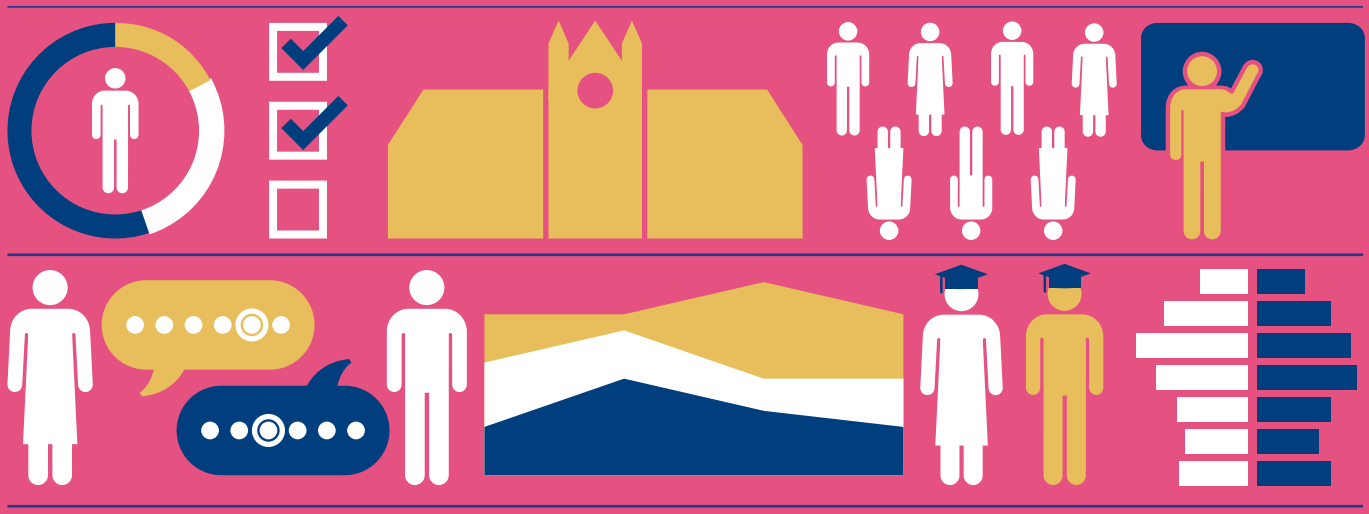
MEASURING UP: INTERNATIONAL CASE STUDIES ON THE TEACHING OF QUANTITATIVE METHODS IN THE SOCIAL SCIENCES

John MacInnes, Maddie Breeze, Maite de Haro, Mor Kandlik and Martina Karels



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Foreword

The UK is in the enviable position of having one of the world's most successful higher education systems. The social sciences are central to this hard-earned reputation in research excellence, and are internationally recognised as as one of the UK's top research strengths. Furthermore, the social sciences are a crucial instrument in the UK's toolbox for addressing some of the most pressing societal challenges of the 21st century: an ageing population, rising obesity, climate change, energy security, migration and wealth inequality can only be understood through investment, and insight from, the UK's social science base.

In its *Society Counts (2012)* statement however, the British Academy drew attention to long-term vulnerabilities within the UK's higher education curriculum. It uncovered a long-standing lack of emphasis on quantitative methods in many courses and programmes of study, and an insufficient attention in degree programmes to methodology and the systematic organisation and production of empirical evidence. Moreover, it found the teaching of quantitative methods failed to relate adequately to the course, skills and research interests of students. Arguing that UK universities suffer from a poverty of aspiration in relation to their students' quantitative ability, the Academy calls on decision makers to intervene in its recent report *Count Us In (2015)*, to ensure the UK moves to a situation where it is normal for science, social science and humanities students to have developed quantitative skills at every stage of education. Following on from this, the Academy has commissioned the ***Measuring Up*** report, as a resource specifically for the higher education community.

Measuring Up is a review of social science departments, identifying the quantitative methods that departments embed in their courses, how they do this, and the effects this has on their students in terms of enhancing their quantitative skills. Looking at 16 different departments across three continents, the report offers an insight into what works in other departments, and the many opportunities for UK higher education leaders to learn from the lessons of other departments across the world.

Changes to the funding landscape of higher education – an increasingly marketised environment where the choices of students whilst still at school will govern the behaviours of university departments – makes the challenge more urgent. How do we embed into our curricula training in those higher level skills that employers and the research world require, but which students fear, or historically have not chosen to pursue? This will require creative solutions, and I urge leaders in higher education to read this report closely, and explore the ways in which they may implement changes in their own departments, in order to ensure the UK retains its position as a global leader in the social sciences.

Professor Sir Ian Diamond FBA FRSE FAcSS
Lead Fellow and Chair of the High Level
Strategy Group for Quantitative Skills
The British Academy

Executive summary

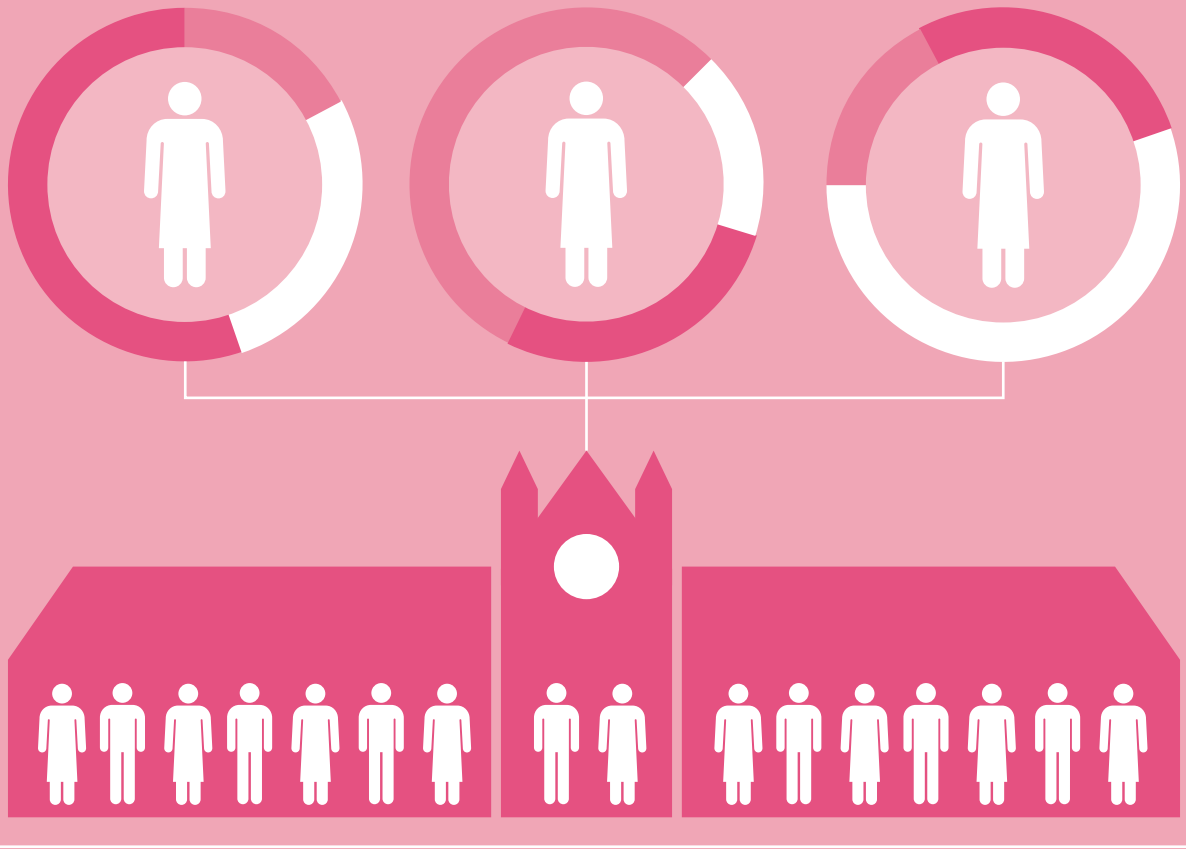
Undergraduate social science students in many universities in Europe, North America and Australasia reach much higher levels of achievement in quantitative skills than even their best UK counterparts.

They are able to do this because their degree programmes devote a much larger share of curriculum time to the study of methods, both quantitative and qualitative, and because the curriculum gives more attention to the collection, evaluation and analysis of empirical evidence.

University teaching staff are much more likely to have advanced quantitative skills than in the UK, but substantial amounts of teaching and support are also provided by post docs and postgraduates.

There is no ‘one best way’ to teach quantitative skills to undergraduates but small group work, working with ‘real’ data, peer learning, frequent assessment and having students write scientific research papers rather than essays are all common features.

If UK universities are to reach the standards achieved by leading universities elsewhere they must consider both the curriculum content of degree programmes and the skill mix of teaching staff.



Chapter one

Introduction

In spring 2015 the British Academy asked the University of Edinburgh to review the provision of quantitative skills (QS) training in social science degrees in leading universities around the world. The aim was not to carry out a survey, given that Parker (2008) had undertaken such a review, but rather to gather examples of best practice and consider their implications for QS training in UK university social science.

This report therefore presents and reviews brief case studies of best practice and innovation in the teaching of quantitative methods (QM) and statistics to undergraduate social science students in 16 universities around the world. It focuses on sociology, social policy, politics and international studies and related disciplines (such as organisation studies, management, education, communications studies). It does not cover economics and experimental psychology given that the approach to teaching in both these disciplines is rather different, both in the UK and elsewhere, so that quantitative skills are generally well developed in degree programmes.

It is not a study of any representative, 'average' or general approach to such teaching in the countries concerned. Nor is it a study of the 'top ten' universities or courses. There is no general survey of QM provision in higher education around the world that would allow us to make such a judgment, even if agreement could be reached on the criteria by which such a judgement could be made, which is doubtful.

Rather the research sets out to uncover examples of best practice or innovation across several countries. The research team identified university departments to approach based on their own knowledge and contacts, and then 'snowballed' by asking these contacts about other departments that they considered might fall into this category. Such an approach carries the risk that only departments within a restricted network of academics familiar with each other's work would be identified. We are confident that this is not the case. However it certainly is the case that a different list of university departments could have been drawn up. Time constraints also meant that there are some universities that we would have liked to include but had to leave out. However we doubt that a different selection of universities would have led to us uncovering a substantially different range of approaches to teaching, or led to us drawing together a substantially different set of lessons or recommendations.

The study is based on interviews with those responsible for the delivery of the teaching, or those who are knowledgeable about it, together with curricula, course outlines or other materials where these were available. The study is thus less comprehensive than Parker's (2008) but collects a fundamentally different range of information. Parker's valuable study collected data on the number of methods courses students took in different disciplines and national higher education systems, but did not examine the content of these courses or how they were taught. We instead are focusing on what lessons QM teaching elsewhere might have for universities in the UK. Our aim was on the one hand to collect enough detail on individual degree programmes and courses to enable readers to reach some judgment about how they function, but on the other hand to produce such case studies in as brief a format as possible to avoid drowning the reader with a mass of detail.

Chapter two

Teaching quantitative skills in university social science: The challenge

Several reports over the last decade have highlighted the fragile position of quantitative skills teaching (QS)[1] in UK social science university degree programmes. The problem is long standing. Seventy years ago the Clapham report on UK university social science noted 'there was a chronic struggle […] for the services of a supply of statisticians' (1946: Para. 18). Rosenbaum (1971) made similar observations and noted the lack of numeracy among social science graduates and the 'disappointingly low' standard of quantitative work in research grant applications.

The British Academy (BA) together with Economic and Social Research Council (ESRC), Higher Education Funding Councils (HEFCE, WFC, SFC) and Nuffield Foundation have tackled the problem recently in a number of ways including:

- Ensuring that all social science postgraduate training includes QS.
- The ESRC *Quantitative Methods Initiative* including the Secondary Data Analysis research programme, and the website quantitativemethods.ac.uk
- The ESRC *Curriculum Innovation/Researcher Development Initiative* programme to produce teaching support materials and training for QM teachers.
- The British Academy policy statement *Society Counts*, together with statements of support from the leading social science professional associations.
- The Nuffield, ESRC, and HEFCE Q-Step programme, establishing 20 centres of excellence in undergraduate QM teaching to secure the 'pipeline' to postgraduate quantitative research.
- Establishing the British Academy's High Level Strategy Group (HLSG) on Quantitative Skills bringing together key stakeholders to coordinate activity around the quantitative skills agenda.
- The 2015 British Academy report on data skills and the economy: *Count Us In*.

The essence of the issue is straightforward to describe, if less easy to remedy. Students in the UK arrive at university to study social science with a range of maths and basic numeracy skills, but only a minority (around 20%) will have A-Level maths while many will have had two or three years without doing any maths in school (after taking GCSEs), or in some cases, no maths qualifications

1 QS are often referred to as 'quantitative methods' (QM). We use the term quantitative skills to cover both skills and methods.

at all. Whatever students' level of maths skill, previous teaching will be unlikely to have had much focus either on statistics or on the application of maths (although revisions to the A-Level curriculum and the introduction of Core Maths may improve this state of affairs).

Once at university the average undergraduate social science curriculum devotes little space to QS, usually in stand-alone methods options that are not always well integrated with the substantive elements of the degree, and can cover only a very limited amount of material in the curriculum time available. This is not the case is economics, demography, psychology and some other areas, where quantitative skills are central to degree programmes. Outside these subjects, only a small minority of academic staff are competent in QS, they devote proportionately more time to externally funded research (reducing their availability for teaching) and there is no necessary link between competence and teaching ability (MacInnes, 2009). Thus departments could find it difficult to expand the amount of curriculum time devoted to QS, even if they wanted to do so. As a result practical research project work by students tends to be qualitative or theoretical, and QS are rarely integrated into or developed by substantive courses.

Students graduate without developing extensive QS, experience in applying them or confidence in using them. This influences the methodological choices postgraduates make at Masters and Doctoral levels, so that the imbalance in faculty skills, skewed towards qualitative work, is reproduced. Thus students not only arrive at university with little exposure to statistics or quantitative skills, but typically are given little encouragement, opportunity or requirement to develop these skills in their undergraduate programmes. If they progress to postgraduate study, they are ill prepared to develop QS there, while if they enter the graduate labour market, they do so with weak quantitative and even numeracy skills.

This weakness is important not only for academic but also for practical economic reasons. The range of high quality quantitative data available to social scientists is increasing exponentially, so that keeping up with new knowledge in any discipline requires the ability to understand quantitative evidence and the techniques used to analyse it. Teachers or students without these skills cannot understand or follow an ever increasing proportion of the literature in their fields of study.

As the BA report *Count Us In* showed, these skills are also fundamental to the development of the digital economy driven by new ways of extracting value from all kinds of data. To be successful the UK economy needs enough graduates with these skills, or the ability to work with and understand those who have advanced QS. The social sciences, and also the humanities, can deliver graduates with the necessary skills, but to do so their curricula need to change.

The Higher Education Careers Service Unit *Futuretrack* study followed a cohort of students who entered university via UCAS in 2006, following them through to graduation and entry to the labour market. The following table shows their views in their final year of study about how much they thought their degree had developed their ability to use numerical data. Fewer than one in ten students studying STEM subjects, economics or psychology answered 'very little' or 'not at all', but no less than seven out of ten humanities students, six out of ten politics students and four out of ten sociology students did so. Conversely fewer than one in twenty social science or arts and humanities students thought their degree had developed their numerical data skills 'very much' (see Table 1).

Table 1 Third/Final year students' views of their degree: development of ability to use numerical data

	Maths	Economics, finance & accounting	Psychology	Biology	Sociology	Politics	All STEM subjects	Soc. Sci. excl. Economics	Law, Arts & Humanities
Very much	63.2	42.1	24.5	18.9	3.4	3.0	29.0	7.7	2.1
Quite a lot	26.0	46.6	50.9	54.0	16.3	10.2	42.1	23.1	6.5
A little	10.2	9.6	18.6	22.9	42.0	30.3	21.1	32.7	23.2
Very little	0.4	1.4	5.1	3.7	27.7	33.6	6.4	24.0	32.9
Not at all	0.2	0.3	0.9	0.5	10.6	23.0	1.4	12.5	35.4
Unweighted N	383	630	928	357	173	315	4,984	2,800	4,332

Source: HECSU Futuretrack survey

A key question that arises is therefore how universities elsewhere approach the teaching of QM and the development of QS in their undergraduates. Understanding those universities which are most successful in delivering much higher levels of achievement by their students ought to help us design better undergraduate curricula and pedagogy, and make best use of the resources that have been made available to tackle the QS deficit in UK higher education.

This report thus describes the key features of successful approaches elsewhere. Two things stand out clearly. First, students from these universities become proficient in a range and level of quantitative skills that are far superior to those of graduates from even the best UK undergraduate programs. UK universities set their expectations unacceptably low. Second, any UK university that wished to could emulate what the universities we examine here do. All that is needed is suitably qualified staff, good teaching and adequate curriculum time.

What stops universities in the UK rising to this challenge? By far the most important barrier to change is the very low proportion of staff in university social science departments who themselves have quantitative skills, and the inertia in the system that makes raising this proportion difficult. As MacInnes (2009) showed the proportion UK social science faculty with *any* quantitative skills at all is astonishingly low: almost certainly below 10%. Allied to this is the relative lack of attention to methodology (of any kind) in the social compared to the natural sciences. This is not the place to go over the post war history of UK higher education, however the rapid expansion of UK university social science in the 1960s and 1970s led to the recruitment of staff with little if any formal methodological training, and to the development of social science curricula that followed the model of the humanities rather than the natural sciences. This appeared to matter little in an age where the collection and analysis of quantitative data was often a cumbersome and expensive process. However, once a department has few or no 'quants' staff, this weakness persists because departments tend to recruit 'in their own image': it is usually easier and more attractive to reinforce existing areas of strength than remedy areas of weakness.

Thus although *every* recent *International Benchmarking Review* commissioned by the ESRC for individual subject areas has singled out QS as an area of weakness, neither individual universities or subject learned societies (with the exception of the Royal Geographical Society) have responded to these signals. The result is market and institutional failure. One might imagine that the need to stay at the forefront of an academic discipline or keep their graduates

competitive in the labour market would encourage departments to embrace QS. Unfortunately neither of these pressures (although there is ample evidence of their existence) has been strong enough to stimulate change. Evaluating the performance of the social sciences and humanities is often more difficult than in the natural sciences because little of the knowledge produced takes a cumulative form within an agreed paradigm: rather there is continuous discussion not only about what approaches are appropriate, but about their value and merit. For example submissions to the last REF Sociology panel were published in over 800 separate journals. The evaluation of teaching and research within higher education is driven by peer review. However, if there is disagreement about what constitutes the core of a discipline or the methods it employs, the danger is that peer review acts to reproduce the prevailing majority view and institutionalise inertia in the system. Given the weakness of quantitative approaches in the UK, peer review together with hiring decision autonomy, has entrenched this weakness.

This report makes it clear that a major reason for the achievements of the universities studied here is that they devote *much* more curriculum time to the development of quantitative skills, and that, while they use specialist methods modules, the skills learnt there are practised and reinforced in students' substantive modules. Following this model in the UK will require extensive staff training or professional development, since it is not only necessary to staff the specialist quantitative skills modules, but also those other modules where skills are applied and practised. It will also require department to take a more strategic view of their teaching and skills development. Teaching tends to follow the research interests of staff, yet these may map poorly on to the skills needs of students.

It remains to be seen what the final form of the Teaching Excellence Framework in England will be. In theory the drive to improve teaching quality ought to encourage universities to improve their delivery of QS. However there is no necessary link between the quality or importance of skills delivered by individual modules and their popularity with or evaluation by students. Students unfamiliar with numerical work, who may have last studied school maths some years before, may rate QS modules less highly, either because they find them challenging, or because they only come to appreciate their value in the graduate labour market later on. There is a real risk that unless it is configured well, the TEF might actually act as a disincentive to good QS delivery, in a similar way to the impact of the National Student Survey in some universities.

Finally, the discussion above suggests that the Nuffield, ESRC and HEFCE Q-Step programme, insofar as it has focused on staff recruitment, increasing the curriculum space for QS teaching, innovation in pedagogy and expecting students to achieve much higher levels of proficiency in QS, is already doing much to follow the approaches taken by the universities studied here. The decisive challenge is to persuade other universities to follow its lead.

Chapter three

The case study research: Leading universities

The project set out to review examples of best practice and innovation in the teaching of quantitative methods and statistics to undergraduate social science students in universities around the world. It focuses on sociology, social policy, politics and international studies and related disciplines (such as organisation studies, management, education, communications studies). It does not cover economics and experimental psychology given that the approach to teaching in both these disciplines is rather different, both in the UK and elsewhere.
It considered four questions

1. What is the range of achievement in QS of degree programmes elsewhere?

2. How far, if at all, do the best approaches exhibit common teaching methods, curricula, assessment or other features, that might form a core of best practice in delivering QS?

3. How far are these approaches translatable to a UK context, or alternatively, do they depend upon special factors inhibiting such transfer?

4. What can UK universities do to reach the standards achieved in the case study universities?

Levels of achievement

It is important to consider five distinct skills in social science quantitative methods:

- Research design (how to carry out empirical research systematically so that the research can address a social science issue, problem or theory).
- Data analysis (how to organise and use quantitative evidence to draw conclusions about society, institutions and social process).
- Statistics (sets of rules and formulae for describing and summarising data, drawing inferences from it and quantifying uncertainty, including when data is drawn from samples and used to make statements about target populations).
- Using computers (how to use computer software to handle data and implement statistical procedures).
- Understanding the relationship between methods, theory and substantive issues in a discipline (how to recognise and evaluate the methodological component of social science knowledge).

In all these areas students in the vast majority of the universities we studied reach much higher levels of proficiency and technical skill, and demonstrate a wider range of quantitative knowledge and experience than is found in even

the best undergraduate programmes in the UK. The gap is perhaps greatest in data analysis and statistics, where students gain much more experience of multivariate analysis and data reduction techniques, and in the integration of methodology with substantive knowledge. The level of achievement expected of students is much higher than in the UK.

UK students will typically learn basic descriptive statistics, elementary conditional probability, the production and interpretation of contingency tables, simple graphical presentation of results, some measures of association for two variables, and some introduction to questionnaire design, survey methods and sampling. They may learn the basics of inference, hypothesis formulation and significance testing, and perhaps, in some of the more advanced courses, an introduction to regression. More rarely they may learn about secondary data analysis, controlling for prior variables, and enough about linear regression to use it as a tool of analysis rather than only being able to understand the meaning of regression coefficients in published work.

In the universities we reviewed students went far beyond these basics. Perhaps more important than the detailed content of the quite diverse curricula offered by our case study universities, was their common commitment to giving students the skills they needed to critically interpret multivariate analyses in substantive research literature, and to aspire to undertake similar analyses themselves. This standard of achievement comprised five main components.

1. Students become proficient in a data analysis package, sometimes SPSS using the Graphical User Interface (a menu driven system of commands) but more usually learning either SPSS syntax or a command language based package such as Stata or R, where statistical and data analysis functions are driven by a programming language. The use of syntax or programming languages both requires and reinforces a deeper understanding of the statistical theory underpinning data analysis.

2. Rather than dealing only in single variables, students go much farther in multivariate analysis, where several indicators are used to measure an underlying variable, through data reduction techniques such as factor analysis.

3. More time and attention is devoted to a deeper understanding of different types of regression analysis for both continuous and discrete variables, including the production and interpretation of diagnostics, the elaboration and testing of models, and the consideration of time series and longitudinal data. In some cases this extends to multi level models, hierarchical data and the treatment of causality through, for example, structural equation modelling.

4. More attention is given to producing the equivalent of scientific research papers, with a literature review, formulation of a research problem and associated research design, hypothesis formulation, identification of relevant evidence or data, analysis, results and conclusions. Students typically do this several times, much as they might produce essays for a course unit in the UK. By contrast UK students would typically learn about this, if at all, only in the context of an end of degree research project.

5. Students are given far more exposure to working with a variety of quantitative data, rather than working through practice exercises or material specifically designed with teaching in mind. Sometimes this is extended to the process of primary data collection, but with more attention given to the design of survey instruments, survey methods and sampling design, at a level students would normally only encounter at postgraduate level in the UK.

Teaching methods and pedagogy

Developing these skills takes time. This was made possible by devoting a much larger proportion of study time, usually in a range of courses across all three or four years of the degree. In most universities in our study the proportion of curriculum time devoted to quantitative methods was at least three times the UK average and often much more than this. The case studies cover many different approaches to pedagogy. Individual programmes varied widely in the specific way they balanced generic versus discipline specific teaching, the relationship of theory to practical application, the sequence and timing of skills taught, the balance of large lecture classes and small group teaching, and forms of assessment. Large, sometimes very large, generic classes with students from several disciplines, were not necessarily a barrier to good teaching. We did identify at least five common features however:

1. All the universities start teaching QS early in the degree, usually in the first semester and always within the first year.

2. They devote much more curriculum space to methods teaching in general and QS in particular than is typical in the UK. While the volume of contact hours and balance between lectures and smaller group teaching varied across universities it was everywhere higher than is common in the UK.

3. Most used intensive forms of continuous assessment to support students, given that knowledge and skills were cumulative in character, and frequent practice was seen as fundamental to sound learning.

4. All universities had a clear sense of progression in the teaching with more advanced skills building on earlier knowledge, although this certainly did not obviate the need for revision and consolidation of earlier work.

5. The diverse set of skills that comprise QS were often brought together in the standard structure of a scientific paper (literature review, identification of a research problem, research design, hypothesis formulation, analysis and testing, results and conclusion). In most programmes students gain experience of writing and presenting several such papers not only in 'methods' courses but in substantive courses too. This also affects how they are taught 'theory' which is seen as something tested by and elaborated through empirical research. This contrasts with the dominance of the essay in student work in UK social science degrees.

Only a minority of universities used 'embedding' where a course with an overall substantive theme is used to develop specific methods skills, but almost all the methods teaching took place within a context of degree programmes that gave more attention to questions of method overall, alongside substantive knowledge. It was normal for students to do extensive secondary data analysis

with material such as the *European Social Survey* or *World Values Survey* or other datasets, rather than rely on primary data collection.

Most universities continued to rely upon courses that were primarily about methods, albeit many would link this to a variety of substantive issues to make clear the relevance and application of the methods taught. Many universities continued to use generic lecture courses (where students from different social science degree programmes would follow the same course) with large class sizes (of up to several hundred students) however this was always accompanied by smaller group teaching or practical work where teaching would be more focused on individual disciplines. Almost all the universities used postdoctoral or postgraduate tutors to facilitate smaller group teaching, and many used different forms of peer learning where students work in groups. This not only reduced the volume of teaching done by faculty, but had pedagogical advantages insofar as students learned from each other as well as staff, and learned to work in groups.

There were no common answers to how to balance the formal statistical and mathematical theory underpinning QM with its practical application within a discipline, or on whether to develop a practical understanding first, and learn the general theory later, or move from theory to practical understanding. In both Auckland and Harvard, teachers set out to capture students' interest via 'intuitive' approaches to data analysis and visualisation, before proceeding to examine the formal statistical ideas on which a more developed interpretation might be based. However there was a universal concern to avoid 'point and click', where students rote learnt procedures using data analysis software without a secure understanding of the concepts underpinning it.

Forms of assessment were also varied, from traditional 'pencil and paper' exams to individual or group project work and presentations. However a common feature was the use of frequent or continuous assessment of various kinds, both as a stimulus to learning and as a way to monitor student progress and understanding, given the essentially cumulative character of much quantitative knowledge.

Beyond the differences in approach there was a general concern to develop innovative or imaginative forms of teaching that would transform student apprehension about maths and statistics (which was common in almost all universities) into a 'sense of achievement' once these skills were mastered. Some of this innovation was in response to poor student evaluations of 'unpopular' methods courses. There was a consensus that there is no reason why proper attention to QS should be problematic for 'the student experience' or, in a UK context, National Student Survey (NSS) ratings.

Student 'resistance' to learning statistics or 'quants', or expectation that a social science degree will not be about numbers, students' 'fear of maths', level of aptitude for or competence in maths, or weak school preparation in relevant skills (such as statistics and the application of maths ideas in novel contexts) is not confined to the UK. While a minority of universities made it clear that students would require good maths skills, very few set specific maths requirements and none required a level of maths skills higher than those required for general entrance to a social science degree programme. Some programmes offered maths support to students, but only one required students to take a maths course. However given the 'outlier' position of secondary

school maths education in the UK, especially in England, it may well be that the case study universities reviewed here could assume a higher level of maths competence from their incoming students. Our respondents did not see either student attitudes or skills as a barrier to students successfully progressing to much higher levels of technical achievement than are typical in the UK. Many also felt that any such student resistance has declined in recent years. Four important means of overcoming it that they cited included:

1. To stress that quantitative (and qualitative) methods are fundamental and basic tools that any social scientist needs to possess.

2. To ensure that students not only see the relevance of methods to the substantive issues that interest them, but also to show how curiosity and imagination are central to good data analysis (as opposed to 'number crunching').

3. To show the relevance of these skills to the labour market, and to progress to further study, usually through alumni accounts of their career experience.

4. To show that rigorous qualitative methods skills are usually even more challenging for students to develop.

The importance of the third point should not be exaggerated. Most of our respondents thought that it was less important than the intellectual, academic and professional reasons for being competent in quantitative methods.

Resources were not seen as a major barrier to what the universities we studied achieved, since they operated under the constraints imposed by limits on education spending or their national student fees regime. What was important however was the proportion of faculty in the relevant departments with good quantitative skills, faculty with the flair to teach quantitative methods in an engaging way, and the commitment of all faculty to the importance of methods as such, whether quantitative or qualitative. Although it is not something the case studies alone can establish, our impression was that most leading departments had staff who felt a vocation to innovate and pursue excellence in QM teaching.

Chapter four

Opportunities and barriers to developing similar teaching in the UK

The case studies allow us to consider what kinds of changes would be needed for universities to follow the kind of approaches to teaching QM that we found and whether there are factors specific to UK university social science that might facilitate or impede such change. There appear to be two main changes that would be required.

The first is a very substantial increase in the proportion of a degree programme that is devoted to research methods (quantitative or qualitative) compared to substantive knowledge and theory. This could be achieved either by increasing the contact hours and volume of teaching on degree programmes, or shifting the balance between methods and other topics, or some combination of the two. UK university social science has generally followed the humanities model of teaching, in which students spend less time in class and more time in independent study, given the volume of reading that is required compared to a typical natural science course. It is not clear that this model is appropriate for methods teaching where the skills to be learnt are highly structured and require guided practice to develop.

Changing the balance of curriculum content is not easy and takes time. It needs careful thought to maintain the intellectual rigour and coherence of a degree programme. It requires consensus over the direction and nature of change, it requires staff to revise or change teaching material, as well as fulfilling the requirements of academic governance (boards of studies, exam boards and so on). However these forces of inertia should not stand in the way of innovation and change where it is clearly needed.

The second is a shift in the skill set of teaching staff towards a greater proportion of faculty with skills in QM. The recent international benchmarking reviews of UK sociology, politics and international studies and geography have all drawn attention to the need to strengthen quantitative research and teaching. There is some tendency in the staff recruitment process for departments to appoint in their own image as it were, so that the profile of staff skills changes only slowly. This is an area where academic leadership within and beyond individual departments has an obligation to ensure that departments have staff with the right set of skills, including competence in QS.

However there are a number of factors specific to the UK that would facilitate such change. The first is the world-class data infrastructure available in the UK through the UK Data Service. The second is the wealth of teaching support resources that have been developed under the ESRC's Quantitative Methods Initiative, the Curriculum Innovation and Researcher Development Initiative, the Q-Step programme and the outreach activities of the UK Data Service.

The National Centre for Research Methods also provides a range of training opportunities for staff and postgraduates. Resources range from teaching data sets and associated work-books and exercises for students to podcasts about QM pedagogy, to complete 'off the shelf' online courses on QM. It has never been easier for departments who wish to do so to substantially expand the methods teaching that they deliver.

The third facilitating factor is the increasing supply of postgraduates and post-doctoral researchers competent in QM as a result of changes over the last decade in postgraduate training. The case studies showed them to be a valuable asset to teaching, allowing departments to manage the heavier contact hours load that methods teaching entails.

Finally the UK already successfully tackles the challenge of students' math competence or anxiety around number work in the STEM subjects. They have developed substantial experience in maths and statistics support, for example through the Sigma programme, on which departments can draw.

Chapter five

What can UK universities learn from these case studies?

The clear message from these case studies is that the standard of achievement in quantitative skills for students is simply in a different league to that in the overwhelming majority of universities in the UK. It appears that UK universities set their expectations far too low.

Given the rising importance of data skills to economy and society, as highlighted in the British Academy's recent report *Count Us In*, UK university social science education risks failing to give students the skills they need in their professional and public lives and risks its reputation as a world leading provider of higher education.

The means to overcome these weaknesses are in universities' own hands. While there is an enduring legacy of indifference to QS to overcome, there is now also an unprecedented level of resources available to help universities shift to greater attention to QS. These case studies give many stimulating examples of what can be done, if there is the will to achieve it.

The case studies

University of Auckland, First year statistics course

Professor Chris Wild

Key points

- **Teaching focused on data visualisation**
- **Innovative use of online resources**
- **Taught to a majorty of undergraduates**
- **Outstanding student feedback**

The University of Auckland's Department of Statistics has a long history of teaching a non-mathematical, conceptual introduction to statistics, and particularly statistical data analysis to upwards of 4,500 students per year. Approximately two out of every three undergraduate students who enter the university will take this course at some stage during their undergraduate studies. Its teachers are extremely highly rated by the students. Some of the students are there because their other courses require it but a majority have opted in. It caters to an extraordinarily diverse student body – diverse in academic background, diverse in disciplinary destination, and diverse in age and social background. The course is taught by a team who work as a team, developing and using a common set of materials. The team won a national tertiary teaching award in 2003. They have a record of innovation and of being early adopters. For example, recorded lecture videos and on-line forums have been in use for over 15 years, audience response systems for five.

This course is currently gearing up for a step change motivated by the fact that the universe of data, big and otherwise, is growing explosively – in volume, in the areas it reaches into, in how it is constituted, and in what you can do with it. In this context they believe that the traditional introductory statistics course has passed its use-by date and are seeking ways to get much further, much faster facilitated by visualisation approaches to both understanding data and understanding inferential concepts. The latter are introduced using modern data-resampling approaches which have the advantage of building off a very small number of ideas that generalise fast to a wide spectrum of applications. A second advantage is an internal logic that is easy to convey visually. This is all made possible by building software aimed at enabling learners to experience a lot quickly with minimal learning curves using a small number of graphical metaphors that, in combination, are very powerful for investigating multivariable relationships.

The new approaches were prototyped in a MOOC entitled "Data to Insight" that first ran on FutureLearn in the closing months of 2014. It is a hands-on data-analysis course that accepts beginners and takes them to working with up to five numeric and categorical variables simultaneously in the same analysis over the first four weeks (and a total of two "teaching" hours). Almost all of the content-delivery is via 42 five-minute videos which have been made freely available on Youtube (see http://tinyurl.com/4StatEducators for a linked index). For motivational reasons, it gets students caught up in the potential of data analysis for discovery before getting bogged down in "limitations". Serious consideration of systematic biases, lurking variables and random error doesn't come until after the mid-way point which also forms the bridge to measurement and study design issues, confidence intervals, and experimentation and significance tests (randomisation tests). In addition to radical rewriting there is ongoing work on lifting the current active-engagement levels in class, with more extensive use of audience response systems and introducing in-class computer-based data-analysis in lecture-streams of upwards of 300 students.

Auckland is also unusual in having a long history of teaching a large number of practical courses in an almost entirely nonmathematical way. Even many "majors" have predominantly studied practical, nonmathematical, computer-based applied statistics courses. After a second applied statistics course which emphasizes linear and generalised linear modelling to establish some modelling-idea foundations, the undergraduate curriculum fans out into many parallel courses including design and analysis of surveys and experiments, advanced statistical modelling, multivariate analysis, time series analysis, statistical programming and modelling in SAS, data technologies, statistical computing, and a minimally mathematical Bayesian course. Part of the reason for this is to provide courses that are accessible to students outside of statistics, picking up skills that will be useful for their later research, as well as providing solid practical training for those who will work as statisticians.

University of Bern, BAs in sociology and politics

Professor Axel Franzen

Key points

- **Early focus on maths and statistical theory**
- **QS courses = 20% of curriculum + dissertation**
- **Students cover SEM and analyse panel data**

Approximately 500 students studying politics, sociology, business and economics do a common first year curriculum in methods which comprises a mathematics and statistics course in each semester: *Mathematics I* (five hours per week Lectures and exercises) *Mathematics II* (four hours) which cover the maths needed for a thorough understanding of statistics, including algebra and game theory, *Statistics I* (four hours) and *Statistics II* (four hours) which cover descriptive and inferential statistics. These courses follow a common format of lectures plus set exercises. *Introduction to Empirical Research Methods* (two hours per week) introduces subjects such as research design, data collection and sampling. Given their generic character these courses focus more on statistical theory and the maths necessary to understand it than on application in a specific disciplinary context. Assessment is by exam. Potential students may be aware of the maths and statistics focus in the first year curriculum and have alternative universities to choose from so that student entry has a degree of self-selection.

In year two sociology and politics students must take *Introduction to Statistics for Social Scientists* (4 hours) and *Applied Research Class I and II* (two semesters, together 4 hours per week) and also a mandatory qualitative methods option. These courses use Stata and focus on multiple linear and logistic regression and related techniques including factor analysis and data reduction with an emphasis on practical application rather than the more theoretical approach in year one. Students are introduced to secondary data analysis using the Swiss Household Panel Survey. These classes have smaller student numbers as they are specific to sociology and politics students.

In years two and three students can also follow elective courses, some of which are shared with the Masters programme, on more advanced approaches such as time series analysis, event history analysis MLM and SEM. Approximately one fifth of teaching in the degree is thus on quantitative methods courses. Students also complete a Bachelor's thesis and around one third follow a quantitative approach based on secondary data analysis or experiments. The thesis is supported by lectures and seminars with student presentations, and takes the standard scientific paper format. Both second year courses and the production of the thesis include elements of revision to consolidate knowledge learned earlier and translate knowledge of statistics into its practical application in empirical research.

University of Bergen, Department of Sociology

Professor Johannes Hjellbrekke

Key points

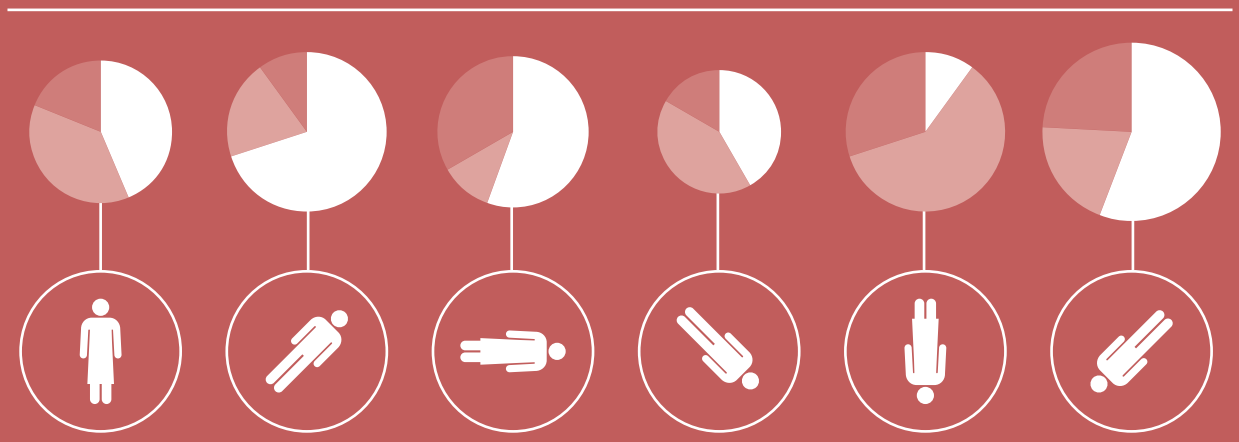
- **Students master OLS regression in year one**
- **Emphasis on data analysis rather than statistical theory**

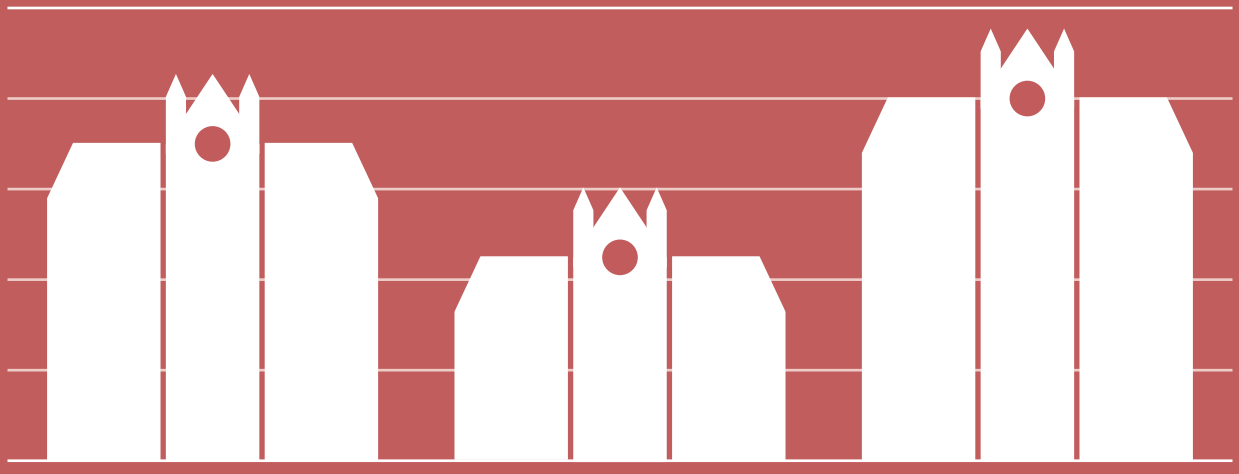
Students are taught a one semester course in quantitative methods in year one which takes up 50% of their workload for that semester (15 ECTS) for around 150 students. There are four hours of lectures (presented by faculty) and four hours of seminar or practical work (also undertaken by postgraduate or post-doc assistants) each week. Teaching starts with univariate descriptive statistics and goes up to a thorough introduction to multiple linear regression and brief coverage of logistic regression. The teaching avoids the mathematical or statistical theory, or formulae underlying different procedures and focuses instead on 'nuts and bolts' of statistical procedures: when it is appropriate to use them, the correct interpretation of results and diagnostics as used in research literature, and the underlying assumptions they require. The course uses a textbook, as well as resources produced by teaching faculty. Statistical ideas are currently implemented in SPSS but the teaching is moving over to Stata. Students also study research design, data collection, qualitative methods, documentary analysis, and ethics.

Assessment has two stages: students must first successfully complete four compulsory tasks, the most complex of which is an OLS multiple regression exercise, but students are not expected to be able to carry out logistic regression. Students are allowed three attempts to successfully pass these exercises (managed by about 90%) and if they do so, then sit a six hour examination which all but a small percentage pass. Performance levels are similar to other courses within the degree. There is no formal system in place of support for weaker students. Students arrive with different maths skills levels (there is no specific maths entrance requirement) and can often be apprehensive about the quantitative methods teaching, however student evaluations are very positive at the end of the course, with a sense of achieving something they expected to find difficult.

There is no formal teaching of methods in years two and three of the degree, and any connections made to the methods teaching elsewhere is the responsibility of those teaching courses and electives. The proportion of staff with good quantitative skills is higher than in the UK, but there are also staff whose skills are mostly qualitative. Students write a 20 page dissertation/extended essay as part of their final degree assessment but would not normally undertake any original or secondary quantitative analysis as part of it. Further study of QM takes place only at masters and doctoral level. Here, around 30% of students will use a quantitative approach.

Although the University of Bergen is also the base of the European Social Survey there are no formal links to the ESS and its educational outreach activities. While access to survey data from the Norwegian data archive is straightforward the cost of access to increasingly important register data from Statistics Norway (administrative data facilitated by unique personal identifiers) has become too expensive for anything but research purposes.





Harvard College, Department of Government

Professor Arthur Spirling

Key points

- **Compulsory methods course breaks with liberal arts tradition**
- **Intensive assessment to ensure students 'learn by doing'**
- **Final years students offered wide range of advanced procedures**

Until 2012, in keeping with the general principle of the strong tradition of what comprises a liberal arts education in the USA, there were few specific methods requirements for those pursuing a BA degree. While students were required to take one or more courses with a quantitative focus, this might be fulfilled by taking a course provided by maths, economics or statistics departments, such as introductory statistics or calculus, without any specific social science or research methods context.

Since 2012 students reading for a BA in Government are required to take the course *Introduction to Political Science Research Methods*, usually in their second year. About 80–100 students take the course. This reflected faculty's views that students should have better quantitative skills given the increasing importance of these approaches in political science. However, another part of the rationale for introducing the course came from students' perception that having more quantitative skills in their degree programme was desirable because of their relevance in the graduate labour market where students may go on to jobs with companies such as Google or Facebook.

The course comprises 22 lectures: two per week over a 14 week semester. One week is used to take the midterm exam, this gives teaching assistants a couple of 'study lectures' to help revise before exams, plus a weekly small group (12–15 students) teaching session led by teaching fellows (PGs or post-docs) which is in a computer lab when required and teaches students how to implement the ideas presented in the lectures in SPSS. The course is a comprehensive introduction to methodology, although its focus is quantitative. It uses SPSS, but with the GUI rather than syntax. The course covers research design as well as data analysis and interpretation:

- Theory (parsimony; falsifiability, testability) and evidence (operationalisation; quantitative and qualitative; levels of measurement; validity; reliability; error)
- Survey and sampling strategies; randomisation and inference; bias
- Causality and correlation; observation and experiment
- Descriptive statistics and distributions
- Hypothesis construction and testing (Chisq; T)
- Regression: estimating and interpreting coefficients; goodness of fit; prediction
- Comparison and case study methods, many variables, small N

Assessment is intensive to ensure that students practice sufficiently to gain a secure command of the principle concepts introduced, with assessed homework or practical exercises (30%), a midterm (30%) and final (40%) exams. Statistics is presented within a disciplinary context (so that research literature from the subject is used) and also uses topical examples drawn from the media or other sources to emphasise the broad relevance of the statistical concepts studied.

In their third year students intending to write a final (year four) thesis take *Research Practice in Quantitative Methods* or an equivalent qualitative methods course. This course uses Stata and builds on GOV50 by looking at multiple regression (linear, binary ordinal multinomial logistic, Poisson, survival, event history, Cox models) and the linear model in greater depth (bias, efficiency, error distributions; panel observation; unobserved heterogeneity; fixed and random effects; logit and probit models; maximum likelihood estimation) and considers selection effects and reverse causality. Students write a short scientific paper using an appropriate procedure to report original results (40%) and are also assessed by homework and quality of presentation and participation in class (60%). Approximately half the students writing a senior year thesis will use a quantitative approach.

In both courses the emphasis is on the 'intuitive' rather than formal mathematical understanding of the relevant statistics, and on being able to understand the methods considered sufficiently well to make informed decisions about their use and evaluation of their application by others, from design through to interpretation of results. Students are typically highly motivated and capable of intensive study to supplement the material delivered in class teaching.

Jacobs University Bremen, BA integrated social science

Professor Adalbert Wilhelm

Key points

- **Interdisciplinary focus**
- **Moving to R as platform**
- **Extensive use of peer learning, group work and assessment**

In the first semester of year one all students (approx. 100, including psychology and economics students) do an introductory course *Introduction to Empirical Research and Research Design* that gives an overview of empirical research, covering both quantitative and qualitative methods, including field studies, case studies, longitudinal research, cross-cultural comparisons, and non-reactive studies. The course also discusses sampling strategies and research techniques, including surveys, observation, experiments, and narrative interviews.

In semester two students take *Statistical Concepts and Data Analysis*. Using SPSS (the GUI rather than syntax) or R the course covers univariate descriptive statistics and graphical presentation of results up to simple multiple OLS regression, ANOVA and significance testing including nonparametric tests. Its objective is to make students 'intelligent users' of univariate and multivariate statistical techniques including selection of appropriate procedures, knowledge of the assumptions made in their use, interpretation, presentation and discussion of results. The textbook used is *Field*, but the course also uses its own resources. The emphasis throughout is on intuitive and practical understanding of statistical procedures rather than theory, but with attention to understanding the constraints and limitations of each method and the proper use of diagnostics.

Both courses comprise five ECTS and three hours teaching per week divided between lectures and labs with support from PG and post-doc teaching assistants. Students work in groups, submitting group assignments so that stronger students support weaker ones. Jacobs is a campus based university with an emphasis on inter-disciplinarity and on students developing their learning skills in group work. Assessment is by assignments and assessed lab exercises (where students work on their own laptops in a class environment but with a limited time period to complete a task) and a formal exam on theory.

'Fear of maths' is an issue with some students, which is addressed by an emphasis on practical work and the use of 'real' data, stressing the link to substantive issues within a discipline. There is some sense that 'opposition' to QM on the part of students has declined. They may not always be enthusiastic, but they are more likely to recognise the value of QM and see it as a necessary and relevant skill in their subject.

In year two students follow a further two courses which extend and deepen their knowledge of multivariate statistics including factor analysis, principal component analysis, and cluster analysis. A course on the logic of comparative research ranges from questionnaire design to issues of reliability, dimensionality and the construction of variables from indicators.

In years two and three students also choose from a range of electives including *Meta Analysis*, (effect sizes and their analysis using meta-regressions based on random- and fixed-effects models); *Econometrics* (which is not only taken by economics students), *Structural Equation Modelling* and *Secondary Data Analysis* (a lecture and lab based course training students in the practical methodological and analytical skills needed for secondary data analysis). In year three students also complete a Bachelor's thesis, which typically takes the form of a scientific paper. The majority of students use empirical data of some kind with a roughly equal split between quantitative and qualitative approaches.

Substantive courses will use quantitative material (e.g. journal articles using various kinds of regression analysis) which students would be expected to understand and use either in essays or in group presentations. Most faculty have some quants expertise, and all would endorse their value: the choice of particular methods is seen as a question of the research question and research design rather than any prior theoretical or epistemological preference.

University of Köln, BAs in sociology and politics

Professor Marita Jacob

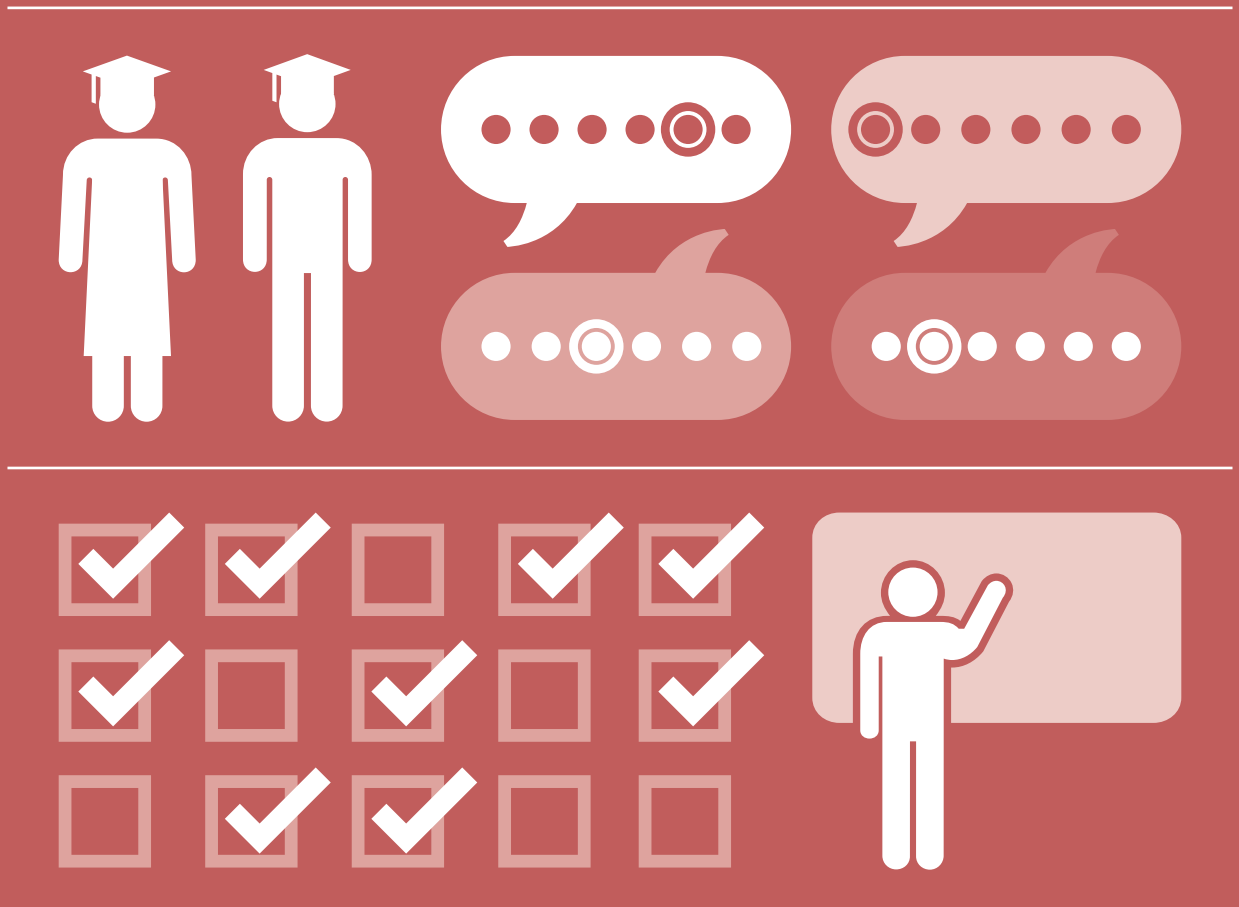
Key points

- **Large (approx. 200 students) second year course delivers advanced techniques**
- **Most students do secondary analysis based dissertation**

In semester one around 300 students take *Introduction to Methods of Empirical Social Research* (four ECTS; two hours lectures, two hours exercises and tutorials per week) which covers the research process, research design, deriving hypotheses from theory, operationalization, measurement and types of data and scientific explanation. In semester two they take *Statistics for Social Sciences I* (eight ECTS; two hours lectures, two hours exercises and tutorials per week), which covers both descriptive and inferential statistics, randomisation and sampling, probability distributions, confidence intervals and hypothesis testing and data analysis using Stata. The focus is on application in the social sciences. Both courses are assessed by formal exam, in part because of regulatory constraints on assessment, but it is planned to introduce an e-learning component to teaching to facilitate more continuous assessment. Previously students attended statistics courses taught from the economics department with less of a social science content and more focus on the formal and mathematical aspects of statistical theory, which students struggled to integrate with their other studies. Lectures are used to promote active learning by having students respond to questions and problems within the lecture. Students submit work beforehand so that lecturers can focus on aspects student find most difficult.

In year two students take a new course, *Statistics for Social Sciences II* (eight ECTS; two hours lectures, two hours exercises and tutorials per week) again replacing one previously taught by the economics department. It focuses on multiple regression, both linear and logistic including data reduction and factor analysis, but may also include other procedures, depending on the rate of student progress. This is still a large course with around 200 students and uses a similar teaching format to the year one courses. Evaluations of these courses by students are improving as they bed in. In contrast to Mannheim, where students who enter will typically expect a substantial quantitative component to their degree, this is less the case in Köln and effort is made to demonstrate the relevance and importance of quantitative methods and the benefits these skills bring. Student attainment and performance is similar to Mannheim however.

In their third year students do their own research project (16 ECTS) in which they use secondary data analysis of an existing data set?. It is usually necessary to revise skills taught in earlier years so that students can successfully apply them. Results take the form of a standard scientific paper. Extensive support is given to students throughout this process. Students are also taught qualitative methods in two eight credit courses, one of which is elective. Most students follow a quantitative path in their research project. They also have the opportunity to take elective courses in advanced quantitative methods shared with the Masters programme (which can include causal inference, time series, fixed and random effects models, MLM and other approaches).



University of Lausanne, BAs in political science and social science

Dr Dominique Joye

Key points

- **Quantitative and qualitative methods skills embedded in *all* substantive modules**
- **Students use both SPSS and R and master wide range of advanced procedures**
- **All staff expected to be fluent in both 'quant' and 'qual' methods**

A revised system was introduced two years ago, in part in response to dissatisfaction with approaches to teaching quantitative methods that did not ground them sufficiently within a social science context.

All students (around 200) are required to study both quantitative and qualitative methodology in a generic first year methods course *Introduction to Research* and two second year courses *Quantitative Methods* and *Qualitative Methods*. Courses comprise two hours lectures and two hours seminars (25–30 students) over a 14 week semester (six ECTS; 56 hours). The first year course covers problem formulation, hypothesis construction, research design, data collection, research instruments, questionnaires, observation, interviews, documentary analysis, surveys, as well as some epistemological issues). The second year course covers descriptive and inferential statistics up to linear and logistic regression using SPSS. Teaching includes both statistical ideas and their practical implementation in labs, as well as the study of their use in published sociological or political science studies.

However, students also study and apply both quantitative and qualitative methods in all their other year one study through substantive topics in seminar courses (also six ECTS; 56 hours over 14 weeks): *Introduction to Research: Family Interactions and the Life Course; Introduction to Research: Individuals Groups and Social Institutions; Introduction to Research: The Social Construction of the Body; Introduction to Research: Gender Research and the Life Course; Introduction to Research: Migration and Globalisation*.

In year two and three a wide range of seminar courses (six ECTS; 56 hours) are open to students, some of which are compulsory, and all of which combine teaching in different aspects of quantitative methods with study of a substantive topic or problem. These include: *Life Course Analysis Comparative Survey Analysis: Social Consequences of Labour Market Change* (which use R); *Measuring Social Attitudes; Mixed Methods* (which studies professional training and focuses on questionnaire design and interviewing); *Big Data* (using logistic regression to undertake sentiment analysis), *Electoral Campaigns* (using SPSS to undertake secondary data analysis on some aspect of an election campaign), *Missing Data* (re-weighting, imputation and other methods for handling missing data), *Social Demography* (analysis of sex-ratio at birth in a large Indian survey using logistic regression), *Elections and Voting in Switzerland* (secondary analysis of survey data), *Large Population Surveys, Empirical Analysis I and II* (lab based seminar analysis of longitudinal Swiss Household Panel, including data reduction techniques and data management) and *Logics of Collective Action* (which includes QCA).

Teaching includes lectures, small group work, practical exercises, computing lab sessions and presentations. Individual and group work, as well as practical exercises are assessed, in addition to formal exams. Students gain experience of the whole process of research including the development and use of different research instruments, primary data collection and secondary data analysis, report writing and presentations, and the evaluation of others' research. Throughout the degree teaching integrates methodology and consideration of the origin and interpretation of empirical evidence with the substantive and theoretical topics normally covered in a social science degree programme.

Students are exposed to both SPSS (with an emphasis on syntax rather than the GUI) and R (with R Studio), with more courses using the latter in years two and three. By the end of their third year students will have encountered MLM and SEM, PCA and Factor Analysis. They will have learned to review literature, formulate problems and hypotheses, develop an appropriate research design, analyse relevant data and present results in the form of a scientific paper and to present and defend it in front of peers.

This is achieved despite the fact that in Switzerland, as in other countries, it is expected that school pupils who are strong at maths will tend to study the natural sciences. Students come to accept that both quantitative and qualitative methods are fundamental tools necessary to master in order to understand the subject, or to progress to Masters level study. This is helped by almost all faculty having a good command of the basics of both approaches, and good relations between those specializing in 'quant' or 'qual'.

University of Leuven, BAs in politics, sociology, and communications

Dr Bart Meuleman

Key points

- **University curriculum project reviewed how to tackle statistics anxiety**
- **Several short methods modules across each year of study**
- **Group work and peer learning, with oral exams to check depth of learning**

Around 600 politics, sociology and communications students take a generic course *Social Statistics* over two semesters (four + four ECTS; 52 teaching hours) with lectures and labs (staffed by teaching assistants) covering descriptive and inferential statistics including simple probability and a brief introduction to Bayes theorem, distributions, graphical representation, parameter estimation, confidence intervals, significance tests and hypothesis testing. Agresti & Franklin is used as a textbook supplemented by bespoke teaching material, with an emphasis on practical application of statistical theory. SPSS (the GUI) is used in computer labs and assessment is based on a practical computer exercise (20%) and a traditional format exam (80%). In their first semester students also take a course in methodology, *Methods and Techniques of Social Research* (six ECTS; 52 teaching hours), which covers research design, operationalization, sampling methods, the concepts of validity and reliability, modes of data collection, induction and deduction, covering both quantitative and qualitative approaches, but with some emphasis on the former. Finally, within their individual disciplines they follow a practical course over two semesters, *Research Practice* (four ECTS; 27 teaching hours), based around the skills needed to prepare a scientific paper, searching, evaluating and processing information and literature, and formulating a research question potentially using secondary data analysis. Assessment is through group work exercises and presentation of a paper. Student failure/dropout is substantial but this is common to all courses and reflects the ease of access to university degree programmes and low fees. In the course of the first year a proportion of students decide not to continue with their studies. There are no specific maths requirements for the social science courses and the limited maths knowledge of students has prompted the introduction of a week long course before the start of the semester to review relevant maths skills.

In their second year students take one qualitative and one quantitative course (an elective for political students but compulsory for sociology students). The *Data Analysis* course (six ECTS; 52 teaching hours) focuses on linear and logistic regression models including interaction effects and ANOVA, with lectures and six labs based on secondary analysis of a range of data sets which also introduces students to using syntax. Students also do a *Practicum* (six ECTS; 52 teaching hours) over two semesters which is based on a substantive topic within the discipline where students work in groups focusing on research design, with special attention to the design of survey instruments in order to produce a piece of original empirical research.

In year three students take a course in social statistics *Data Analysis: Data Reduction* (compulsory for sociology students, and elective for politics students giving a class size of around 60), which focuses on data reduction, missing data and scale construction (PCA, exploratory and confirmatory factor analysis, cluster analysis, (six ECTS; 52 teaching hours) SEM and correspondence analysis) with lectures and around six lab sessions. Assessment is by exam and oral. The latter is used to check that students understand the data analysis and interpretation they produce, rather than simply mastering as set of technical procedural steps. They also follow a *Sociology Seminar* (seven ECTS; 52 hours) over two semesters. The seminar is based on a substantive topic and has students go through all stages of the quantitative research process from specifying a research question, operationalization and research design through data collection and analysis to the reporting of scientific results. The paper that results from the seminar can form the basis of a Masters research proposal for students who proceed to further study.

The faculty was the home of the EPOS project (Educational Project Overcoming Statistics anxiety) funded by the university, to stimulate the embedding of methodology teaching in substantive courses (five courses at undergraduate level within the political science curriculum; further details are available at http://soc.kuleuven.be/web/staticpage/9/48/eng/696). Developing embedding remains the prerogative of individual course teachers. The faculty continues to review methodology teaching and there is debate and discussion about the desirable balance between methodological skills and substantive knowledge, and between understanding methodology theory and skill in the application of methods.

University of Mannheim, BAs in sociology and politics

Dr Shaun Bevan, Dr Henning Best

Key points

- **Emphasis on autonomous study for highly motivated students**
- **Very high standards of achievement expected**
- **Some undergraduates gain work experience on staff research projects**

Because of its strong reputation in the social and political sciences Mannheim is able to be somewhat selective in its intake of school students each year, and assume that all first year students have an above average level of maths ability.

In year one (two semesters of 14 weeks each) students study a range of statistical methods, up to linear and logistic regression, in generic lecture classes (1.5 hours) across subject areas focusing on research design, data analysis and the presentation of results in the form of standard scientific papers. Lab sessions run by PGs or post-docs focus more on the application of ideas taught in the generic lectures to specific disciplines. Theory is taught separately from implementation in software, which is usually R or Stata, however there is less emphasis on the underlying mathematics than on the logic of the statistical procedures used (e.g. 'walking the students through' the relevant R/Stata code or syntax), on when it is appropriate to use them, their assumptions and constraints, and the proper use and interpretation of diagnostics. There is a heavy emphasis on students taking responsibility for their own intensive and advanced learning and it is assumed that students will be highly motivated to study hard. As an institution driven more by research than teaching there is less attention given to teaching quality assessment, content control, or specification in terms of learning objectives, pedagogy and progression than in the UK, although faculty can take courses in pedagogy and courses are evaluated using a standard student questionnaire. The inter-connections between courses are mainly driven by staff research interests. Support is offered through staff 'office hours'. Marking in assessments is strict, with GPAs well below the national average (such that work credited with a bare pass at Mannheim might achieve a first class mark elsewhere) but there is little systematic feedback on performance beyond grading. There is a substantial attrition rate at the end of Year One with students who find the programme too intense (as many as 20%) going elsewhere.

Electives in years two and three have smaller class sizes (15–25 students) and include methods courses, but there is also an expectation that substantive courses include a substantial methods component insofar as discussion of the methods and evidence used is as important as the substantive conclusions of the material discussed. In both methods and substantive courses reading is almost exclusively journal articles (since this is where the latest developments in any field are to be found) and students would be surprised to be asked to read material that did not rely to some extent on the application of advanced statistical methods. Student papers for assessment in electives would typically take the form of a scientific paper rather than an essay format and statistical content would normally be expected to form a substantial part of the paper. As such methods infuses *every* course except some core lectures in year one. There is a final year dissertation that will almost always use analysis of some kind of statistical material in the form of a scientific paper.

In addition to formal teaching, undergraduate as well as PG students often gain experience by working as research assistants on professors' research projects.

University of Melbourne, School of Social and Political Sciences

Dr Aaron Martin

Key points

- **Few compulsory QS modules in Australian system**
- **Many students start with few maths skills but evaluations are very positive**
- **PG's support weaker students**

Social science students (including criminology, political science and sociology) now do a compulsory ten week QM course in year three (qualitative methods are covered by a similar course in year two) which accounts for one quarter of their workload that year. Each week comprises 1.5 hours lectures and 1.5 hours computer labs, supported by teaching assistants (normally PG students or post-docs) with extra support if need be for weaker students. Elsewhere in Australian social science HE, QM courses, if taught, are electives. There are no specific maths skills requirements for entry to an Arts degree. Maths aptitude and skills of students varies, so that the course focuses on giving students an intuitive grasp of the main concepts, avoiding formulae or algebra where possible and emphasizing practical skills by using SPSS (GUI rather than syntax) in order to produce descriptive statistics, contingency tables, correlation and simple regression. There is also some attention to the logic of experiments and mixed methods. The World Values Study is used as a teaching dataset, to keep the study of statistical ideas grounded in a social science context, and examples are also drawn e.g. from health risk studies relevant to everyday experience.

There are three components to assessment. Students do three practical SPSS based in-class assignments (which also help ensure that students keep up with the course). Students write a research proposal based on data from the WVS; they then carry out and write up the proposed research using the techniques covered in the course. Students who progress to a fourth, Honours year of their degree write a Bachelor's thesis (15,000 words) but the majority use qualitative or non empirical approaches. The small proportion who use quantitative methods are steered towards secondary data analysis given the difficulties of good quality primary data collection.

Demonstrating to students the relevance of quantitative methods to the rest of the degree programme is a challenge, given the preponderance of qualitative approaches in social science in Australia, and an emphasis on the debate and interpretation rather than assessment of empirical evidence and methodology. This can also mean that finding sufficient teaching assistants with the necessary quantitative skills and confidence to teach them can be difficult. However student attitudes that may be negative at the start of the course improve as they come to understand the relevance and importance of quantitative evidence and gain some confidence in their ability to master the skills involved, which is reflected in student evaluations of the course.

Princeton University, Department of Politics

Professor Kosuke Imai

Key points

- **Poor student evaluations of traditional QS modules stimulates change**
- **Data exploration used to raise questions that require statistical solutions**
- **Intensive use of exercises: learning through doing**

Students enrolled in the liberal arts program used to take a standard introductory statistics course going from univariate descriptive statistics through to regression and requiring no prior knowledge of maths or statistics. Like other statistics courses at Princeton this course tended to receive student evaluations well below that of other courses and students often struggled to master both statistical concepts and techniques of data analysis at the same time. It was therefore decided to trial a course that would focus on data analysis rather than statistics so that for example there would be no coverage of inference, hypotheses testing and standard errors. A new course was developed (Pol 246) and was piloted specifically on the potentially weakest group of students that could be identified. These students might be bright and highly motivated but were disadvantaged relative to others, such as first-generation students (i.e. students who were the first in their family to go on to higher education, from inner-city schools who may have had little exposure to maths education, or no access to a computer at home).

The course focuses on data analysis rather than statistics. Students start by exploring data from an experiment to consider how causality can be inferred from patterns in data (examining employers' mean response rates to job applications in which only the gender and ethnicity of the applicant varies). The course also considers spatial data, social networks and analysis of text, to demonstrate that data can come in other forms than the rows and columns of a data matrix, and emphasises the challenges of measurement: how data can be constructed and collected, and considers explanation and prediction. Outside speakers address the course about how they use data in their work, in order to show the diversity of applications of data in different contexts. Statistical concepts are introduced in a data analysis problem solving context, including descriptive statistics, correlation and regression, with Friedman, Pusani & Purves used as a textbook.

The course uses problem sets, which are reviewed in class with the instructor, followed by group work (so that stronger students can help weaker ones), with close monitoring of students' progress so that attention is focused on those issues that students find most challenging. Students who might otherwise fall behind can be identified and helped. This helps to ensure that all students are active learners in the labs and that these do not relapse into a form of lecture with the instructor simply repeating the explanation of the concepts the students are learning. This is important because of the cumulative nature of the skills and knowledge in the course. The course is based on R, but bespoke teaching materials and the emphasis throughout on data enable students to learn the basics of its programming language quickly. Use of R enables the use of an R package to monitor student performance. A statistics help desk (QuantLab) is staffed by PG students and course staff have office hours where students can also seek help.

After piloting as a summer school course this is now a standard course for year one students. There are two hours of lectures and two hours of computer labs each week over six weeks, with problem sets to be completed. Assessment is through exercise in the lab (15%), problem sets (40%), a midterm exam (25%) and a group data analysis project presentation based on secondary data analysis (20%). Further electives (taken by around one third of students) develop skills in research design, regression, elementary probability theory, distributions sampling and inference.

Students can use the skills they have learned in their third (junior) year developing and presenting a research papers and in a final (senior) year thesis, which typically takes the format of a standard scientific paper.

Vrije Universiteit, BA sociology

Professor Harry Ganzeboom

Key points

- **Group work with student research projects presented to student conference**
- **Advanced procedures taught in intensive year 2 full-time modules**

There are no special maths skills requirements for incoming students, but in school students in the Netherlands will have had algebra (equations) and some exposure to statistics and probability (e.g. the normal distribution).

In year one all social science students (approx. 500) follow a generic course on quantitative and qualitative methods (*Methodology of Social Research,* six ECTS) including research design and data collection with a focus of the translation of social science problems into researchable questions. *Descriptive and Inferential Statistics* (six ECTS) takes students from univariate descriptive statistics through to correlation and OLS regression, ANOVA, and significance testing. They face the choice between successfully competing a set of practical assignments and a formal examination. Students receive individualised data sets (randomised selections from a master data set) so that although they can collaborate on how to complete an assignment, their results and conclusions will differ. Recommended texts include Julie Pallant *SPSS Survival Manual* and Andy Field *Discovering Statistics with SPSS*. Because SPSS is readily available to students, most will have their own copy, and teaching focuses on the syntax. There is no move to R, given its initial steeper learning curve.

Students are also introduced to the fields of research of the department (*Sociology Working Group; Data Collection*) and choose a topic from those fields on which to conduct a literature review, design a research instrument, collect and analyse data using SPSS, and present the results in a student conference. Courses use lectures, small group work (although groups may be up to 30 students) and computer labs using StatLab as well as SPSS with an emphasis on syntax rather than the GUI. In year two the *Research Practical* course (six ECTS) develops skills in secondary data analysis using linear and logistic multiple regression, with a focus on the causal interpretation of results (construction of variables from indicators, standardisation, dimensionality, factor analysis, interpreting coefficients, confidence intervals, confounding and mediating variables, and interaction (moderation) effects). As in year one this is done within a substantive field of interest of the research programme of the department, using secondary data analysis of different data sets each week. This is a 'full time' course of intensive study lasting three to four weeks with two lectures, small group work and a computer lab each week. However at least some of the course time is spent revising basics learnt in year one. Students also do a qualitative skills course using Atlas.ti to code text using a grounded theory approach.

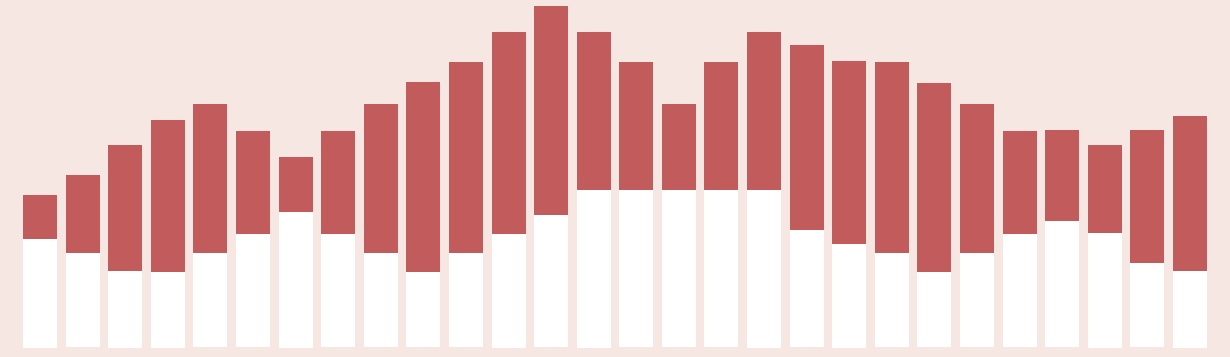
The preparation course for the Bachelor's thesis in year three includes lectures and computer practicals that review and revise quantitative skills learnt in the first two years with an emphasis on the causal interpretation of regression. Students will be guided in their topic by a supervisor who ensures they address a feasible research question and become aware of the relevant literature. The thesis follows the format of a scientific paper and will typically involve secondary data analysis, e.g. of ESS or WVS data.

Although there is no formal link made between the methods and substantive courses, this is achieved by the focus of the methods courses on the substantive research fields of the department, and the requirement in substantive courses to master literature with quantitative content (e.g. the ability to critically evaluate the research design and results, including regression coefficients of research reported in journal articles). The preparation for the final year Bachelor's thesis follows the structure of a scientific paper, which also helps to make such links.

There is no systematic data collected on the relevance of QM teaching for graduate employability but anecdotal evidence is similar to that for the UK: alumni often cite the methods work they did in their degree as most useful for their career.

Problems faced and challenges:

- Math preparation is not required and students show considerable variability in math skills and interest.
- Quantitative teaching is too intermittent. Students tend to forget earlier instructions they were exposed to and need more repetition. This is partly due to lack of integration between substantive and methodological courses. It would be better if these substantive courses more often included practicals and assignments in which substantive analyses are replicated.
- Like their instructors, many students are mainly oriented towards quantitative or qualitative research designs. However the ambition is to expose them to both and train them for mixed mode designs, but this raises issues of the range of faculty skills.



University of Stockholm, BAs in sociology and applied social science

Dr Martin Hällsten

Key points

- **Excel used as a vehicle for introduction to statistics**
- **Students practice entire research cycle from design and data collection to presentation of results**
- **'Surface learning' tackled by insistence on practical work**

In year one students will do up to three courses, one in each of the three semesters (although some of these students will be taking these courses as part of other BA programmes). The first semester course carries 7.5 ECTS, and second and third semester 4.5. They comprise eight lectures (two hours; with interactive elements) and in the second and third semesters three hour computer labs (c20 students) run by TAs, using SPSS (the GUI). The first semester course covers basic descriptive statistics, graphics and visualisation, correlation, and contingency tables and takes a fairly generic format. It also briefly covers other elements of research methods such as research design and data collection. Small group work in the second semester onwards (three–four students per group) and assignments give an element of continuous assessment and encourage students to work with and practice the skills covered in lectures and labs. This formative assessment accounts for 10% of marks. A final traditional format summative assessment exam accounts for the other 90%. The legislative and regulatory environment for Swedish universities in practice limits teachers' ability to diversify forms of assessment.
The second semester courses covers OLS regression in some depth, including underlying assumptions and practical use, such as handling dummy variables, understanding interaction terms and presenting results. Students work in small groups on secondary data to undertake and present a regression analysis. As with the first semester course there is also a formal exam. On both courses the emphasis is on analysis and interpretation rather than hand calculation.

In year two first semester a second course on regression (7.5 ECTS) with the same structure as the year one courses takes students onto logistic regression and further techniques within linear regression (e.g. diagnostics; transformation of variables).

Students must complete a Bachelor's thesis (15 ECTS) and around one in four use quantitative techniques, almost always some form of secondary data analysis. Students are strongly discouraged from attempting primary data collection because of the limited pedagogical benefits and time constraints.

The department also offers the BA Programme in *Applied Social Analysis*. About 30 students enter the programme each year. In addition to the courses required for the Sociology BA described above, students on this programme do a year one first semester course in *Basic Statistics,* which uses Excel as a vehicle to look in greater depth at descriptive and inferential statistics. The second semester course focuses on data management (e.g. variable transformation; file management) in SPSS, including some data reduction techniques: index construction and simple factor analysis, to facilitate the practical implementation of the understanding of regression delivered in other courses.

Starting in the second semester of year one and carrying on into the first semester of year two, students follow a fifteen week (22.5 ECTS) course *Data Collection Methods* which takes students through the whole process of research, from formulation of hypotheses and instrument design to sampling, data collection management and analysis, and presentation of results. Within a general theme, small groups (3–4 students) choose a particular topic and design the relevant part of the survey instrument (a postal questionnaire) and follow this through data collection and entry to analysis and presentation of results. Learning outcomes and students' evaluation of the course are very positive, in part because of its practical emphasis.

Among the issues considered by the department are how to avoid surface learning given the requirement to use a traditional exam format, the balance between teaching *about* quantitative methods and practical experience of *doing* them, the sequence of learning and progression and whether and how to teach syntax rather than rely on the SPSS GUI.

University of Utrecht, BA sociology

Dr Richard Zijdeman

Key points

- **Students' Union organises support sessions**
- **Emphasis on empirical operationalization of research questions emphasized in substantive modules to creating universal 'embedding' of QS in degree programme**

Students arrive with a variety of maths skill levels, but it is made clear in the application process (e.g. at 'Open Days') that an aptitude for maths is required.

Students do eight 10 weeks courses in year one, in four blocks. Four of these have a methods orientation. *Methods Techniques and Statistics I* covers both quantitative and qualitative approaches, focusing on general methodology such as research design, formulating research questions and hypotheses, interviews, and sampling. *Methods Techniques and Statistics II* covers basic statistical procedures from univariate descriptive statistics up to simple OLS regression with two independent variables and including tests of significance (T, Chi Sq). Gravetter and Wilnau is used as a course textbook.

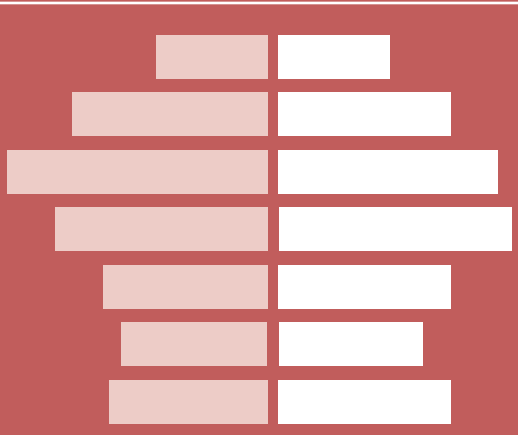
The statistical theory is presented first, before implementation using SPSS which is taught using syntax rather than the GUI to avoid 'point and click' (i.e. rote learning of how to undertake procedures without understanding the statistical ideas involved), using secondary data analysis and the presentation of results in report form. The department is starting to move from SPSS to R.

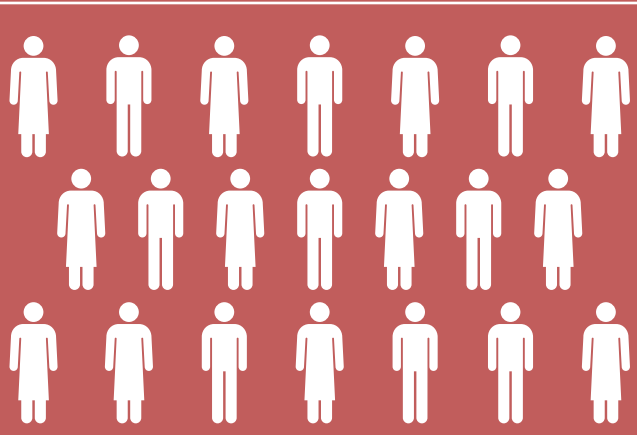
Student Research Orientation includes survey methods and data collection, including practical experience of different methods of data collection. In the final course teams of students go through the whole process of research, from literature review, formulation of research questions and hypotheses, operationalization into a survey instrument, primary data collection, data exploration and hypothesis testing, analysis and production of a research report in the form of a scientific article. Lectures, (presented by professors) which last two–three hours each week are generic with around 150 sociology, politics, psychology and other students, but students split into subject groups for practical classes of around 20 students each week which may be facilitated by either a lecturer or post-doc. Support sessions for students are organised by the Students Union, staffed by PG students and others.

In years two and three other QM courses are available to students, which include more advanced techniques such as Factor Analysis and Multi-Level Models, as well as more advanced theory, such as a broader consideration of the nature of standard errors. Courses include *Models for the Analysis of Social Interaction, Practical Data Analysis, Models of Measurement in Sociological Research, Social Networks in Theory and Empirical Research.* Students can also spend a half semester at Mannheim or Köln universities with a strong reputation in QM. However, perhaps more important is that substantive courses typically include either methods components or the application of statistical knowledge in using the research literature covered by the course. In this sense, 'embedding' is universal. Theory is taught in a distinctive way compared to that typical in the UK. There is a consistent emphasis on the operationalization of theory (so that e.g. Durkheim's analysis of integration can be empirically studied using group behaviour). Final year dissertations will usually have some quantitative content and can include advanced quantitative methods or secondary data analysis. All faculty have advanced quants knowledge, at least up to the level of regression.

There is evidence that sociology graduates from Utrecht find employment faster than graduates from comparable less quantitative degree programmes (e.g. Amsterdam).

Students proceeding to Masters study can follow a QM intensive Research Methods programme (two years and then on to a PhD), where there is extensive cooperation with Nijmegen and Groningen, and Masters students may follow advanced courses at international summer schools.





Yale University, BA sociology

Professor Richard Breen

Key points

- **Advanced QS electives are taught by the Statistics Department**
- **Students who choose to specialize can cover a wide range of advanced procedures in these electives**

The Degree follows the liberal arts model with student doing at least one foreign language course and courses taken in each of the humanities, sciences, social sciences, writing and quantitative reasoning. Most courses satisfying the quantitative reasoning requirements are taught via the mathematics, statistics and computer science departments, as well as economics, psychology, and sociology. All students, no matter their declared major are exposed to some form of quantitative thought.

Students majoring in sociology at Yale University are not required to take a quantitative methods course. To graduate from the program students must take two methods classes, one of which is a *Methods of Inquiry* course, an introductory overview of research design, including the ethical implications of doing social research, sampling and measuring and the interpretation of data, as well as the writing of a research proposal. The second methods requirement can be chosen freely.

For sociology students with a concentration in Markets and Society the compulsory methods course is *Social Networks and Society*, which provides a theoretical and practical introduction to social network analysis. No prior knowledge in statistics is expected. The course includes a practical component, introducing students to network analysis software, and using structural, dynamic and statistical approaches. Here too, the second methods requirement can be chosen freely.

The department offers also offers a concentration in Health and Society, which does include compulsory quantitative methods training. Students are to take a course in statistics, either *Methods in Quantitative Sociology*, an introductory course covering descriptive data and graphical representation, basic concepts of probability, bivariate and multivariate linear regression and regression diagnostics; or *Introduction to Statistics in the Social Sciences*, an introductory course offered by the Statistics department which exposes students to descriptive and inferential statistics for data analysis in a social science context. The course covers numerical and graphical representation of data, data collection, concepts of probability, hypothesis and confidence testing, as well as correlation and regression. High school level algebra skills are expected, yet the focus is on statistical reasoning rather than mathematical foundations. An additional course option to fulfil the statistics requirement is *Applied Quantitative Analysis* offered by Global Affairs. This course also features the mathematical and statistical foundations that underpin quantitative analysis.

Students interested in further quantitative research training have the option to elect advanced classes offered by the statistics department. Relevant courses include: (a) *Introductory Data Analysis* which covers plots, transformations, regression, analysis of variance, clustering, principal components, contingency tables, and time series analysis, using R and Web data sources; (b) *Theory of Statistics* which addresses maximum likelihood, sampling distributions, estimation, confidence intervals, tests of significance, regression, analysis of variance, and the method of least squares; (c) *Data Analysis*, a practical (in-lab) course which buttresses software skills in R and covers linear and nonlinear models, maximum likelihood, resampling methods, curve estimation, model selection, classification, and clustering; and (d) *Multivariate Statistics for Social Sciences* employs extensive computation and introduces students to SAS or SPSS. The course covers principal components analysis, factor analysis, cluster analysis (hierarchical clustering and k-means), discriminant analysis, multidimensional scaling, and structural equations modelling.

Columbia University, MA in quantitative methods in the social sciences

Professor Andrew Gelman

Key points

- **PG courses focus on new forms of data, programming and data mining**
- **Programming seen as alternative basis for QS to mathematics**

Columbia University offers a postgraduate MA programme in quantitative methods in the social sciences (QMSS). The program takes an interdisciplinary ethos in teaching quantitative methods, incorporating perspectives rooted in economics, history, political science, psychology, sociology and statistics into the curriculum in order to accommodate students' professional aspirations and career goals. An increasing focus is on learning programming and using the logic of programming rather than mathematics as the basis of statistical reasoning. This is also relevant to the new sources of data made possible by such techniques as web scraping or the processing of administrative or other data sources where data does not come in a standard data matric format.

QMSS was formed in response to the weak and ineffective quantitative methods training in US social sciences at the undergraduate level. Many applicants have a background in the social sciences with only limited quantitative training, or a strong foundation in numeracy, with little exposure to the social sciences. To cope with this the program structure is flexible and can be tailored according to individual interests, needs and skill levels. To address the specific areas of interests and backgrounds of students, QMSS offers different tracks. The following information relates to the traditional track, which allows the most flexible selection of courses, rather than the concentrations in economics, data science, and experiments with a more restricted and discipline focused program structure. The program sets out to provide students with rigorous training to develop expertise in quantitative research methods and analysis, including the communication of data, both written and verbal, and the critical interpretation and evaluation of statistical evidence.

Like most postgraduate courses in the US, Columbia requires GRE scores, standardised test scores measuring verbal and quantitative reasoning, analytical writing, and critical thinking skills. Although QMSS responds to the shortcomings of UG quantitative teaching, familiarity with statistics or higher-level analysis is expected in order to successfully handle the programme's demanding course load. Incoming students are required to provide evidence for their quantitative abilities; those with little or no experience with maths or statistics are encouraged to take continuing education classes at accredited institutions to fill any gaps *before* commencing the course.

Student normally take five core courses and four to five electives, and complete a Masters' thesis. The five required core classes consist of: (a) a foundational course in theory and methodology which introduces students to quantitative research, research design and the interpretation and strategic evaluation of numerical data from both historical and contemporary research contexts; (b) two sequential seminars which expose students to varying examples of quantitative research applied in practice in academic and non-academic settings; (c) a course in data analysis which can (or must, depending on concentration) be taken with either QMSS *(data analysis*), economics (*advanced econometrics*), statistics *(probability and statistics*) or political science (*multivariate political analysis*). The QMSS *Data Analysis* course uses R. The syllabus covers linear regression, probability models, statistical graphics, polynomial models, analysis of multivariate outcomes and repeated measures, and logistic regression. This course prerequisites an introductory statistics course that has covered linear regression.

Electives can be chosen from an extensive list of skill-based courses offered by QMSS or other departments (e.g. mathematics, statistics, economics, or political science). Two of these elective courses must be in research methodology, either research design or data analysis. The remaining two or three courses can be chosen freely.

Elective Course Options in QMSS:

Time Series Analysis introduces the core concepts, methods and limitations of regression analysis of temporal processes in the social sciences. Students learn about the practical applications of time series and panel data using STATA. The course focuses on traditional explanatory models used in sociology, economics, public health and psychology. Although the course has no formal prerequisites, and stresses that it does not require calculus or algebra, it is

assumed that enrolled students have a solid grasp of the mechanics and interpretation of OLS regression.

Introduction to Missing Data discusses the mechanisms that can produce missing data, as well as the implications, and potential solutions for missing data in data analysis using STATA.

Survey Methods addresses the practical and theoretical concepts, techniques and challenges involved in the designing and collecting surveys and survey data.

Social Network Analysis is an introductory course providing students with a basic understanding of social network analysis.

Data Visualisation is a practical course in which students learn techniques and algorithms for the comprehensive visualisation of complex data. Throughout the semester students are to produce several scripting, data analysis and visualisation design projects, as well as a final project the results of which are expected to be turned into a conference paper.

Bayesian Statistics for the Social Sciences introduces Bayesian statistical methods in the social science context, emphasising regression modelling and model checking. Students learn to use Stan software, and R.

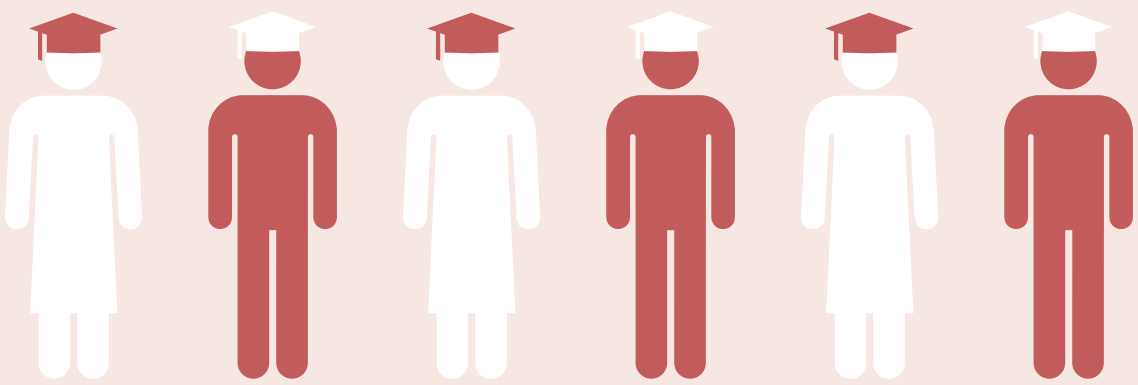
Experimentation in the Social Sciences introduces students to the theoretical and practical foundations of experimental methods in the social sciences.

GIS Spatial Analysis is a foundational course, providing a basic introduction to spatial analytical skills using Geographic Information Systems (GIS) and database management. The course includes a practical component (in-class software labs), focuses on substantive case studies and requires students to design and write an independent spatial research project.

Advanced GIS Spatial Analysis builds directly upon the concepts and skills acquired in the introductory GIS Spatial Analysis course. This course teaches and applies advanced spatial statistical modelling tools in GIS and R, covering, amongst others, the graphical and quantitative description of spatial data, variogram models, spatial autoregressive models, and spatial sampling procedures. As the preceding course, GIS Spatial Analysis is a practical (lab) class, focuses on substantive examples, and requires an independently developed final research project.

Students can also opt to do a relevant Internship or an Independent Study.

In addition to courses offered, QMSS's website provides a list of internal and external QM resources with interactive e-lessons aimed to help weaker students, as well as specific statistically tools. The Mathematics Department offers drop-in clinics assisting with algebra, calculus, and other skills.



Glossary

Anova	Analysis of variance
Applied Statistics/ Analysis	Statistical concepts, analysis or calculation applied to an empirical problem
Categorical Data/ Variables	Variables which take the form of discrete categories rather than a continuous value range. E.g. The level of formal education qualification held by a respondent
Confounding Variable	A variable that is related to both the explanatory and response variable in regression or other procedures
Correlation	The degree of relationship between two variables
Data Analysis	The exploration of patterns in data in order to summarize it or infer conclusions about underlying structures of various kinds
Data Collection	The process of producing data through the use of survey instruments or other means
Data Management	Organising and cataloguing data in order to facilitate its analysis
Data Matrix	The organisation of data into variables and cases to facilitate its analysis
Data Reduction	The use of several indicators to measure a smaller number of underlying unobserved variables
Descriptive Statistics	The use of statistics to summarize and describe data
Diagnostics	Procedures which assess whether assumptions made in a statistical procedure have been violated, possibly resulting in misleading results or conclusions
ECTS	European Credit Trasnfer and Accumulation System is a credit system designed to make it easier for students to move between different countries. Since they are based on the learning achievements and workload of a course, a student can transfer their ECTS credits from one university to another so they are added up to contribute to an individual's degree programme or training
Elective	A course which is not compulsory
Embedding	The use of substantive courses to deliver or reinforce knowledge of methods

Factor Analysis	A data reduction procedure that reduces a set of observed variables to a smaller set of unobserved variables or factors
Generic	Applying to many disciplines, or independent of them
Graphical Methods	The use of diagrams, charts, plots and other forms of visualisation to represent variables and their relationships
Graphical User Interface (GUI)	The system of menus, icons, buttons or other graphics on a computer screen that allow users to issue commands to a software application using a mouse or trackpad instead of computer code or syntax
Implementation	The use of statistical software to calculate statistics or carry out data analysis
Inferential Statistics	The use of probability to estimate whether some property of a sample of data can be generalised to the population from which it has been drawn
Interaction Effects	In multiple regression or analysis of variance where the effect of one variable upon another is affected by a third variable
Missing Data	Cases in a dataset where no value has been recorded for a particular variable
Multi-level models (MLM)	Multi-level models are used in the analysis of hierarchal data (for example individuals within families, children within school classes)
Model	A numerical summary of data or relationships within it
Multivariate Statistics	The analysis of relationships between several variables. For example the use of regression to examine the correlation between two variable controlling for others
Operationalization	The translation of an abstract concept into an empirical variable or set of variables that can be measured in some way
Panel Data	Data collected on repeated occasions on the same units of observation
Parametric	The assumption that data are well summarised by a known distribution
Principal Components Analysis (PCA)	The transformation of a set of variables into a smaller set of variables that are not correlated linearly with each other
QCA	Qualitative comparative analysis
R	Computer programming language with component packages that perform a wide range of statistical analysis and data presentation tasks?

Regression	The use of one of more variables to produce an equation estimating the value of another variable
Reliability	The extent to which a process (such as measurement or an experimental procedure) can be repeated and yield the same result
Research Design	The overall design of a piece of empirical research intended to address a research problem
Research Problem	The specification of an issue that can be addressed by empirical research
Research Question	The translation of a theoretical or conceptual question into one that can be addressed by empirical research
Sampling	The selection of cases from a larger population of cases
Significance Testing	Procedure used to estimate the probability that a relationship between variables found in sample data would be found in that data if no such relationship existed in the population
Scientific Research Paper	A standard form of research report. Including a literature review, formulation of a research problem and associated research design, hypothesis formulation, identification of relevant evidence or data, analysis, results and conclusions
SPSS	Statistical software package that can be menu (GUI) driven or run from syntax (code)
Stata	Statistical software package
Structural Equation Modelling (SEM)	An advanced multivariate procedure that can be used for investigating causality, confirmatory factor analysis or other approaches.
Substantive Course	A course based on an empirical area within a discipline, such as 'voting behaviour' or 'social mobility'
Survey Instrument	A research tool used to collect data, such as a questionnaire, observation protocol, something missing here?
Syntax	Programming language for statistical software such as SPSS or Stata
Univariate Statistics	Statistics dealing with only one variable. For example the calculation of an average
Validity	The extent to which an empirical measurement represents a theoretical concept
Variable	The characteristic of an object of analysis that varies across different objects

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In 2011, the British Academy launched a new programme, with funding from the Department for Business, Innovation and Skills, targeting deficits in languages and quantitative skills. The programme of work reflects the Academy's longstanding concerns about deficits in these areas of the humanities and social sciences, as well as in UK education and research. Through the programme, the Academy funds research and relevant initiatives, and seeks to influence policy in these areas.

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