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Statistics in public policy debates: Present crises and adult mathematics education

Jeff Evans

Middlesex University

<j.evans [at] mdx.ac.uk >

Abstract

Statistics is one of the important branches of mathematics taught in schools, colleges and universities. It is also an important tool in public policy discussions. This paper focuses on the use of statistics in the latter context, rather than its use in adult mathematics education research. I review the key characteristics of the statistical approach to constructing public knowledge, and give a very brief history of key points in its development. I discuss how what I call the "overt crisis of statistics", the apparent disenchantment of large sections of the public with the "expert" statistical methods, outputs and pronouncements, leads to dilemmas both for citizens and for democratic governments. Recently "Big Data" and data analytics seem to many to offer new solutions to problems resulting from the essential lack of certainty surrounding efforts to understand society, and from the need to make quick decisions in a rapidly changing world. These approaches have potential, but also limitations. This leads me to consider a second, "covert" crisis of statistics, resulting from a struggle between proponents of freely available public information and public argument, and those aiming to profit from the appropriation and sequestering of information for private ends. I finish by considering what can be done by ourselves, as citizens, at adult mathematics teachers, and as researchers.

Key words: statistics; public policy; big data; data analytics; technology corporations

Introduction

During most of our lifetimes, it has been accepted that, in most countries with a developed civil society, citizens and policy makers could rely on statistics – those produced by government agencies, or those from well-designed surveys from other agencies – to set a baseline for discussion and decision making. Thus we have quoted official statistics, results from the European Labour Force Survey, or figures compiled by the World Bank, in discussions of unemployment. Or we have used national household surveys, to estimate the numbers of victims of crime, or of those who rate their own health as poor.

Now, given events of the last two years, and subsequent public reactions, these previously accepted resources are facing new challenges. For example, a recent article by Will Davies in The Guardian, "Have statistics lost their power in public policy discussions?", has raised challenging questions regarding the role of statistics in public discussions:

> Rather than diffusing controversy and polarisation, it seems as if statistics are actually stoking them. Antipathy to statistics has become one of the hallmarks of the populist right, with statisticians and economists chief among the various "experts" ostensibly rejected by voters in 2016.
>
> (DAVIES, 2017)

Davies, writing just after the Brexit vote and the Trump victory, focuses on the UK and the US, but the issues apply more widely. Here, I first briefly consider key points of the statistical approach, and its historical development. I then explore the idea of a "crisis" in statistics, and argue that it is actually two different crises, based in different social groups. This leads me to consider the recently voguish notion of "Big Data", and the sorts of data analytics used with it. I finish with some suggestions about how citizens can withstand the most challenging features of the society that the large technology / media companies have established, and consider some ways that these ideas can be highlighted in the adult mathematics classroom.

The statistical approach, and a brief historical development

In order to have a clear discussion, we need to understand that "statistics" can refer to three different aspects, though they are related:

(i) statistical data, and / or

(ii) statistical techniques of data analysis (e.g. averages, measures of spread and correlation, statistical models), and / or

(iii) the particular discipline, which of course includes "experts" in its ideas and procedures.

Key examples of the ideas and procedures of statistics include:

- The importance of investigating a representative sample from a specified population about which one wishes to draw conclusions, and familiarity with the methods of representative sampling and with the drawing of inferences from samples
- The importance of comparable and stable measurements of all the members of the sample, and knowledge of ways to assure the quality of such measures
- The *difference* between correlation and causation, and ways to design studies so as to be able to construct more dependable explanations for what is observed

From the late 17th century, the idea gained ground that statistics should be used to understand an entire population (not only potential soldiers, or tax-payers). Originally, this was not necessarily to be done using numbers, as in geographical descriptions of various German states, pre-unification. In England William Petty & John Graunt introduced the estimation of population size via counting of deaths, rather than via a census (costly).

In 18th and 19th century, in post- Revolutionary France, statistics began to be produced by trained cadres in a centralised statistical office. Across Europe and beyond, in data analysis, the normal distribution was found to be surprisingly powerful for supporting the growth of scientific knowledge, in quantifying and understanding apparently unrelated phenomena:

(i) errors of measurement (Gauss),

(ii) approximations to probabilities of gambling outcomes (de Moivre), and

(iii) the distribution of physical (and mental) characteristics (Quetelet, Galton).

This distribution was argued to underlie variation in a large number of natural phenomena, and so became an assumption of much data analysis well into the 20th century.

In the 19th and 20th centuries, around the world, specific indicators, clearly defined and systematically produced, were constructed for simplifying description of diverse and complex populations. Examples include: population size and vital statistics (births, marriages, deaths);

classifications of disease, national income statistics (e.g. GDP). Surveys and opinion polls of representative samples of the population, and of subgroups, using variations of simple random sampling (itself an advance on haphazard sampling) were introduced. Experimental designs (nowadays called Randomised Controlled Trials - RCTs) were introduced for agricultural trials and extended into the study of medicine and psychology; quasi-experimental designs were introduced from the 1960s, to increase their applicability to contexts where experimental designs were ethically or practically impossible. In addition, in line with a widespread general concern with comparative methods in the social sciences and history, there were efforts in statistical data production to enhance comparability across time, and across nations and subgroups. Overall, statistical data have allowed democratic countries, in particular, to sharpen their political agendas, and to design progressive policies, when the will and the resources to do so were available.

The "overt crisis" of statistics and resulting dilemmas for citizens and democratic governments

Some dimensions of the current crisis include an increasing lack of trust in statistical data, and a consequent decline in their authority. For various reasons this has become particularly evident in the UK and the USA over recent years. For example, Davies (2017) cites survey results in the US which indicated that 68% of Trump supporters distrusted government economic statistics; and in the UK, that 55% distrusted data on "the number of immigrants living here"; see also Pew Research Center (2018, 14 May). This leads people to brand any evidence that seems contradictory to their preferred worldview as "fake news", or as something fabricated by "experts". Thus there is evidence of a lack of generally accepted baselines for discussing competing claims about society; and consequently a resort to "speaking one's own truth", and drawing on "intuition" and emotion as alternative bases of knowledge.

We can consider further some important aspects of these contemporary reactions to statistics. A key dilemma arises from the need to govern the population as a whole vs. (increasing) pressures to respond to feelings of particular citizens in a particular place and time. This can lead for example to a mismatch between what politicians say about the general state of the labour market, and local experience of the labour market, by individuals or by neighbourhood groups. Recently, such problems have been aggravated by a difficulty of satisfactorily portraying the state of the nation, with the use of summary statistics – because of the fragmentation of available identities and the foregrounding of differences within society. Even if one tries to be sensitive to social differences, by avoiding an overly crude use of averages, the available measures of spread, such as the standard deviation or the range, cannot capture the full quality of the differences currently emerging, say in sexual identity or political allegiance.

Thus there have been strains on existing classifications and definitions, due to changes in cultural politics – more fluid identities, attitudes and beliefs (emotions), and the reshaping of global economy and society. This has made various definitions more complex e.g. of unemployment, or GDP, or even gender. There has been an evident need not only to classify, but also to measure, say *intensity* of employment, or *commitment* to actually exercising one's "voting preference" on election day.

There have also been challenges in ensuring comparability across time, as the governance of states has changed (or fragmented), and especially comparability across nations, for example as the number and variety of countries participating in PISA has changed. For example, it is one thing to rank 10th in a set of 23 countries in the PIAAC survey; it means something different to rank 10th in a group of 62 countries in PISA.

And now … Here come Big Data and Data Analytics

What is Big Data? What are Data Analytics?

Big Data and data analytics are seen as possible solutions to pressing problems, such as limited research capability or the difficulty in producing the results of complex analyses in a timely fashion. Big Data can be characterised as the availability of exceedingly large amounts of data. However, these are accumulated by default, as a by-product of other processes, usually without attention to research design (e.g. sampling), but requiring the extensive use of electronic technology for capture, analysis, and presentation.

Examples of *Big Data* include the use of speed cameras or other video cameras, for behaviour monitoring, and for storage of alleged proof of mis-behaviour (allowing efficient legal prosecution). The use of loyalty cards allows monitoring of purchasing behaviour, plus correlation of such data with a number of demographic variables - "freely" produced by the card-holders themselves – so as to facilitate the targeting of marketing communications – with an option of experimenting with differential "special offers" (or experimental treatments). A further example is the harvesting of electronic texts – from individual acts of communication, which in an earlier time might have been assumed to be private, e.g. information searches, social media posts (and possibly emails and internet phone calls?). These texts can now be subjected to *data analytics*; this collection of techniques includes *data mining*, where many of the data analysis decisions are made by "artificial intelligence" – algorithms run by machines, rather than by human analysts. These are supplemented by *data linkage* (linking of data on a person from several databases), and *sentiment analysis*, used to striking effect by certain companies in the US election and the UK referendum (Cadwalladr, 2017).

Other examples are perhaps more positive: "Citizen science" (e.g. astronomical observation by many citizens) and "Citizen maths" (performing time-consuming calculations / simulations by many citizens). In contrast, Mass Observation, begun in 1937 and continuing in various forms to the present, was not electronically supported, and relied on named volunteers to do the interviews and the observations (Hubble, 2010).

Issues with Big Data and Data Analytics

In methodological terms, the data involved is "big" indeed, i.e. not limited in the ways relevant to the pre-electronic period, but there are several serious limitations. First, the approach involves "haphazard" harvesting of large amounts of data – indeed impressive amounts. However, a huge sample can still be biased (e.g. Marsh, 1979) and, if there is no known sampling design, generalisation to any recognisable population will be difficult in principle.

In many cases too, the data comes without settled categories, since people can take on self-selected identities. This means that data from one database may be hard to "link" with data from another, and it thus may be difficult to analyse even degrees of correlation. Further, even if you have access to a huge data set, and that data shows a very *high correlation* between A and B, that still does not prove that A causes B!

Other more political issues arise for the responsible citizen – to do with freedom of the consumer (data provider), privacy and ownership of data. The "freely chosen" declarations of "informed consent" (EULAs) that individuals are asked to sign in order to use a range of applications provided by the technology companies – and that many sign in an inappropriately off-hand way – may be agreed to long before some particular data is extracted from the "user", and the permissions thereby granted are considered currently to be for forever. Data linkage raises not only technical issues (about how to do it accurately), but also issues of privacy: Would you want data from your medical records to be linked to your income tax return information, or to your Facebook page? If this sounds far-fetched, see the striking novel, *The Circle* (Eggers, 2014), which describes a fictional company, with a resemblance to a combination of Facebook and

Google, which proclaims a commitment to "total transparency" … with instructive consequences for the idea of privacy!

Much data nowadays is *appropriated* by private companies, for their own uses, in much the same way that common lands in English villages were appropriated by private landowners since the 17th century, during periods of "Enclosures"; see e.g. Polyani, (2001). These private companies have few or no obligations towards openness or transparency – though much rhetoric is often heard. Thus the user of the services, who is also of course the provider of the data, may never know what the data says about them – much less how it might be interpreted later by an unknown, and perhaps suspicious, user.

The covert crisis: from a "logic of statistics" to a "logic of data analytics"

Thus, we have aspects of a second, "covert", crisis of statistics, based on opposing ideas of knowledge. On the one side, we have the "experts" of the Office of National Statistics – bound by research ethics, and monitored by UK Statistics Authority – and on the other, the experts of Google, Facebook, and other less known policy actors, such as Cambridge Analytica (Cadwalladr, 2017-18, e.g. 2017). These latter appropriate data from unsuspecting individuals, link it with information available from public or privatised databases, analyse it (sometimes) and sell it on to a range of customers, to be used for purposes, including "tailored messaging" – by marketers, politicians, "opinion formers". Some of these interests are oriented to maximising the appropriation of other people's data, so as to maximise advertising revenues – the 'media corporations'. Others may be oriented to undermining rational, open, public discussion of values and policy – the "ideologues".

There are currently (July 2018) official investigations ongoing into the way these methods were used by the Brexit campaigns in the UK, by the Trump campaign in the USA, and by the media corporations themselves. This is clearly a continuing process, with many landmarks. An important one is the establishment of the General Data Protection Regulations by the EU in May 2018; see https://www.eugdpr.org/ .

Summary

The "overt crisis" of statistics appears to result from the public's disenchantment with the provision of statistics to be used as a basis for public discussions of policy. I have also aimed to describe a "covert crisis" lying behind the overt one, where certain interest groups are stoking the overt crisis for their own ends. For without statistics, and social research more generally, made available publicly and discussed freely (without interference or manipulation from unknown human beings, and non-human "bots"), we cannot construct unambiguous, objective, potentially consensus-forming claims about society – nor can we provide a corrective to faulty claims. In such a situation, there will be few mechanisms to prevent people from instinctive reactions and emotional prejudices.

Many have pinned their hopes on certain Open Data initiatives offered by state statistics and certain agencies. However, these public initiatives seem unlikely to be mirrored by the sharing of the results of data analytics by private corporations. In Davies's (2017) judgment, data analytics is "suited to detecting trends, sensing the mood, spotting things bubbling up" – but not so much for the type of social explanation that many feel is necessary in an advanced democracy. Further, the numbers produced by data analytics are "generated behind our backs and beyond our knowledge". And the results are appropriated, owned and sold on by private concerns – without the original providers' knowledge!

Thus, the battle is not between "an elite-led politics of facts versus a populist politics of feeling" (Davies, 2017). Rather, it is between those committed to public knowledge and argument versus those who profit from the privatisation of information and "the ongoing disintegration" of public knowledge and argument.

Conclusion: What might be done?

Here, we can focus on what might be done (a) by ourselves as citizens; (b) by teachers of adults' mathematics / numeracy; and (c) by researchers.

As citizens, it is important to rethink our relationship with IT and media companies, especially the "FAANGs" (Facebook, Amazon, Apple, Netflix, Google – and many users of Windows may not want to exclude Microsoft!).

a1. "There is no such thing as a free lunch.". So we need to read the EULA (End User Licensing Agreement) before we click to "Accept" the "free access" to software offered by many companies on the web. You are signing a contract, and you are giving something away in return: it is worth thinking about what that something is!

a2. Maybe there are still "free searches"? How many details of your life are on the file-server, of Google? Use gmail? Always "google" when you are searching? (There are alternatives: the search engine DuckDuckGo calls itself "The search engine that doesn't track you.")

a3. Maybe there is still "free" news? Of course, every news source must be selective. But the more they know about you and your "likes", the more selective they can be, so as not to disturb your bubble, and so as to keep you "clicking" (and providing them with income). The alternative is to get news from professional journalists, who take a somewhat broader view and will often have a long-term commitment to, and knowledge of, an issue - and they may occasionally come up with something surprising, like the Panama papers or the Paradise papers. Many good newspapers support the International Consortium of Investigative Journalists. But good journalism requires funds. In most countries, you can support a newspaper, by subscribing online, taking out a paid membership - or even by buying a copy, once in a while.

a4. "Think globally; act locally." Many things can still be bought at a local store, which employs local people, perhaps even some that you know. You can keep your Amazon account for the truly hard-to-find commodities.

a5. Many countries have "fact-checkers", e.g. agencies that check the more important claims made in the political and social sphere: e.g. Full Fact in UK (https://fullfact.org/). They are often charities that depend on financial support from members of the public.

As teachers of adults' mathematics / numeracy, we can encourage our students to consider their positions with respect to the trends described above, with the help of available statistics, and using surveys that can be done in the classroom.

b1. Many countries have available on the web a wealth of statistics produced by government or other agencies. For example, one could consider the data available on unemployment, and ask what it tells us about the current state of work, and "precarity" of employment (e.g. Evans, Ruane and Southall, 2019; Frankenstein, 2014). Or we could ask what is the level of migration into and from our country, and whether we could estimate the numbers of refugees, "economic migrants", and so on (e.g. Tyler, 2017). These are challenging questions, and we can expect one result to be that the students find that an apparently "objective" number comes with a lot of assumptions in these areas of discussion and indeed controversy!

b2. Examples can be given of cases in the era before "big data" where a very large sample could be very biased indeed (e.g. Marsh, 1979).

b3. Many examples of the difference between correlation and causation can be found in a good newspaper; a notorious example is the correlation over time between the number of storks in Germany and the number of human births – seeming to provide corroboration for the view that storks bring babies; see for example,

https://www.researchgate.net/publication/227763292_Storks_Deliver_Babies_p_0008

b4. There is scope for a group of students researching themselves, as to the level of their use of Facebook, Twitter, and Amazon – and their reasons for their use, as well as their beliefs about how their date is used.

As researchers, we might be interested in several types of research.

c1. Researchers might do the type of survey described above, but with a more wide-ranging questionnaire, and a larger and more representative sample.

c2. Further research and analysis is needed to investigate which feelings are most crucial in the "new politics of feeling" mentioned above. This need is most pressing for the groups characterised as "those left behind" in various traditionally democratic societies. on these issues. The most important would seem to be:

- Anxiety / Fear vs. Hope / Love
- Trust vs. Distrust
- Anger / Discrimination vs. Solidarity / Inclusion

Some forms of these feelings will be recognisable from the classroom, by mathematics educators and researchers. They are of course inter-related. For example, anger is often born of fear and anxiety and can be directed against recognisable "Others" (Mishra, 2017; Fraser, 2017).

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