Q-Step Benchmarking

A report by Technopolis Group

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A step-change in quantitative social science skills

Funded by the Nuffield Foundation, ESRC and HEFCE

About Q-Step

Q-Step is a £19.5 million programme designed to promote a step-change in quantitative social science training. Over a six-year period from 2013, fifteen universities across the UK are delivering specialist undergraduate programmes, including new courses, work placements and pathways to postgraduate study.

Q-Step was developed as a strategic response to the shortage of quantitatively-skilled social science graduates. It is funded by the Nuffield Foundation, the Economic and Social Research Council (ESRC) and the Higher Education Funding Council for England (now the Office for Students). For more information go to www.nuffieldfoundation.org/q-step

About Technopolis Group

Technopolis Group is an international research and consulting organisation. We work for government and public clients at the regional, national and international levels across a number of policy areas, ranging from research and innovation to higher education by way of healthcare and energy / transport. We have over 120 consulting staff working across our offices in Amsterdam, Bogotá, Berlin, Brighton, Brussels, Frankfurt/Main, Paris, Stockholm, Tallinn, Vienna.

Our goal is to provide policy advice and support to aid decision-making for organisations and people with a mission to address environmental and societal challenges and achieve economic growth by means of science, technology, innovation and education. For more information go to: www.technopolis-group.com

About the Nuffield Foundation

The Nuffield Foundation is an independent charitable trust that funds research and student programmes to advance social well-being across the UK. We want to improve people's lives, and their ability to participate in society, by understanding the social and economic factors that affect their chances in life.

The research we fund aims to improve the design and operation of social policy, particularly in Education, Welfare, and Justice. Our student programmes enable young people to develop their skills and confidence in quantitative and scientific methods.

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Foreword

Q-Step operates across 15 University Centres and three Affiliate institutions and aims to promote a step-change in quantitative social science training in the UK. Since 2013/14, participating institutions have re-crafted their teaching and learning (across education; geography; international relations; law; linguistics; political science; population health; PPE and sociology) to embed quantitative skills in ways that make them relevant to, and inseparable from, the subject matter being studied.

Q-Step is deliberately experimental and did not set out to prescribe what should be taught and at what level across the institutions and subjects. However, the experiment had been underpinned my some careful research and reflection, often funded by the Economic and Social Research Council (ESRC) and drawn together by Professor John MacInnes.

In the course of this and subsequent work, Professor MacInnes set out a number of key skill development topics that encapsulated attributes that skilled quantitative social scientists (arguably, any quantitative researcher) should possess. These 35 learning outcomes could be approached at different levels of degree study, repeatedly (to build up confidence and understanding), and could usefully be seen as setting out benchmarks for a new approach to quantitative teaching and learning.

The Nuffield Foundation worked with Professor MacInnes and a small pilot group of three Q-Step Centres (the University of Exeter, the University of Glasgow and Manchester Metropolitan University) to turn the 35 statements into a benchmarking tool which the Q-Step network could use to describe, at a high level, what the quantitative content of their degree programmes comprised.

This benchmarking exercise was completed by all of the Centres and one of the Affiliate institutions. Along with the Q-Step pedagogy review that was published in 2017, this offers institutions and academics without the Q-Step network (and in other academic disciplines) sight of the potential elements to include in courses and programmes that seek to develop students' data skills and confidence. It also offers employers (including postgraduate research centres and units) a very clear idea of the skill levels they can expect from Q-Step graduates.

As the Programme nears the end of its fifth year, the Foundation and co-funders (the ESRC and the former Higher Education Funding Council for England) will begin sharing teaching materials developed across the network. In this way, we hope that we can support the use of the positive lessons learned from Q-Step to the benefit of a wider audience. The benchmarks are critical to this and we thank the Professor MacInnes for the use of the benchmark statements, the Q-Step network for responding to this work so fulsomely and to Adam Krcal and Billy Bryan at Technopolis Group for carrying out the review.

Dr Simon Gallacher
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Q-Step Benchmarking Synthesis

1.1 Introduction

This brief note provides an initial overview of the Q-Step Benchmarking data available up to date to the Nuffield Foundation and provided to Technopolis as part of the Q-Step evaluation project. This short synthesis review takes stock of the available data and, early in the evaluation process, aims at helping the understanding of the baseline. It also aims at providing some emerging findings and recommendations for the subsequent rounds of reporting from the Q-Step Centres and Affiliates (referred to as "Q-Step delivery partners").

Technopolis will revisit the benchmarking process throughout the evaluation and will provide the Nuffield Foundation with updated findings once the remaining Q-Step delivery partners have submitted their reporting data.

1.2 Description of the data

The data set contained benchmarking information from 12 Q-Step Centres and one Affiliate institution. These Q-Step delivery partners reported data on 56 courses ranging from 3-year undergraduate degrees to Masters programmes, all with varying proportions of Quantitative Methods (QM) elements. The coverage for each Learning Outcome (LO) for each year and level (introductory, intermediate and advanced), as well as the percentage of credit students could expect to earn from QM activities, was reported for each course. These LOs covered a wide range of topics, from conceptual approaches ("The concept of a rate, including rates of change") to practical methods (Graphical summaries of data and data visualisation). A full list is included in Appendix A. Some delivery partners included additional LOs that their courses covered outside of the 35 core LOs in the benchmarking template. Qualifications, justifications and additional details were invariably provided for each course, for example adding more context to the medium in which a particular LO was covered or whether a LO was only covered if the student chose an optional module.

This dataset was well populated with few instances of missing data, to the Q-Step Partners' credit. However, there were some inconsistencies across the data set and issues relating to the format of data entry that require some consideration. These are summarised at the end of this report with suggestions for improvement going forward.

1.3 Emerging findings

1.3.1 Level of learning outcomes and coverage

Table 1 summarises the level of LOs and coverage data for each Q-Step delivery partners. All of the Q-Step Centres and one Affiliate supplied data for this exercise. Total core LO coverage was determined by marking each LO using a binary measure if the centre marked the LO as covered/not covered. We have assumed that the 'core' learning outcomes are the 35 in the list included in the Appendix A that ends with 'Event history analysis'. These were then averaged to determine percentage coverage for each course and each centre. The LO levels covered per year were determined by totalling the number of LOs covered per year and per LO level, then the percentage of each across the three levels were determined for each LO level across the years covered by the course. This was done for each course and averaged across each centre. The totalled percentage averages on the final row of the table are all weighted against the number of courses delivered across all Q-Step delivery partners. The raw unweighted data simply shows the percentage average under each year and LO

level for each centre. Year 4 is exclusively Masters level data (in red) which was not relevant for every centre or every course, although a small number of courses were four year undergraduate masters.

Table 1 Summary table for Q-Step Partner benchmarking data.

Q-Step delivery partner	Courses (number)	Total core learning outcome coverage	Year 1			Year 2			Year 3			Year 4		
			Introductory	Intermediate	Advanced	Introductory	Intermediate	Advanced	Introductory	Intermediate	Advanced	Introductory	Intermediate	Advanced
1	2	93%	49%	49%	2%	16%	72%	12%	0%	10%	40%	n/a	n/a	n/a
2	4	100%	4%	35%	62%	0%	33%	67%	0%	14%	86%	n/a	n/a	n/a
3	2	40%	83%	17%	0%	0%	93%	7%	0%	0%	0%	n/a	n/a	n/a
4	1	80%	70%	30%	0%	44%	42%	14%	9%	5%	86%	n/a	n/a	n/a
5	1	83%	100%	0%	0%	46%	54%	0%	4%	58%	38%	n/a	n/a	n/a
6	5	91%	0%	100%	0%	0%	100%	0%	0%	50%	50%	0%	49%	51%
7	5	100%	17%	33%	50%	16%	84%	0%	35%	29%	35%	9%	3%	89%
8	4	89%	43%	25%	32%	3%	23%	73%	6%	0%	94%	n/a	n/a	n/a
9	1	97%	28%	50%	22%	0%	17%	83%	0%	19%	81%	n/a	n/a	n/a
10	7	93%	82%	18%	0%	23%	77%	0%	11%	19%	69%	7%	48%	44%
11	6	81%	88%	9%	3%	42%	50%	8%	42%	45%	13%	n/a	n/a	n/a
12	7	82%	28%	41%	31%	0%	50%	50%	0%	0%	100%	100%	0%	0%
13	1	91%	100%	0%	0%	10%	71%	19%	0%	6%	94%	n/a	n/a	n/a
14	7	86%	100%	0%	0%	0%	100%	0%	0%	81%	19%	n/a	n/a	n/a
15	2	94%	87%	13%	0%	24%	71%	5%	23%	15%	62%	n/a	n/a	n/a
16	1	97%	72%	28%	0%	6%	62%	32%	6%	21%	74%	n/a	n/a	n/a
Total	**56**	**88%**	**49%***	**32%***	**19%***	**16%***	**68%***	**16%***	**15%***	**33%***	**53%***	**11%***	**24%***	**65%***

**Weighted based upon number of courses*

The data on core LO coverage show that 88% of core LOs across 56 courses were covered on average. Encouragingly, 80-100% of core LOs were covered across Q-Step delivery partners, with one exception. Looking across to how LOs were covered over the four years and at what level, the proportions align with what might be expected: an increase in LO level from year one to year four. The proportions of the expected LO levels (1: introductory, 2: intermediate, 3+4: advanced) are highest in each year by between 20-40% compared to the second highest LO level. The Masters level courses have the highest proportion of advanced coverage of LOs and lowest proportions of the other LO levels, as might be expected.

It is interesting to note that LOs are covered at a relatively high level in the first year of courses, with almost a third of LOs covered at an intermediate level and 19% at an advanced level. The proportion of the introductory level, which is perhaps the most expected for the first year, is lowest when compared to the proportions of the other levels that can be expected in their respective years. The coverage of LOs at an advanced level reduces from year one to year two, yet more than triples from the second to the third year (which can be expected: learning outcomes at an advanced level should be more likely to appear in higher years of studies). This may be appropriate but could have implications in terms of the preparedness of students to manage this sudden increase. It may be attenuated by the high level of intermediate LO coverage in the second year, but more analysis would be required to determine this.

We have included the proportions across the Q-Step delivery partners to illustrate their cross-course average proportions that often differ substantially across delivery partners. We considered performing this analysis at the individual LO level, but this was deemed too complex as there were 35+ individual LOs and 3x3 in terms of level of coverage (3-4 years and 3xLO levels). We, therefore, could take a more complex look once all the remaining delivery partners have delivered their reporting data, perhaps following some of our recommendations for a more efficient way of reporting (mentioned below).

1.3.2 Overall assessment of pathway/degree QM content

Figure 1 shows how Q-Step delivery partners answered the benchmarking question on the percentage of credit students could expect to earn from QM activities. It gives a proportional view of how the question was answered, determined by totalling the selections under each category and calculating the percentage proportion for each answer against the total. This is based upon 55/56 courses as the University of Glasgow reported this data point on 6/7 of courses.

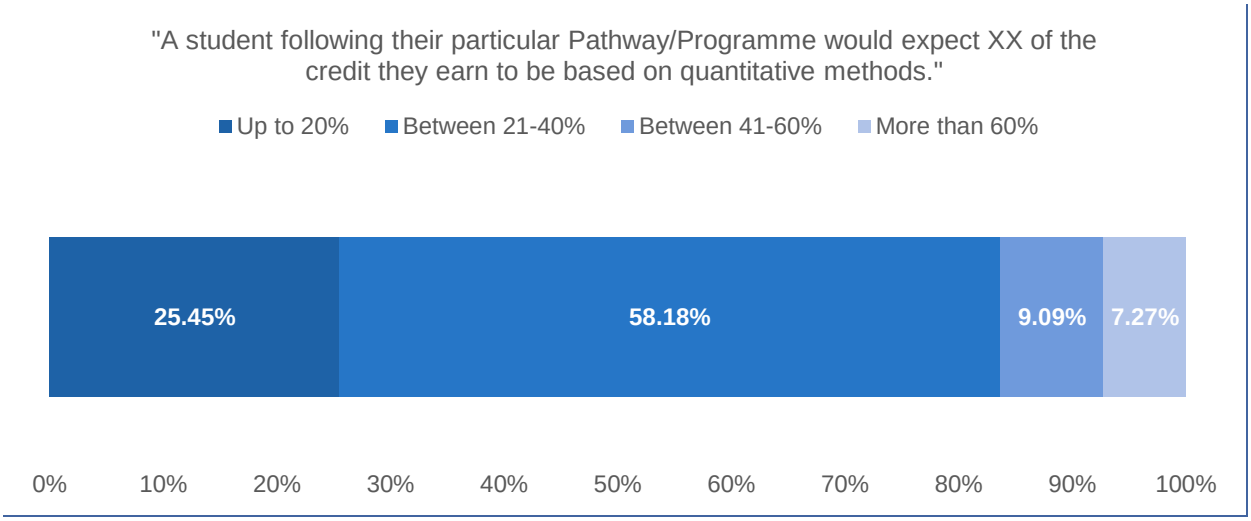

Figure 1 Overall assessment of pathway/ degree QM content.

The data in Figure 1 show that, in the majority of cases, Q-Step delivery partners provide courses in which students can expect to derive between 21-40% of credit based upon quantitative methods. Students can expect to earn up to 40% of credit in almost 84% of

cases, compared to 16% of courses that provide the student the opportunity to earn 41% and above.

1.4 How this data can inform decision making

The data in Table 1 are encouraging in that the weighted totals are in line with what might be expected in terms of how LOs are covered, at what level and at what point in the courses. This high-level programme view is useful, but consideration must be given to how the individual delivery partners cover LOs. It may be prudent to determine how decisions were made in each of those cases to understand the enablers and barriers to delivering these QM elements. This may be due to factors such as the type of course or equipment/expertise available. QM elements in optional modules may also impact upon the actual coverage of LOs, yet this impact cannot yet be measured because it is not recorded in this benchmarking exercise. It is important to note again here that we did not analyse this at the individual LO level. It may be that some LOs are consistently covered at a low level or only once across three years, further analysis will be required to determine this.

As already identified, the heterogeneity of data between Partners is high which has can skew our final results for the coverage of LOs. For example, some Partners reported multiple courses in one sheet and some provided data with no course title which could imply they reported at a university level instead of a course level. In future, we would implement minimum and maximum figures for each Partner's courses and years of study in determining percentage coverage. This allows us to not only better represent each Partner in comparisons but to also better understand how Partners apply modules in their courses and whether some are focusing in on certain best practice methods of delivery. We were not able to implement this in our analysis due to the issues mentioned and other issues in the reporting. We plan to implement this when the benchmarking data is collected again, ideally more robust with our suggestions to ensure our analysis can be effective.

The data showing how much credit a student can expect to earn from quantitative methods clearly shows us that credit bearing activities with QM elements are in the minority compared to the rest of those courses. If this figure is perceived to be off-target compared to what was originally envisaged by the Q-Step leadership, it may be worth capturing information on the specific QM and non-QM modules delivered in each course to further explore how QM is organised and delivered within and across courses. This could include the modules' credit bearing values and whether they are optional or not to further understand how QM is covered at course level and what choices each student has at what stage. This could inform programme level learning in identifying potential barriers and enablers to engagement with QM modules that could be explored qualitatively with coordinators, lecturers and students.

1.5 Looking ahead

We have summarised our suggestions for improving the data capture and reporting process below:

Table 2 Issues in the data capture and reporting process with suggestions for improvement.

Issue (design, entry etc.)		**Suggestion**
Inconsistencies in reporting	Missing course titles	May be remedied with a first 'summary' sheet that asks for a list of courses.
	Missing data for 'Overall assessment of pathway/degree QM content'	The first 'summary' sheet could also include this question answered against each course with a comments column.
	Missing 'other' learning outcome labels but recorded data against them	May be an error in 'copy and paste'
	Multiple entries in the beginner, intermediate and advanced columns	Only one entry per row per year should be allowed. In these cases, we have considered only the highest indicated level of coverage e.g. advanced when both intermediate and advanced options are checked.
	Some study abroad years left blank but occupied the space of one year in the LO data.	This year, if no learning outcome data can be reported, can be ignored when entering learning outcome data to aid analysis. If LO data needs to be entered this can be entered in the correct year sequence. A short guidance statement on the 'introduction' sheet should aid this.
	Data reported for multiple courses on one sheet.	There will be nuanced differences between each course, so data should be entered on separate sheets.
General user and evaluator friendliness		Avoid 'freezing panes' and restricting the number of columns and rows on the sheet to aid navigation around each sheet and in adding columns for formula calculations
		Clearer guidance on how to record Masters level programmes. Should be entered in the 'year 4' column as many HEIs entered this in year 1. We have amended this for our analysis.
		Drop down menus for LO coverage instead of numerical or 'x' ensures that this section is binary and would not show empty cells.
Those additional optional LOs that are outside the 'core' learning outcomes (ending with 'Event history analysis') are not possible to analyse across courses/centres		Consideration should be given to how any additional learning outcomes are accounted for in analysis across centres. These could still be added as optional but into predefined categories of LOs, as already suggested, so that they would contribute to the core analysis as opposed to being outside of it.
The question on the percentage of credits students can expect to earn is placed in line with the first 4 LOs which makes them look directly linked for data entry.		A first sheet could be created to separate the LO data entry and this question. This first sheet could be named 'summary' and include a list of courses with this question answered against each with a comments column.
Masters course data was often entered in the 'year 1' column.		A dedicated labelled 'masters' column in addition to or replacing the 'year 4' column could be included to clearly differentiate

Issue (design, entry etc.)	Suggestion
	undergraduate courses from Masters courses.
Optional elements of courses/LOs are not apparent. This may mean that some LOs are only covered if students choose a particular module (sometimes reported by partners)	Indicate which LOs at which stage and at which level are optional.
Number of individual LOs and optional additional LOs is too high for individualised analysis.	LOs could be grouped up for the future work of the Nuffield Foundation i.e. 5-7 categories with related LOs in each (e.g. conceptual LOs that cover validity, reliability and bias).
The number of editable cells is restricted which limits analytical work e.g. adding formulas at the end of the sheet.	Do not limit the number of editable cells on the worksheet
It is difficult to determine where the QM credit bearing elements are within the courses.	As already suggested, it may be worth capturing more granular data on how QM module/learning is structured within courses. Particularly, how QM credited activities are distributed within courses and which of those elements are optional for students.

Appendix A: Core Learning Outcomes

1. Understand the vital role of quantification in the empirical description of societies and its capacity to generalise from samples to populations. Appreciate that many social regularities and patterns are visible only to quantitative analysis.
2. Measurement: classifying and counting things and events in time and space.
3. The inevitability of error in measurement and classification. An appreciation that all data is socially produced and captured. Understand the challenges involved in any kind of measurement and likely sources of error associated with that.
4. Levels of measurement.
5. Validity and reliability in measurement.
6. Informal estimation and spurious accuracy
7. The concept of a variable and its distribution. Variables values and cases.
8. The concept of a proportion and its numerical and graphical expression.
9. Summary descriptive statistics of level and spread such as a mean, median, standard deviation or ‘five number summaries’. identification of outliers
10. Transformation or standardisation of data to facilitate presentation or analysis (log scales, percentaging etc).
11. Tabular data of the kind commonly found in reports, understanding how data may be standardised for purposes of comparison, discerning trends, observing associations, checking key items such as definitions of categories, sources of data.
12. Graphical summaries of data and data visualisation.
13. The concept of a rate, including rates of change.
14. The concept of probability or risk, and the nature of randomness. Understand the concepts of a trial and its sample space. The three probability axioms. Carry out simple probability calculations. Distinguish frequentist and subjective accounts of probability.
15. The concepts of independence and association. Correlation and its distinction from causation.
16. Regression to the mean and its implications.
17. Conditional probability.
18. Simple inverse probability and Bayes theorem. False positives and false negatives. Type I and type II errors.
19. The concept of an experiment, and its similarity and difference to that of observation and control.
20. Research design: randomisation, comparison, control and observation. The key role of prior variables and selection effects in social enquiry. Coping with social change and time. Theories of causation.

21. The logic of random sampling and sampling distributions, and the importance of selection effects (but not how to go about making calculations, e.g. of the sample size needed to capture a given effect size).
22. Awareness of the limitations of non-probability samples.
23. Data exploration and description. Theory testing and elaboration, hypothesis formulation and testing, inference from samples to populations, confidence intervals, significance, effect size and power. The concept of a model and residuals from it. N-way contingency tables, comparison of means, correlation coefficients, analysis of variance. Linear and logistic regression, including model fitting and analysis of residuals.
24. Be able to construct and evaluate simple models. Recognise the importance of parsimony and clarity. Understand and use the main diagnostic tests available.
25. Survey design. Sampling theory, sampling frames, stratification and clustering. Cross-sectional, repeated cross sectional, panel, cohort and longitudinal data. Response rates, attrition and bias.
26. Sources of data. The census. Major surveys (e.g. the LFS, ESS, US, BSAS). Administrative data. Transactional and social media data. The data archive. The question bank.
27. Secondary analysis of data. Using survey documentation to understand question routing. Identify, locate and interpret variables correctly. Understanding weights.
28. Simple data management and manipulation: recoding variables, creating new variables. Dealing with missing values or observations. Dealing with hierarchical data, merging datasets.
29. Data curation and management. Security, anonymization, confidentiality and disclosure risk. Data protection. Legal and ethical obligations.
30. Good practice in the tabular and graphic presentation of data (histograms, bar charts, box and scatterplots).
31. Common misuses of and mistakes in the presentation of statistics and quantitative evidence. Common fallacies encountered in poor statistical reasoning (e.g. the ecological fallacy or fallacy of affirming the consequent. Texan sharpshooter).
32. Data reduction techniques: e.g. Factor analysis.
33. The General Linear Model.
34. Multilevel models. Hierarchal data.
35. Event history analysis.