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Building Confidence in Using New Research Methods: Reflections from a Former Numerophobe's Use of Computer Programming and Advanced Statistics

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Abstract

Using unfamiliar research methods requires confidence and open-mindedness. I am not a confident mathematician, and could previously have been called numerophobic. But a research question as to why the British Government was losing more immigration appeal cases in court forced me to engage with quantitative methods. I sought to explain the fact that 25 of 78 immigration appeal cases were lost by the crown from 1970 to 1994, but 90 of 174 cases were lost in just 17 succeeding years. I suspected the explanation lay in the increased indeterminacy of parliamentary legislation. My question, and theory, demanded I use computer-assisted natural language processing of legal documents, and that I then analyse the results with multivariate logit regression analyses, including models for random effects. These methods would, in the past, have left me bewildered. But my journey of methodological discovery was, in the end, rewarding and demonstrated the centrality of confidence to teaching and learning.

Learning Outcomes

By the end of this research case study, readers should be able to

- Identify methods they have little confidence in using, and perhaps even fear to use.
- See how their research practices affect their learning and teaching.
- Appreciate the centrality of self-reflection and confidence for learning and teaching.

Case Study

Introduction

I have always found it easier to reason through words, than numbers. And, for want of confident numeracy, I refused to engage properly with quantitative political science. Indeed, as is so often the way, I distrusted what I did not fully understand. I was suspicious, even downright hostile to the superficiality of quantification, as I then saw it.

That all changed when a new research question forced me to grasp the quantitative nettle. I wanted to conduct a historical survey of immigration appeal cases. These are politically charged lawsuits that made it to the highest heights of the British justice system. In particular, like many in the public and press, I wanted know why claimants were defeating the government more frequently in court, and why there was a significantly engorged caseload for judges to deal with. Some factors were obvious. Increased immigration to the United Kingdom (UK), and improved facilities for appeals meant more successful litigations against the British government. But, on closer inspection, mystery remained. Legal tools — such as the *Human Rights Act* (HRA) 1998 — did not straightforwardly benefit immigrants. The HRA gave new powers to courts for identifying human right abuses, but many of the powers already existed in UK law prior to 1998, and the protections for immigrants did not change substantially. Added to which, an increase in the raw number of appeals should not have affected the rate of success for claimants. So how was I to explain the fact that 25 of 78 appeal cases were lost by the government from 1970 to 1994, but 90 of 174 cases were lost in just 17 succeeding years? A number of theories and hypotheses needed testing. And the way forward was, it became clear, to use a machine-reading computer program, and multivariate logit regression analysis with models for random effects.

A machine-reading computer program was needed to analyse the laws enacted by Parliament, to see if the determinacy of their language had changed through time. And multivariate logit regression analysis was needed to test various models of what caused government defeats in court. Logit regression entails a discrete rather than continuous outcome (win or lose), and multivariate analysis means that several different explanations can be tested simultaneously. There was a time when something like these last few sentences would have been enough for me to glaze over, panic a little, and skip reading an article! So, in this case study, I will explain how I went from fearing maths, to genuinely enjoying complex calculations. I will also walk you through the research project, so that the utility of my mixed-methods approach becomes clear. Overarching this reminiscence is a key point. Self-reflection, confidence and open-mindedness are crucial to research. Confidence does not mean arrogance. All is needed is sufficient self-possession to try new and unfamiliar approaches. This confidence, for me, came from others. By opening myself up to colleagues, and others who have shared their research experiences, I felt increasingly comfortable in trying techniques that only five years previously would have left me cold.

Further, reflecting on confidence has, I believe, improved my learning and teaching. Some of my undergraduate students similarly struck against that which they feared, and did not fully understand. Rather than pandering to their fears, I have increasingly urged openness and inquisitiveness. To achieve this, students have to be prepared to let go of pernicious internal narratives, along the lines of: ‘I’m no good at this stats nonsense!’. None of which is to say that I am now some maths prodigy — far from it. But at least I have tried.

This case study begins with a detailed description of my project and research design. After which I elaborate on how the method actually worked (but also often faltered). The final section goes deeper into the psychology of research and teaching, considering the importance of confidence to research, learning and teaching.

Research Design

I was reminded, constantly, as a new doctoral student that method is driven by theory, not vice versa (see, for instance, King, Keohane & Verba, 1994). And yet I hesitated. I did not want to acknowledge what this dictum implied for my own research — that I was going to have to convert textured social phenomena into numbers. This was because I sought a wide-angled lens through which to view changes in immigration appeals since the first such appeal in 1970. This was of critical importance to answering my question — why are judges increasingly ruling against the government? My theory was that judges impose rules of law against the government more often, because the rules themselves have become increasingly indeterminate. So, it was because Parliament had not constructed clear enough immigration law that judges were increasingly called upon to make sense of it all. In so doing, judges would often side with the weaker party (the immigrant), simply on the grounds that a government should not take indeterminate and unaccountable power from a contestable contract. Benefit of the increasing doubt, more often than not, went to the immigrant.

I was building on existing theories that the policy influence of judges depended on the quality of law, not the judges themselves. In other words, I was not convinced that judges were becoming bleeding hearts, who used the law to push their own policy agendas. To test my claims, I had to provide two types of evidence: (1) that the law on immigration had become more indeterminate, and (2) that this indeterminacy helps explain when the government loses appeal cases.

Put technically, I needed to provide descriptive and causal inferences (see, for example, Whitehead, 1998). To make matters more onerous, I was wading deep into interdisciplinary territory. When I spoke to legal scholars, they were usually convinced that legislative language was less comprehensible today than it had been 40 (plus) years ago (see, for example, Bix, 1993). But, they were not sure how this could be demonstrated without first receiving training in the rules of legal interpretation. I did not have time to retrain as a lawyer, so I looked to see what legal scholars and linguistics experts have done in the past to chart changes in the language of law (Hiltunen, 2012; Kurzon, 1997; Trosberg, 1995). They had typically counted parts of speech that distort meaning. In other words, they had counted sources of meaninglessness, rather than sources of meaning. This is a much safer approach to take. Meaning is not fixed, but is dependent on context. Meaninglessness — as caused by adjectives, conjunctions, certain modal verbs, and long sentences — is less rooted to any particular time or context. An example I used in my 2017 article comes from section 5 of the *Special Immigration Appeals Commission Act 1997* (Williams 2017b). This section was relied upon by seven men the government wanted to deport as allegedly threatening national security:

‘(1) The Lord Chancellor may make rules... (b) for prescribing the practice and procedure to be followed on or in connection with appeals... including the mode and burden of proof and admissibility of evidence on such appeals, and (c) for other matters preliminary or incidental to or arising out of such appeals’

Various parts of speech muddle meaning here. I wanted to measure changes in Parliament’s use of adjectives (*preliminary* or *incidental*), conjunctions (*preliminary or incidental to or arising out of*), indeterminate modal verbs (The Lord Chancellor *may*), and broad enabling verbs (*may make rules*). To see through the wide-angled lens, I was going to have to measure these parts of speech across many years of legislation. For my doctorate, I did this by hand, painstakingly reading nearly 9,000 sampled sections of legislation (Williams, 2016; Williams, 2017a). This produced the goods, but sated my appetite for more. A colleague remarked, somewhat surprised, at how much effort I had put into reading so much on the hunt for meaninglessness! He pointed me to various linguists who had successfully used computer programs to machine-read text and spit out desirable data in fractions of a second (see, for example, Moretti & Pestre, 2015).

Here's where the anxiety kicked in. How was I supposed to program a computer to read immigration law? I had no such experience. The very thought of it filled me with dread. But, I realised that to tackle my question, and to use a replicable method, I needed to write some code. Having reached this conclusion, I searched online for blog posts and articles written by those who have also arrived late to programming. There was an enormous community of similarly tentative souls, looking nervously as robots devoured their research questions. Machine-reading was able to achieve in seconds what could otherwise have taken years. For my new book, I present computer analyses from all 41.5 million words of legislation enacted by Parliament between 1900 and 2015 (Williams 2018). Such a scale of analysis would be utterly impossible without computer assistance.

To write the code, I read as much as I could from those who had trodden similar paths. There are great websites, such as StackOverflow, where programmers share experiences and knowledge. Soon I was able to cobble together a program written in Python script that could run 'Natural Language ToolKit' (NLTK) software. This software enables all sorts of fun things in what is called Natural Language Processing (NLP). NLP is used in search engine algorithms, and is a way of analysing written text for patterns. It is capable of correcting spellings and completing sentences. NLP was certainly capable of meeting my modest ambition of analysing the frequencies of indeterminate parts of speech. An excerpt of the code is provided in Figure 1.

Figure 1 Example of Natural Language Processing code

No doubt, longer-in-the-tooth coders will be unimpressed. My code could undoubtedly be more elegant. The problem with constructing code from bits and pieces of other programs is a certain lack of fluidity. But, it works. And it provided the evidence I needed that legislative indeterminacy was a variable, not a constant. Of course, there were practical problems, that I describe later in this case study. Nonetheless, having a program that worked was a major psychological breakthrough for me. I am the sort of luddite who looks at a smartphone as some sort of unfathomable devilry. Modern information technology is, to me, bewildering and awe-inspiring. There is no question that my program is basic, but its potential power is significant.

Having worked out how to measure legislative language, I then had to work out whether it mattered or not. In my previous life as a qualitative researcher, I would have selected a limited number of court cases to compare, based on their theoretical significance. For my doctorate, I compared all court cases, which were drawn from litigations under just two Acts of Parliament. These Acts were chosen because they varied significantly on the independent variable (the determinacy of their language), but were otherwise very similar. The research rested on a ‘method of difference design’, to use J.S. Mill’s terminology (Mill, 1843). Results were strong, but I was not confident in generalising my findings. I had good evidence for how two Acts of Parliament had been interpreted by the courts. But what about the other 34 enactments from 1905 to 2016? I wanted a surer sense of what had changed in immigration jurisprudence, so I needed to analyse all appeal court cases pertaining to asylum and immigration over a significant period of time. In the end, I analysed all 252 court cases heard by senior appeal courts between 1970 and 2012. Each and every reported case was analysed. I selected senior appeal court cases because of their significance in affecting the law and policy on immigration.

To analyse so many cases, process tracing each one was not an option. Only correlation analysis was a viable means of even coming close to understanding why judges’ behaviour had changed over 40 years. Specifically, logit (a.k.a. logistic) regression analysis was needed. This is because the dependent variable (win or lose for the government) can take only two discrete values. In addition to which, the analyses had to include several explanatory variables (besides legislative language), so as to test the effects of confounding forces. And, furthermore, the analysis needed to model random effects. Where most variables have fixed effects (i.e. apply uniformly across cases), a test for random variation was needed for each individual judge, and for the different courts. In random effects modelling, there are separate models for individuals, rather than just a single model to cover everybody involved. The aim being to see whether individual judges or different courts even needed different models, or whether the differences were so small that a fixed effects model will do. By using multiple variables, and random effects, I was able to test my hypotheses against rival claims pushed by other theories. In brief, I did not expect the random effects models to show any significant difference between judges or courts. The only variables I suspected would be important were those measuring differences in language.

All of this was new to me. I had undertaken standard graduate training in statistics, which had given me a decent grounding. But, I was not even remotely comfortable in using statistics, nor the software that was available. I bit the bullet, because my research question demanded it of me. Only a wide-angled lens (provided by statistical analyses) could show up the sort of patterns in judicial behaviour I was searching for. It was this inquisitiveness as to what I might find that pushed me to use new research methods. In essence I had to pretend as if I were a different researcher. One with more confidence in using quantitative methods, and with less fear of failure. This acting ‘as if’ allowed me to move from mere inquisitiveness to active research using unfamiliar methods. To succeed in this act, I had to ask other researchers what they would do, or see what they had done, to solve similar puzzles. It was – to use a pun and an analogy simultaneously – method acting.

For example, I had to use various software packages that were wholly unfamiliar to me. I opted to use R Studio, as it is free to obtain, has amazing capabilities, and crucially has plenty of online tutorials. I was therefore able to pretend I was a well-seasoned statistician by reviewing how other researchers had worked with the software. (Other software, such as SPSS and STATA work just as well.) When I started using R Studio, I realised an old adage fit my situation perfectly — thinking is harder than doing. In my mind, using stats software to perform fairly advanced transformations on data seemed so alien to me that I imagined I could never do it. In reality, by taking things slowly, I was able to achieve what was needed. There’s no question it took a long time – at least a month of daily trial and error – and the resulting R code was far from pretty. But, again, it worked. Ultimately, that is all that matters.

Research Practicalities: Successes and Set-backs

Plain sailing, this research was not. Reflecting on the experience now, I feel almost wistful. At the time my anxiety was regularly heightened. In this section I share some of the particular tribulations, in the hope that others will avoid them.

My most frustrating difficulty in research was in trying to communicate with machines. It was some irony that my research in communication would so often founder on my own inability to communicate clear commands to a computer. One particular stumbling block is seared into memory. When writing out my machine reading program from elements of existing code, I used a Microsoft Word document. This was so I could record the fragments of code, but also leave notes for myself on how they worked. The problem, that I

took a good week to uncover, is that Word uses an enriched text format, but, to be executable, code needs to be in plain text. I had no trouble copying and pasting lines of code from Word, except when quotation marks were involved. It turns out that Word quotation marks are too fancy for computer code. They needed to be plain, no-frills, quotation marks. Whilst Word can produce plain text quotation marks, this is not the default arrangement. As such, every time I pasted code into a console to execute it, it would fail for no clear reason. I ended up having to work out by process of elimination what the offending item was. If I had simply written the code directly into the console, instead of copying and pasting from Word, it would have worked fine. In this instance, I was not able to find anything online to help solve this problem, and I felt too embarrassed to ask. Instead I just struggled for the sake of some quotation marks! In retrospect, I definitely should have reached out to colleagues. I would not think any less of someone trying to develop a new skill who was making amateurish mistakes. I should have trusted my colleagues to have been similarly charitable. Instead, my own fear and pride led me to waste days being tormented by punctuation.

Having established code that worked, I tested it on some Acts of Parliament. I had set up the program's feed out to tell me all words that had been counted as 'indeterminate'. Preliminary findings were predictably ridiculous. I had, for instance, instructed the program to identify and count all adjectives and adverbs. But, of course, words like 'British' and 'local' can be classified as adjectives that turn up time and again in legislation, but are not indeterminate. The program needed heavy pruning. As such, I coded some Acts of Parliament outside my data range (1899-2017). From these, I determined which adjectives posed no risk to indeterminacy and listed them all in the program as not to be counted. This, again, was laborious but essential.

Even more laborious was data pre-processing. For Acts of Parliament to be readable by my program they too needed to be in plain text format. That meant, no PDFs, no copying and pasting from websites, and certainly no Word documents with fancy quotation marks. All relevant Acts had to be copied to plain text files individually. And, whilst that was technically straightforward, it was highly consumptive of time and energy. Similarly sapping was the energy taken to find some of these Acts. I wanted the analysis to be comprehensive, rather than based on sampling. As such, I had to find online versions of some very old laws. For example, I had a difficult time finding the *Aliens Act* 1905 online, and when I did find a copy, it was a scanned document. As such, I had to use an OCR (optical character recognition)

program to render into digital text the analogue scan. Several Acts had to be cleaned up in this way.

For the statistical analysis, I was a little better at reaching out and asking for help. Several colleagues read drafts of my work and suggested statistical techniques that were needed. For instance, a colleague pointed out that I would need some test for stationarity in the data. I had no idea what he meant by this, so he explained that with time-series data, there is a risk of auto-correlation, where the effect is its own cause. This would imply that judges ruling against the government encourage judges in future cases to do likewise. This is far from implausible, given that a shift in legal precedent at t could encourage more anti-government ruling at $t+1 \dots t+n$. There are various ways of testing for auto-correlation (such as a Priestly-Subba Rao test) that were pointed out to me, and turned out to be crucial in giving my findings credibility.

A more substantial problem I faced in the statistical analyses was converting so many complex phenomena into binary variables (0s and 1s). These binary measures were needed, for the most part, where no obvious continuous scales were available. For instance, I coded a legal dispute with 1 if in the case summary it was recorded that human rights law was used by counsel. This dilution of each case's particularities went against my instincts as a qualitative researcher. But it was necessary if I was to achieve a wider perspective. One act of binary quantification was too far for my reviewers, and required me to recode for a month. Specifically, I had four language variables, counting different parts of speech. If a section of legislation was litigated and contained any of these four offending parts of speech it received a 1 coding for each of the categories. So, even if the section had oodles of adjectives, but only one use of 'may' it would be coded as 1 for adjectives and 1 for indeterminate modal verbs. My reviewers quite reasonably suggested that this was too simplistic, and that a measure of word frequencies would give more texture to the analysis. At the same time, it was the reviewers who suggested I use a random-effects model, to test for the importance of each individual judge. Both of these suggestions took weeks to sort out. But I am very grateful for the help in improving the piece. In the end, any time taken helped me develop my computer program and my statistical analysis skills. This will be of great utility for my future researches.

Confidence in Research, Learning, and Teaching

My experience of using these new methods has changed my attitude to maths (Williams 2017b; Williams 2018). I am still not confidently numerate, but at least I am no longer numerophobic. In all honesty, I had a tough time with maths as a child. A particularly cruel maths teacher at school used to publicly shame me for making elementary mistakes. Now that I am a teacher (and most definitely still learning) I have an even stronger belief in the importance of self-confidence. For years, I had refused to engage with mathematical methods, simply because of haunting memories from a bullying teacher. His influence on my life was profound, but quite contrary to what any teacher should aim for. I have always focused on the confidence of my students, but now take a little more time to work on my own self-possession as a learner and researcher.

Various taxonomies of teaching practice describe the skills developed by effective pedagogy (see, for example, Anderson et al, 2001; Bloom et al, 1956). Whether one aims to encourage sharp evaluation or creativity in students, confidence is indispensable. And, not just the learner's confidence, but the teacher's as well. Prior to my forays described in this case study, I was uneasy when discussing mathematical methods with students. I knew I had to at least present an open-mind to students, but I fear I was not terribly convincing. Now, I have much greater confidence in describing the pros and cons of mathematically modelling social phenomena. The research project, despite taking a year and expending a lot of emotional energy, has changed me for the better.

Conclusions

To provide a wide-angled lens on changes to judicial behaviour, I needed to perform some quantitative analyses. This took me comprehensively outside of my comfort zone. But, I persevered because I was so committed to the research question. It was a question that I sorely wanted an answer to, so I had to pretend as if I had confidence in learning and researching with mathematical methods. After only a couple of weeks I could drop the pretense, as I became genuinely confident in using new methods. There is no doubt that persevering cost me time and energy. I could have taken a more comfortable path and produced a reasonable response to my question. I am nonetheless glad that the bigger question stuck in my craw. I could not ignore the wider implications, and had to commit to developing my methodological repertoire. This was the best decision I have taken since my doctorate. The motivation to overcome literally years of numerophobia amounted to a form of

immersion therapy. As I have stressed, I am not a whizz with figures now, but I no longer look in horror at equations in journal articles. I therefore feel much more comfortable in discussing and teaching the pros and cons of quantification in political science.

So, my top tips for overcoming a lack of confidence are:

1. **Thinking is harder than doing.** If you start down a particular path you will get to the end, provided you have a clear objective in mind. My objective was to solve the puzzle of why judges had changed their behaviour over 40 years. My approach to starting down a difficult new path was to pretend as if I were a different researcher.
2. **Universities are sharing communities.** It is fairly well guaranteed that someone else will have been through a similar exploratory experience to you. So, share your concerns and seek solutions communally.
3. **Study best practice.** For complex methodologies, there will often be existing solutions that can be re-purposed, or tweaked to your needs.
4. **And, most importantly, be self-reflective.** Is there something missing from your research tool kit? Is it missing because you don't need it, or because you believe you can never attain it? If the latter, see tips 1-3.

Exercises and Discussion Questions

1. Reflect on whether there is something missing from your research tool kit due to your lack of confidence. Describe how you would go about attaining the confidence to add it to your toolkit.
2. Describe a time in your life when you persevered to develop a skill you previously thought you may never be able to attain.
3. How do you describe methods to colleagues and students when you have no experience of using them, and perhaps doubt their utility?
4. What strategies do you think would help you overcome difficulties in using new research methods?
5. What research questions do you wish you could answer, but feel incapable of answering because of your research skills? Detail which research skills are needed and how you will go about obtaining those skills.

Further Readings

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Web Resources

Matthew Williams website: matthewlippoldwilliams.com

Natural Language Toolkit: nltk.org.

Python for Beginners: python.org/about/gettingstarted/.

Stack Overflow: stackoverflow.com.

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