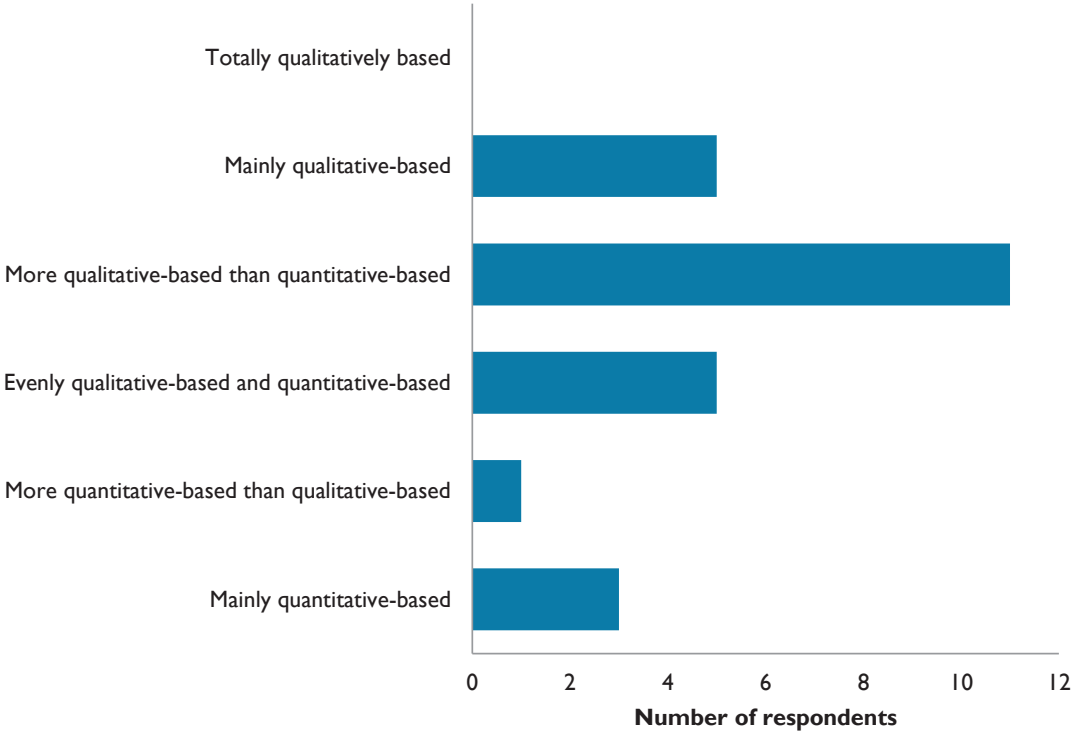

Figure 6: HEA STEM staff survey: Which of the following descriptions most closely describes the approach to Business/Management adopted in your degree programme? (N=25 respondents)

Some participants at the HEA STEM Tackling Transition event felt that degree programmes do not include enough Mathematics. Delegates also queried how the content of the current QAA subject benchmark statement should be interpreted and implemented with regards to quantitative methods in Business and Management degree programmes. There was a feeling that the statements referring to quantitative methods are rather vague.

All of the staff survey respondents (N=25) said that quantitative methods material is taught in the first year. As shown in Figure 7, quantitative methods teaching in the first year tends to take the form of compulsory modules with a substantive quantitative methods component, with less than a quarter of the HEA STEM staff survey respondents (6 out of 25, 24%) reporting that quantitative methods is embedded across their programmes in the first year. (Note that 2 respondents reported the existence of both compulsory and embedded modules in the first year.) The situation appears to change in the second year with less emphasis on compulsory modules and more on embedded modules, with some respondents (4 out of 25, 16%) saying that quantitative methods material is not taught in the second year. In later years there is even less of an emphasis on quantitative methods teaching with none of the staff survey respondents reporting compulsory modules at this level, and some respondents (8 out of 25, 32%) saying that quantitative methods material is not taught in later years. The majority of staff survey respondents (17 out of 25, 68%) said that quantitative methods content is embedded in modules across the programme in later years. As previously stated, the number of respondents (N=25) exceeds the number of programmes (N=22) and due to the number of respondents the staff survey may not be representative of the situation across the higher education sector as a whole.

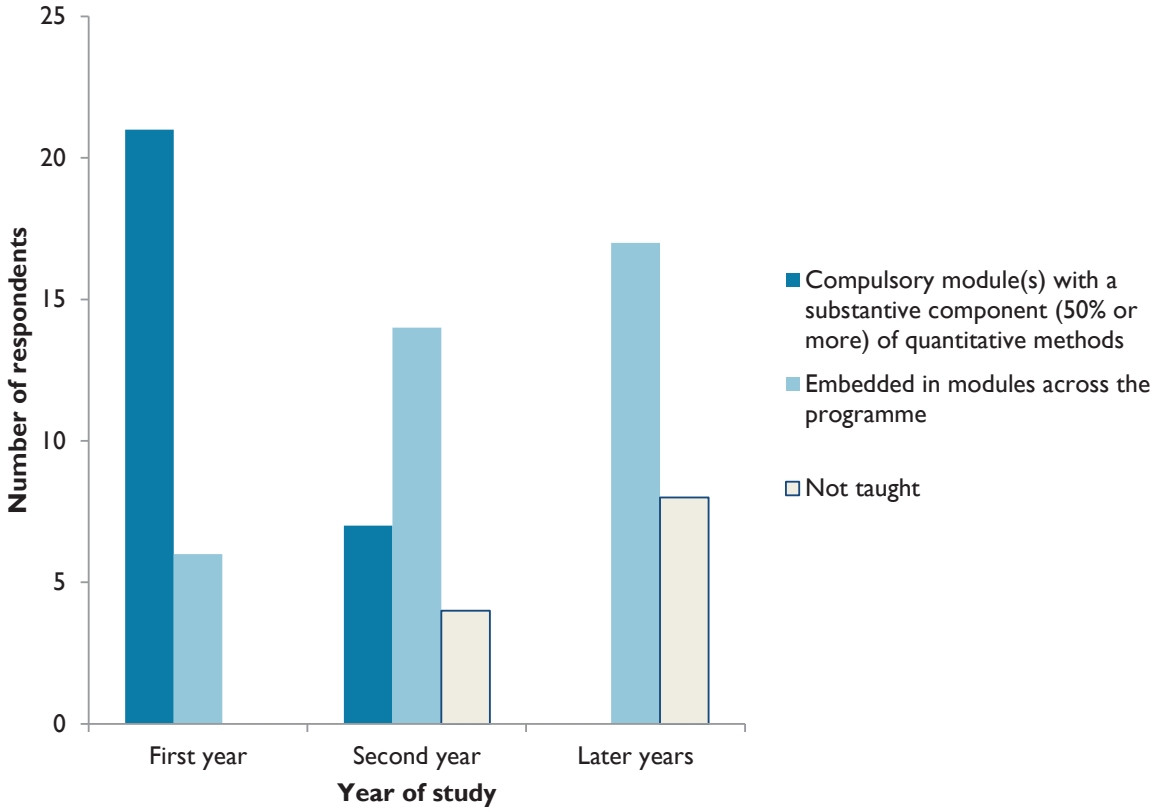

Figure 7: HEA STEM staff survey: When and where is quantitative methods content taught in your programme? Please tick all that apply. (N=25 respondents)

Figure 8 gives more information about the number of compulsory modules in programmes. Most staff survey respondents (15 out of 25, 60%) reported that there were just one or two compulsory modules with a substantive quantitative methods component on their programme, although some (6 out of 25, 24%) reported three, four or even six compulsory modules. One respondent said that there were 1.5 compulsory modules with a substantive quantitative methods component on their programme, but it is not known what the respondent meant by this. Three respondents (out of 25, 12%) did not answer this question, which suggests that there were no compulsory modules on their programmes with a substantive component of quantitative methods.

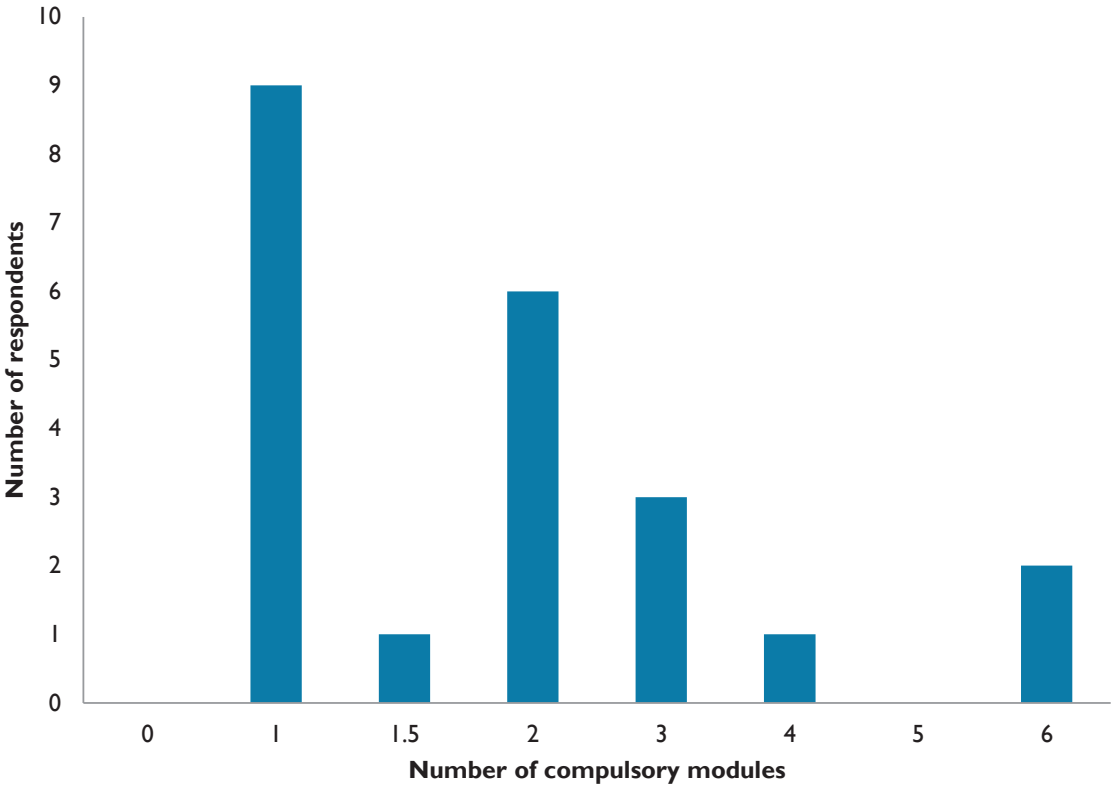

Figure 8: HEA STEM staff survey: How many compulsory modules with a substantive component (50% or more) of quantitative methods are there in your programme? (N=22 respondents)

The respondent who said that there were 1.5 compulsory modules with a substantive quantitative methods component on their programme did not state unambiguously at what level these modules are taught. Excluding this response and using additional survey data provided about the other 46 compulsory modules included in Figure 8, revealed that the majority (33 out of 46, 72%) of compulsory modules are taught in the first year and the remainder (13 out of 46, 28%) are taught in the second year.

Approximately a quarter (6 out of 25, 24%) of staff survey respondents said that students are divided into different streams for quantitative methods teaching. Of the six responses, just one referred to streaming on the basis of a diagnostic test result; one said it depends on the choice of degree programme; and the other four said that it depends on the students' Mathematics qualifications.

The HEA STEM staff survey did not ask whether additional time is allocated to the teaching or practising of quantitative methods over and above that allocated to other modules on the degree programme. MacInnes (2009) claims that quantitative methods is rarely allocated sufficient time in the timetable. It is not a subject one can easily teach oneself from a text book (Cox, 2007) and students need time to practise the subject (Foster, 2003).

4.4 Course content

In the HEA STEM staff survey, respondents were asked which topics are taught, practised and assessed on their programmes. In Figure 9, these topics are ranked according to the frequency with which they are taught (based on the responses received from all 25 respondents). Surprisingly, no topic was reported as being common to all degree programmes. Correlation and regression comes close, with no respondents giving a 'not-covered' response, although there were some respondents who did not know.

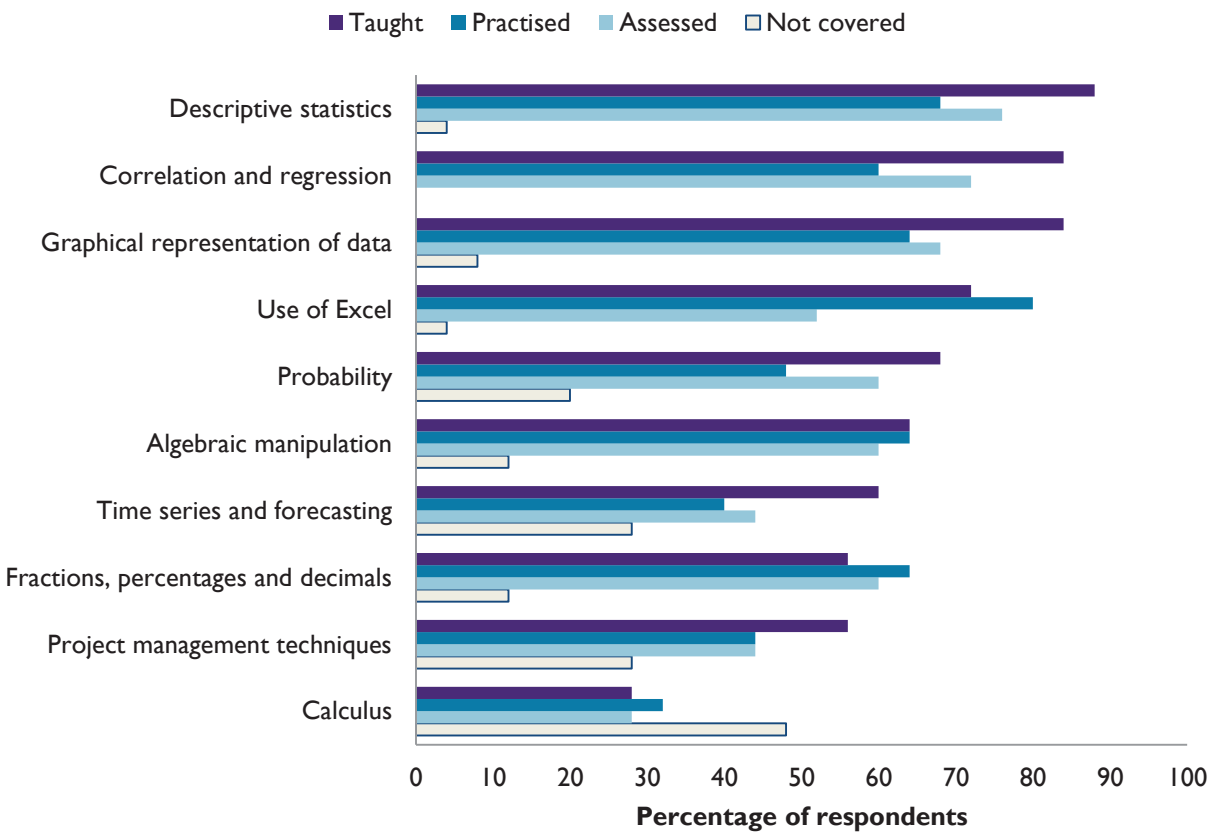

Figure 9: HEA STEM staff survey: Which of the following are taught, practised and assessed as part of your Business/Management programme? (N=25 respondents)

Delegates at the HEA STEM Tackling Transition event indicated that students need to have basic numeracy and algebra skills. Not only are these areas which many delegates said are fundamental to Business and Management but these are also areas in which new students are often thought to be particularly weak or lacking. It is surprising, therefore, to see algebraic manipulation and fractions, percentages and decimals relatively low down on the list of topics that are taught, practised and assessed. It is difficult to interpret this contradiction between what appears to be required and what seems to be happening. This could be taken as evidence that it is being assumed that students enter higher education adequately prepared in these areas or, more likely, it is possible that these topics are being implicitly, rather than explicitly, taught, practised and assessed.

The fact that calculus is at the bottom of the list, with 48% of respondents saying that it is not covered by their degree programme, suggests that mathematically inexperienced students should be able to find Business and Management programmes which do not require the study of this topic.

When content was discussed at the HEA STEM Tackling Transition event, there was some feeling that the GCSE Mathematics curriculum is dominated by Mathematics, rather than Statistics, whereas it was felt that Statistics, rather than Mathematics, is required for Business and Management programmes, in order for students to be comfortable and confident using data and undertaking analytical work in dissertations. Delegates at the Tackling Transition event also highlighted the importance of providing context when teaching quantitative methods.

Some delegates expressed the view that quantitative methods is different from many other subjects (particularly other subjects on a Business and Management degree), in that it needs to be practised. Even then the best students, who work hard, may not have real understanding. It was felt that there is a distinction between process (i.e. being able to "do" quantitative methods) and conceptual understanding (i.e. "getting" it).

Delegates at the Tackling Transition event recognised that all university programmes are different and have different course content. While it is normally possible to get some information about course content from university websites and prospectuses, this usually consists of a list of module titles and often, but not always, a paragraph outlining the content of each module, without going into detail of the actual techniques that are to be considered or of any pre-requisite knowledge expected for entry level modules. This lack of detailed published information makes it difficult for the pre-university sector to appreciate the requirements of different Business and Management degree programmes.

4.5 Teaching

In the HEA STEM staff survey it was found that the majority of the 46 compulsory modules with a substantial quantitative methods component (for which unambiguous information is available) are taught by a member of the department (38 out of 46, 83%), with 11% (5 out of 46) being taught by someone from another department and the remaining 7% (3 out of 46) being either taught by staff contracted especially to do this teaching or "Other" (not specified)[5].

Respondents to the HEA STEM staff survey identified a number of factors that are taken into consideration when decisions about the allocation of staff to teach quantitative components of modules are made, as shown in Figure 10. The respondent who said "Other" specified that this meant "Sharing the load". Responses to this question were obtained only for those 22 respondents who said that there was at least one compulsory module on their programmes with a substantive component of quantitative methods.

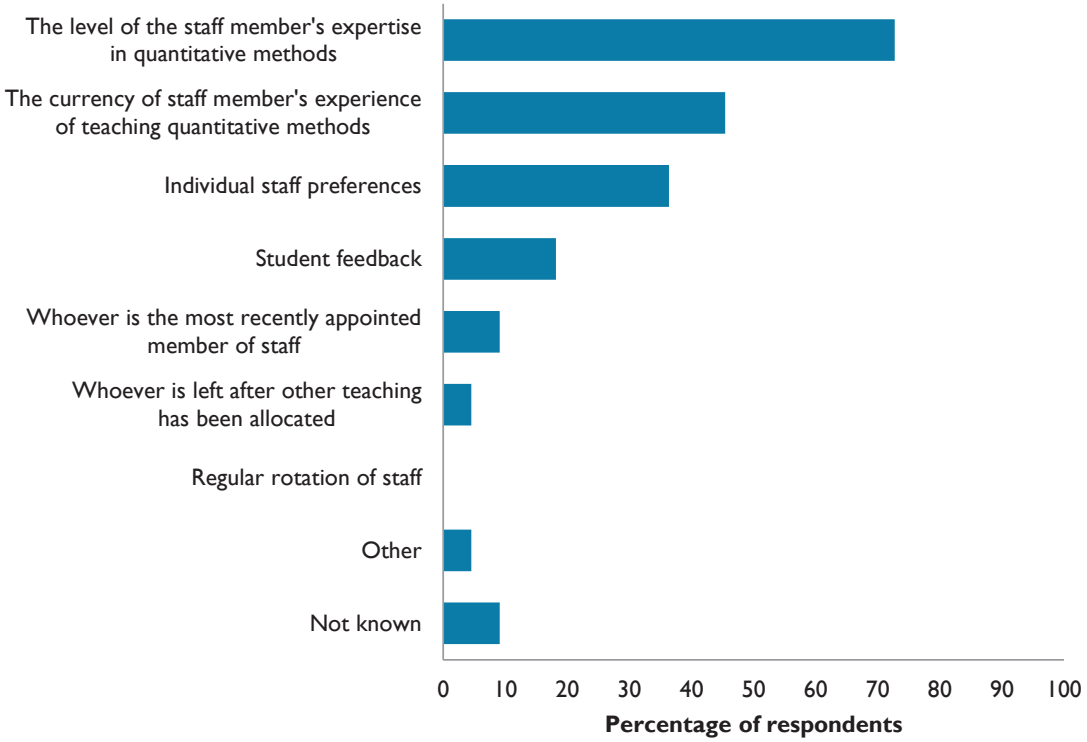

Figure 10: HEA STEM staff survey: When decisions are being made about allocating staff to teach quantitative methods components of modules what factors are taken into consideration? (N=22 respondents).

None of the 7 (out of 8) heads of department who responded to the question said that staff teaching quantitative methods undertake any training which is specifically tailored to the teaching of quantitative methods, although three did not know.

5 The percentages are subject to small rounding errors.

Two out of these seven heads said that postgraduate students assist with the teaching of quantitative methods, of whom one said that postgraduate students who teach quantitative methods receive specifically tailored training. This training takes the form of "PhD courses in quants methods". This is assumed to refer to training courses in quantitative methods undertaken as part of a PhD programme, rather than a PhD in quantitative methods.

Fifteen lecturers responded to the questions about training specifically aimed at teaching staff. All of them had current or recent (last five years) experience of teaching quantitative methods. Just four lecturers (27%) said that they had undertaken training specifically tailored to the teaching of quantitative methods. For three out of the four this training took the form of academic training (two had a PGCE and one had postgraduate qualifications in Statistics) and for the fourth lecturer this training took the form of short courses run by the university plus HEA STEM seminars.

The majority of lecturers who responded (13 out of 15, 87%) said that they felt "very confident" about their subject knowledge of the quantitative methods they have been teaching and none of the lecturers said that they felt "unsure" about their subject knowledge. By contrast, some delegates at the HEA STEM Tackling Transition event expressed the view that not all of their colleagues were happy to teach, or capable of teaching, quantitative methods.

At the Tackling Transition event some delegates felt that quantitative methods teaching is not valued very highly – possibly because it is seen as difficult by students.

4.6 Student and staff expectations

All 46 respondents to the HEA STEM student survey said that they had studied quantitative methods as part of their degree programme. Of these, 87% (40 out of 46) knew, before starting their programme, that there would be some quantitative methods and/or Mathematics/Statistics in the degree programme, and 70% (32 out of 46) expected to have to extend their knowledge of quantitative methods at part of their chosen degree programme.

The majority of respondents to the HEA STEM student survey (25 out of 46, 54%) said that the amount of quantitative methods in their degree programme was about what they expected, with 26% (12 out of 46) saying that it was more than they expected and 20% (9 out of 46) saying that it was less than they expected.

All but three students (43 out of 46, 93%) said that they understood why quantitative methods were included in their degree programme, although only 80% of respondents (37 out of 46) said that this had been explained to them since starting their degree programme. Most students (43 out of 46, 93%) appreciated the relevance of quantitative methods for other areas of their Business/Management degree.

Respondents to the HEA STEM student survey were asked how difficult they found quantitative methods. Just under a quarter of students (11 out of 46, 24%) said that they usually or always found quantitative methods difficult. The responses are summarised in Figure 11. It is possible, however, that the proportion of students who are less skilled or knowledgeable in quantitative methods in this self-selected sample of students may not be representative of the student body as a whole.

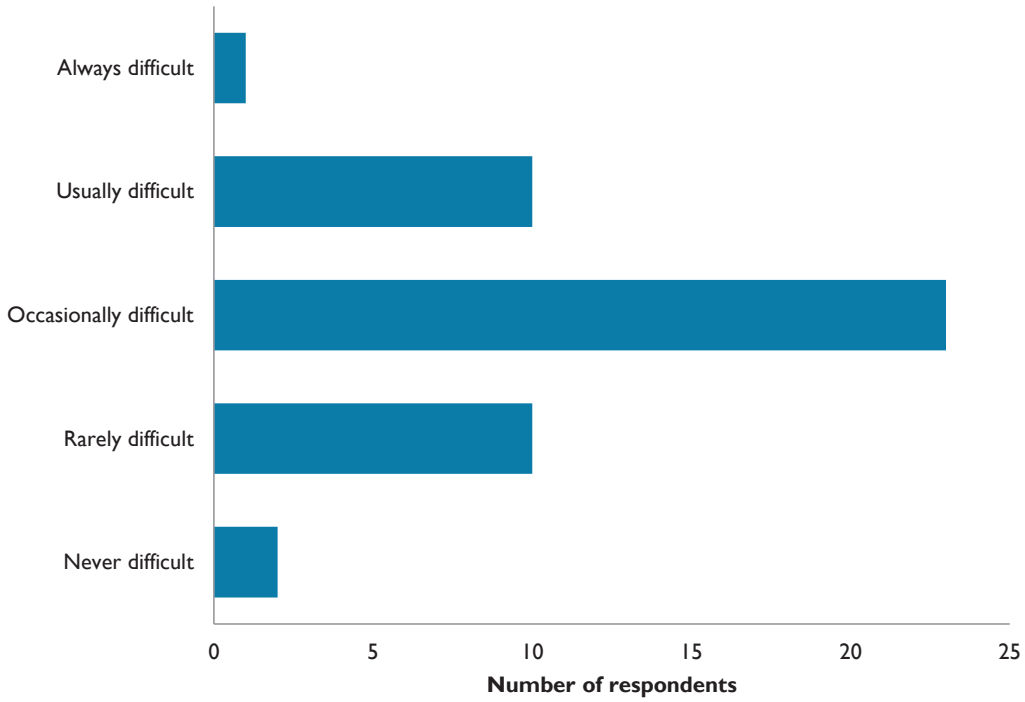

Figure 11: HEA STEM student survey: Which of the following most accurately describes how you find quantitative methods? (N=46 respondents)

Of the 46 students who took part in the HEA STEM student survey, just 13% (6 out of 46) said that they did not perform as well in assessments on quantitative methods as they did on other areas of their degree programme. Half of the respondents (23 out of 46, 50%) said that they performed about the same in assessments on quantitative methods as on other areas of their degree programme, and over a third (17 out of 46, 37%) said that they performed better. Again, it should be remembered that this is a self-selected sample.

In answer to a direct question, 20% of students (9 out of 46) said that they would describe themselves as someone who struggles with quantitative methods. This contrasts with the 24% of students (11 out of 46), identified in Figure 11, who said that they usually or always found quantitative methods difficult, suggesting that some students make a distinction between finding quantitative methods difficult and struggling with it. The explanations chosen by the nine students who struggle with quantitative methods as contributing to the reasons why they struggle are shown in Figure 12.

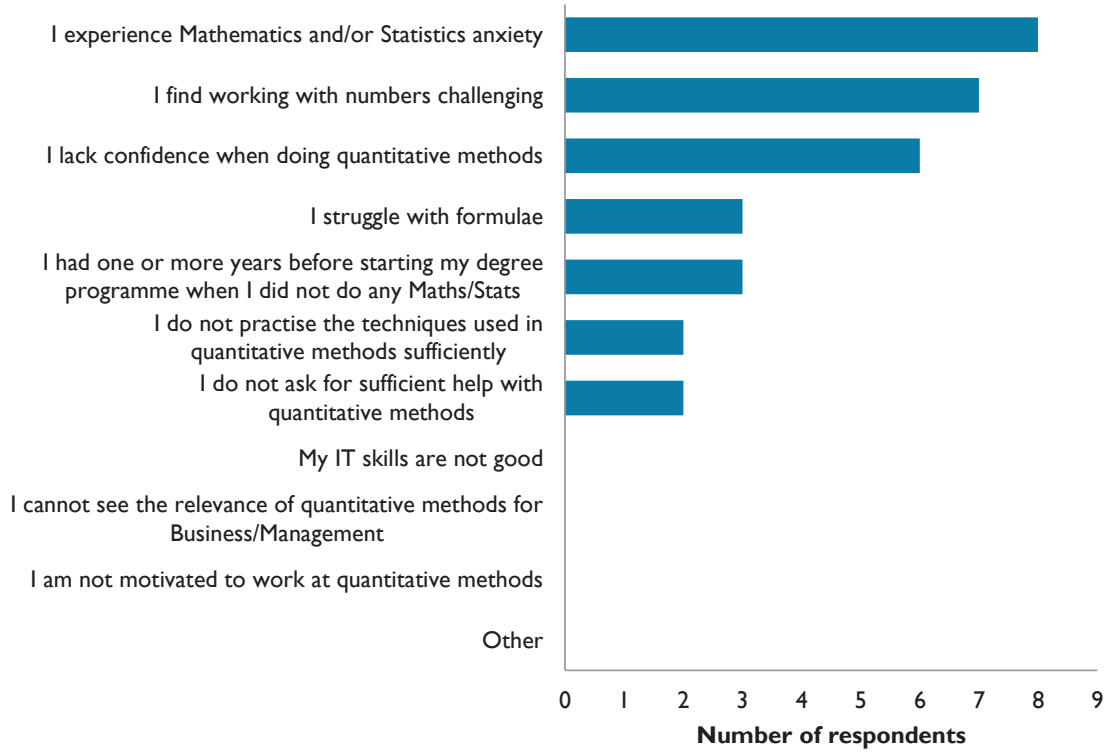

Figure 12: HEA STEM student survey: In your opinion, which of the following contribute to why you struggle with quantitative methods? Please tick all that apply. (N=9 respondents who said they would describe themselves as someone who struggles with quantitative methods)

In the HEA STEM staff survey, respondents were asked which factors inhibit the development of students who struggle with quantitative methods. The responses are shown in Figure 13. The two staff survey respondents who chose "Other" specified: "Previous study being of the learn-an-exam-and-forget variety" and "See it as acceptable not to struggle [persevere?] with the material".

There are some interesting mismatches between the staff and student responses, which may correspond to real differences in staff and student perceptions, or which may simply reflect differences in the membership of the self-selected samples. For example, none of the student respondents who said they struggle with quantitative methods said that they cannot see the relevance of quantitative methods for Business/Management, whereas 64% of the staff respondents (16 out of 25) said that students who struggle with quantitative methods cannot see the relevance. Similarly, none of the student respondents said that they were not motivated to work at quantitative methods or that their IT skills were not good, whereas 48% of the staff respondents (12 out of 25) selected a lack of student motivation as a factor, and 28% (7 out of 25) selected a lack of IT skills.

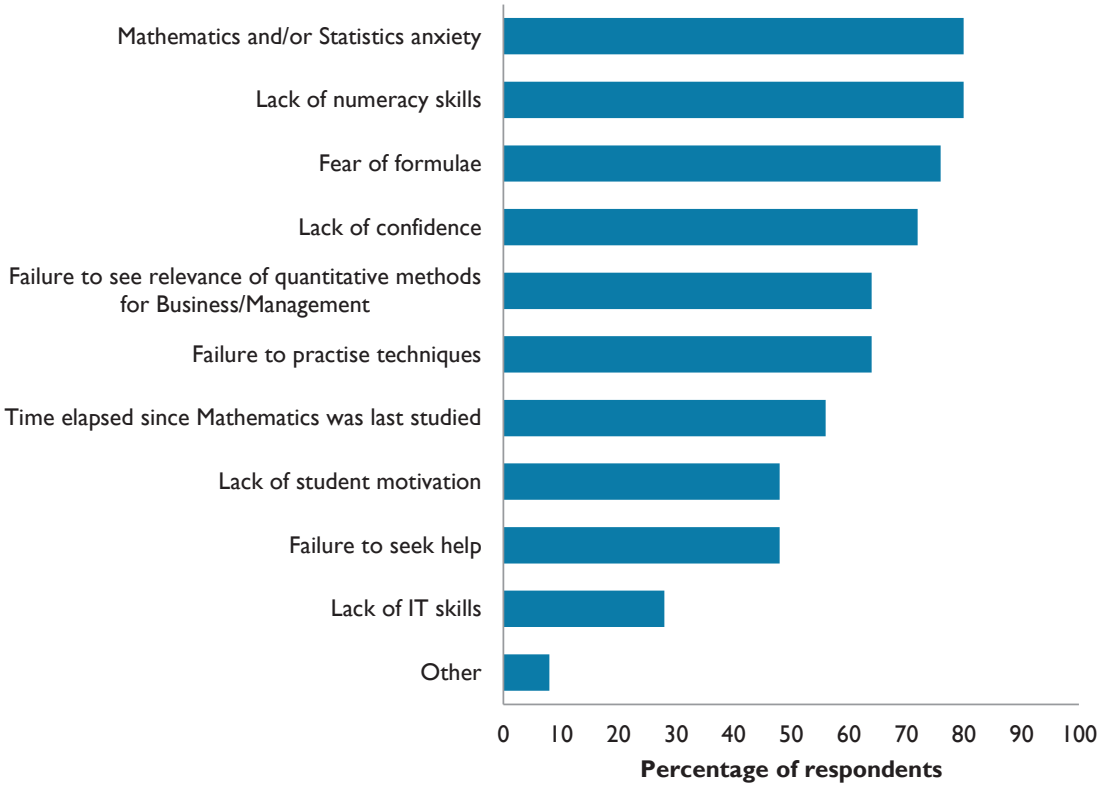

Figure 13: HEA STEM staff survey: For students who struggle with quantitative methods, which factors typically inhibit their development in this area? Please tick all that apply. (N=25 respondents)

In the HEA STEM staff survey, respondents were also asked to identify the extent to which they agreed or disagreed with a number of statements. The responses are shown in Figure 14.

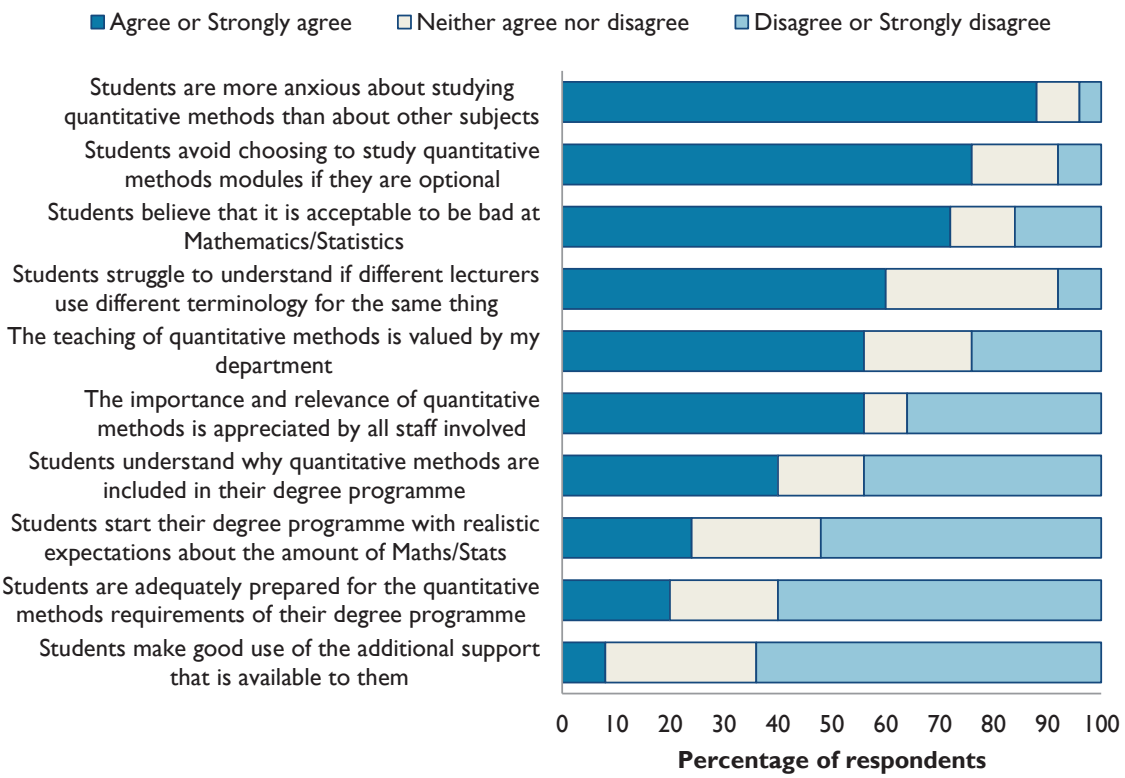

Figure 14: HEA STEM staff survey: For the following questions please select the extent to which you agree or disagree with the statement. (N=25 respondents)

Delegates at the HEA STEM Tackling Transition event felt that, as most universities "only" require GCSE Mathematics grade C, some higher education lecturers have very low expectations of new students with regards to their numerical knowledge and skills. There was some feeling among delegates that GCSE Mathematics is not very demanding, particularly at the lower tier, and that some students with GCSE Mathematics grade C lack fundamental skills such as working with percentages and basic algebraic manipulation. Furthermore, it was felt by some delegates that many higher education lecturers have no real understanding of what GCSE Mathematics grade C actually means in terms of syllabus or attainment. This is a view supported by Lawson *et al.* (2003), who suggest that there is a lack of understanding in universities of the true meaning of any particular grade at both GCSE and A-level Mathematics.

Some delegates reported that UK students who did not study Mathematics beyond GCSE level had forgotten much of the Mathematics they learnt at school by the time they started university, and that, having forgotten what they knew, they then lost confidence. Delegates noted that it would not necessarily help though if students were required to study Mathematics beyond GCSE level as they would cover a lot of material that is not needed for a Business and Management degree. Some delegates at the HEA STEM Tackling Transition event were of the opinion that it is necessary to teach most quantitative topics from the beginning, as it could not be assumed that all topics had been covered at, or remembered from, school.

Delegates at the Tackling Transition event generally felt that students were "turned off" Mathematics at school and that students' expectations were not realistic as they expected to come to university and not do any Mathematics, although the student survey results indicate that this is not the case. There was some concern among delegates that many new students are unprepared for the transition to university.

Lawson *et al.* (2003) highlight a mismatch between the confidence, skills and knowledge of many students upon entry, and the expectations of those teaching in universities, and suggest that this mismatch may arise as a result of inadequate preparation in schools and colleges – itself due to a variety of causes including curriculum shortcomings, emphasis on assessment and league tables, shortage of mathematically qualified teachers, and social influences. Croft (2001) and Sutherland and Dewhurst (1999) are also of the opinion that students often lack confidence and arrive at university with a dislike or fear of Mathematics and their university experience may reinforce their prejudice. Often students have preconceived ideas about how difficult quantitative methods content is (Metje, 2007). This, coupled with any bad experiences they may have from school (MacInnes, 2009), led to many thinking or hoping at the age of 16 that they would never have to do any Mathematics again.

The delegates at the HEA STEM Tackling Transition event agreed that they were concerned as to whether graduates will have met the level required for future study or employment and discussed the challenges of a continuing agenda of widening access which, some delegates felt, puts pressure on staff to reduce the mathematical content in order to get students through. Lawson *et al.* (2003) suggest that widening of access to higher education with the acceptance of students with much more diverse backgrounds and experiences of Mathematics than previously may also explain the mismatch between the confidence, skills and knowledge of many students upon entry, and the expectations of those teaching in universities. Even within the relatively small sample of students who took part in the HEA STEM student survey there was considerable diversity in entry qualifications. Croft (2001) and Sutherland and Dewhurst (1999) argue that effective teaching is very difficult to achieve when there is diversity among the student population.

4.7 Diagnostic testing

With widening participation and expansion of the higher education sector, students enter universities with diverse educational backgrounds and they often do not have the mathematical knowledge previously expected by universities. Faced with this diversity, together with a recommendation from the UK Engineering Council, many universities have introduced diagnostic testing (Hawkes and Savage, 2000). Lawson *et al.* (2003), set out reasons for diagnostic testing of new students upon entry to university. More recently Gillard *et al.* (2010) investigated current practice of universities using diagnostic tests.

Common reasons for using diagnostic testing identified in the studies by Lawson *et al.* (2003) and Gillard *et al.* (2010) were to:

- gather information on the cohort of students;
- identify students who needed extra support or are at risk;
- identify students' strengths and weakness;
- identify areas that need to be revised in teaching;
- prepare support material for students who need it.

Just five respondents (out of 25, 20%) to the HEA STEM staff survey reported that any form of diagnostic testing was used at the start of the programme to determine the level of students' mathematical/statistical knowledge and/or skills. Four out of these five respondents (80%) said that they made use of an online test – the other respondent did not know. Where implemented, diagnostic testing is used to inform students' self-awareness of their knowledge and skills (4 of 5, 80%); to gauge the skills level of the cohort (3 of 5, 60%); to enable tutors to direct individual students to appropriate support (2 of 5, 40%); to determine the starting point of the quantitative methods coverage (1 of 5, 20%); and/or to stream students according to their knowledge and/or skills (1 of 5, 20%).

In contrast, just over half (24 out of 46, 52%) of the respondents to the HEA STEM student survey said that some form of testing was used at the start of their degree programme to determine the level of their mathematical/statistical knowledge and/or skills. For almost all of these students (21 out of 24, 88%), this testing took the form of a written test. An online test was administered to just three of these 24 students, and one of the students had to undertake an introductory assignment. Respondents to the survey could choose more than one option, to allow for the possibility that more than one form of testing was used, but just one student selected more than one form of testing.

At the HEA STEM Tackling Transition event there was some discussion of the use of diagnostic testing/screening. Most of the delegates at the event were from higher education institutions that use some form of screening or diagnostic testing. Seeing it as their job to support students at the level they come in, delegates at the Tackling Transition event said that diagnostic testing was helpful in identifying students' knowledge gaps and appropriate interventions to minimise this gap. This corresponds to the HEA STEM staff survey findings, where respondents from the five institutions where diagnostic testing is used said it is used primarily to inform students' self-awareness of their knowledge and skills and to gauge the skills level of the cohort.

4.8 Additional support

Mathematics support in universities has grown substantially over the past 20 years, and is now becoming the norm across the UK (Mac an Bhaird and Lawson, 2012). In a survey of higher education institutions, Perkin *et al.* (2012) found that over 85% of UK higher education institutions (of the 103 that responded) offered some form of Mathematics support provision. A detailed review of the literature relating to the evaluation of Mathematics support in UK universities is contained in Matthews *et al.* (2012).

Almost all respondents (22 out of 25, 88%) to the HEA STEM staff survey said that additional support is offered to students needing assistance with their mathematical and/or statistical knowledge and/or skills. Figure 15 shows the different forms that this additional support takes (based on the responses of the 22 members of staff who said that additional support is offered to students). In many cases (17 out of 22, 77%) staff said that more than one form of support is offered.

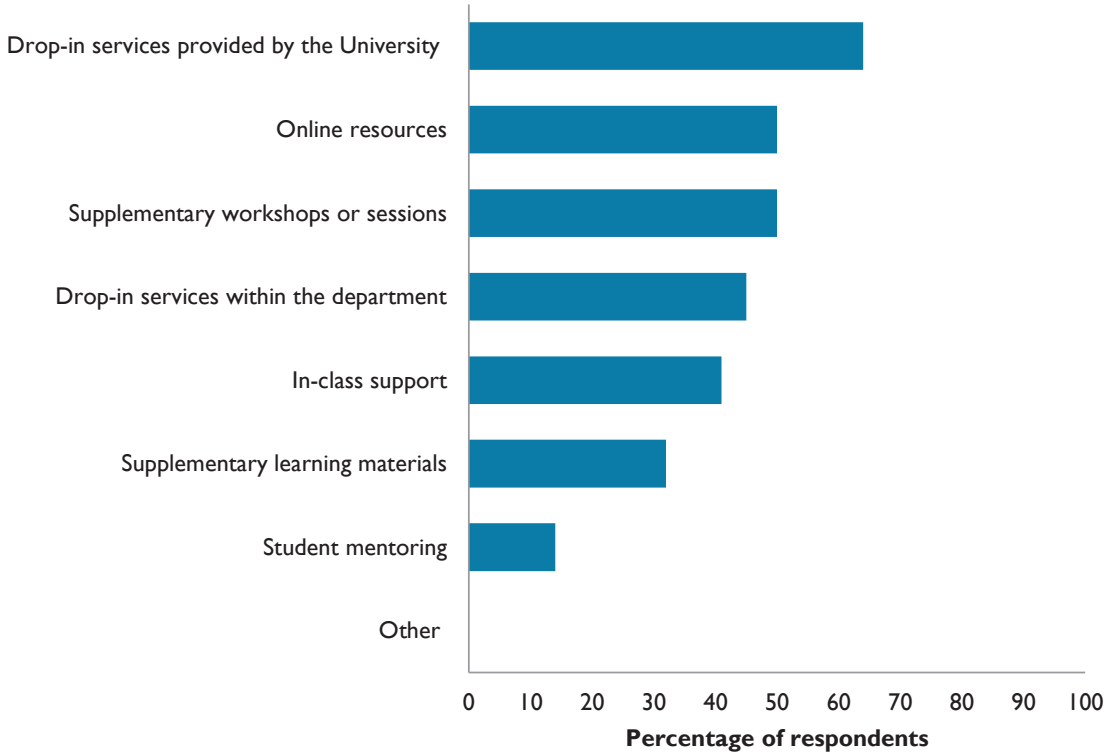

Figure 15: HEA STEM staff survey: What forms of additional support are made available to students needing extra assistance with their mathematical and/or statistical knowledge and/or skills? Please tick all that apply. (N=22 respondents who said that additional support is offered to students)

Support is usually available in all years of the course (16 out of 22, 73%), but 18% of respondents (4 out of 22) said that support is only available in the first year. Two respondents (out of 22, 9%) referred to a mix of support types, some of which are available in all years and others of which are only available in the first year or within modules.

A total of 48% of respondents (22 out of 46) to the HEA STEM student survey said that additional support is offered to students needing assistance with their mathematical and/or statistical knowledge and/or skills, but 39% (18 out of 46) said they did not know. 13% (6 out of 46) said that no additional support is offered to students. Figure 16 shows the forms that this additional support takes (based on the responses of the 22 students who said that additional support is offered). Although relatively few institutions and/or programmes are represented in the self-selected student sample, students on the same programme at the same institution differed in their awareness of the availability of additional support and/or in their knowledge of the different forms that this support takes.

Almost all students (20 out of 22, 91%) who said that additional support is available stated that this additional support is available in all years of the course, with the remaining 9% (2 out of 22) saying that it is only available in the first year.

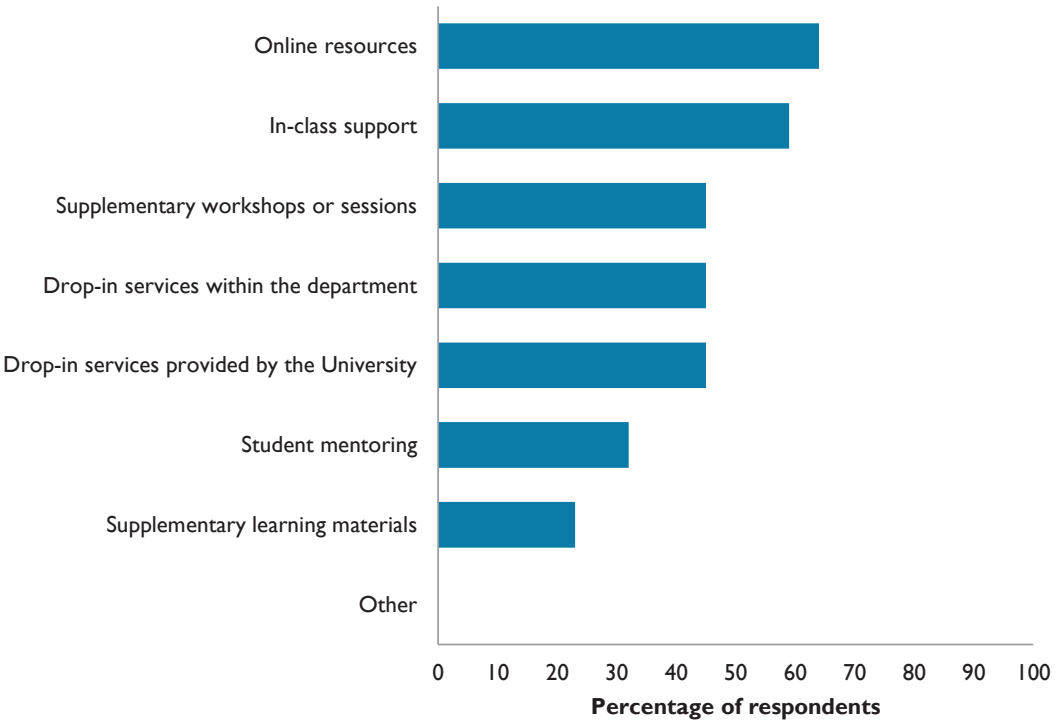

Figure 16: HEA STEM student survey: What forms of additional support are made available to students needing extra assistance with their mathematical and/or statistical knowledge and/or skills? Please tick all that apply. (N=22 respondents who said that additional support is offered to students)

Discrepancies between the HEA STEM student survey values (Figure 16) and the staff survey values (Figure 15) may reflect the ways in which students encounter or engage with the support available, or may be due to the different institutions represented by the staff and student survey samples.

Just under half of respondents to the student survey who said that additional support is available had made use of the additional support that was available to them (9 out of 22, 41%) and these nine students all said that this additional support was helpful.

It was suggested at the HEA STEM Tackling Transition event that it is necessary for higher education institutions to offer remedial support in Mathematics at a basic level in order to support students. Although delegates at the Tackling Transition event reported that diagnostic testing/screening is often used to identify students who would benefit from additional workshops, there was a feeling among delegates that students often fail to take advantage of these. Similarly there was some feeling among delegates that students failed to take advantage of other sources of face-to-face support, such as drop-in centres. One higher education lecturer, involved in providing drop-in numeracy support, was of the opinion that the students most likely to make use of these services are rarely those who are most in need of help and support.

Pell and Croft (2008) claim that there is anecdotal evidence that some of the students most in need of support fail to access it at all, and that many of the students who make good use of the support available are those who would pass the mathematical components of their course anyway. Providing support through a dedicated support centre usually requires students to be proactive and to take the initiative in accessing the support that is available. If students are unaware of their weaknesses or lack the motivation or confidence to seek support, then that support will be unused. Symonds *et al.* (2008) conclude that for many students the reasons for not accessing the support are complex. Croft (2001) observes that students arrive at university with a wide range of problems and prior experience and while Mathematics support is a very effective part of the solution to the "Mathematics problem", it will not solve all problems for all students (Mac an Bhaird and Lawson, 2012).

5 Conclusions

The main area of concern of the work described in this report is the transition from pre-university education to undergraduate Business and Management degree programmes at university, with particular reference to the experiences of first year undergraduate students within the UK. This potentially affects tens of thousands of students and almost all higher education institutions, as Business and Management programmes are very popular among school and college leavers and are offered by most institutions. However, there is relatively little published research that relates specifically to Business and Management – the work described in this report is one of the first UK studies designed to identify issues that relate specifically to the Business and Management discipline.

The key findings and conclusions from the HEA STEM staff survey, the HEA STEM student survey and the HEA STEM Tackling Transition event are summarised below. Although the main coalition groups were represented, it should be remembered that, despite efforts to increase the number of responses, response rates were low and relatively few institutions were represented in the staff and student surveys and at the Tackling Transition event. The reasons for the lack of engagement are unclear but may be due, in part, to the timing of the surveys.

5.1 Summary

5.1.1 Entry requirements

GCSE Mathematics grade C, or equivalent, is the most common entry requirement specified for Business and Management degree programmes, although some institutions specify GCSE Mathematics grade B or A or, very rarely, A-level Mathematics (or equivalent). The specified entry requirement is only a minimum which means that, in practice, there may be considerable diversity with students on the same programme having studied different amounts of Mathematics and Statistics across a range of Mathematics qualifications prior to starting university.

At the HEA STEM Tackling Transition event there was some feeling that GCSE Mathematics grade C it is not really sufficient but, in order to attract sufficient numbers of students, it is not possible to ask for more. There is a tendency to teach each topic from the beginning anyway as staff cannot assume every student has been taught a particular topic, or that students will remember it.

5.1.2 Programme structure

All Business and Management programmes covered in the staff and student surveys included some element of quantitative methods, in accordance with QAA subject benchmark statement requirements (Quality Assurance Agency for Higher Education, 2007), but degree programmes vary widely in content. While this should make it possible for applicants to find a programme that suits their abilities and preferences, in practice it is difficult for schools, colleges and students to determine the skills requirements of individual Business and Management degree programmes.

All of the degree programmes described in the staff survey included quantitative methods teaching in the first year, usually in the form of compulsory modules. In later years there is less of an emphasis on quantitative methods teaching, with fewer or no compulsory standalone modules and more embedded teaching.

5.1.3 Teaching

The HEA STEM staff survey found that the allocation of staff for the teaching of quantitative methods generally takes into account staff expertise, experience and preferences. Most quantitative methods teaching is undertaken by staff from within the department, and most staff feel "very confident" about their subject knowledge. There is relatively little training offered that is directly relevant to the teaching of quantitative methods but, given the high level of confidence in their subject knowledge expressed by the staff carrying out the teaching, it is not clear whether this is an issue or not. The HEA STEM staff survey did not look beyond staff confidence in their subject knowledge to determine whether staff might, despite their confidence, benefit from training in teaching students without a strong mathematical background or in developing case studies to illustrate the use of quantitative methods in context, to give just two examples. Future work might explore staff confidence, expertise and experiences in teaching quantitative methods in more depth.

5.1.4 Course content

The HEA STEM staff survey did not identify any mathematical/statistical topics common to all Business and Management degree programmes. This further highlights the diversity in provision. Although students are thought to lack knowledge and skills in basic numeracy (including fractions, percentages and decimals) and algebra, these topics are not explicitly taught, practised or assessed in all degree programmes, although such general topics are likely to be embedded in other modules. At the other extreme, fewer than half of Business and Management degree programmes include calculus. This suggests that mathematically weak students should be able to undertake Business and Management programmes without needing to study this topic.

5.1.5. Diagnostic testing

The HEA STEM survey results indicate that diagnostic testing is used in some institutions, but the small number of institutions represented in the survey responses means that it is not possible to determine how widespread the use of diagnostic testing is. About half the students surveyed had undergone some form of diagnostic testing, mostly in the form of a written test. Where used, diagnostic testing seems to be used more to inform staff and students of the students' knowledge and skills than to ensure teaching is at an appropriate level or to direct students towards appropriate help and support.

Some institutions stream students for quantitative methods teaching but streaming is not widespread and, where used, is more likely to be based on mathematical qualifications upon entry rather than diagnostic test results.

5.1.6 Additional support

The HEA STEM staff survey found that additional support is widely provided, most commonly in the form of drop-in support at university level, online resources and/or supplementary workshops. At the Tackling Transition event some delegates expressed concerns about the poor take-up of these services by the students who would benefit most from them. The HEA STEM student survey found that many students did not know if additional support was available to them. Of those that did know that additional support was available, less than half had made use of it but all who had made use of the additional support had found it helpful.

5.1.7 Student and staff expectations

The HEA STEM staff survey found that some staff feel that students do not always see the relevance of quantitative methods for studying Business and Management. Many delegates at the Tackling Transition event believed that there is a need to contextualise quantitative methods teaching, in order to make it relevant for Business and Management. Most students surveyed knew, before they started their degree, that there would be some quantitative methods in their programme and they expected to have to extend their knowledge of quantitative methods. Most students seemed to understand why quantitative methods was included in their Business and Management programme and had reasonable expectations about the amount of quantitative methods study involved. Not all students had, however, had the relevance of quantitative methods explained to them, or could see the relevance of quantitative methods for other areas of their degree programme.

There was some overlap in the views of staff and students who responded to the HEA STEM surveys when they were asked to specify the main reasons that students struggle with quantitative methods. Staff indicated that they believed that the main reasons that students struggle with quantitative methods are: Mathematics/Statistics anxiety, lack of numeracy skills, fear of formulae and lack of confidence. Some staff were of the opinion that students are more anxious about studying quantitative methods than any other subject, avoid studying quantitative methods if it is optional and believe that it is acceptable to be bad at Mathematics/Statistics.

Those students who said that they struggle with quantitative methods identified a number of reasons, the most common of which were: Mathematics/Statistics anxiety, finding working with numbers challenging, and lacking confidence when doing quantitative methods. In contrast to the views expressed by some staff, none of the students surveyed said that they struggled with quantitative methods because they could not see the relevance of quantitative methods for Business and Management or because they are not motivated to work at quantitative methods.

Relatively few students in the HEA STEM student survey felt that their performance on quantitative methods assessments was worse than in other areas of their degree programme. The evidence is not strong, however, as only eight institutions were represented in the survey responses, and teaching of quantitative methods may be embedded in modules across the programme after the first year.

5.2 Concluding remarks

This study was designed to obtain information to help identify the key issues affecting the transition from the pre-university sector to the higher education sector with regard to the requirements for mathematical and statistical skills within university degree programmes in Business and Management. This is believed to be the first such study of its kind undertaken in the Business and Management discipline. It is hoped that the findings and recommendations presented in this report will encourage positive change and inform constructive dialogue between the higher education sector, the pre-university sector and interested sector bodies as well as providing a starting point for further work in this area.

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