Skills in Mathematics and Statistics in Psychology and tackling transition

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Foreword

This report is one of a series of reports 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 Psychology.

At the start of the study 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 Psychology consisted of (i) a literature review; (ii) survey work; (iii) a discussion event; and (iv) informal discussion with Psychology undergraduate programme accreditors.

The mathematical and statistical requirements of a Psychology degree can be, on occasion, quite demanding. However, the actual mathematical entrance qualifications for Psychology degrees can be comparatively low. This disparity provides particular challenges in Psychology which have been recognised increasingly over time. This is partly as a result of substantial research in the area, indicating the importance that this issue is given within the Psychology community. The present study aims to review this literature and to add to it a sound evidence base regarding current practices to inform future discussion, policy developments and teaching practice in the discipline.

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I Summarised findings and recommendations

1.1 Introduction

Psychology is defined by the British Psychological Society as ‘the science of mind and behaviour’, and the discipline can be classified both as a social science and as a science. Psychology has been classified by the Advisory Committee on Mathematics Education (2011) as a social science in which students will experience “significant Mathematics” – the quantitative methods content in a Psychology degree typically includes a very substantial Statistics component.

The British Psychological Society accredits the majority of Psychology degree programmes in the UK. The inclusion of quantitative methods and Statistics in degree programmes are important criteria for accreditation, and Psychology departments value this component of the Psychology degree highly. Many Psychology departments divert considerable resources into supporting quantitative methods teaching, and also offer a variety of supporting activities to help students who are struggling. However, the “Mathematics problem”, which has been identified in several disciplines, also occurs in Psychology: many incoming students do not have the required skills and confidence in Mathematics to prepare them for the quantitative methods aspects in their Psychology degree. In this work, information specific to Psychology has been sought to provide evidence about mathematical and statistical skills, and barriers to the acquisition of such skills, at the transition to higher education and during degree programmes.

The Higher Education Academy (HEA) Science, Technology, Engineering and Mathematics (STEM) project was undertaken to provide an evidence base on Mathematics/Statistics-related issues encountered by students at the transition from pre-university to undergraduate degree programmes in a range of discipline areas. This report presents findings of this work in the Psychology discipline.

A literature review was undertaken at the start of the study, and three surveys were developed to follow on from this. One survey was aimed at staff teaching within Psychology and a second survey was directed at heads of department or those with responsibilities for organising teaching in Psychology (taken together these form the HEA STEM staff survey). The third survey was for students taking degree programmes within Psychology. 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 the full spectrum of disciplines involved in the project. The surveys were in circulation 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 Psychology event provided an opportunity for staff working in Psychology 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 during the work.
1.2 Findings and recommendations

1.2.1 Notable findings

1 Quantitative methods are an integral part of the Psychology degree, with over 85% of respondents included in the HEA STEM staff survey saying that compulsory quantitative modules are included in year one. The HEA STEM staff survey did not identify any Psychology programmes that were totally qualitative.

2 In the HEA STEM staff survey most staff were of the opinion that the teaching of quantitative methods was valued by their department. Although over 90% of staff said they were confident about their subject knowledge of quantitative methods, fewer than 20% had undertaken specifically tailored training on the teaching of quantitative methods.

3 Over 85% of students in the HEA STEM student survey came to university knowing that there would be quantitative methods in their degree programmes. However, respondents to the HEA STEM staff survey, delegates at the HEA STEM Tackling Transition event and evidence from the literature review suggest that students do not have realistic expectations about the amount of quantitative methods content involved in a Psychology degree.

4 The Quality Assurance Agency (QAA) subject benchmark statement in Psychology identifies quantitative methods as a core knowledge area within Psychology and gives information about generic quantitative skills that undergraduates should acquire in a Psychology degree programme. However, details of actual statistical techniques are not included.

5 The British Psychological Society accredits undergraduate degree programmes in Psychology with standards that imply a sophisticated level of applied and theoretical understanding of quantitative methods. It was found that the statistical topics that are taught in undergraduate degree programmes in Psychology are broadly consistent between institutions and undergraduate psychologists generally receive a thorough grounding in statistical methods.

6 The HEA STEM staff survey showed that most Psychology undergraduate programmes have a Mathematics-related entrance requirement, most commonly at GCSE grade C or equivalent. Quantitative methods are included in syllabuses for A-level and equivalent qualifications in Psychology, as well as in Mathematics syllabuses (although not all students studying Psychology at undergraduate level have studied an A-level or equivalent qualification in the subject).

7 Diagnostic testing of students’ mathematical/statistical skills at the start of Psychology degree programmes is not widely used. Less than 10% of students surveyed in the HEA STEM student survey had been tested.

8 More than a third of students responding to the HEA STEM student survey said that they struggled with quantitative methods in their degree programme. For students who struggle with quantitative methods both the HEA STEM staff and student surveys identified Mathematics/Statistics anxiety and lack of confidence as key factors that inhibit students’ development in this area. Over half of the students also identified that the time elapsed since they had studied Mathematics contributed to their struggle with quantitative methods.
9 Over 75% of staff responding to the HEA STEM staff survey said their institutions offered at least one form of additional mathematical/statistical support to students, and the HEA STEM student survey showed that over 90% of students who made use of the additional support found it helpful.

10 In the HEA STEM student survey, over three-quarters of students reported that they performed as well or better in quantitative methods assessments as in other areas of their degree programme.

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

1.2.2 Recommendations

1 Higher education institutions and professional bodies in Psychology should provide clear signalling to the pre-university sector about the amount of quantitative methods in Psychology degree programmes.

2 University staff with responsibility for managing degree programmes in Psychology should review their approach to, or consider introducing, diagnostic testing of their students’ knowledge and skills in quantitative methods at the start of their Psychology degrees, and use the results to inform feedback and other follow-up actions.

3 Staff with responsibility for managing degree programmes in Psychology in institutions that do not offer any forms of additional support in quantitative methods to their students should consider introducing these.

4 Students on university degree programmes in Psychology should be provided with information about all the opportunities for support with their quantitative methods and university staff in Psychology should actively and regularly encourage students to use the available resources and opportunities.

5 Key stakeholders in the Psychology discipline and university staff with responsibility for managing degree programmes in Psychology should actively engage with developments in post-16 qualifications in both in Psychology (quantitative methods content) and Mathematics (e.g. “Core Maths”).
2 Background

It is estimated by the Advisory Committee on Mathematics Education (ACME) that around 60,000 social science students will experience significant Mathematics within their degree with a further 150,000 experiencing some mathematics (Advisory Committee on Mathematics Education, 2011). ACME classified Psychology as a social science with “significant mathematics”. The Mathematics within Psychology degrees is predominantly Statistics, which underpins the Psychology higher education curriculum.

The British Psychological Society (BPS) defines Psychology as “the science of mind and behaviour” (BPS, 2014), because the discipline is grounded in the scientific method. Ofqual treats Psychology as a science and in the ongoing revision of A-level courses, Psychology is grouped with Physics, Chemistry and Biology, although it does not include a separately assessed coursework component (Ofqual, 2013). As such, understanding the philosophy of science is core to understanding Psychology. Psychology students will all be taught “research methods” which is a term typically encompassing standard procedures, philosophies, and data-analytic techniques that psychologists use to answer scientific questions. Research methods can be split broadly into quantitative and qualitative methods. In simple terms, both are concerned with extrapolating evidence for a theory or answering a scientific question, but qualitative methods are used to do this from what people say, write or do, whereas quantitative methods do the same using numerical data. As such, the methods associated with collecting numeric data to answer psychological questions and the statistical techniques for analysing these data fall under the banner of quantitative methods. This quantitative methods training typically contains a very substantial Statistics component.

The BPS accredits Psychology degree programmes in the United Kingdom (UK) (The British Psychological Society, 2012). At the time of writing (Summer 2014), the British Psychological Society accredits almost 400 Psychology degree programmes within well over 100 different universities; because of the requirement of a Graduate Basis for Chartered Membership (GBC) to the BPS to become a professional psychologist it is extremely rare that Psychology degree programmes are not accredited. As detailed later in this report, the BPS accreditation criteria acknowledge that quantitative methods and Statistics are the backbone that supports Psychology degree programmes.

Given the importance of quantitative methods within Psychology as a discipline, this study sought to answer questions in five broad categories: to identify differences in how quantitative methods are approached in different institutions; to outline any sector requirements set out by accreditors and other organisation; to review the quantitative methods skills taught on undergraduate Psychology degrees in the UK; to investigate barriers to acquiring those skills; and to determine the implications these have for the transition from school/college to university.

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1 Much of this information comes from personal communication with the accreditation team at the BPS.
3 Research objectives and methodology

The primary purpose of this work was to investigate the use and teaching of skills in Mathematics and Statistics within the Psychology discipline with a particular emphasis on the transition between school/college and university within Psychology higher education programmes. To meet these objectives a multi-faceted approach was taken using a variety of methods selected by the Higher Education Academy (HEA) Science, Technology, Engineering and Mathematics (STEM) project team.

3.1 Literature search and review

A systematic review was conducted on the existing research literature. A literature search was run in November 2012 and March 2013 using electronic databases, reference lists of reviews and relevant studies, and a hand search of books. Searches were conducted using PsycARTICLES, PubMed, Web of Knowledge and Google Scholar with the following keywords used as search terms alone and in combination: teaching, Statistics, anxiety, humour, Mathematics. The reference lists of relevant reviews and studies were examined to identify any further studies for inclusion. In addition, books which included chapters on teaching Statistics were also hand searched. Studies were included if they met these criteria:

1. They related to teaching Statistics/Mathematics in Psychology in higher education or statistical/mathematical skills in undergraduates or A-level students (or equivalent).

2. The research related to teaching/skills within Psychology or related disciplines.

In addition, meetings took place with experienced accreditors. These meetings helped to identify relevant policy documents to be considered in the review.

3.2 Programme and module documentation

A search was done of higher education institutions to obtain web-based programme documentation and contact addresses for convenors of quantitative methods modules in Psychology. Twenty-one convenors were identified and emailed requesting programme documentation. This process resulted in programme documentation from 11 higher education institutions. Due to the relatively low return, these data were not used. Instead data relating to programme content were taken from survey work.

3.3 HEA STEM Tackling Transition event

A HEA STEM Tackling Transition event was held on 11 February 2013 to which higher education lecturers, teachers, level three (or equivalent) curriculum and assessment representatives, and student representatives were invited. In total, 48 attendees were present. It is perhaps worth noting that invitations were sent to individuals who were thought likely to have an interest in the teaching of quantitative methods in Psychology, and thus their views may not have been representative of others from the same stakeholder groups, although they are likely to have been carefully considered opinions. An initial overview of the project work in Psychology and the main issues that need to be quantified and tackled (based on the literature search) were presented. Attendees were then split into six groups of eight people (with individuals representing different stakeholders groups on each table) and given two of four questions to discuss (allocated across the tables to ensure that all questions were discussed. If sufficient time was available, having discussed the two allocated questions, groups were then encouraged to think about the other questions):
for those representing pre-university education: what quantitative skills do you think are needed in year one at university? For those representing higher education: what quantitative skills do you expect a typical Psychology student to have on arrival at university?

for those representing pre-university education: what quantitative skills are taught in schools/colleges? For those representing higher education: what are the quantitative skills taught in universities?

from your experience, in the context of quantitative skills, what could be done to ease the transition for Psychology students?

to what extent are students’ expectations of the amount of quantitative methods they will meet in their degree matched with reality?

Transcriptions of five of the group discussions were used to identify common responses (the sixth was not transcribed but briefer summary notes indicated that similar themes were covered in this group).

3.4 HEA STEM staff and student surveys

The HEA STEM project team developed three online surveys. The questions for use in Psychology were tailored to the Psychology discipline in terms of language and likely quantitative methods content. The first survey was designed for heads of Psychology departments/schools within higher education institutions and the second for lecturers teaching quantitative methods to undergraduate psychologists. Together these two surveys make up the HEA STEM staff survey in Psychology. These two surveys were identical except for three questions where heads of department were asked about training of staff and postgraduate involvement, while lecturers were asked about their own training and confidence in teaching quantitative methods. The third survey, the HEA STEM student survey in Psychology, was designed for students currently studying Psychology at degree level.

The surveys were delivered online. The survey link was emailed to the Association of Heads of Psychology Departments (AHPD) mailing list, which goes to the heads of department of all British Psychological Society-accredited Psychology departments. The survey (and link) was featured in the HEA Psychology e-bulletin, which has around 4,800 recipients, most of whom are Psychology lecturers who have opted to receive it. The link was also distributed on Twitter and the HEA Psychology Facebook page (to at least 900 potential recipients). Specific lecturers with interests in teaching quantitative methods, and the higher education delegates from the workshop, were contacted and asked to distribute the survey to interested colleagues. The student survey was distributed via similar mechanisms.
For the HEA STEM staff survey, 78 responses were received, 63 (81%) from lecturers and 15 (19%) from heads of department. For most questions the responses from heads of departments and lecturers were very similar; therefore data are presented from the sample as a whole, except where there are interesting differences in the profile of responses between the groups. Of the 63 lecturers, all had current experience or experience within the last five years of teaching quantitative methods on their degree programme. The HEA STEM student survey yielded 472 responses (although some respondents omitted responses to some questions). Throughout this report, N is used to denote the number of responses received to each item on the survey. Of the student respondents in this sample, 85% were female (N = 469), 76% were under 21, 14% were aged 21-30, and 10% were over 30 upon commencing their degree (N = 469). 26% were in their first year, 36% in their second year and 37% a different year (N = 469). 92% were single honours Psychology students (N = 468). It should be borne in mind that the 78 staff responses and the 472 student responses may have come from individuals within common departments, and so the data may reflect instances where departments are included more than once. In addition, particularly for staff, some individuals may be working on more than one Psychology programme, and their responses may reflect this.
4 Main findings

The main findings are split into four sections pertaining to four key questions identified by the project team:

1. how are quantitative methods developed by undergraduate psychologists throughout their programme of study?
2. what quantitative methods skills are Psychology students expected to acquire?
3. what are the barriers to learning quantitative methods skills?
4. how can the transition from pre-university education to higher education be improved?

Each section integrates information from the literature review, surveys and workshop discussion event.

4.1 What differences are there in the treatment of topics in Mathematics and Statistics across higher education undergraduate programmes in Psychology?

The HEA STEM staff survey asked several questions relating to the delivery and content of quantitative methods in Psychology degree programmes. These questions address not just the extent of the teaching but how decisions are made about who teaches it, and what training teachers are given. Figure 1 summarises responses to questions relating to the pragmatics of teaching quantitative methods (N = 78). It is clear that all respondents agree that quantitative methods are fundamental to Psychology, and 87% agree or strongly agree that teaching it is valued by their department. There is also a broad consensus that quantitative methods content is demanding to teach: 78% disagree or strongly disagree that anyone can teach it, more than half (59%) disagree that it is no more challenging to teach than other core Psychology modules, and 68% agree that it uses more resources than other core Psychology modules (Figure 1).
Figure 1: Percentage of respondents to the HEA STEM staff survey agreeing to questions about issues relating to teaching quantitative methods (N = 78). The size and colour of the bubbles are proportionate to the number of respondents endorsing each option.

Figure 2: Percentage of respondents to the HEA STEM staff survey indicating different numbers of quantitative methods modules operating in Psychology degree programmes (N = 76) (noting that some respondents may be working on the same programmes).
Figure 2 shows that it was rare that a degree programme had only one quantitative methods module. Similarly, it was rare to have five or more quantitative methods modules. The vast majority of respondents (93% of 76 respondents) indicated that their degree programme had between two and four modules\(^2\). In total, the 76 respondents provided information about 216 modules (remembering that most respondents worked at institutions that ran more than one quantitative methods module). Quantitative methods teaching is more or less evenly split between first and second year: 45% of modules were taught in first year, 47% in second year and the remainder in later years. Furthermore, on 97% of these modules, teaching is done by a member of the Psychology department.

![Diagram](image-url)

**How are quantitative methods taught?**

![Diagram](image-url)

**When are quantitative methods taught?**

Figure 3: Percentage of respondents to the HEA STEM staff survey endorsing options relating to how quantitative methods is taught across the three years of their Psychology degree programme (N = 78). The size and colour of the bubbles are proportionate to the number of respondents endorsing each option. Note that programmes can include both embedded and compulsory modules, and so respondents may have indicated the presence of both on their programmes, thus totals may sum to more than 100%.

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\(^2\) At least some of the variance is likely to be explained by how a module is defined: at some institutions quantitative methods modules might be split by term or semester whereas in others the module runs for the entire academic year. The number of credits per module is also likely to vary across institutions.
Figure 4: Percentage of (Ns = 15 heads of department [HoD], 61 lecturers) respondents to the HEA STEM staff survey endorsing each of nine responses to the question “When decisions are being made about allocating staff to teach quantitative methods (QM) components of modules what factors are taken into consideration?”

Figure 4 reveals how decisions are made about who teaches quantitative methods. These data are presented by whether the respondent was a head of department or a lecturer because their responses differed more than for other questions. The rank order for both groups was the same: predominantly staff expertise, staff preference and current experience were the main factors in allocating teachers to quantitative methods teaching (proportionately fewer lecturers selected these options than heads of department). This echoes the earlier view that not everyone can teach quantitative methods (Figure 1). Staff seem to be allocated to quantitative methods teaching based on staff member’s expertise, the currency of their teaching experience and staff preferences. Although heads of department tended to select these options more frequently than lecturers, these responses were overwhelmingly the most frequently selected in both groups. In the less frequently selected responses, lecturers perceived student feedback as slightly more important in terms of allocating staff to quantitative methods teaching than did heads of department, and they also perceived teaching to be allocated based on workload distribution, recency of appointments and other factors.
80% (12 of 15) of heads of department said that they employ postgraduate assistants on quantitative methods modules. Of those that do 42% (5 of 12) reported that postgraduates received specific training in teaching quantitative methods. In terms of staff training, 13% (2 of 15) of heads of department reported that staff was given specific training in teaching quantitative methods. Lecturers shared this perception: 83% (50 of 60) respondents said they had not undertaken training specifically tailored to the teaching of quantitative methods. Despite this, 67% (40 of 60) were very confident and 28% (17 of 60) confident about their subject knowledge of quantitative methods; the remaining 5% (3 of 60) were neutral.

In summary, higher education Psychology departments value quantitative methods teaching and appreciate the challenges it presents. Quantitative methods are an integral part of the Psychology degree with the vast majority of degree programmes having compulsory modules in years one and two, and embedding in other Psychology modules across all years is the norm. Teaching is almost always done by Psychology staff, who are rarely specifically trained but have high confidence in their subject knowledge. It is customary for postgraduates to assist with the teaching, and about half of the time they will receive specific training in quantitative methods teaching. The choice of who teaches quantitative methods seems, on the whole, to be based on criteria such as expertise, currency of experience and staff preference.

4.2 What are the mathematical and statistical requirements set out by: (i) the relevant benchmark statement; (ii) accreditation requirements; (iii) other professional body requirements?

The BPS accreditation process\(^3\) means there is consistency in the main learning outcome expectations of students with respect to Statistics and research methods across England, Scotland, Wales and Northern Ireland. The QAA has identified quantitative methods as a core knowledge area within Psychology; their benchmark statements for Psychology were developed in consultation with the British Psychological Society and defines broadly the content and quality expectations of undergraduate Psychology degree programmes (The Quality Assurance Agency for Higher Education, 2007). Table 1 summarises the QAA-identified Psychology-degree related defining principles, and transferable and specific skills that contain a direct or implied connection to research methods and Statistics. However, the QAA document does not advise on the specific statistical content that should be taught.

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\(^3\) Students are aware of this accreditation process: only 1% (7 of 469) of respondents in the student survey said that did not know whether their degree was British Psychological Society accredited.
<table>
<thead>
<tr>
<th>Defining Principles</th>
<th>General Skills</th>
<th>Specific skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aim to produce a scientific understanding of the mind, brain, behaviour and experience, and of the complex interactions between these.</td>
<td>Communicate effectively. Effective communication involves developing a cogent argument supported by relevant evidence and being sensitive to the needs and expectations of an audience.</td>
<td>Apply multiple perspectives to psychological issues, recognising that psychology involves a range of research methods, theories, evidence and applications.</td>
</tr>
<tr>
<td>2. Present multiple perspectives in a way that fosters critical evaluation.</td>
<td>Comprehend and use data effectively. This is accomplished through the significant core of research training in a psychology degree that acquaints graduates with understanding, analysing and presenting complex data sets.</td>
<td>Integrate ideas and findings across the multiple perspectives in psychology and recognise distinctive psychological approaches to relevant issues.</td>
</tr>
<tr>
<td>3. Develop an understanding of the role of empirical evidence in the creation and constraint of theory, and also in how theory guides the collection and interpretation of empirical data.</td>
<td>Problem-solve and reason scientifically. The research process, enables graduates to identify and pose research questions, to consider alternative approaches to their solutions and to evaluate outcomes.</td>
<td>Carry out empirical studies involving a variety of methods of data collection, including experiments, observation, psychometric tests, questionnaires, interviews and field studies.</td>
</tr>
<tr>
<td>4. Include the acquisition and knowledge of a range of research skills and methods for investigating experience and behaviour, culminating in an ability to conduct research independently.</td>
<td>Make critical judgements and evaluations. The need to take different perspectives on issues and problems, and to evaluate them in a critical and sceptical manner to arrive at supported conclusions ... The importance of looking for similarities and general principles to increase the power of the analysis is also stressed.</td>
<td>Carry out an extensive piece of independent empirical research ... demonstrating the ability to reason about the data and present the findings effectively; discussing findings in terms of previous research; evaluating methodologies and analyses employed.</td>
</tr>
<tr>
<td>5. Develop knowledge, leading to an ability to appreciate and critically evaluate theory, research findings, and applications.</td>
<td>Use effectively personal planning and project management skills... In particular, psychology degrees culminate in the completion of an independent, empirical inquiry where a pragmatic approach to a time-limited project is required.</td>
<td>Employ evidence-based reasoning and examine practical, theoretical and ethical issues associated with the use of different methodologies, paradigms and methods of analysis in psychology.</td>
</tr>
<tr>
<td>6.</td>
<td>Handle primary source material critically.</td>
<td>Generate and explore hypotheses and research questions.</td>
</tr>
<tr>
<td>7.</td>
<td>Be computer literate. Psychology students … will display, at the very least, skill in the use of word processing, databases and statistical software packages.</td>
<td>Identify and evaluate general patterns in behaviour, psychological functioning and experience.</td>
</tr>
<tr>
<td>8.</td>
<td>Analyse data using both quantitative and qualitative methods.</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Present and evaluate research findings.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Use a variety of psychological tools, including specialist software, laboratory equipment and psychometric instruments.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Summary of the QAA identified defining principles, subject-specific and general skills for undergraduate Psychology programmes in the UK that embody research methods and Statistics (The Quality Assurance Agency for Higher Education, 2007).
Based on this table, Field (2010) argues that research methods training permeates five of the six defining principles for Psychology and is core to the vast majority of both the transferable and subject-specific skills. The British Psychological Society standards for undergraduate programmes in Psychology were revised in 2012. The standards do not prescribe specific quantitative skills, instead they identify a curriculum based on ten requirements (taken from The British Psychological Society, 2012, pp 12-13):

1. “Ability to apply multiple perspectives to psychological issues, recognising that Psychology involves a range of research methods, theories, evidence and applications;

2. Ability to integrate ideas and findings across the multiple perspectives in Psychology and to recognise distinctive psychological approaches to relevant issues;

3. Ability to identify and evaluate general patterns in behaviour, psychological functioning and experience;

4. Ability to understand and investigate the role of brain function in all human behaviour and experience;

5. Ability to generate and explore hypotheses and research questions;

6. Ability to carry out empirical studies involving a variety of methods of data collection, including experiments, observation, psychometric tests, questionnaires, interviews and field studies;

7. Ability to analyse data using both quantitative and qualitative methods;

8. Ability to present and evaluate research findings;

9. Ability to employ evidence-based reasoning and examining practical, theoretical and ethical issues associated with the use of different methodologies, paradigms and methods of analysis in Psychology;

10. Ability to use a variety of psychological tools, including specialist software, laboratory equipment and psychometric instruments.”

As should be clear, these requirements are closely connected to the QAA benchmark. Statistics is most obviously present in requirement seven, but requirements one, five, six, nine, and ten also imply a sophisticated level of applied and theoretical statistical understanding. However, neither the QAA benchmark statement nor the BPS accreditation document refer to specific statistical techniques that should be taught.

The BPS' expectation is that the GBC curriculum is taught and assessed at level four, level five or level six, as defined by the Framework for Higher Education Qualifications (The Quality Assurance Agency for Higher Education, 2008; The British Psychological Society, 2012). This translates to levels eight, nine and ten of the Scottish Credit and Qualifications Framework (Scottish Credit and Qualifications Framework, 2012). The empirical project must be delivered at level six (ten in Scotland), and any Statistics covered at level four (eight in Scotland) must be supported with additional coverage at levels five and six (nine and ten in Scotland). As such, students will be taught Statistics at least in first and second year, with some taking advanced modules in later years and most will apply statistical methods as part of their empirical project. These observations match the survey data discussed in the previous section.
Although the BPS does not prescribe a specific Statistics curriculum, according to one long-standing academic assessor of applications for accreditation, assessors who review applications for accreditation have consistent expectations. He said (personal communication, 2013):

“(1) a degree programme would never be accredited on the basis of a purely qualitative curriculum;
(2) although they often have to ask for more qualitative content, it is never the case that there is too little content around quantitative methods;
(3) SPSS is the most commonly taught statistical package;
(4) there is an implicit checklist of statistical techniques that reviewers expect to see (for example descriptive Statistics, parametric/nonparametric tests, correlation and regression, Analysis of Variance (ANOVA), factor analysis). This implicit checklist is a bare minimum and in reality many programmes will include more advanced topics such as analysis of covariance, effect sizes, power analysis, mediation analysis, meta-analysis, multilevel models, loglinear analysis, multivariate analysis of variance (MANOVA). It seems clear from these expectations that Psychology students across the UK will, as a bare minimum, be required to understand concepts such as sampling, central tendency, variance, graphical presentation of data, standard errors, confidence intervals, nonparametric tests, ANOVA, t-tests, regression, correlation and factor analysis and many will learn a great deal more. There is variety in the degree to which these will be taught “pen and paper” or conceptually, using a computer to do the calculations while students focus on the application and interpretation of the technique.”

Figure 5: Percentage of respondents to the HEA STEM staff survey (N = 78) endorsing different responses to the question “Which of the following descriptions most closely describes the approach to Psychology adopted in your degree programme?”
4.3 How are quantitative methods skills developed throughout higher education undergraduate programmes in the Psychology discipline? What knowledge and skills are developed?

The observations about accreditation in section 4.2 were borne out by the HEA STEM staff survey data. Figure 5 shows the breakdown of how respondents (N = 78) classified the approach to Psychology taken on their degree programme. No one classified their approach as totally qualitative, and only 3% (2 of 78) selected more or mainly qualitative. In stark contrast, 79% (62 of 78) selected more or mainly quantitative. The responses depicted in Figure 5 show a very heavy leaning in Psychology towards a quantitative philosophy on degree programmes, which is consistent with the experienced assessor’s comments suggesting that assessors of accreditation applications expect to see certain statistical techniques taught on Psychology programmes.

Figure 6 shows the survey data for whether different statistical techniques are taught, practised and assessed at degree level. Consistent with what might be expected based on the BPS accreditation procedure there is little variance in responses. The techniques are listed very broadly from basic (for example descriptive Statistics) to more complex (for example multivariate) techniques ascending the vertical axis. With the exception of very complex (and relatively modern) techniques such as Bayesian analysis and bootstrapping, the majority of respondents indicated that the techniques were taught. (Although bootstrapping has been around for more than 30 years it was only introduced into SPSS, the computing package most widely used for teaching Statistics in Psychology in the UK, in 2009). For most statistical techniques at least 82% (64 of 78) and up to 99% (77 of 78) said that they were taught with only more difficult topics such as factor analysis (63%, 49 of 78) and multivariate methods (53%, 41 of 78) taught in fewer respondents’ degree programmes. By comparing the size (and, therefore, percentages endorsing) of bubbles within each statistical technique in Figure 6 (that is, looking along the rows of bubbles) some idea of the relationship between teaching and assessment can be obtained. In general, looking across the three columns to the right of the figure (teaching, practice, assessment), the evidence suggests that if a given technique is taught it is usual for it to also be practised and assessed.
Figure 6: Bubble plot showing the percentage of respondents to the HEA STEM staff survey (N = 78) endorsing different response options for the question ‘Which of the following are taught, practised and assessed as part of your Psychology programme?’ The size and colour of the bubbles are proportionate to the number of respondents endorsing each option. Note that totals will not add up to 100%, since content can be taught, practised and assessed within each programme.

In terms of what should be taught to undergraduate psychologists, Field (2010) argues that, given the increasing use of Statistics and science by journalists and politicians, it is important for Psychology degree programmes to provide their students with statistical transferable skills. Utts (2003) has identified seven statistical “useful life skills”:

- when causal relationships can and cannot be inferred, including the difference between observational studies and randomised experiments;
- the difference between statistical significance and practical importance;
- the difference between finding “no effect” and finding no statistically significant effect;
- sources of bias in surveys and experiments;
- understanding that coincidences and seemingly very improbable events are not uncommon because there are so many possibilities;
- “confusion of the inverse” such as the prosecutor’s fallacy;
- understanding that variability is natural, and that “normal” is not the same as “average”.

Field, A. (2010). {
According to Field (2010) the content of the typical UK Psychology degree will endow students with all seven of these skills. Indeed the HEA STEM staff survey data (Figure 6) suggests that undergraduate psychologists receive a very thorough grounding in statistical methods with the vast majority of sampled institutions teaching all but the most complex statistical techniques that a social science researcher would need.

To sum up, there is enormous consistency across the UK with respect to the statistical content of Psychology degree programmes. The British Psychological Society Graduate Basis for Chartered Membership ensures that a bare minimum level of statistical competency is seen in all Psychology graduates. The HEA STEM staff survey data suggests that for most institutions these competencies go well beyond what might be considered a bare minimum based on the British Psychological Society criteria for accreditation. The vast majority of students are taught, practice and are assessed on a wide variety of quantitative methods skills ranging from basic descriptive techniques (graphs, means, etc) right up to multivariate methods such as multiple regression, factor analysis and even structural equation modelling. In the section on transition this rigorous training in statistical methods is contrasted with what level three (or equivalent) students experience.

4.4 What are the barriers to learning quantitative methods skills in Psychology?

The wealth of literature aimed at making Statistics more palatable to students in Psychology and related disciplines (Berk, 2003; Field, 2009; Field, 2010; Lesser and Pearl 2008, Onwuegbuzie and Wilson, 2003; Pyrczak, 2009; Ruggeri et al, 2008; Schacht and Stewart, 1992) as well as direct research (Gordon, 2004; Ruggeri, 2009) create the impression that Psychology students struggle with quantitative methods. Although the HEA STEM student survey data showed that only 38% (178 of 470) identified themselves as struggling (Figure 10), only 19% (87 of 470) said it was rarely or never difficult. A substantial number of students (43%, 202 of 470) found it occasionally difficult, and a large minority (39%, 181 of 470) usually or always found it difficult (Figure 7). In addition, when comparing performance on quantitative methods assessments to other areas of their degree, 39% (182 of 470) reported doing better in quantitative methods, 40% (187 of 470) performed about the same, and only 21% (101 of 470) reported doing worse on quantitative methods assessments.

Figure 7: Percentage of respondents to the HEA STEM student survey endorsing each response to the question “Which of the following most accurately describes how you find quantitative methods?” (N = 470).
Conners et al. (1998) have identified four barriers to teaching Statistics to undergraduate psychologists: Statistics anxiety, motivation, performance extremes (students either “get” Statistics or they don’t), and making learning last. Field (2010) argues that the latter two barriers will be eased by addressing motivation and anxiety. Bessant (1992, p. 143) has called Statistics anxiety “one of the most significant barriers that instructors encounter while teaching statistics”. Blalock (1987) suggested that overcoming fears should be a primary goal in teaching Statistics.

These themes were echoed at the HEA STEM Tackling Transition event and in the HEA STEM staff and student surveys. At the workshop, all five groups identified Statistics anxiety as a barrier to learning, and two groups proposed diversity in knowledge and skills as an issue. The survey data revealed that nearly all staff respondents (N = 78) agreed or strongly agreed that student anxiety is greater (93%) and self-efficacy lower (73%) for quantitative methods than other areas of Psychology (Figure 8) and they most frequently selected anxiety (98%) and lack of confidence (88%) as barriers to learning (Figure 9). Similarly, students struggling with quantitative methods (N = 179) also most often selected anxiety (54%) and lack of confidence (70%) as barriers to their learning (Figure 9).

These results echo research in the social sciences more widely. For example, 25.1% of Sociology students reported being “very anxious” and 32.8% “anxious” about taking a Statistics module (DeCesare, 2007). Onwuegbuzie and Wilson (2003) report that between two-thirds and four-fifths of graduate students experience uncomfortable levels of Statistics anxiety. In Psychology, 43% of students expressed worries and 20% reported difficulties with research methods and Statistics (Rowley et al., 2008). Furthermore, in a study that compared students in different university faculties, science faculty students (83.6% of whom were psychologists, N = 335) had statistically significantly higher Mathematics anxiety than health faculty and business faculty students, significantly lower anxiety than arts, media and design faculty students, and equivalent levels to computing, engineering and technology faculty students (Hunt et al., 2011).
Research carried out in the United States has suggested that many variables affect Statistics and related anxiety. Attitude to science (Bui and Alearo, 2011) and previous mathematical experience (Baloglu, 2003) have been indicated as a significant predictor of Statistics anxiety. In terms of demographic predictors, some studies have shown that Statistics anxiety is significantly more prevalent in women than men (DeCesare, 2007), in older students compared with young (Baloglu, 2003), and in African Americans compared with Caucasians (Onwuegbuzie, 1999); however, other evidence suggests no significant gender differences (Baloglu, 2003, Bui and Alearo, 2011), no significant difference between Latino, Caucasian and other ethnic groups, and students entering university older than 25 compared with younger students (Bui and Alearo, 2011).

For those that experience anxiety it can be an important barrier to learning. Statistics anxiety can have a detrimental effect on module performance: it reduces memory efficiency when trying to understand and to learn new statistical material, and affects a student's ability to understand research articles and analyse and interpret data (Onwuegbuzie and Wilson, 2003, Benson, 1989). On the flip side, positive attitudes to Statistics can enhance performance on introductory Statistics modules (Elmore and Vasu, 1980, Schutz et al., 1998). Field (2010) also suggests that there is a broader impact to Statistics anxiety in that it could prevent some very gifted students from pursuing careers in Psychology because they fear their uncertainty with Statistics could make them “bad” at their job or be perceived by colleagues as unintelligent. This argument applies not only to careers in academic Psychology, but in evidence-based careers such as Clinical, Educational and Organisational Psychology.

Most students on non-Statistics degrees fail to see the transferrable skills that Statistics offers: one study of 279 students showed that only 7% thought that Statistics skills were generally useful in life, and only 16% could see the relevance to their Psychology degree (Gordon, 2004). A qualitative element of a study by Ruggeri et al. (2008) concurred that students fail to see the importance of Statistics to Psychology (“We never see why it matters in Psychology”) or life in general (“I would prefer not to do [statistics], I think it’s useless and it’s maths and we’ll never really use it”). The disconnect between Statistics and Psychology in the minds of undergraduates is likely to decrease motivation. For example, in the Ruggeri study a student reported that “If we want to keep on going with Psychology we have to do Statistics but it seems like that is what keeps me from doing well in Psychology.” (Ruggeri et al., 2008). Statistics anxiety is also likely to have a knock-on effect in reducing student motivation: anxiety will reduce student’s self-efficacy, which in turn will weaken their achievement expectancies, and increase the likelihood of them giving up when confronted with challenging material (Paxton, 2006). A lack of student motivation, and factors related to motivation (such as failure to practice) were selected as a barrier to learning by large numbers of staff (58% and 73% respectively, N = 78) and students (38% and 45% respectively, N = 469-470) in the HEA STEM surveys (Figure 9). The rank order of barriers selected by staff and struggling students was very similar; the notable exceptions were that staff seem to overestimate the failure of students to see the relevance of quantitative methods to Psychology (hardly any students identified this as a problem) and students saw the time that had elapsed since they studied Mathematics as the second most common barrier to learning: something not picked up by staff perceptions, but consistent with the conclusions of a recent report on this topic by Forkess (2013).

Some of the HEA STEM survey data were consistent with the view that students fail to see the relevance of quantitative methods to Psychology: 53% of staff (41 of 78) selected a failure to see the relevance of quantitative methods for Psychology as a barrier to learning (Figure 9). The student survey showed that 91% (427 of 469) of students had been told why quantitative methods were in their degree (Figure 10). In addition, 88% (411 of 469) knew there would be quantitative methods in their degree, 87% (408 of 469) expected to extend their understanding of quantitative methods in their degree, 99% (466 of 469)
understand why quantitative methods are in their degree, and 96% (451 of 470) see the relevance of quantitative methods to Psychology (Figure 10). Finally, more than half of staff responding (55%, 43 of 78) agree or strongly agree that students understand why quantitative methods are included in their degree programme (Figure 8) and only 2% of struggling students (4 of 179) felt that a failing to see the relevance of quantitative methods to Psychology was a barrier. This finding suggests that for many students at either or both higher education and pre-university level, considerable effort is being made to help students to see how quantitative methods are intrinsically linked to understanding psychological processes. The picture painted by the HEA STEM survey data contrasts dramatically with that earlier research, which could reflect (1) a positive trend in Psychology departments’ efforts to help students connect qualitative methods to Psychology; (2) differences in the diversity of study samples (the Gordon and Ruggeri studies did not sample across as many institutions as the HEA STEM survey); or (3) a bias in the HEA sample (the HEA STEM survey was administered during the end of year exam period so it is possible that only the more confident and high achieving students took the time to respond).

![Percentage of respondents to the HEA STEM staff and student surveys](image_url)

Figure 9: Percentage of respondents to the HEA STEM staff and student surveys (N = 78 staff, N = 179 students) endorsing each of 11 responses to a question about what factors typically inhibit the learning of students who struggle with quantitative methods (students self-identifying as strugglers, they selected factors that inhibit themselves).
Finally, in terms of barriers, 98% of staff (76 of 78) agreed or strongly agreed that there is wide variability in the numeracy and statistical skills of students on Psychology degree programmes (Figure 8). Also 71% (55 of 78) of staff disagreed or strongly disagreed that students enter their Psychology degree with realistic expectations about the amount of Mathematics and Statistics that their degree will involve. This point will be further discussed in the context of transition.

Figure 10: Percentage of respondents to the HEA STEM student survey (N = 469-470) responding yes or no.

Figure 11: Percentage of (N = 246 students, 49 lecturers, 13 heads of department) respondents to the HEA STEM staff and student surveys endorsing each of eight responses to the question "What forms of additional support are made available to students needing extra assistance with their mathematical and/or statistical knowledge and/or skills?"
It is clear that the teaching of quantitative methods is challenging and that there are intrinsic barriers to learning for some students. However, there is much that universities do to mitigate these challenges. Figure 11 shows responses to the HEA STEM staff and student surveys concerning various support mechanisms for teaching quantitative methods. Of the 78 staff responses, 62 (79%) selected at least one option, as did 246 of the 273 student respondents (90%). This suggests that many departments have support structures in place for quantitative methods modules. On the whole, lecturer and student endorsements of different support mechanisms were very similar. There were some differences between responses from heads of department and students and lecturers (more lecturers/students report having departmental drop-ins and online resources than heads of department, but heads of department report student mentoring schemes more often). The key message seems to be that more than half of both staff and students report having departmental drop-ins, and in-class support, and more than a third have online resources, university drop-ins, supplementary materials, and student mentoring. There were relatively few “other” resources (9 of 246 students and 4 of 62 staff selected this response) suggesting that the HEA STEM survey captured the main support mechanisms. Students (N = 245) and staff (N = 62) agreed that support resources were available throughout the degree programme with 84% of students and 76% of staff endorsing this response compared to only 6% and 8% respectively responding that additional resources are available only in first year.

The data in Figure 11 could reflect either widespread use of a few support resources or a small number of institutions using a lot of different support resources; Figure 12 shows the percentage of 79 staff respondents that selected different quantities of the eight listed support resources in Figure 12. This figure therefore indicates the percentage of staff whose institutions are implementing different numbers of support resources (although, of course, this says nothing about the quality of those resources). The picture is very encouraging with 79% of respondents reporting that their institution implemented at least one support resource, 67% implementing at least two, and 52% implementing three or more forms of additional student support for quantitative methods modules. Nevertheless, 21% of Psychology staff respondents reported using no additional support at all. Of course, these figures are only the perceptions within Psychology departments and universities may provide discipline-wide support for Mathematics and Statistics of which individual departments are unaware or not using.
It seems that a large number of institutions implement support systems for quantitative methods teaching, but do students use them and are they helpful? The HEA STEM student survey revealed that 45% (N = 245) of students made use of these resources and of the 111 who used these resources 94% found them helpful. However, these forms of support might not address the particular barriers to learning that have been identified. For example, providing online material does not necessarily increase motivation or reduce anxiety. At the Tackling Transition event, most of the solutions proposed to overcome barriers to learning were around expectation management (three out of five groups), which will be discussed later in this report as part of transition, more engaging material (three groups), and drop-ins (one group). Clearly many universities do use drop-ins (Figure 11).

The HEA STEM surveys were not designed to provide information about the content of materials or the teaching format of quantitative methods modules, and so cannot be used to conclude anything about how widespread attempts are to make quantitative methods engaging to students. However, a variety of research on this aspect is reported in the literature. The use of engaging material has often been discussed because Statistics is often taught passively through equations and dry examples. Many teachers have found a place for attention-grabbing songs (Lesser, 2001), videos (Berk, 2007), demonstrations (Lesser & Glickman, 2009; Lesser & Pearl, 2008), and examples (Berk, 2003; Pyrczak, 2009) in their teaching. Humour is often cited as a possibility for motivating students and reducing anxiety (Field, 2009; Berk, 2000; Berk, 2007; Lomax and Moosavi, 2002; Neumann et al., 2002; Lesser and Pearl, 2008; Field, 2014). Humour can take the form of jokes, cartoons, or songs (Lesser and Pearl, 2008; Lomax and Moosavi, 2002) but it can also be useful to embed a lighter tone within the examples themselves (Field, 2014). Using examples and analogies to which students actively relate enables them to anchor statistical ideas to their own experiences (Field, 2010; Field, 2014). Lesser and Pearl (2008) suggest that fun should not be perceived as frivolous and unrelated to the material, but (Field, 2014) believes that even if fun is tangential to the material it can be a useful tool for reducing anxiety, which should help students to engage with the “serious” content. For example, educational films achieve better learning outcomes in children when they contain unrelated humorous inserts (Zillmann et al., 1980).

Field (2014) suggests that humour enhances communication, reduces student anxiety, increases student participation and attention by making the module more interesting, “humanizes” the lecturer, and improves recall of information (see Lesser and Pearl, 2008; for reviews, Friedman et al., 2002; Field, 2009). Students certainly seem to want humour: 96.6% report that an “ideal” teacher would use humour (Epting et al., 2004) and the use of humour is positively related to student evaluations of teachers’ effectiveness and appeal (Bryant et al., 1980). There are also studies suggesting that humour can reduce student anxiety generally (Berk, 2000; Schacht and Stewart 1990) and when used in test situations (Berk 2000; Berk and Nanda, 2006). For example, a qualitative study revealed that 47% of students reported that humour reduced anxiety and lightened the mood and 45% said that it helped maintain their attention (Neumann et al., 2002). Also, humorous videos on Statistics result in higher ratings of the lesson, the quality of the lecturer and significantly better recall of information compared with videos without humorous inserts (Garner, 2006). Compared with lectures with no humour, specific concepts presented humorously were better remembered six weeks after the lecture (Kaplan and Pascoe, 1977). Grade point average (GPA)-matched groups of Psychology Statistics students who sang humorous jingle versions of definitions remembered them better than students who read them (VanVoorhis, 2002). Finally, chapters from humorous textbooks are rated by students as more enjoyable (Klein et al., 1982).

To sum up, the HEA STEM student survey data suggest that many Psychology students find the quantitative methods part of their degree challenging (82%, identified as occasionally, usually or always finding it difficult, N = 470), but the vast majority rise to the challenge and perform at least as well on quantitative
methods assessments as in other areas of their degree (79% of students reported that their performance in quantitative methods assessments was as good or better than their performance in other elements of their degree, N = 470). However, a substantial minority identify themselves as struggling (38%, N = 470) and do worse on quantitative methods modules (21%, N = 470). The HEA STEM student and staff surveys and the HEA STEM Tackling Transition event revealed a lot of consensus in the perceived barriers to learning. The major barriers appear to be related to Mathematics/Statistics anxiety, lack of confidence, low self-efficacy, numeracy, diversity in knowledge and skills, and at the HEA STEM Tackling Transition event unrealistic expectations were perceived to be a factor too. However, although many students find quantitative methods challenging only a minority actively struggle. Many higher education institutions have a variety of support systems in place and the majority of institutions use at least three different types of support activity. Students who use these facilities appear to find them useful, and Psychology is a subject in which many students perform well in their quantitative methods modules. This performance could reflect the success of the support mechanisms and insight that lecturers clearly have into the barriers to learning. Nevertheless, a fifth of students (21%, N = 470) are at risk of being left behind – either because the support mechanisms are not enough, or perhaps because they are at the one in five institutions that implement no additional student support specific to quantitative methods modules. Finally, it is worth reiterating that Mathematics/Statistics anxiety, and a lack of confidence and self-efficacy do not affect all students: many Psychology undergraduates are very able students who enjoy Statistics, are very motivated, confident, and do extremely well on their quantitative methods modules. In helping to motivate and teach the minority of struggling students, we need to be careful not to neglect those who might want to be stretched on their quantitative methods modules.

### 4.5 Transition

Undergraduate psychologists receive a rigorous training in statistical methods, but to what extent are they prepared for this training by their experiences pre-university and at the start of their degree programmes? This question can be addressed by looking at (1) the extent to which level three Psychology acts as a foundation for quantitative methods at degree level; (2) statistical and quantitative methods skills at the point of university entry; (3) entrance requirements and how diagnostic testing is used at the start of degrees; and (4) what do students expect coming into their degrees?

#### a) School or college Psychology as a foundation for quantitative methods at degree level

Teachers, on the whole, see the value of quantitative methods within the Psychology curriculum: they tend to agree that the level three curriculum (level six in Scotland) should be aligned to what is taught at university, and they are likely to disagree with statements suggesting that teaching Statistics is not important for level three Psychology students (The British Psychological Society, 2013). There are four boards that offer specifications for the curriculum and assessment of A-level Psychology, as well as a variety of other level three qualifications (level six in Scotland, e.g. Scottish Highers, International Baccalaureate and Access to higher education). The curriculum specifications differ across boards, but the largest board is the Assessments and Qualification Alliance (AQA) who set and mark the papers for approximately half of all GCSEs and A-levels in England, Wales and Northern Ireland. As the most frequently taught specification in Psychology, the AQA-A specification is used as a representative example (note that AQA offer two specifications, which differ slightly from each other). Table 2 summarises the specifications relating to quantitative methods for the AQA A-level qualification (Assessments and Qualifications Alliance, 2012).
<table>
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<tr>
<th>Unit</th>
<th>Research Methods</th>
<th>Quantitative Analysis</th>
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<tbody>
<tr>
<td>PSY A1</td>
<td>Demonstrate knowledge and understanding of: experimental methods; studies using a correlation analysis; observational techniques; self-report and interview; case studies; hypotheses, including directional and non-directional; operationalisation of variables; control of extraneous variables, reliability and validity; ethics; sampling techniques; demand characteristics.</td>
<td>Be familiar with: presentation and interpretation of quantitative data including graphs, scattergrams and tables; analysis and interpretation of quantitative data; measures of central tendency (median, mean, mode) and dispersion (range and standard deviation); analysis and interpretation of correlation data; interpretation of correlation coefficients.</td>
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<tr>
<td>PSY A4.</td>
<td>The major features of science: replicability, objectivity, theory construction; hypothesis testing; empirical methods; validating new knowledge; designing psychological investigations; selecting and applying appropriate research methods; bias and generalization in sampling; assessing and improving reliability and validity; ethics.</td>
<td>Appropriate selection of graphical representation; probability and significance, including the interpretation of significance and Type I/Type II errors; factors affecting choice of statistical test, including levels of measurement; the use of inferential analysis, including Spearman's Rho, Mann-Whitney, Wilcoxon, Chi-Squared Analysis and interpretation of qualitative data; conventions of reporting on psychological investigations.</td>
</tr>
<tr>
<td>How Science Works/ Mathematical Requirements</td>
<td>Use theories, models and ideas to develop and modify scientific explanations and pose scientific questions; use appropriate methodology; carry out experimental and investigative activities; analyse and interpret data to provide evidence; evaluate methodology, evidence and data; appreciate the tentative nature of science; communicate information and ideas; consider applications and implications of science; consider ethical issues in the treatment of humans; appreciate the role the scientific community in validating new knowledge; appreciate the ways in which society uses science.</td>
<td>Recognise and use expressions in decimal and standard form; use ratios, fractions and percentages; estimate the results of calculations (without a calculator); use appropriate precision; compute the mean; construct and interpret frequency tables, bar charts, scatterplots and histograms; understand probability; understand the terms mean, median and mode; use a simple statistical test; understand basic symbols (eg. =, &lt;, &gt;, ~); substitute numerical values into algebraic equations; translate information between graphical, numerical and algebraic forms.</td>
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Table 2: Summary of the AQA-A research methods specifications for A-level (Assessments and Qualifications Alliance, 2012)
At face value, Table 2 suggests that A-level Psychology students who have studied A-level Psychology on the AQA-A specification should enter Psychology degree programmes with a conceptual and (to some extent) practical understanding of descriptive Statistics, graphical presentation of data, correlation (PSYA1), hypothesis testing and basic statistical tests such as chi-square (PSYA2), the philosophy of science (all modules) and basic numeracy and algebra (mathematical requirements).

At the HEA STEM Tackling Transition event participants from higher education were asked what statistical skills they expected incoming students to have. The discussions in four of the five groups focussed only on basic maths and graphical representation of data. The assumption was that quantitative methods in the degree programme would start from scratch assuming just some basic numeracy skills. This assumption is likely driven by the fact that A-level Psychology is rarely an entrance requirement for a Psychology degree.

It seems that the A-level syllabus should endow students with the statistical and numeric competencies that higher education lecturers expect. However, discussions at the workshop suggest that higher education lecturers perceive that the majority of students lack even this basic set of competencies. This was supported by the HEA STEM surveys in which lack of numeracy was selected highly as a barrier to learning (Figure 9). With input from teachers and representatives from the pre-university sector and assessment boards, several problems were identified at HEA STEM Tackling Transition event. The views of those attending were that: coverage of quantitative methods is superficial and “tagged on” at A- level (five of five groups); A-level is too focussed on learning to the exam than acquiring a full understanding of concepts (five of five groups); numeracy skills from GCSE are not maintained through level three (level six in Scotland) and therefore to university (two of five groups); there is no time at level three (Scottish level six) to cover quantitative methods or numeracy revision (three of five groups); students are anxious about Statistics (five of five groups); and teachers lack confidence in quantitative methods (two of five groups). Although based on a small number of focus groups at the HEA STEM Tackling Transition event, the discussions give credence to the idea that although the quantitative methods specifications at level three (Scottish level six) might be adequate to prepare students for their Psychology degrees, the operationalisation of these specifications leaves students falling short of even the basic expectations of higher education Psychology lecturers. To be clear, this does not seem to represent a failing of teachers — discussions within the groups at the HEA STEM Tackling Transition event indicated that they diligently implement the specifications given to them — or of the specifications themselves, but more due to the amount that teachers are expected to cover and the tendency for assessments to encourage learning to the exam rather than conceptual understanding (The British Psychological Society, 2013). In Scotland, the changes resulting from the Curriculum for Excellence are intended to result in more flexible Psychology curriculum content and assessment methods at level three (Scottish level six) from 2014-15, and it will be interesting to see the extent to which this initiative will help to address concerns around “teaching to the test”, and thus impact on student preparedness.

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4 This was also endorsed as a barrier to learning by almost a third of respondents (N = 79) in the HEA STEM staff survey and identified as a major barrier to learning by struggling students in the HEA STEM student survey (Figure 9).
b) Quantitative methods skills at the point of university entry

The argument that level three Psychology (or level three more generally, Scottish level six) leaves students falling short of the statistical skills expected at the point of entry to higher education can be explored by looking at studies that have quantified the numerical or statistical skills that Psychology students have when they begin university. For example, students studying Psychology, Nursing and Sports Sciences did not differ in their mathematical knowledge and skills during their first week of university, and all three groups scored statistically significantly higher on a diagnostic mathematical test than students studying Business Management or on a Business foundation year (Bhakta et al., 2010).

Although this study might imply that Psychology students are better prepared than students in some other disciplines, historically, not all Psychology students have been found to have basic competence in arithmetic, probability or algebra (Greer and Semrau, 1984). The burgeoning popularity of Psychology in the last ten to 20 years may have exacerbated these problems by creating cohorts of students with increasingly heterogeneous background skills in Mathematics (Mulhern and Wylie, 2005). Indeed, there is evidence that undergraduate Psychology students’ core mathematical skills are on the decline. Mulhern and Wylie (2004), based on measures of calculation, algebraic reasoning, graphical interpretation, proportionality and ratio, probability and sampling, and estimation, showed that a 1984 cohort outperformed a 1992 cohort on some measures (broadly speaking). More concerning, the 1992 cohort outperformed a 2002 cohort on all measures. In a follow-up study using students from a broader range of universities (N = 8) from England, Wales, Scotland and Northern Ireland, Mulhern and Wylie (2005) showed that in all but two institutions the average score on a maths test taken in the first few weeks of the first term was less than 50%. At the remaining two institutions students’ scores averaged only just above 50%. Mulhern and Wylie (2005) used the same test as Mulhern and Wylie (2004) and, therefore, measured different facets of Mathematics. Students fared particularly badly on probability and sampling (female students always got less than 20% correct and males always less than 40% and typically less than 20% correct), algebraic reasoning and estimation (scores were typically below 40% correct). In general males performed significantly better than females, which is particularly important in Psychology where there is typically a 4:1 female-to-male ratio. Also, it is particularly worrying that the areas in which students were particularly poor are ones that have obvious connections to Statistics (for example sampling, estimation and algebra).

These problems may not be specific to Psychology. A large-scale study surveying medical students at the start of their programme showed a decline in their perceived technical skills (performing and designing experiments, Statistics, calculations, analysing data) between 2000 and 2008 (Whittle et al., 2010). In the same study, the percentage of students who claimed to be “experienced” with Statistics fell from 87.9% to 73% over the eight-year period. This suggests a declining trend in the statistical skills of students entering university in disciplines related to Psychology.
c) Entrance requirements and diagnostic testing

It is possible that the gap between what higher education lecturers expect and the numeracy and quantitative methods skills that incoming students possess reflects a failure to set appropriate entrance requirements. Indeed, more widespread and higher mathematical entrance requirements were raised as solutions by two of the five groups at the at the HEA STEM Tackling Transition event. The HEA STEM staff survey revealed that 82% (N = 78) of respondents said their institutions had a minimum Mathematics entrance requirement. Of the 62 respondents who indicated what that requirement was, all required a GCSE or equivalent qualification (including International Baccalaureate and Scottish Standard Grade) with 84% requiring grade C, and the remaining 16% requiring grades B or A. Only one respondent noted a preference for A-level Science or Mathematics. In the HEA STEM student survey, respondents were asked to state their highest pre-university maths qualification. These responses were coded, where possible, into GCSE, AS-level and A-level grades or equivalent (so these data include students reporting any qualification that could be translated into an equivalent grade at GCSE, AS or A-level). From the HEA STEM student survey responses that could be categorised in this way it is clear that nearly all (99%, N = 403) respondents have at least GCSE grade C or equivalent, and the vast majority (73%, N = 403) started their degrees with a GCSE grade A to C (or equivalent) and no further Mathematics qualifications, with the most common grade being A. A further 15% (N = 403) of respondents had A-level Mathematics (and presumably a good grade at GCSE too), and these students typically had grades A or B (Figure 13, although this may in part be a result of Psychology providers requiring A and B grades at A-level or equivalent in order to gain entry to the programme).

The figures from the HEA STEM student survey are similar to recent smaller-scale surveys: based on seven programmes, five required students to have GCSE maths grade C whereas the other two had no formal mathematical entrance requirement (Advisory Committee on Mathematics Education, 2011). Although based on an incredibly small sample, these requirements were higher than for Sociology, consistent with subjects such as Criminology, Chemistry and Bioscience, but lower than Physics, Accounting and Economics. Similarly, Science A-levels do not feature in the top five A-level subjects held by accepted Psychology students, except at Russell Group universities for which Mathematics was the fifth most common A-level (Stagg, 2009).

Therefore, institutions are known to be setting entrance requirements but it could be the case that these requirements are too low. For example, GCSE-based requirements, which are by far the most common, take no account of the possibility that skills at GCSE might not be maintained through the two years of A-level study - an explanation generated by two of the five groups at the HEA STEM Tackling Transition event.
With respect to diagnostic testing of students’ mathematical/statistical skills at the start of the degree programme, the HEA STEM staff survey (N = 78) revealed that it was relatively uncommon: only ten respondents (13%, eight lecturers and two heads of department) said that diagnostic tests were used at the start of the degree programme. Within this group, these tests were never oral but consisted of one or more written tests (50%, N = 10), online tests (30%), introductory assignments (20%) or other (10%). The purpose of these tests were to gauge the level of the cohort (60%), determine the starting point of the quantitative methods coverage (10%), stream students (10%), give students self-awareness of their skills (80%), enable tutors to direct individual students to appropriate support (60%) and other (10%). Oddly, despite one lecturer reporting that diagnostic tests were used to stream students, in a different question no staff reported that students were divided into streams for the purpose of quantitative methods teaching. Similarly in the HEA STEM student survey only 8% of students (N = 471) said that they had had a diagnostic test at the start of their degree; of those 36 students who had participated in diagnostic testing, 75% had a written test, 11% online, 3% oral, 17% an assignment and 17% something else (respondents could select more than one response). To sum up these responses, it seems rare that diagnostic tests are used at all, but when they are they do not inform the content or level of the teaching delivered to individual students; instead it is used as a general benchmarking device to make students aware of their skills level and to signpost support for those that need it.

The literature reviewed here seems to suggest that Psychology students may be better prepared than students in other disciplines, including some Social Sciences students, to deal with the Statistics component of their degree programmes. However, focus groups with representatives from both the pre-university sector and higher education suggest that even if Psychology students are “better prepared” than some other disciplines, there is an impression that many still fall short of the basic statistical and numerical skills expected of them.
d) Student expectations

A study conducted in Northern Ireland suggests that only 46.7% of students were aware of the Statistics element of a Psychology programme (Ruggeri et al., 2008). Attitudes towards Statistics (for example its worth, interpretation anxiety, fear of teachers, value and difficulty) did not change from first to second year suggesting that once students have started their Statistics modules (regardless of their prior expectations), their attitudes do not significantly improve. These views were echoed at the HEA STEM Tackling Transition event: three of the five workshop groups selected the view that student expectations about Psychology degrees need to be better managed. The HEA STEM staff survey data emphatically concur that students’ expectations about the quantitative methods content of degrees are unrealistic: 71% of respondents (N = 78) disagreed that students had realistic expectations about the amount of Mathematics and/or Statistics that their degree will involve compared with only 11% who agreed (see Figure 8). In addition, four out of five of the groups at the event workshop believed that incoming undergraduate Psychology students did not view Psychology as a science. This belief is surprising given that 58.5% of Psychology undergraduates have studied Psychology prior to university entrance (UCAS, 2012), and that the “How Science Works” or AO3 strand is a specific skill set embedded in A-level curricula relating to scientific practice within Psychology (see, for example, Table 2).

Past research supports this bleak view of student expectation. Rowley et al. (2008) explored the expectations of 169 single honours Psychology students at an English university during the third week of their degree and again during the final teaching week of first year. At entry, the vast majority (69%) reported that there was more emphasis on Statistics than they would like on their module. Although this percentage had fallen by the end of the first year, over half (54%) still felt this way. Students going into their degree with A-level Psychology were not necessarily prepared for the statistical element of their degree: only 46% reported feeling prepared for research methods in general, and just 16% felt well prepared for Statistics (with 30% feeling completely unprepared). The narratives on the questionnaires were telling with one student suggesting that “my Psychology teacher didn’t explain stats in the slightest and the only time we ever touched upon it was at the last minute for coursework”. At the start of their degree 43% of students expressed worries and 20% reported difficulties with research methods and Statistics, but by the end of the first year these values had fallen to 23% and 13% respectively. The Rowley et al. (2008) study suggests that level three students are generally ill-informed about the statistical component of their Psychology degree, and that this causes difficulties and worry. The positive picture is that after a year of Statistics fewer students report these worries and difficulties. Some of these findings were echoed in the HEA STEM staff survey results in which over half of respondents (N = 79) agreed that students’ failing to see the relevance of quantitative methods to Psychology was a barrier to learning (see Figure 9). The HEA STEM Tackling Transition event workshops generated some solutions for these problems: two of the five groups thought that higher education and pre-university institutions should have more interaction (for example sampler days, school visits, and more honesty about the statistical content of the degree).

However, the HEA STEM student survey painted a very different picture of expectation. As noted earlier, Figure 10 shows that 88% of students knew there would be quantitative methods in their degree and 87% expected to extend their understanding of quantitative methods in their degree (N = 469). As such, the vast majority of students were aware that quantitative methods were part of Psychology and that their degree would expect them to develop these skills. These findings concur with a United States (US) study in which first-year Psychology students were asked about the skills they expected to gain during their programme on a scale from 1 (not at all) to 7 (extremely well developed). These skills were grouped into categories of application, research, critical thinking, communication and technology. Students reported a significantly higher expectation of skill development for research and application compared with the other three groups (Gaither and Butler, 2005).
5 Conclusions

5.1 What is being done well in Psychology?

Students on higher education Psychology programmes receive a considerable amount of quantitative methods training that endows them with a sophisticated set of statistical skills for evaluating evidence. There seems to be thorough and consistent training in quantitative methods across a range of higher education institutions, with these modules typically compulsory in years one and two as well as often being embedded in other Psychology modules throughout the three years. In general, Psychology departments seem to value this component of the Psychology degree highly and make sensible resource allocation decisions: that is, teachers are assigned based on expertise and experience. There is an appreciation of the challenges this topic presents, and teaching staff are allocated primarily based on skill, a desire to do the job, and current experience. Teaching is almost always done in-house which has the advantage of the teaching being Psychology-related, and the teaching staff having an appreciation for the concerns and anxieties students may bring to the module. In addition, the majority of higher education departments offer a variety of supporting activities (for example online material, drop-in sessions) to help students who are struggling. Similarly, teachers in pre-university institutions value quantitative methods, and level three (or equivalent) specifications emphasise their importance too. Despite staff perceptions, and previous research, students who responded to the HEA STEM student survey generally seemed to be aware that a Psychology degree contains a quantitative methods component. The data do not provide information about whether student expectations about the difficulty of degree-level quantitative methods are realistic. In short, Psychology is evidencing considerable good practice: although the vast majority of students find quantitative methods difficult to some degree, they also typically do at least as well on these modules as their other Psychology modules, which suggests they are supported to overcome the challenges that quantitative methods content can pose.

5.2 What can be done better in Psychology?

There is a consensus view that, despite the relatively low expectations of higher education lecturers, incoming students do not have the required skills and confidence in Mathematics to prepare them for the quantitative methods training in their Psychology degree. At face value, level three (or equivalent) Psychology curricula seem to cover enough material to prepare students for higher education; however, teachers and other relevant representatives identified problems with how the syllabus is implemented. Given the volume of material teachers need to cover, and the way assessments are organised, qualitative and quantitative research methods, despite being a major part of the syllabus, often have to be covered superficially because the material is not embedded within the core Psychology content. The level three Psychology curricula also place too much emphasis on teaching to the test rather than conceptual understanding and critical thinking. This emphasis does students a huge disservice because quantitative methods in Psychology degree programmes focuses on understanding statistical concepts, retention of complex statistical ideas and their application to novel situations, and subjective interpretation of unfamiliar data. Students who have been trained to learn to the test are ill-prepared for the very different philosophy they encounter in higher education. Some teachers expressed the view at the HEA STEM Tackling Transition event that level three could be improved by redressing the perceived requirement that they teach to the test. At this event there was a view from teachers that they needed the time and space within the material to develop students’ conceptual grasp of quantitative methods as an embedded and integral foundation for understanding Psychology. Developments on qualifications in Scotland, in the context of the Curriculum for Excellence, may go some way to achieving these aims.
There is also worrying evidence that basic numeracy and statistical competencies are on the decline. Although most degree programmes set minimum Mathematics entrance requirements (typically grade C GCSE or equivalent) and most students exceed these requirements, they are perhaps not enough. The extent to which increasing Mathematics entrance requirements would help the transition to degree level Psychology is unclear. Some institutions set the grade at B (or equivalent), and most students exceed the basic C grade requirement. The survey, however, clearly identified a serious issue regarding whether material covered at GCSE is retained over the two-year level three period: students, at least, perceive it is not. This suggests that policymakers need to pay careful attention to embedding core mathematical skills (perhaps through compulsory free-standing mathematical qualifications) in the level three curricula generally (not just in Psychology). This issue was also raised by Porkess (2013), who identified a need for students pursuing a multitude of disciplines, including Psychology, at undergraduate level, to engage in mathematical study post-16, especially if they were not taking AS or A level Mathematics. Recent announcements suggest that students will now be encouraged to engage with “Core Maths” qualifications at level three if they do not follow an AS or A-level route (Department for Education, 2013).

Diagnostic testing is rarely used at the start of the Psychology degree, and when it is it typically does not feed into specific teaching arrangements for students likely to struggle. However, it is used to direct students to resources. Given the infrequent use of these diagnostic tests, more higher education institutions should consider using such tests to, at the very least, help students to identify their own skills and sources of support. However, 21% of institutions appear not to provide such resources and this is an obvious area for improvement.

The degree to which the “thorough and consistent” quantitative methods training has been absorbed will depend upon barriers such as Mathematics/Statistics anxiety. Although the majority of universities appear sensitive to these anxieties in the support they provide, more work is needed to inform best practice in delivering material in a way to reduce anxiety and promote the relevance of quantitative skills to both Psychology and life more generally.

Finally, although most students come to university informed that there will be some quantitative methods components in their Psychology degree programmes in general, it is unclear whether they have a realistic sense of the quantity and difficulty of the material. More research is needed. There is work to be done by both pre-university and higher education institutions to better inform students both when they consider their degree choices and after those decisions are made.
6 References


Ruggeri, K. 2009. Statistics anxiety and attitudes among undergraduate psychology students. Ph.D., Queen’s University, Belfast.


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