

**MEETING TWENTY-FIRST CENTURY  
DATA DEMANDS: THE SUPPLY AND  
DEMAND OF QUANTITATIVE SKILLS**  
Project Report

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# Executive summary

## Introduction

This report presents the findings of a twelve-month teaching enhancement research project at the University of Leeds that explores the current state of quantitative skills teaching in higher education and the changing demands of industry. The project involved working one day per week over the course of a calendar year (2017) in the Leeds Institute for Teaching Excellence (LITE) thus equating to 44 days of research and exploration.

It will be no surprise to readers of this report that quantitative and data skills are very much at the forefront of employer minds when seeking graduates to take on roles. This report considers the perceived gap between graduate skills (supply) and industry needs (demand) and provides recommendations to higher education on bridging this divide.

## Methodology

This work adopts a simple methodology whereby employers are interviewed and canvassed on their views regarding graduate skills. Employers are asked to highlight skills most desired when seeking new employee graduates. This is then contrasted with the findings obtained from Internet research exploring higher education curricula. The work is divided into three distinct parts:

Exploring demand – what skills are currently most in-demand by commercial and public sector organisations who typically recruit graduates for quantitative/data roles?

Exploring supply – what skills do current graduates from a range of subject backgrounds typically exit university with?

Bridging the gap – how close is higher education to meeting the demand of industry and how can this gap be closed?

## Findings

This report finds the following:

1. There is a gap between industry demand and higher education supply with regards to quantitatively skilled graduates.
2. STEM subjects embed quantitative skills across the vast majority of modules whereas other degree programmes (namely social sciences) isolate such skills to one module and this has various negative implications.
3. Many higher education curricula haven't evolved over recent years and, in some subjects, rely on out-dated content.
4. There is ample room in the curriculum for more innovative teaching and resource development, ranging from early education to university-level.



## Recommendations

This report recommends the following:

1. The teaching of core quantitative skills should be further integrated and developed at the GCSE and A-Level stages of education freeing up time for universities to focus on developing skills demanded by industry.
2. Quantitative skills should be further embedded across all/most of modules in a given discipline in higher education rather than being restricted to one methods-type module. This would provide greater exposure of such methods to students and avoid the misconception that such skills are of little importance as they comprise minimal degree time.
3. Innovation and practice around quantitative methods should be encouraged with programmes such as Q-Step supporting staff as well as students and acting as a bridge between further and higher education.
4. Industry involvement in curriculum design would benefit all parties through regular skills audits.

## Conclusions

This research concludes that a skills gap is evident between the offering of higher education and the demands of industry with regards to quantitatively skilled graduates. At a time when data are changing, both in terms of volume and type, the requirements of a contemporary graduate and degree programme differ from previous years. This project presents the outcome of a supply and demand analysis culminating in a series of actionable recommendations.

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# 1. Introduction

## 1.1 Initial scope of project

It is important to note that the initial aim of this research was to investigate the value of Massive Open Online Courses (MOOCs) in assisting students to understand and engage with contemporary quantitative methods. A credit-bearing MOOC (higher education) and/or entry level MOOC(s) (school-level) were proposed, however, due to institutional priorities and the limited timescales set by this research project the remit was refined. Whilst it is still the intention of the author to develop such resources, this report presents a higher-level review of quantitative skills teaching, primarily at the higher education level, followed by recommendations for ensuring graduates are not left behind due to the advances being made in industry in terms of both methods and data applications.

The executive summary (pages 4-5) present a succinct overview of the goals of this research and the means to which it will be carried out.

## 1.2 Aims

This research focuses on the extent to which university education prepares graduates for employment in quantitative/data-heavy subjects.

The core aims of this research are to:

- Understand the current climate with regards to quantitative and data skills in the workplace (industry – demand);
- Appreciate the skills obtained by the typical university graduate (higher education – supply);
- Provide recommendations to ensure universities provide ‘data savvy’ graduates that are fulfilling the demands of contemporary industry.

## 1.3 Report overview

This research report is structured into four chapters as follows:

- Chapter 1 (this chapter) defines the remit of the work and the broad research aims.
- Chapter 2 provides a succinct overview of how each aim will be explored.
- Chapter 3 presents the core findings from this research in relation to each of the aims presented in section 1.2.
- Chapter 4 turns the findings detailed in chapter 3 into actionable recommendations.

## 2. Methodology

### 2.1 Fulfilling the research aims

In order to achieve the aims put forward in section 1.2, this research will adopt the following approaches:

**Aim:** Understand the current climate with regards to quantitative and data skills in the workplace (industry – demands)

**Approach:** Conduct a thorough review of quantitative and data skills demanded by industry through exploring a range of graduate-level employment opportunities and speaking to recruiters / line managers in typical ‘data-centric’ careers. From this, develop a list of core ‘new’ skills sought by recruiters when seeking quantitatively skilled graduates.

**Aim:** Appreciate the skills obtained by the typical university graduate (higher education – supply)

**Approach:** Conduct a review of curricula in a range of university-level subjects (mixing more standard quantitative and ‘other’ subject domains). Determine the typical quantitative skills that graduates from different disciplines exit with and weigh up their market worth.

**Aim:** Provide recommendations to ensure universities provide ‘data savvy’ graduates that are fulfilling the demands of contemporary industry

**Approach:** Based on the findings from the demand and supply aims (above), develop both recommendations and resources to ensure quantitative and data skills are taught in line with industry trends. Resources should span different levels of education and provide usage at the local, institutional and potentially national level. Recommendations should be actionable and tangible measures which could be put into place to ensure higher education supply meets industry demands with regards to quantitative skills.

### 2.2 Summary of data collection techniques

This project places considerable attention on the development of both actionable recommendations and usable resources to support quantitative skills teaching in higher education. Before such recommendations/resources can be developed, stakeholders on both sides need to be consulted to understand the current supply (higher education) versus demand (industry) position. This research will make use of face-to-face interviews with leading graduate recruiters commonly in the market for graduates with an appetite for data analysis to understand the demand position. It will then adopt a more conventional internet research approach to analyse subject-level curricula before contrasting taught skills with industry desired skills. A fuller breakdown of each method is included as part of the findings discussion in chapter 3.



## 3. Findings and outcomes

### 3.1 Introduction

This chapter presents the findings and outcomes from addressing each of the three aims first stated in section 1.2 and elaborated upon in section 2.1.

### 3.2 Demand for data skills (Aim 1)

The inspiration for this project came about due to very apparent changes in the skills required by twenty-first century graduates. Graduates entering employment nowadays need very different quantitative and data skills to those seeking employment even five years ago. The famous and well-rehearsed phrase that *'90 per cent of the world's data [has been] generated in the past two years'* (Wall, 2014) is testament to this.

Core quantitative skills such as descriptive statistics and probability are still important but are being overtaken by the skills needed to handle 'Big Data' and other new forms of data that are being produced at such a rapid rate (as evidenced by Wall, 2014). Such skills are becoming increasingly mandatory in a range of graduate careers, not simply the more technical-facing and stereotypical data/numerate roles.

When one considers the way in which data are generated today, it is easy to understand why skills are changing. Shopping in the supermarket (using a loyalty card), broadcasting views and options (via social media) and leaving hotel or restaurant reviews (via a mobile phone app) all generate data in ways which were far less mainstream in previous years.

Leading media organisations and researchers in this domain regularly state that *"businesses are drowning in data but starving for insights"* (Watkins, 2016) and that *"Big data needs new skills, but the business and academic worlds are playing catch up"* (Ross, 2015, p.119). The former phrase is highly aligned to Wall (2014) and the notion that contemporary society is generating more data than ever before but the fact that organisations are 'starving' for insight suggests that there are holes in workforce skills which need to be plugged. Ross (2015) points this finger at universities and suggests that it is the role of the higher education sector to ensure teaching and training in such skills are refreshed and delivered in line with industry demands.

#### 3.2.1. View of the employer

In support of the above academic and popular press findings, one aspect of this research focused on direct communication with leading data-centric employers who regularly seek to recruit quantitative graduates for entry-level positions. Such entry-level positions are most often occupied by staff who work with data on a daily basis and are required to 'get their hands dirty' through a variety of data processing and analysis functions. It is these staff who work on data the most and pass outputs onto middle- and higher-level management for decision-making.

The employers surveyed in this work were principally asked about core skills desired in new recruits, specifically graduates. This process of surveying employers was instigated through

the author's role of visiting students on year-long placements as part of their degree programmes. Both the format of discussion (face-to-face) and purpose of visit (to check on status of student) enabled an honest and in-depth conversation regarding in-demand skills.

The employers surveyed as part of this research are detailed in Table 1:

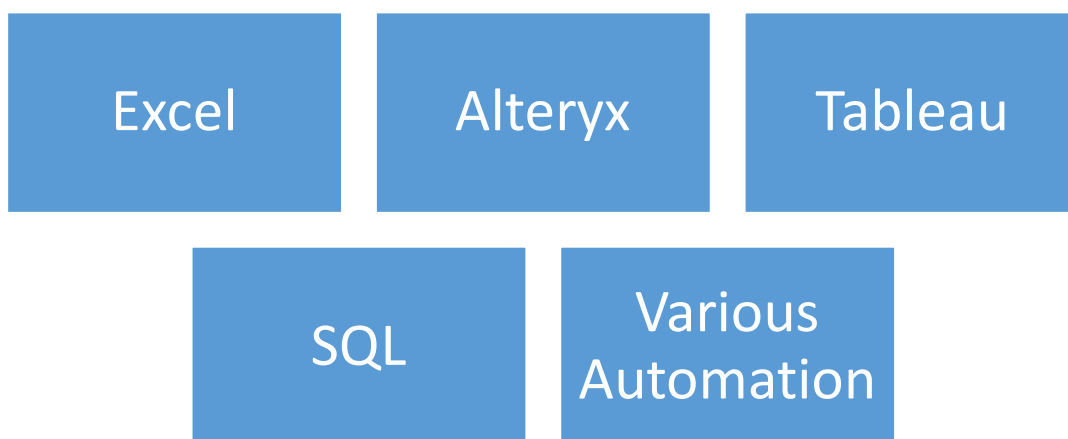
Employer	Location (all UK)	Typical graduate role
CACI Ltd.	London	Data Analyst
Callcredit Ltd.	Leeds	Data Analyst
Edge Analytics Ltd.	Leeds	Demographic Analyst
Javelin Group Ltd.	London	Locations Analyst
Leeds City Council	Leeds	Various Analyst roles
National Health Service	Leeds	Research Analyst
Savills UK Ltd.	London	Retail Research Analyst
WM Morrisons Supermarkets PLC	Leeds	Competition Analyst

**Table 1: Employers surveyed on core graduate data skills**

The eight employers surveyed (Table 1) were principally private sector organisations and hence those who tend to innovate most with data. In addition, several other organisations were canvassed more informally through unplanned interactions and discussions. Both groups generally agreed on the skills they would like to see graduates obtaining at university and hence carrying forward into graduate employment.

It should be noted that all of the employers surveyed regularly recruited for analyst positions, as noted in Table 1, with analysts being the most data 'hands on' of all employees. Analyst roles typically involved handling large amounts of data and generating insights to inform business operations or policy. With the newer forms of data and increased volume of data (termed 'Big Data') now being generated, the skills required by such organisations very much reflect the changing landscape.

Without wanting to directly attribute specific skills to particular organisations, the five most popular skills as referenced by those surveyed are shown in Figure 1.



**Figure 1: Employer-requested skills as stated by surveyed organisations**

Interestingly, most organisations were quick to list specific software packages when asked about contemporary ‘skills’, more so than naming broader skills per se such as problem solving or data blending. Consequently, software packages account for three of the five components in Figure 1. Exploring this further, the software packages named by the organisations link to the specific skills listed in Table 2. Note that Table 2 only presents the core operations of the named software.

Software / ‘skill’ noted by organization(s)	Skills for which software is used (in brief)
Excel	Spreadsheet package required for statistical/data handling; Macros; Lookups; graphical presentation etc
Altreyx	Software package useful for data blending; predictive/statistical/spatial analytics; visualisation
Tableau	Software package useful for data visualization; ‘Big Data’ handling; general analytics
SQL	Database communication language (‘Structured Query language’)
Various automation	Completing data tasks (often large and repetitive) without the need for manual execution; computer programming

**Table 2: Explanation of software (plus skills) referenced by surveyed organisations**

The skills/software put forward by the eight data-centric employers in Figure 1 and extended upon in Table 2 fit very neatly with the societal view that the most in-demand skills for graduates are changing. Core quantitative skills such as descriptive statistics and probability are still important but are being overtaken by the skills needed to handle ‘Big Data’ and other new forms of data. Such skills are becoming increasingly mandatory in a range of graduate careers and hence universities are advised to note this feedback.

Data is referred to by many as being ‘*the new oil*’ (Agrawal et al., 2018) but as also widely noted, having lots of it is unlikely to make produce wealth or richness unless the skills are in place to handle, process and refine it. Whilst it is clear that industry is moving forward at a rapid pace through data innovation, it is imperative that higher education does the same to ensure supply meets demand. Section 3.2 will explore the state of higher education with regards to data skills teaching provision and attempt to highlight the supply/demand gap currently in existence.

The author would like to formally thank staff at all of the organisations listed in Table 1 for cooperating and providing information in support of this research. A full list of contributors can be found in the acknowledgement section of this report (page 31).

### 3.3 Supply of data skills (Aim 2)

In order to determine the gap (if present) between skills demanded (industry) and skills supplied (higher education), an exploration of quantitative and data skills in higher education was conducted. This process involved a review of subjects in the Science, Technology, Engineering and Mathematics (STEM) domain plus more traditional social science subjects. The rationale behind the choice of subject domains follows discussions from employers (see Table 1) regarding subject areas from which they typically recruit. STEM subjects, particularly technology and mathematics, were referred to by many employers as being ‘target subjects’ whilst social science subjects, such as geography and psychology, also attracted considerable attention from data-driven organisations, the latter subjects also named by White (2010) as leading the way with regards to employability more generally. Table 3 lists subjects referred to by employers as being of particular interest to them when recruiting for quantitative positions, such as analysts, in addition to some brief rationale. Note that subjects are listed alphabetically and hence are not in a ranking/preference order.

Subject	Categorisation	Rationale
Computing (also includes: Computer Science, Information Technology, Information Systems)	STEM	<ul style="list-style-type: none"> <li>• Numerate</li> <li>• Some skills in automation</li> <li>• Ability to learn new software and processes quickly</li> <li>• Problem solvers</li> </ul>
Geography	Social Science	<ul style="list-style-type: none"> <li>• More technically-minded than similar [social science] subjects</li> <li>• Ability to think spatially</li> <li>• Problem solvers</li> <li>• Aware of data sources</li> </ul>
Mathematics (also includes: Statistics)	STEM	<ul style="list-style-type: none"> <li>• Numerate</li> <li>• Problem solvers</li> <li>• Confidence with data and equations</li> </ul>
Physics	STEM	<ul style="list-style-type: none"> <li>• Problem solvers</li> <li>• IT savvy</li> <li>• Ability to learn new software and processes quickly</li> <li>• Numerate</li> </ul>
Psychology	Social Science	<ul style="list-style-type: none"> <li>• Statistically able and confident</li> <li>• Problem solvers</li> <li>• Largely numerate</li> </ul>

**Table 3: Subject preferences for employers seeking data savvy graduates**



Interestingly, even when cherry-picking subjects and, to a lesser extent, universities, employers still noted a shortfall in desired quantitative skills. The subjects listed in Table 3 may be the subject areas from which the canvassed employers typically recruit, however, these are also the subjects from which the same employers listed the skills shortfall as reflected in Figure 2. This therefore suggests that whilst employers are hand-selecting the 'best' subjects from which to recruit, there is still a gap between what is provided and what is ultimately desired regarding skill outcomes.

### **3.3.1. A review of curricula**

As part of analysing data and/or quantitative skills provision, a review of core undergraduate methodological modules (or similar) was conducted across a range of subjects at several institutions. The rationale behind this was to determine the content taught in practical modules which tend to deliver quantitative skills training. Furthermore, whilst there is an appreciation that some students may select additional modules given interests in this domain, such methodological (or similar) modules tend to be core components of most degree programmes and hence provide a baseline level of training. Undergraduate programmes were analysed given that these supply the vast majority of industry graduates. Postgraduate programmes were not considered as part of this work.

The general consensus from reviewing subject-level curricula at the University of Leeds and elsewhere (including viewing programme and module catalogues at comparable institutions – names not included in this public report) is that there are rather different approaches to embedding core skills in STEM subjects when compared to social science subjects. Naturally, STEM subjects are more quantitative by definition and as such the vast majority of modules include elements of data/quantitative/numeracy skills albeit in a range of different subject-specific contexts. For this reason, such disciplines do not require a core methods-type module but this differs to social science subjects (such as Geography and Psychology). Disciplines categorised as falling into the social science grouping include a wide range of modules, many with little or no quantitative demands. A lack of modules with analytical requirements means that social science subjects tend to incorporate an often large and core methods module – Geography and Psychology typically fit this pattern when explored across the four universities mentioned above. This module often resides in the second year of a three-year programme and is designed to prepare students for a dissertation or independent research project in their final year. Interestingly, whilst this project didn't explore all subjects, many social science subjects, such as history and politics, lacked quantitative skills even within a devoted methods module.

From the exploration of Geography and Psychology curricula at the universities mentioned, quantitative content common to both disciplines for a methods-type module include skills such as those listed in Table 4. Note that this list has been compiled from a range of degree programmes comprising Geography and Psychology content, either in full or part, and reflects the common baseline content only. Psychology degrees then tend to progress to focus more on aspects such as sampling, probability and statistical functions with Geography following similar lines albeit with a greater emphasis on more spatial forms of data and associated techniques.

<b>Social science programmes – common quantitative skills provision</b>	<b>Overview</b>
Data types	Basic, ratio, interval, ordinal, nominal, continuous
Descriptive statistics / central tendency	Mean, median, mode, standard deviation / variance, minimum, maximum, skewness, kurtosis
Probability and sampling	Significance, p-values, sample error, sample bias, sample selection
Regression	Linear regression, nonlinear regression
Correlation and relationships	Pearson's correlation, Spearman's rank, uni-variate / bi-variate and multi-variate analyses
Data description	Box plots, histograms and other forms of data description and presentation

**Table 4: Common quantitative content in social science (Geography and Psychology) undergraduate programmes**

It is essential to highlight here that whilst the skills presented in Table 4 are taught in contemporary social science degrees, often in specialist methods modules, these are also the same quantitative skills that underpinned similar degrees many years ago. This therefore highlights two issues:

1. Core quantitative skills have not been refreshed or adapted in line with industry demands.
2. Core quantitative skills remain separate from the main curriculum and in a devoted methods-type module.

When one considers the first point, it is rather striking that core social science 'methods' training has not evolved over the past two decades. In the current era of Big Data and with needs to handle, process and understand new forms of data it of concern as to why curricula have not kept pace with demand. This observation is explored further in chapter 4.

With regards to the second point, and also as a consequence of quantitative skills being arguably more important than ever before, it remains concerning that these skills appear detached the remainder of curricula. Such skills ought to be far more entrenched in traditional social science modules enabling students to see how such skills relate to contemporary society. At present, curriculum design is as much to blame for the nation's skill deficiency as the content itself. This observation is also explored further in chapter 4.

### **3.4 Inspirational resourcing for data skills teaching (Aim 3)**

One of the aims of this project was to take onboard the criticisms of quantitative and data skills education with respect to market demand and provide recommendations for change. Whilst such recommendations are provided in chapter 4, part of this process involved the design of new educational resources. As referenced in chapter 1, the initial remit of this work was to design MOOC(s) to provide an engaging and interactive journey through interesting subject content using quantitative approaches, however, this scope had to be refined for reasons discussed. Instead, a range of alternative and more traditional resources

have been produced and these are outlined in sections 3.4.1 and 3.4.2. Resources are available upon request.

### 3.4.1. SAGE Research Methods resources

SAGE have recently launched a Research Methods portal (see SAGE, 2018) enabling academics affiliated to any worldwide university to produce case studies aimed at students with a particular focus on conveying complex or difficult to understand methods. Many of these case studies link to academic papers but provide the student audience with a 'jargon free' account of the work and more importantly the methods followed. Most case studies also provide advice to students on how to adopt the same method in their own work.

In line with the goals of this research, publishing via this portal represents an excellent way to produce several engaging case studies in a range of subject areas covering data/quantitative methods. As part of this project, three case studies were developed with a fourth in press. These are detailed in Table 5 with the method highlighted in **bold** font. Note that content has been deliberately developed for different subject areas.

#	Status	Subject area	Media	Title	Access
1	Published 2017	Sociology	Written case study	Locating and Measuring Loneliness in the United Kingdom through the creation of a <b>Composite Index</b>	<a href="http://dx.doi.org/10.4135/9781526440457">http://dx.doi.org/10.4135/9781526440457</a>
2	Published 2018	Health	Written case study	Creating a Health/Deprivation Geodemographic Classification System Using <b>K-Means Clustering Methods</b>	<a href="http://dx.doi.org/10.4135/9781473977839">http://dx.doi.org/10.4135/9781473977839</a>
3	Published 2018	Geography	Video case study	Using <b>Geodemographics</b> to Better Understand Health and Deprivation.	<a href="http://methods.sagepub.com/video/using-geodemographics-to-better-understand-health-and-deprivation">http://methods.sagepub.com/video/using-geodemographics-to-better-understand-health-and-deprivation</a>
4	In press	Politics	Written case study	Analysing political and voting behaviour in the US using innovative <b>data visualisation methods</b>	TBC

Table 5: Subject-specific resources designed to support contemporary quantitative and data skills in higher education

Examples of each of these outputs can be found in Appendix A.

### **3.4.2. Schools resources**

In addition to formal online outputs (aimed at a national and international student audience), focus was also directed more locally at a range of sixth form colleagues. One of the recommendations of this work is to embed more fundamental quantitative and data skills in curricula prior to university entry such that time is available once students reach degree level to further develop such skills and place greater emphasis on developing the skills demanded by industry (see Chapter 4). With this in mind, resources were designed for the sixth form stage of education (Key Stage 5) and are available to view in Appendix B. These resources were developed in the summer period of 2017 and have already been utilised by over sixty sixth form students, all of whom were invited to attend the University of Leeds for a 2.5 hour quantitative skills session in conjunction with Q-Step<sup>1</sup> and LITE.

Student feedback from these sessions were wholly positive and is available upon request.

<sup>1</sup>Q-Step is a programme designed to promote a step-change in quantitative social science training in the UK. It is funded by the Nuffield Foundation, ESRC and HEFCE.



## 4. Conclusions and recommendations

### 4.1 Introduction

Upon completion of this project, the research has proven the hypothesis eluded to in chapter 1 – that being that there is a clear (and arguably growing) skills gap between qualified graduates exiting degree programmes (supply) and the requirements of contemporary society / industry (demand). This chapter will provide a concise summary of the research findings before overviewing a series of recommendations designed to remedy this skills gap albeit with an appreciation that such deep-rooted and longstanding approaches will take time to change.

### 4.2 Conclusion and summary

In order to best highlight the principal findings of this work, it is necessary to re-visit the three aims as first put forward in chapter 1 and illustrate (1) how these have been met and (2) the core findings associated with each.

- **Understand the current climate with regards to quantitative and data skills in the workplace (industry – demand)**

This aim focussed attention on the demands and desires of industry when seeking new recruits, typically graduates, into analyst/data roles. At a time when data are being generated at such a rapid rate and Big Data is dominating the sector, industry understandably require different skills to those needed five to ten years ago. Commercial and public sector organisations surveyed in this work listed core data skills that they would now like to see as part of university-level curricula (and also specific software experience/competence). These general skills included advanced spreadsheet skills, data visualisation, automation/programming and database management with a keenness for software such as Alteryx and Tableau.

A recent GRIT report (Greenbook Research Industry Trends) specifically pinpointed data visualisation as one of the most in-demand skills with 63% of organisations valuing this particular asset. The more generally termed ‘Data Science’ role/skill also received considerable interest at 58% (Morgan, 2015).

The above highlights that standard university degrees, particularly in the social sciences, are not yet equipping graduates with the new skills deemed necessary by leading employers. Whilst this skills gap may be manageable at present (and remedied via in-house training from employers), the longer this gap exists one can only expect it to widen.

- **Appreciate the skills obtained by the typical university graduate (higher education – supply)**

This aim involved focussing on the skills currently taught in higher education with regards to quantitative and data education. This aim is wide-ranging and very difficult to fully assess

without considerable time and resources, particularly given the number and breadth of degree programmes on offer and the institutions offering these.

The consensus reached here is that STEM subjects are more able to embed quantitative skills into graduate programmes than other subjects, such as the social sciences. This may seem like an obvious statement, particularly if comparing mathematics with sociology for example, but the primary reason for this is down to ensuring that quantitative skills span the whole curriculum. STEM subjects ensure all (or certainly most) modules require some analytical ability whereas social science programmes tend to separate such skills into one larger ‘Research Methods’ (or similar) module. This separation doesn’t aid student learning as (1) it doesn’t offer students prolonged exposure to such methods and (2) it gives the impression (to students) that quantitative skills are only one part of their education whereas in reality these should be embedded more widely to reflect societal importance.

Furthermore, it became apparent that the specific quantitative skills taught today only vary slightly when compared to those delivered more historically. Whilst software may change, the importance placed on skills such as descriptive statistics, probability and regression remain the same, particularly in the social sciences.

Whilst industry is innovating (and will continue to innovate) higher education is relying on tried and tested quantitative content which is becoming increasingly out-of-date. There is a duty on the higher education sector to innovate and at least remain on the heels of industry such that graduates are existing with market-ready skills.

- **Provide recommendations to ensure universities provide ‘data savvy’ graduates that are fulfilling the demands of contemporary industry.**

One important aspect of this work involves the production of a series of recommendations to attempt to bridge the quantitative skills gap – this integrates the findings of the preceding two ‘demand’ and ‘supply’ aims. Whilst part of this involves the generation of resources to complement innovative data education, the greatest importance is placed on how to take the knowledge generated in this report forward. Four recommendations are proposed and discussed in full in section 4.4.

### 4.3 Limitations

Undertaking such a wide-ranging project on a one-day-per-week basis over the course of a year inevitably means the output is somewhat undeveloped and open to criticism. The author is fully aware of limitations that have impacted this work and readers should also interpret results with caution. In particular, whilst recommendations are made (see section 4.4) and industry trends identified these rely solely on the interviews and canvassing of the selected employers and may not be wholly reflective of wider society. Furthermore, the state of higher education quantitative methods teaching is determined through a review of selected subjects and institutions and variations and exceptions will no doubt exist. The trends identified in this report are generalised and not reflective of any specific degree programme or institution. This research also does not take into account delivery methods / practicalities or assessment strategies when proposing the recommendations in section 4.4.

## 4.4 The way forward – recommendations

Whilst there is undoubtedly further work which could be undertaken on the topic of quantitative skills education, this work has conducted a supply versus demand assessment and identified shortcomings. Readers with a particular interest in this work may also be keen to explore the following works. It should be noted that whilst all studies do agree on certain aspects, there are also differing views presented. Each of these studies (including this one) were completed independently:

Mason, G., Nathan, M. & Rosso, A. (2015), *State of the nation: A review of evidence on the supply and demand of quantitative skills*, The British Academy. Available online: <https://www.britac.ac.uk/sites/default/files/BA-NIESR%20State%20of%20the%20Nation%20-%20A%20review%20of%20evidence%20on%20the%20supply%20and%20demand%20of%20OQS.pdf>

Warwick, M. (2015), *Count us in: Quantitative skills for a new generation*, Available online: [https://www.britac.ac.uk/sites/default/files/Count-Us-In-Full-Report\\_0.pdf](https://www.britac.ac.uk/sites/default/files/Count-Us-In-Full-Report_0.pdf)

In line with the research presented in this report, the following four recommendations are put forward. It should be noted that there is an acute awareness by the author that change takes time, particularly then attempting to change processes which have remained static over prolonged periods. There is also a great appreciation that some of the proposed recommendations are far more achievable than others.

### **1. The teaching of core quantitative skills should be further integrated and developed at the GCSE and A-Level stages of education in the UK.**

Students at the pre-university stage of education need to be exposed to more fundamental quantitative and data skills than at present. Such education does not need to be delivered via mathematics / numeracy classes but can instead be embedded more widely (e.g. via geography, history, sociology etc). Consequently, this would be advantageous as it would (1) equip the workforce who opt not to study at university with some of the skills demanded by contemporary society and (2) it would free up time for universities to focus on educating students on the skills currently most in-demand by industry, rather than needing to introduce (or at best reinforce) fundamental data skills.

To some extent, there is wider appreciation that this needs to happen already with basic computer programming already encouraged at primary school level but this process needs to be furthered to encompass basic numeracy, data handling and interpretation skills.

The Royal Statistics Society (RSS) is also aware of the above and recently highlighted the importance of greater analytical and statistical teaching at the early stages of education in its 'data manifesto' (RSS, 2016). This is firmly supported by the famous survey of Members of Parliament in 2011 when basic mathematics skills were tested and ability was found to be wanting, see Burns (2017b) for details – also available in Appendix B.

The resources developed and delivered as part of this project to over sixty sixth form students is evidence that this is achievable (see Appendix B). The highly positive feedback received from all participants is also an indication that students at this stage of education would like to be exposed to such skills.

## **2. Quantitative and data skills should be further embedded across subjects/disciplines in higher education**

Quantitative and data skills need not and should not be seen as a self-contained subject as this is damaging to student education. Such skills need to be embedded widely across degree programmes enabling students to regularly ‘learn by doing’. Partitioning quantitative education into a self-contained module (often a ‘Research Methods’ type module) is perfectly acceptable provided that these skills are introduced in this module but then applied more widely and in other module contexts. Restricting quantitative skills to this module alone implies (to students) that these only make up a small proportion of their degree whereas in reality these skills are some of the most in demand in society. Furthermore, in order to produce ‘data savvy’ graduates, students need experience of applying a wide range of quantitative skills in as many different contexts as possible. The term ‘problem solvers’ is regularly observed on job specifications nowadays and enabling students to take core skills and apply these in projects in very different domains develops people with such problem solving skills.

Skills such as computer programming and data visualisation (as highlighted by the GRIT report) are not only two of the most in-demand skills but also two skills that lend themselves to widespread adoption in a range of subject areas outside of core methods classes.

## **3. Innovation and practice around quantitative methods should be encouraged**

The core skills taught in current degree programmes (particularly in the social sciences) are dated and do not fully align with industry demands. There is a firm appreciation that students must learn the rudimentary processes before attempting more advanced work but if such rudimentary processes could be delivered earlier in the educational life cycle (as noted in recommendation #1) then this enables a total refreshing of higher education curricula. University education should not feel restricted to follow academic norms when teaching data skills, it would be far more beneficial to the student learning experience to ‘learn by doing’ and hence understand quantitative methods almost subconsciously whilst learning about exciting current affairs and topical issues. Whilst re-designing content to fit with current affairs is no doubt daunting for time-stretched teaching staff, making use of innovative datasets is not and would certainly improve engagement. For example, analysing tweets on political party support, crime locations, relationships between health outbreaks and socio-economic classification are far more engaging for a student than case studies adopted at present.

In addition, it would be wise for existing initiatives (such as Q-Step) to encourage the above and support staff as much as students. Furthermore, linking Q-Step (and other initiatives) with pre-university education would provide a figurehead for GCSE and A-Level students at



a time when they are developing their subject interests. By visiting schools / sixth form colleges, Q-Step (or equivalent) representatives can become those figureheads and act as inspiration to students and encourage / support the pursuit of quantitative and data skills. Armed with exciting datasets, activities, extracurricular sessions and a knowledge of careers for students to aspire to, this would provide a useful connect between universities and local schools and colleges. The resources developed and delivered as part of this project (detailed in section 3.4.1) are testament to this and best evidenced through the wholly positive feedback from students.

#### **4. Industry involvement in curriculum design would benefit all parties**

Whilst academic institutions working in partnership with commercial or public sector bodies may seem unrealistic given the time pressures on both parties, occasional skills audits should be sought. Academic disciplines / departments liaising with employers who regularly seek their graduates and modernising curricula accordingly would represent progress and be advantageous for both parties. The academic discipline could market itself as having formal links with industry and undertaking skills audits with employability in mind whereas the industry partner would be in a position to recruit graduates knowing that they have received the desired levels of training required to fulfil their role. Such audits would also ensure supply keeps pace with demand as innovation by industry would be closely followed by innovation in teaching by the academic department.

### **4.5 Closing remarks**

This project has by no means identified new supply versus demand relationships with regards to quantitative skills education and industrial demands but it has attempted to highlight the growing disparity between the two. The recommendations put forward in section 4.4 represent suggestions to firstly narrow this gap and secondly ensure it remains bridgeable.

Readers of this report should be aware of the limitations associated with this work, as detailed in section 4.3.

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# Appendices


## Appendix A | SAGE Research Methods teaching resources


Included below are examples of the three SAGE Research Methods case studies published to date. A further case study is in press and will be published in due course.

Note that the full articles cannot be reproduced here as a paid subscription is required to view. Most higher education institutions have a subscription. A free trial service is also available. Table 5 includes direct weblinks to these resources.

SAGE Research Methods case study #1 (Health):

See: Burns (2017a).


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### Creating a Health/Deprivation Geodemographic Classification System Using K-Means Clustering Methods

 CASE





By: [Luke Burns](#)


Published: 2017 | Product: SAGE Research Methods Cases Part 2

DOI: <http://dx.doi.org/10.4135/9781473977839>


Methods: [Classification](#)

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Methods Map




Explore the Methods Map

Related Content







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#### Abstract

This research case study presents the findings of work specifically designed to investigate the usefulness of using geodemographics to profile areas based on health outcome. It seeks to identify local authorities in England which may currently be at risk from problems linked to household deprivation and matters regarding poor health/illness or those in danger of deterioration. Presented in this case study is a guide through seven phases of geodemographic system development. The phases range from identifying a clear purpose for the system through to clustering via the k-means algorithm, profiling, and better understanding the demographic composition of an area. All phases are evidenced through a 2009 study seeking to identify local authorities in England which may be "at risk" from matters linked to deprivation and ...




## SAGE Research Methods case study #2 (Sociology):

See: Burns and Lucy (2018).

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### Locating and Measuring Loneliness in the United Kingdom Through the Creation of a Composite Index

 CASE



**By:** [Luke Burns](#) & Laetitia Lucy


**Published:** 2018 | **Product:** SAGE Research Methods Cases Part 2

**DOI:** <http://dx.doi.org/10.4135/9781526440457>

**Methods:** [Case study research](#)


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Published Articles 

**Lucy, L., & Burns, L. (2017).** Devising a composite index to analyze and model loneliness and related health risks in the United Kingdom. *Journal of Gerontology & Geriatric Medicine*, 3, 1–10. doi: <http://dx.doi.org/10.1177/2333721417714876>

Methods Map 



Related Content 

### Abstract

This case study presents a detailed overview of the methods and findings from research undertaken to explore loneliness in the *United Kingdom*, as published in the *Journal of Gerontology and Geriatric Medicine*. A composite index is proposed and stepped through, thus, evidencing how loneliness can be predicted and measured at a small geographical scale. The composite index put forward in this research is evidenced on the London Borough of Southwark, but designed such that it could be applied more widely. The work adopts an entirely quantitative approach through the combination of current census and accessibility variables to form the index with each of the six development phases clearly explained. The output is a scoring system, whereby each small area is assigned a value indicating the ...


## SAGE Research Methods case study #3 (Geography):






See: Burns (2018).


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Using Geodemographics to Better Understand Health and Deprivation

 VIDEO

      
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 Segment 1: How Geodemographics Works




**Dr. Luke Burns**  
Lecturer in Quantitative Human Geography, University of Leeds

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TranscriptSummary

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**00:00** [MUSIC PLAYING] [Using Geodemographics to Better Understand Health and Deprivation]

**00:09** LUKE BURNS: My name is Luke Burns. And I'm a lecturer in quantitative human geography at the University of Leeds. My background is in a range of quantitative techniques, including geodemographics, composite indices, and geographical information systems. I've worked in industry and academia, and try to bring these experiences into my teaching. The purpose of this video is to introduce

**00:31** LUKE BURNS [continued]: geodemographics and

## Appendix B | Schools teaching resources

Included below is an extract from the A-Level resources developed and delivered to sixth form students (~60 students).

The full resource is available upon request free of charge.



A step-change in  
quantitative social  
science skills  
Funded by the  
Nuffield Foundation,  
ESRC and HEFCE



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### ArcGIS Web Map – Census data exercise

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*"The Office for National Statistics in England and Wales and the General Register Office in Scotland are responsible for the collection of census data. In the UK, a census is taken on a single day, usually the third Sunday of April, once every ten years. Everyone, by law, must take part. All households in the UK will receive a census form and must complete it with information about everyone living in the household.*

*This data is used by the government to make plans for maternity care, education, pensions, employment, housing and transport. The government need to know about changes in population so they can make plans for the use of their resources, for example, do they need more schools?" (BBC Bitesize, 2017).*



In this activity we are going to explore census data from 2001 to understand how West Yorkshire looked around the time you were born! The most recent census occurred in 2011 so if we have time we will look to compare how West Yorkshire looked in 2001 to how it looks more recently.

## Appendix C | Additional project outputs

Included below are additional outputs associated with this project. These are:

- LITE project blog
- EduLearn Conference paper
- EduLearn Conference presentation

Included below is a blog associated with this project, published on 15/03/2017.

See Burns (2017b).

### **BLOG: Opinion: Higher education and the data revolution**

A STAGGERING total of 90 per cent of the world's data has been generated in just the past two years. But what does this 'data revolution' mean for higher education, students and the way they are taught? [LITE Teaching Project Enhancement Leader](#), [Dr Luke Burns](#), explores here this changing world.

We are awash with data, whether these be more traditional datasets such as school performance statistics or store revenue estimations or newer forms of what we now term 'Big Data'.

These new and exciting datasets include social media interactions like Facebook check-ins or geolocated tweets and data generated from a wide range of daily activities such as loyalty card swipes, mobile phone usage, credit card spends and internet searches.

There is no doubt that we live in a data rich society so much so that 90% of the world's data has been generated in the past two years, and that is one statistic that we should sit up and take notice of.

As educators, we need to both enthuse and nurture the next generation of the workforce where such data and analytical skills will only grow in importance.

The 'data revolution' is here to stay and with that comes a need for people with the appropriate skills to help turn this mass of data into meaningful action.

#### **Future skills**

Data skills are not just important when developing the next cohort of computer programmers, accountants or statisticians, these quantitative skills are necessary across the full breadth of industry.

With such rich data at our fingers tips both the public and private sectors are looking to skilled graduates to help them better understand this data and make informed decisions.

One great line that succinctly sums up this demand-supply relationship is that "*Businesses are drowning in data but starving for insights*".

## Interesting results

Sadly, in the UK we are generally poor when it comes to teaching and learning quantitative skills. Many people are open in their lack of confidence when working with numbers whereas others vastly overstate their abilities, perhaps deliberately.

This is somewhat highlighted by the market research company Ipsos MORI's bi-annual opinion poll of MP's.

In winter 2011, the Royal Statistics Society approached Ipsos MORI and asked if they could slip a question into this poll to test the basic quantitative skills of MP's – the result was rather startling. The question posed was a simple one: *What is the chance of getting two heads if you toss a coin twice?*

MP's were given five multiple-choice responses to select from, meaning that even a wild guess would lead to a 20% chance of getting the answer right, and only 40% responded correctly.

The fact that only two-in-five MP's could conduct a simple probability is alarming in itself but even more so when close to 80% of the same group of MP's declared confidence in their numeracy skills.

With half of these people being on the then government list and all very well-educated, not to mention making big decisions on risk and return on a daily basis, our approach to quantitative skills education ought to be evaluated.

## Change needed

I have a firm belief that universities should be held to account when it comes to producing what I term 'industry standard' graduates – these are graduates with strong quantitative skills but also the right quantitative and data skills needed for modern-day industry.

Part of this battle is overcoming statistical anxiety and a fear of numbers as partly evidenced above. The other part is ensuring graduates have the toolkits to be able to handle some of the newer datasets that more traditional quantitative techniques can't address, even if these are still readily taught with little consideration given towards their industry value.

There is a need to change tact, modernise curricula and reconsider approaches to teaching.

Research suggests that students first develop their core interests, and rarely sway too far from these, during their early education years and so this process of engagement with data must start much earlier than in the university lecture theatre.

## Solution

My [LITE project – Massive Open Online Courses: Engaging tomorrow's data programmes today](#), pulls together the increasing need for specialist numerate data professionals with an appreciation that these skills need to be embedded far earlier in the education lifecycle.

The output will be a suite of freely available Massive Open Online Courses (MOOCs) aimed at pupils and teachers at the GCSE and A-Level stage of education.

The interactive courses, which will be made available via the FutureLearn platform, will enable pupils to see first-hand how data can be used to solve problems in a wide range of application areas such as crime, health and business.

The resources will be designed in a way such that they can be used by teachers for whole-class sessions or taken by interested pupils in their own time to develop their skills and interests and enhance university applications.

All resources will be fully supported and endorsed by Q-Step, a national initiative that seeks to get more social science students using and embracing data.

Whilst this project is about data and quantitative skills, it is not solely about probability and descriptive statistics – topics which have been part of quantitative curricula for many years.

It is about using engaging examples and interactive forms of teaching to introduce new datasets and the tools and techniques needed to handle them.

It is about getting young people excited at the prospect of using data and introducing these skills early enough in the educational journey such that they are pursued at the school/college level, into university and beyond.

And it is about bringing together stakeholders such as QStep, FutureLearn and the [University of Leeds](#) to generate inspiring teaching which acts as stimuli for the pursuit of contemporary quantitative skills.

With over 3 million students – 500,000 having accessed the University of Leeds' courses – and the schools market growing, MOOCs via FutureLearn represent a real opportunity to make a difference and start developing the data professionals of tomorrow, today.



Included below is a conference paper associated with this project. Note that only the abstract is available publically at present. This is accessible via:

[dx.doi.org/10.21125/edulearn.2017.1387](https://dx.doi.org/10.21125/edulearn.2017.1387)

Conference details:

9th International Conference on Education and New Learning Technologies

3-5 July, 2017, Barcelona, Spain

See Burns (2017c).

## **Using MOOCs to educate and enthuse the data professionals of tomorrow**

This research pulls together the increasing need for specialist numerate data professionals in the contemporary workforce with an appreciation that these skills need to be embedded far earlier in the student education lifecycle to be successful.

With 90 per cent of the world's data generated in the past two years, the data needs of industry are changing. Core quantitative skills such as descriptive statistics and probability are still important but are being overtaken by the technical skills needed to handle 'Big Data' and other new forms of data.

This research undertakes a skills audit of industry before developing pedagogically-influenced Massive Open Online Courses (MOOCs) aimed at pupils and teachers at the GCSE (General Certificate of Secondary Education) and A-Level stage of education in the United Kingdom.

The interactive courses, which will be made available via the FutureLearn educational platform, will enable pupils to see first-hand how data can be used to solve problems in a wide range of application areas such as crime, health and business whilst at the same time introducing new data forms such as 'Big Data' and social media.

The resources will be designed in a way such that they can be used by teachers for whole-class sessions or taken by interested pupils in their own time to develop their skills and interests and enhance university applications.

All resources will be fully supported and endorsed by Q-Step, a national initiative that seeks to get more students using and embracing data.

Whilst this project is about enhancing data and quantitative skills, it is not directly concerned with common statistical techniques which have been part of quantitative curricula for many years. It is about using engaging examples and interactive forms of teaching to introduce twenty-first century data skills to young people at a time when their academic interests are first developing.

**Keywords:** MOOCs, data, quantitative, e-learning, industry.

Included below is a conference presentation associated with this project. This was delivered at the following conference:

Conference details:

9th International Conference on Education and New Learning Technologies

3-5 July, 2017, Barcelona, Spain

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## Using MOOCs to educate and enthuse the data professionals of tomorrow

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## Overview

- About me
- About LITE
- The project – inspiration
- The project – data skills gap
- The solution – MOOC development
- More information

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## About me

- Luke Burns
- **BA(Hons)** Geography, **MSc** Geographical Information Systems, **PhD** Geodemographics (data analysis!)
- Currently a Lecturer in Quantitative Human Geography
- Also: Worked (in various capacities) at GMAP Ltd. (UK), IIASA (Austria), Leeds City Council (UK) and iTrain Ltd (UK)
- Interests very much in 'data' education, 'data' applications and employability
- Seconded to the Leeds Institute for Teaching Excellence in 2017, one day per week

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## About LITE

- Leeds Institute for Teaching Excellence
- Established in 2016
- Community of research and innovation
- Seeking to establish the University of Leeds as a sector leader in teaching practice and scholarship
- Follow our work:
  - <http://teachingexcellence.leeds.ac.uk/>
  - @leedsteaching

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## The project – inspiration



- As a student, I had pedagogical interests...
- In 2015, a report was published by Universities UK
- *"Analytic Britain – Securing the right skills for the data-driven economy"*
- In a nutshell:
  - "Data Revolution" – so much data!
  - Importance of quantitative skills – 70% of employers demand these
  - Recommendations for ensuring these skills are developed from primary school to industry
  - Available online at: [http://www.nesta.org.uk/sites/default/files/analytic\\_britain.pdf](http://www.nesta.org.uk/sites/default/files/analytic_britain.pdf)
- Two problems: (1) shortage/poor quantitative skills and (2) changing data demands

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## The project – (1) shortage/poor quantitative skills

- An alarming story of quantitative skills (or not!) in action...
- As a general rule, in the UK we are poor at TEACHING and LEARNING statistics and quantitative skills
- In 2011, the Royal Statistics Society approached Ipsos MORI to include a question on next poll to test the basic quantitative skills of MP's
- The question posed was a simple one: *What is the chance of getting two heads if you toss a coin twice?*
- Five multiple choice options to selection from
- And....only 40% got it right

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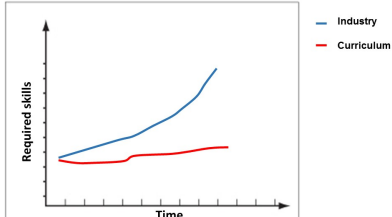
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## The project – (2) changing data demands

- Quantitative skills needed by contemporary industry
- Skills have changed considerably overtime
- *"Businesses are drowning in data but starving for insights"* (Watkins, 2016)
- Supply and demand relationship → universities and industry
- BUT there is a shortfall and this is (apparently) widening
- But it is not widening from both sides...

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Required skills

Time

Industry

Curriculum

## What is the red line?

- Descriptive statistics
- Software (Excel, SPSS, Minitab, MatLab)
- Regression
- Probability

## What is the blue line?

- Data cleaning ('dirty' data), acquisition and application
- Problem solving
- Software (Excel, R, Hadoop, SQL)
- 'Big Data'
- Spatial data



## The solution – MOOC development

- Quantitative skills ought to be embedded far earlier in the education lifecycle
- This frees up time for Higher Education to teach more nuanced techniques
- Output: A portfolio of MOOCs aimed at GCSE/A-Level (ages 14-18)
- Themed around topical issues to make skills training more passive, starting with:
  - Geography
  - Sociology
  - Politics
- Funded by LITE and Q-Step with support from the Open Data Institute
- 'School MOOCs' from the University of Leeds available on FutureLearn
- 500,000 participants on our MOOCs so far, predicted to grow...

## The solution – MOOCs @ Leeds

- 'School MOOCs' from the University of Leeds available on FutureLearn
- 500,000 participants on our MOOCs so far, predicted to grow...
- Leeds one of eight institutions offering credit-bearing MOOCs
- 'Data' MOOCs expected to progress from Schools to credit-bearing



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Horton, 2015

## Thank you for listening!

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Blog:  
<http://teachingexcellence.leeds.ac.uk/opinion-higher-education-and-the-data-revolution/>



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# About the author and acknowledgements

## About the author

Dr Luke Burns is a Lecture in Quantitative Human Geography in the Centre for Spatial Analysis and Policy in the School of Geography at the University of Leeds. Having worked in both industry and academia, Luke has developed firm expertise in several areas of quantitative geography including the advanced application of geographical information systems to socio-economic problems and the construction and application of geodemographic classification systems. Luke regularly delivers presentations at conferences/events on his work and through the university teaches on a broad selection of analytical courses comprising undergraduate, taught postgraduate, online/open distance learning and continuing professional development.

Luke maintains longstanding interest in graduate employability, particularly through the importance of teaching contemporary quantitative skills.

## Acknowledgements


It is important to recognise the support and contributions of several people who have enabled the fulfilment of this research.

The Leeds Institute for Teaching Excellence provided both the time and funds to enable the completion of such an important assessment of graduate skills.

The following individuals were generous enough to offer their time to discuss graduate skills and potential for change:

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David Jackson (Leeds City Council)  
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Jordan Nightingale-Greenfield (Savills UK Ltd.)  
Laura Short (Javelin Group Ltd.)  
Milosz Tarkowski (CACI Ltd.)  
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