Effective teaching practice in Q-Step Centres

Professor John MacInnes

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 (HEFCE). For more information go to www.nuffieldfoundation.org/q-step

About the author

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Foreword

Q-Step set out to bring about a step-change in the way in which quantitative skills are developed as an integral part of social science undergraduate teaching and learning in the UK. Central to this endeavour has been the recruitment of new staff in 15 Centres and their development of new modules and degrees, integrating quantitative material closely with subjects across the social sciences, education and geography.

The new approaches to teaching have also included innovations in the use of technology (such as the University of Kent's 'bring your own device' approach), new analytical tools (using R as a data handling package) and substantive work placements where students put their skills to the test under real working conditions.

As we enter the last stages of this experimental programme, with the current phase of funding due to end in 2018/19, we are taking steps to capture the lessons learned. Understanding the successful (and less successful) elements of Q-Step will help the Foundation and its partners to plan future interventions concerning the quantitative skills of undergraduates in an evidence-led way.

The central role of teaching in Q-Step gives us a particular interest in the pedagogical aspects of quantitative education. What has been taught, how has it been taught and what early signs are there of the way in which this new approach is having an impact on student outcomes?

In order to shed light on this area, we commissioned Professor John MacInnes, who has extensive experience of understanding how to embed quantitative skills in the social sciences, to review the current state of teaching and learning across the Q-Step network. John's report is based on semi-structured interviews with the key teaching and learning personnel in all 15 Q-Step Centres and the three Q-Step Affiliate institutions.

John's independent findings indicate that there are still some challenges ahead, but that we have made progress and learned a lot. For example:

- Establishing new modules or courses takes a lot of time and energy and it is usually easier to establish something new than reform what is already there.
- Work placements are very highly valued and effective but require considerable support to establish and maintain.
- Curriculum 'space' is important, as students need time to practice, consolidate and develop skills – to gain 'flying time'.
- Existing teaching resources are rarely adequate for easy integration with the new teaching approaches.
- Communication across the network and the sharing of resources and materials is at an early stage of development and is an area that it would be fruitful to support.

Embedding and sustaining change in higher education is a long-term task and (what will be) six-years of funding for Q-Step may only be the beginning of the real 'step-change' in quantitative social science skills we have been seeking. This review and its important

messages about the most significant components of Q-Step – teaching and learning – offers us the evidence to help us understand what has been achieved, how to make a more notable and positive impact in the final stages of this phase of Q-Step, and how to build a sustainable model for quantitative skills development in the future. We are very grateful to Professor MacInnes for this timely, insightful, and constructive report.

Dr Simon Gallacher
Head of Student Programmes
Nuffield Foundation

1. Introduction

This review of quantitative social science teaching and learning is derived from interviews with practitioners across the Q-Step network. These interviews took place across the latter part of 2016 and the spring of 2017 and all of the 15 Q-Step Centres and three Affiliate Q-Step institutions took part.

The review was commissioned by the Nuffield Foundation as part of the programme of work we are carrying out (with our funding partners, the Economic and Social Research Council (ESRC) and the Higher Education Funding Council for England (HEFCE)) to support the impact of Q-Step. It is also intended that the review will inform the development of new activities to support quantitative social science teaching and learning.

2. How students learn quantitative methods (QM): the role of pedagogy

Pedagogy has always been important to Q-Step. A core feature of its rationale was that the typical ways of teaching quantitative methods in UK social science were inadequate and produced poor results. When Q-Step was developed, there was recognition that the typical 20 credit 'add-on' methods course usually did not develop students' quantitative skills successfully. Conversely it was often argued that QM could be taught successfully when students had both confidence in their own ability to master quantitative skills (so that they might overcome any 'statistics anxiety'), and faith in their relevance to the rest of their degree programme, so that they could see why they needed such skills in the first place.

One conclusion drawn from this was to promote 'embedding' of these skills in substantive courses; another was that it takes more time to develop students' quantitative skills than a typical 20 credit course might allow. Beyond this, the Q-Step funding process was deliberately non-prescriptive; asking centres to propose what they thought would be the most effective means towards the goal of delivering better QM teaching. In the run up to the invitation to apply, there was some debate both about the relative merits of raising the standard for all students versus specialising on those more interested in or competent at 'quants', and about how far these two goals might compliment or contradict each other in practice. The funders did not take a view on this in the invitation to apply, their hope being that by letting centres make decisions about how best to tackle the problem, new insights would emerge about how to teach QM well.

3. Diversity

Q-Step Centres and Affiliates have different aspirations and different strategies to achieve them, although almost all centres have tended to produce some combination of new, revised or extra teaching for all students (which I refer to as new **modules**), and more specialist options or degree programmes for students prepared to specialise in 'quants' (which I refer to as 'with QM' **programmes**). This diversity enhances the 'experimental' nature of Q-Step pedagogy and the lessons that can be learned. All centres have introduced radical changes not only to teaching content but also to *how* students are taught and how they learn. The scale of this change is perhaps greater than was anticipated, and is discussed at greater length below. It was made possible by the success of the initial staff recruitment exercise, which has given Q-Step a cohort of remarkably able and enthusiastic teachers. However,

this diversity of approach has also left centres unsure of 'how well they are doing' and unsure of how their aims compare to those of other centres. The enthusiasm and energy of Q-Step staff means that some caution is needed in estimating how scalable Q-Step may be in the future. Less enthusiastic or able staff might effect less substantial change with the same level of investment.

4. Creating course units and degree programmes

It is clear that staff have undertaken a very substantial amount of time-consuming and challenging curriculum change in a relatively short period. The volume of this effort has been greater than was anticipated at the outset. Universities are not always very flexible organisations, and this has sometimes been accentuated by a desire to constrain diversity in order to simplify management, prepare for teaching or research evaluation exercises, or satisfy consumer protection legislation. Q-Step has posed particular demands in terms of the technology needed for teaching, the format of teaching (small group computer labs and concentrated blocks of teaching instead of a traditional single or double hour lecture or tutorial slot), and both its timetabling within the degree programme (generally there is competition to deliver material to students in year one, to create scope for progression in later years), and its articulation with existing degree programmes.

The outcome of this process so far has been a substantial variety of both programmes and individual modules. Typically, staff have avoided standard textbooks, and either supplemented or replaced them with a large volume of bespoke teaching and assessment material. There has been a lot of good work using visualisation and graphic methods in teaching. Such material is costly to produce, and I discuss how to tackle this issue below under **communications**. The time devoted to creating modules and programmes, and their associated teaching and assessment resources mean that staff have typically had less time left to develop research activity. When thinking about the future development of Q-Step and its potential to 'scale up' or be replicated elsewhere, this needs to be taken into account.

5. Student Recruitment

Some, but not all, centres have found student recruitment difficult. Both numbers and the sources (e.g. transfers from other programmes) vary widely. Centres are aware of the mix of students that emerge from their university's recruitment procedures, entry standards and reputation, as well as the typical career aspirations of their recruits, which can differ greatly between universities. There is therefore substantial diversity in centres in terms of the prior qualifications required for students on 'with QM' programmes. For example, Manchester Metropolitan University (MMU) Q-Step Centre accepts students with a C, and occasionally D grade at GCSE Mathematics, while the University of Edinburgh Q-Step Centre asks for Higher or A-Level Mathematics. On some programmes, small numbers may produce problems in the future, not only because of economies of scale in teaching, but also because there is some evidence of the impact of a critical mass of students for student identity and motivation. In centres where there was a cohort of a dozen or more students doing 'with QM' programmes there seemed to be a much stronger student identity and motivation, which paid dividends in terms of student performance.

The University of Edinburgh Q-Step Centre had some, very limited, evidence that prior ability in maths may be an indicator of aptitude for QM. Students who had taken their 'Maths for Social Scientists' course did better on other courses, while those who took a conversion course without the usual maths Higher/A-Level prerequisite were less likely to decide to transfer on to the 'with QM' programme, did slightly less well on its modules when they did transfer, and some struggled to keep up later. There will be some selection effect in this, and it may be that it is not specific technical skills that are important, but rather that a background in maths makes it easier to cope with the 'cumulative knowledge' aspect of QM that I discuss below. By contrast, the experience of MMU makes it clear that it is possible to teach large volumes of students with limited maths skills to analyse data using linear regression, and for them to evaluate that teaching significantly more positively than previous, less ambitious, QM teaching. The experience of Q-Step Centres at the Universities of Bristol, Edinburgh, Exeter, Oxford, UCL and elsewhere suggest that, with cohorts of students who already have some maths background, even faster progress to ambitious levels of achievement are possible.

6. QM is different, or QM is difficult?

Cumulative knowledge and skill identification

The first insight that has emerged from the experience of the centres is that we may have underestimated the importance of *the distinctiveness* and the *cumulative character* of QM skills. At university, all knowledge claims to be cumulative to some extent, insofar as there is an expected level of progression across the years of a programme in the extent of subject knowledge, level of difficulty, and competence and fluency in the construction of an essay or dissertation for example. However, QM skills are cumulative in a different sense: there is a common technical body of knowledge that students must master incrementally. For example before the concept of correlation can be understood, the concept of a variable's distribution needs to be mastered. Understanding this distribution requires the ability to think in terms of variables, values and observations, and so on. Most important of all, there is little 'discussion' or 'debate' about this technical knowledge (e.g. about *how* to calculate a mean or the linear association between two continuous variables). There might be such debate about the value of doing so, or how best to identify and deal with sources of error in any measurement or sampling involved, but mastering the *non-debatable* technical knowledge is a prerequisite of competent participation in such debates.

This is important because such cumulative technical knowledge requires a different form of learning. Much of it comprises a mixture of fairly simple maths with a series of logical decisions that must be taken correctly to obtain the right result. Such thinking requires concentration and effort and carries with it the risk that a slip at any stage of the process risks undermining the whole enterprise. Kahneman (1) refers to such thinking as 'system 2' or 'slow' thinking that requires intuitive ideas to be suspended while more effortful logical calculation takes place. This kind of mental work is largely absent elsewhere in social science students' curricula. Elsewhere the diversity of analytical approaches preclude much consensus about what might comprise any 'basics' upon which cumulative knowledge might rest. While there is no shortage of 'difficult' theoretical work, it is mostly of a more forgiving character, in the sense that the alternatives faced are rarely 'right' or 'wrong' but concern issues of interpretation and emphasis that are to some extent always up for discussion. This absence of any cumulative base, and emphasis on discussion and interpretation, means that

for most students, an effective strategy for learning in many modules is to focus on one or two topics at the expense of others (in order to write an essay or answer an exam question for example), and to focus on 'compare and contrast' approaches to ideas and concepts. However, applied to quantitative methods modules, this strategy would be disastrous, yet students may realise this too late or not at all.

Q-Step Centres have taken a variety of approaches to deal with this. The most explicit signalling of the cumulative development of skills was taken by MMU Q-Step Centre, with a card listing a set of key skills on which a graduate teaching assistant (GTA) or lecturer would 'sign off' that a student had demonstrated competence in each skill as their learning progressed. Other centres also commented that it was important to signal to students just what skills they were learning, how to describe them (e.g. on a CV), and what applications they could have. They found that individual skills and the way in which they built upon each other, whilst obvious to staff, could be much less clearly visible to students, so that some effort had to be put into ensuring that students were aware of their own learning and its direction. For example students were often not just picking up technical skills in data analysis or research design but other transferrable skills, especially in group working and communication. As well as facilitating student learning, creating some kind of skill record helped students write better CVs and demonstrate their skills to potential employers.

Practice, repetition and 'flying time'

Cumulative knowledge also lies behind the issue of practice, repetition and revision. Many teachers said they sometimes found themselves revising or re-teaching things they expected students to have learned in previous modules. Others commented on the modest pace of learning that could be expected from students. This is partly a matter of curriculum space and partly the learning speed of students, which varies across different student profiles. However, it seems that given the radically different cumulative technical knowledge that students are building up, it is easy to overestimate the speed at which this can be done. Technical knowledge that may seem so obvious to teachers as to be hardly worth stating explicitly may be challenging to grasp for students learning QM, especially at introductory stages. There is probably no substitute for practice and repetition in consolidating such knowledge and skills, yet the time needed to do this is vulnerable when it comes to fitting all that centres aspire for students to achieve into the limited curriculum time available. It seems that students need, and benefit from, substantial 'flying time': repeated practice in applying the knowledge and skills they have been taught.

Surmounting the initial barrier to QM learning

The second insight from the experience of the Q-Step Centres is that we have probably underestimated the scale of the initial intellectual investment that students need to commit in order to learn QM. Many students and teachers described an initial state of confusion, disorientation and anxiety when learning QM until the initial superficial understanding of its core concepts comes to be properly integrated and mastered. At some point, students 'get it' and from then on everything is much easier. It would appear that there are a set of core building blocks of QM knowledge that each presuppose knowledge of the others and provide a platform upon which later learning is consolidated. Students face three challenges:

- Each of these blocks presupposes some understanding of the others, yet it is difficult to master them all at once.
- It is possible to 'learn' the formal properties or definitions of these blocks but still not understand how they function in practice.
- In addition to this conceptual technical work, students also need to master software skills through which it can be realised, such as SPSS or R. A few Q-Step Centres found that R implied an especially steep initial learning curve, however they also found that students eventually negotiated it successfully.

This barrier deserves some discussion. It may be useful to distinguish three 'levels' of QM learning, although they are not strictly hierarchical. The first, most basic, comprises a sense of some of the different forms that quantitative evidence takes, how such evidence is obtained, how to interpret simple tabular or graphical summaries of such evidence and how to avoid basic errors or confusions in its use.

The second comprises some ability to locate, analyse and present quantitative evidence independently, including the ability to manage and analyse relatively simple data using software, to produce graphical or tabular summaries, compute coefficients or carry out analyses using more than two variables, for example using regression techniques, and to understand the logic of observation and control.

The third goes beyond these technical competencies to a vision of the social world in which the understanding of causal narratives and their empirical illustration is replaced by the explanation of patterns of probabilistic regularities described in terms of the empirical distribution of variables and their association, and their comparison with 'theoretical' distributions in order to draw inferences given certain conditions. This third level of understanding, what one might call a 'statistical imagination' underpins the first two levels since understanding them is unlikely to get far without at least some understanding of probability. However, it can usually be fully developed only through much practice with the more 'technical' skills of the first two levels. It may be that 'getting it' is about coming to terms with this third level of understanding. To some extent, these understandings overlap, insofar as some technical competence in the former is a foundation needed to get to grips with the latter, while the former is unlikely to get far without at least some understanding of probability.

It seems there is no way 'around' this initial barrier, and several ways through it. Some Q-Step Centres focus first on 'theory', for example Edinburgh starts its students on 'Maths for Social Scientists', while others choose to start with exploring data as an avenue towards the statistical principles necessary to analyse and describe it. Hard work, plenty of practice, small group teaching, and peer learning all seem important. Here, the traditional format of lectures, seminars and labs can be a barrier to learning. It is often useful to focus teaching, learning and practice over a number of hours or even days in a workshop format (which may explain the success and popularity of formats such as summer schools and 'boot camps'). Once this initial barrier is surmounted, students seem rapidly to turn from being daunted by the process to being enthusiasts for the new skills they possess, and highly conscious of how this sets them apart from their peers on non-quants degree programmes, who they sometimes saw as 'coasting'.

How much contact time is necessary to surmount this barrier?

If this account of how students embark on learning QM is accurate, it has three implications for future work. The first is that it provides a rather different account of the failings of the typical 20-credit QM course to that of the 'faith and confidence' criticism that underpinned the emphasis on 'embedding' in the initial design of Q-Step. 'Embedding' addresses relevance, by placing QM within substantive learning modules and addresses confidence by increasing curriculum time devoted to quants. However, if 'getting' QM requires students to overcome some initial barrier created by the need to integrate a range of cumulative technical and theoretical knowledge, it may be that the key problem with the traditional 20 credit methods module is that it is either insufficient to carry most students through this barrier, or, by trying to take students too far, gives them an insufficiently robust command of the basics.

It may well be that most non Q-Step students who encounter QM only on a traditional methods module do not get beyond the initial state of confusion and disorientation, even though they may master some of the technical details well enough to perform reasonably on assessments. Even worse, it may be that such courses only teach students enough QM to put them off the subject, by taking them up to the barrier but not through it. Staff with limited curriculum time naturally try to cover as much as possible in order to give students a coherent view of what QM can achieve. This precludes much emphasis on practice, repetition and consolidation. Students have insufficient time and support to surmount the 'barrier' described earlier, and may conclude that QM is an alien territory accessible only to those with some special aptitude for numbers or maths. Unless they have realised the distinctive cumulative character of QM, their learning strategies may compound this, by leading them to a fruitless focus on specific aspects of the course rather than building up their knowledge and skills incrementally. If this is the case, it means that 'raising QM standards for all' may require more change than better methods modules plus reinforcement from embedding. It may require *either* the allocation of more curriculum space (so that most students can surmount the initial QM barrier) *or* a much more modest expectation of what students can expect to learn in one module. Less may be more, if teachers focus on ensuring that students have a firm grasp of some core skills, rather than a shaky understanding of a wider range of material. This is a difficult trade-off to get right.

The second implication is that 'embedding' may be more difficult to achieve and have less certain results than was hoped for, because it may be more difficult to articulate well with the kind of skills being developed in methods options, and because it may offer insufficient reinforcement of the skills being taught there. I discuss embedding further below, as there are other issues to consider.

The third implication is that it may often be easier to construct new degree programmes than reform existing ones. New programmes have much more freedom to allocate curriculum space, design the cumulative development of skills and create more flexible timetabling or teaching arrangements, and above all, to devote a larger proportion of time to 'methods' work. There is also another factor at work. New programmes are free to adopt their own understanding of what 'social science' comprises. This last remark needs some elaboration, and a brief historical excursion.

Paradigms of social science

In the teaching of social sciences at LSE and elsewhere, before the expansion of the 1960s brought social science departments to most other universities, the only 'methods' specifically taught were basic statistics, and perhaps some attention to questionnaire design and survey methods. Alongside expansion in the 1960s and 70s came the growth of 'interpretive' approaches and the critique of what was described as 'positivism'. These critiques led to the term 'qualitative' methods being applied to describe any approach that was not statistical, so that what 'qualitative' actually meant could vary greatly, nor was there necessarily any 'methodological' component to it.

Whatever the reasons for the success of these approaches, we do know that they became widespread and have led to an important feature of the way in which empirical evidence continues to be treated in many substantive social science modules in UK degree programmes. Evidence is usually there to do two things: (1) to illustrate a theory and (2) to serve as a background to debates about which theories are to be preferred. This is subtly different to the status of empirical evidence within a quantitative approach. Here the emphasis is on data exploration (i.e. what *is* the key evidence and how far is it consistent with different accounts of the social world) and the scrutiny of evidence, either to examine its status (is it robust or does it depend on questionable assumptions about its production or interpretation), or to *test* existing theory in some way rather than *illustrate* it, for example by demonstrating that a theory or argument is incompatible in some way with empirical evidence.

Embedding

Given this division, staff unconvinced of the value of quantitative approaches may not always see the relevance of incorporating quantitative empirical material into their courses, nor have the skills to do so, nor do it in such a way as to reinforce students' learning in their QM options. So far 'embedding' seems to have enjoyed mixed fortunes in the Q-Step Centres, and is often dependent on the commitment and cooperation of non-quants colleagues that is not always forthcoming, leaving the bulk of teaching resource preparation to Q-Step colleagues. This presents a dilemma. Would the time spent on 'embedding' be better spent on other activities? Or does it represent the inevitable investment of time needed to shift slowly the balance in existing degree courses towards greater use, scrutiny and discussion of empirical evidence? This raises a wider question of the best balance to be struck between reform of existing degree programmes, and the creation of new ones, which might initially reach a much smaller number of students. There is no clear answer to this question, but it is one of which Q-Step Centres ought to be aware.

7. Student identity

Virtually every Q-Step Centre has found that its students have rapidly developed a strong sense of identity, indicated by many student-led initiatives such as organising student societies or events. This identity should be cultivated as it is a potentially valuable resource. It will help develop an effective approach to alumni engagement, and with tracking the destinations of graduates. It could also be developed *across* Q-Step Centres, for example by establishing a Facebook group or other social media platform. Regional student events seem to have been successful, since they avoid large accommodation or travel costs. Some sense of identity increases students' commitment to the programme, and heightens its

'internal' visibility in universities. The programme's students and their achievements are a tremendous asset that ought to be exploited appropriately. They make an invaluable contribution to student recruitment, employer engagement and to demonstrating the value of Q-Step to Vice Chancellors.

8. Graduate Teaching Assistants

Small group teaching and the use of graduate teaching assistants (GTAs) is virtually universal, as it was in the universities studied in *Measuring Up* (2). This raises three issues. The first is training for GTAs and the related issue of upskilling other teaching staff who may have limited skills or experience of QM. The second issue is the supply of GTAs. This will mean that the commitment of the new Doctoral Training Programmes (DTPs) to providing good QM training will be important. To the extent that Q-Step provides a good supply of students going on to postgraduate study this problem will be addressed. However, there is no guarantee that each Q-Step Centre will have access to an adequate supply of good GTAs in the short to medium term. The GTAs I met were as enthusiastic as the Q-Step staff themselves, and provided excellent role models for undergraduate students. The third issue however, is the incentive structure for GTAs. Were they to consider the career benefits of e.g. writing and publishing a paper and compare them to those from teaching, then the returns to the former are much greater. It would therefore be valuable to ensure that GTAs' contributions to teaching is recognised in a way that enhances their future career opportunities.

9. University timetables and regulations

The inflexibility of existing university timetables is often a constraint, and greater scope to develop more intensive blocks of teaching as necessary would be useful. 'Summer schools' of various kinds seem to have been successful, as have some of the regional events on which some Q-Step Centres have collaborated. There seem to be substantial pedagogical benefits from enabling relatively small groups of students to work together for several hours, or over several days, without other distractions. It also helps to build a sense of community and common purpose amongst students, rooted in part on their sense of achievement from developing new skills. There seems to be little student resistance to more contact time.

10. Work placements

Work placements appear to have been very successful; employer and student reaction is universally enthusiastic, and again this is a story of diversity in the kind of work done, arrangement for payment, length, timing and assessment. However, we have learned that:

- Placements take a great deal of administrative effort to establish and manage, so are relatively resource intensive.
- There is some sense that Q-Step Centres that established their work placements earliest were able to secure the 'best' opportunities.
- Assessment, where it is in place, is a substantial challenge.

It would make sense to form a working group specifically on placements, rather than relying on whatever other arrangements are made for communications between Q-Step Centres. Such a working group should consider producing a guide to the issues involved and alternatives faced in organising placements (so that lessons learned are shared), and there may be some role for coordinating the supply and demand of placement opportunities centrally.

11. Support

Q-Step Centres have trialled a number of different support mechanisms for students, such as drop-in support sessions, 'maths cafes', progress cards, and mentoring and 'data buddy' arrangements. All appear to be useful, however it is too early to reach any firm conclusion about what methods work best and in which situations. It does however; seem to be useful to distinguish 'maths support' as offered in many universities, from the kind of support social science students learning QM require. Most QM requires little advanced maths, but it does require fluency in basic arithmetical and algebraic operations that many social science students will have lost after dropping maths at 16.

12. Sustainability and scalability of current pedagogical approaches

Current teaching is resource intensive, and in many cases students are to some extent self-selecting. This raises the question of how far it will be possible to scale-up existing efforts, or whether results might become less impressive with larger cohorts of possibly less motivated students or less committed staff. However, against this it could be argued that much of the effort so far has gone into the construction of new teaching resources, new modules and degree programmes. This overhead investment should reduce the teaching burden in the medium term, and once made, needs much less effort to reform and refresh in future years.

It seems that Q-Step often has a higher external than internal visibility within higher education institutions (HEIs). Internal visibility is important for developing a wider awareness of the importance of the skills that Q-Step students are learning, the volume of work, curriculum time and staff effort involved, and crucially, for sustainability.

13. Learning gain

The diversity of approach, nature of degree programmes, and student profiles across Q-Step Centres means there was no common standard of 'learning gain' and this was part of centres' uncertainty about how well they were doing. Learning gain is frustratingly difficult to measure and poorly captured by such metrics as 'learning outcomes'. While it would not be useful to set a common standard, or establish one as a target for centres, it *would* be valuable for many audiences (recruitment, employers, and universities) to be able to describe the skills and knowledge that Q-Step students develop. There was a feeling in some centres, not least from the students themselves, that those on Q-Step degrees were developing skills and knowledge to a level that was significantly higher than their peers on other degree programmes. In many cases, because of the low level of QM teaching on other social science degree programmes, undergraduates are doing work above the standards expected of students on Masters or doctoral training programmes. The implications of this requires some consideration. Different degree programmes have always demanded different

levels of performance from students, so that Q-Step is not exceptional in this regard. However such differences ought to be readily visible, both to applicants to the programme, and to employers recruiting from it. Degrees garner a public reputation that enhances or moderates their value, so that opportunities to foster this public reputation should be taken. One way of doing this would be to develop some kind of record of student achievement, or summary statement of the skills and knowledge typically acquired by students on Q-Step programmes. This would also help centres to compare their activities with each other.

14. Communications: Sharing teaching resources

The innovative nature of Q-Step means there is a lack of suitable available teaching materials, leading centres to create their own 'bespoke' resources. Much of this effort has been necessary, as textbooks tend to focus on statistical analysis rather than 'data wrangling' or the range of data management and preparation skills necessary to take raw data and transform it into a form suitable for analysis, and then present that analysis in an understandable way. It is also valuable to have material that reflects particular disciplines, or combines 'theory' with more practical skills, such as using software. At a more basic level, the range of module specifications and reading lists produced by centres is extensive.

Sharing these resources is a challenge. This is to be expected. There is little tradition in higher education of either the collective development of, or sharing of, teaching resources. Many projects that have set out to stimulate this have had modest impact, at best. I found that people are willing to share the teaching and assessment materials they have created, but are inhibited by apprehension that they will be received critically, especially as most resources are not fully finished, created as they are to a tight schedule that leaves little time for editing or review. Paradoxically, this 'work-in-progress' character actually makes resources *more* re-usable, since they typically have to be tailored towards specific module objectives or different target student audiences. There is no obvious channel to facilitate sharing. We know from the experience of JORUM and other initiatives that simply providing a platform is insufficient. Resources need to be effectively catalogued, tagged and promoted, intellectual property needs to be protected and copyright observed if relevant, and resources need to be deployable across different virtual learning environments. Rendering resources shareable takes time. Competing, pressing, priorities on staff time mean that this work will not be done spontaneously or voluntarily. It therefore requires someone with the knowledge and experience to curate and promote resources. It would also be useful to involve the end users, students, in this process. I was struck by the way in which some groups of students had constructed and shared lists of useful web resources they had discovered. Some mechanism whereby students reviewed, quality assured or commented upon teaching resources would be very valuable. Done well, sharing will reduce the burden of creating teaching and assessment material across all centres, as well as making it easier for staff in other universities to emulate what Q-Step has achieved. Access will need to be managed so that resources are available only to staff in other centres, to students, or more widely as appropriate.

However, none of this will happen until staff members faced with producing or revising teaching or assessment material are confident that searching out and adapting material produced by others will be easier than creating new material. This requires three things. Resources need to be catalogued or tagged in a way that fits with teaching aims or learning

outcomes. Unless a system can take someone quickly to what they want, or show that it doesn't exist, it is unlikely to be used. They need to be as 'granular' as possible (that is, capable of being adapted or disassembled for different purposes easily). Finally, they need some form of promotion or publicity to regularly remind people of what is available, so that the creation of new resources ceases to be the default option.

It would be helpful if centre convenors could agree a 'code of practice' on sharing material to encourage its development. As a first preliminary step, my sense from talking to centres is that there would be no resistance to requiring teaching staff to deposit course outlines and 'associated teaching resources' in a repository accessible to other Q-Step staff. 'Associated teaching resources' is a deliberately vague formulation. The ideal scenario is that open-ness and willingness to share by individual staff would encourage reciprocity and the creation of a steadily more valuable source of material. The development of shared resources should also stimulate more communication between centres, which has hitherto developed in a piecemeal fashion, and left some centres with little sense of 'how they are doing' in comparison to others.

Whatever method Q-Step chooses to address this problem, it should be done in consultation with the ESRC National Centre for Research Methods and the UK Data Archive, which are both active in producing teaching resources, and it may also be useful to involve the private sector (such as Sage) who have also developed suites of resources that many universities subscribe to, and who have greater technological experience in the area.

15. Communications between Q-Step Centres

This has perhaps been a weak spot in the development of the programme. The intranet constructed by the Nuffield Foundation remains virtually unused, as does the Wiki developed by one of the centres. The workshops held at the Q-Step Symposium in Warwick demonstrated a desire amongst centres to find out more about each other's activities and to share experiences, yet no 'spontaneous' system of communication has emerged. Again, this is probably due to competing demands on staff time, but it means that pedagogical lessons learned are not always being shared, compared or reflected upon.

The traditional solution to this has been production of news bulletins, the regularity of which provides a deadline to create or pass on 'news'. More innovative solutions attempt to share news using social media (LinkedIn, Facebook groups/pages or Twitter), or via an email discussion list, such as the QM teachers list supported by the National Centre for Research Methods (NCRM). None of these platforms have decisive advantages or drawbacks, but to be successful they will need someone to energetically edit, develop and promote them. Initially, this will require a reasonably substantial time commitment, perhaps 30% of a staff member's time for six months or so. Once established, this role that might rotate around centres or transfer to a group drawn from the centres. Such communication ought also to facilitate working or interest groups on particular topics, such as placement organisation, where it was clear that some centres had built up valuable experience that could readily be passed on.

16. Conclusion

This review has touched upon many activities and outcomes that are still developing but which nevertheless provide strong evidence that Q-Step is having a positive impact on students, academics, employers, and institutions. In some ways the challenge facing Q-Step may have been greater than originally envisaged. Creating new modules and degree programmes, and precipitating institutional change, requires more than simply producing new lecture notes or courses. From the perspective of pedagogy and innovation in teaching and learning, however, it appears that those challenges are being met with success. The achievements of students taking Q-Step modules shows that students can develop a much more robust command of quantitative methods than has typically been expected of social science students within their degree programmes. Students on Q-Step programmes have a command of quantitative methods that goes well beyond what has previously been achieved on undergraduate degrees, preparing them to go on to postgraduate work using advanced 'quants' or to help meet the strong demand from employers for graduates with quant skills. These achievements have been made possible by the energy and commitment of Q-Step teaching staff, GTAs and administrators on the one hand, and the enthusiasm of students who discover an aptitude for quantitative work on the other.

Many students find quantitative work difficult and view it with some trepidation. Q-Step has given us new insight and understanding of the challenges students face and how best to tackle them. Successfully getting students over the initial barrier to learning requires skill and support, but also time and adequate curriculum space. The cumulative nature of much quantitative knowledge and skill also means that students can chart their progress and see where it is leading. In this regard, the work placements, attractive in their own right, give employers a chance to shape the skills of the future and allow students to put their abilities to the test. Crucially, they also help students get a sense of the wider workplace context that their technical skills need to fit within, and the premium on communication and team working skills.

Students are beginning to develop a strong sense of collective identity as 'Q-Steppers'. Their interest and achievement will form an important complement to efforts to promote Q-Step to potential new students, and to ensure that universities and employers fully appreciate the value of the programme. This student/alumni network needs to be grown and supported.

Lastly, and possibly as a result of the pace of change, implementation and delivery, the efforts to link up Centres and Affiliates as a self-supporting network that regularly shares experiences and teaching resources has not taken hold successfully. While different platforms can be tried and tested, this has more to do with supporting a change in the way Q-Step colleagues work together. This, arguably, is not a change that can develop on its own and may benefit from the establishment of a role dedicated to network building and management.

Q-Step has established itself swiftly in the academic world and is beginning to attract the interests of potential new students, employers, institutions and disciplines not yet covered by the network. There is, even at this early stage, much to be learned and shared with others. The programme is well on the way to securing a step-change in quantitative social science

training in the UK. To the extent that the insights and experiences of the programme are shared and taken up elsewhere, we will be closer to achieving that goal.

17. References

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