LEADING CHANGE: DEVELOPING A NEW APPLIED DATA SCIENCE PROGRAMME

Jennifer Brown
University of Canterbury, Christchurch, New Zealand
jennifer.brown@canterbury.ac.nz

Data science is a fast emerging new profession aligned with the exponential growth in size and availability of "big data" and the data driven industry. To respond to these changes, universities worldwide are developing programmes of study in Data Science. At the University of Canterbury we developed a programme in Applied Data Science. The Applied Data Science has as its mission "to enable data hungry students to become data-savvy". The programme is multidisciplinary and involves courses from across campus. To create such a programme we used a number of leadership techniques to bring a diverse mix of University staff together, and to achieve an outcome that we are all proud of.

BACKGROUND

Data Science is an emerging growth area and is considered one of the essential skills of the 21st century. However, data science has been identified as an area that faces a significant skill shortage; a 2011 McKinsey report predicted a 50% gap between projected demand and supply by 2018. Data science involves the use of specialised computational and statistical techniques for analysing and extracting useful information from the ever expanding volumes of data being collected. In order to leverage the 'big data' generated in our digital world, and the increasing digitalisation of business economies, there is a growing need for data scientists. OECD research (2011) noted the importance of a skills mix for success in innovation in emerging fields, including both advanced technical and soft skills such as strategy development, multidisciplinary teamwork and collaboration across cultural boundaries. Within New Zealand and Australia, searches for data scientist in career websites will produced results for a wide variety of organisations – both private and public - who are looking for data scientists, data advisors, BI/data/analytics consultants, and data/insights analysts.

The growing demand for work-ready graduates in this area has led New Zealand and international universities to introduce more specialist master's degrees/postgraduate qualifications. This is reflected in the growth of data science programmes now available. We reviewed in 2015 the range of available programmes and saw there were gaps in the existing offerings. In particular:

- There were few broadly packaged Master in Data Science programmes for New Zealand and Australian students in applied areas.
- While there were many programmes available in New Zealand and Australia, there were few programmes that supported the development of students from different backgrounds and domain knowledge. We saw this as an important feature of a programme if it were to provide industry with the mix of quantitative, commercial and people skills needed for innovation.

We also noted that there was considerable interest in postgraduate conversion programmes and there was an international trend towards conversion and specialist Master's programmes that can be completed in less than two years (e.g. from 12 to 18 months). Specialist and conversion master's programmes align with our University's strategic plan for growth of student numbers and development of highly sought-after graduates.

CREATING A NEW PROGRAMME

Development of the programme in Applied Data Science was a process of change. The world of mathematics and statistics is undergoing change and how we, as tertiary educators, respond to this will define us. With the new field of data science, mathematics and statistics are even more an integral part of modern science, engineering, medicine, finance and business. Two main underlying reasons for this change (National Research Council, 2013) are:

- The increase in computational capacity.
- The explosion in the amount of data available.

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Every organisation has the seeds for change, and leadership is about creating an environment to capture this energy (Nilikant & Ramnarayan, 2006). In our School we used five key steps in the development of the programme (Kotter, 1995, 2012).

Understanding the need

The fundamental steps in any process is to have a collective understanding of the need for change, and having a sense of urgency about the change (Kotter, 1995, 2012). Our initial conversations were about the opportunities data science provides, and then about our response to this. We challenged ourselves to focus on the opportunities ahead, building on our strengths, our underlying purpose in the School, and on solid evidence about the growth in data science and the need to act now.

Shared vision and agreed values

We had a clear vision for what a graduate from a data science programme would look like, and kept referring back to this throughout our process. We developed this vision together, so we have a sense of ownership and responsibility for it (Kotter, 1995). We were able to develop the programme into something quite different from other programmes at our University using the collective of our creative minds (Hill, Brandeau, Truelove, & Lineback, 2014). This meant building on our common purpose and committing to our shared values which included respect of our differences. At times we had very different opinions, but we valued our differences because we recognised differences represent capacity for change (Fullan, 2001; Heifetz & Linsky, 2002). We were able to move our "creative abrasion" to "creative resolution", a much more comfortable place for everyone (Hill, Brandeau, Truelove, & Lineback, 2014).

Collaboration

We had a wide range of staff involved and created an environment where communication was open so that staff were receptive to new ideas (Nilikant & Ramnarayan, 2006; Pascale, Millemann, & Gioja, 1997). Everyone had a voice, and the choice of how they participated (Nilikant & Ramnarayan, 2006) from being in formal working groups through to informal conversations. We didn't impose a structure about how things should be done, but recognised and encouraged complementary systems (Kotter, 2012) that allowed everyone to contribute in their own way (Jansen, Cammock, & Conner, 2011). We operated outside discipline focused groups and academic hierarchy and instead encouraged and embraced an informal network as described by Kotter (1995, 2012).

Champions of change: creating a culture of change

Change is ongoing and our capacity to be adaptable to future changes ahead is part of the culture of our School (Nilikant & Ramnarayan 2006). With more capacity for change we are in a good position to recognise the next new challenges, and should have the ability to stay in tune with the evolving world of statistics and data science (Jansen, Cammock, & Conner, 2011). In our School we have flexible structures that continue to encourage innovation (Brafman & Beckstrom 2006; Jansen, Cammock, & Conner, 2011). For example, rather than having set committees, or regular staff meeting, and we have an organic process of meetings-on-demand, and specialised working groups set up to address specific issues in a specific timeframe. In our School we have the culture that if you walk out of a meeting and there is no change in behavior then that is not time well spent.

Learning from the Change

For change to be successful we recognised that we will learn as we go. Change is staged so short term goals can be met, and in response the programme can be adapted over time (Kotter, 1995, 2012). We have measurable milestones, both short term such as student numbers, and feedback from recent graduates, and long term such as employer satisfaction and enrolment trends. We are tracking how we go with both hard measures e.g., student enrolments, graduate numbers, employer satisfaction, and soft measures e.g., changes in our teaching style, student feedback, and processes in the School, in staff behaviour and our culture (Clarke, 1998; Katzenbach, Steffan &

Kronley, 2012; Kotter 2012). Already in the first months of year 2 of the programme we are making adaptions with the mix of courses on offer, and teaching style in response to the current student numbers and background.

DEVELOPING THE PROGRAMME

We had a small group of enthusiastic staff to guide the programme development (Brafman & Beckstrom, 2006; Katzenbach, Steffen, & Kronley, 2012; Kotter 2012). This was made up of five staff from all Colleges in the University. Such a diverse group was chosen because data science is not a subject that is only mathematics and statistics, but a science that involves many others.

We started with an initial workshop where staff from across the University were invited to join. We used an affinity mapping process. Staff were put into groups of 5 to 6, and each person in the group was asked to write (on sticky note paper), and not show each other, one or two words that would describe what a graduate would look like, in other words, someone coming out of the progamme. This was repeated but now, one or two words that would describe what someone coming into the programme would look like. In their groups, using large sheets of paper, they placed these key words into natural groupings and mapped (literally with a pen) what was required to get from the start with students coming, to where graduates exited the programme. There were many intermediate steps on the way between the start and end, and the affinity mapping was an exercise to link and find these connections. From here we combined maps between groups and, as often happens in these exercises, the similarities were striking. Some example notes from the affinity mapping are shown in Table 1.

Table 1. An example of the ideas used in affinity mapping for the new programme.

Students coming in will be	Links to make connections	Students coming out will be
Anyone from anywhere		Comfortable working with data
Data aware	Industry support	Computation skills
Data hungry	Group projects	Big picture thinking
Industry aware	Capstone project	Statistically literate
Capable of team work	Industry projects	Effective visualization
Capable of independent work	Modular courses	Strong foundational skills and domain expertise
	Interdisciplinary	Recognised by industry
		Employable
		Problem solver and adaptable

We then asked each group to draft a one-page programme flyer. The intention of this exercise was to direct their focus and thinking on some key questions; what it is we will offer, what makes us unique and different, why come to University of Canterbury rather than somewhere else? Examples of the wording in the draft programme flyers are below (Table 2). The final marketing brochure wasn't quite as creative because it had to fit within the University guidelines, but the exercise did help focus our thinking.

Table 2. Examples of the marketing flyers drafted in the affinity mapping exercise

Example 1	Example 2	Example 3
Understand and use information. Take your subject to the next level. Whole of University. Personalize your course of	Suited to graduates from any discipline interested in strengthening skills in data analysis. You will be upskilled to be industry ready for work in data science and BIG DATA.	What's your future looking like? To make the answer easy, read on. To make sense of the world we need to understand BIG DATA. No matter where you've come from, or what you've studied, you can take this programme.

study. Team work with industry. Understand and use information.		Learn: Team work Computer skills Communication Learn from industry. Employment prospects, pay off your student debt, get paid to study.

From here our next meeting was with the academic advisors and our international marketing team from all the Colleges at University of Canterbury. Again we used group techniques, but this time we started with the description of a student coming in, and a student exiting. We had very creative discussions and developed a programme structure with a set of foundation courses some students would take, a set of required core courses all students would take, and the remainder being a set of domain specific courses (this was a way to recognise each student's domain would differ from each other). A capstone project course would have students working in groups on industry projects, or in internships.

As the programme evolved to the final version submitted for academic approval we worked within the same five principles as above, with final decisions being made by the collective guiding group and using the five steps of change described above.

APPLIED DATA SCIENCE PROGRAMME

The Applied Data Science programme is now successfully in place at University of Canterbury. It is a 12 month conversion masters with 4 core courses covering machine learning, data mining, data analytics and digital humanities; a set of foundation courses students can take (all, or some of) in statistics, data management and computer science, and a wide range of domain specific courses relevant to each student's individual interests. These can include more advanced courses in Biological Sciences, Computer Science, Digital Humanities, Economics, Environmental Science, Finance, Geography, Geology, Mathematics, Physics, Psychology, and Statistics.

The discipline of data science is still developing and there is no agreed "industry standard". There are many definitions and for us the idea of an interdisciplinary data-driven science, and gaining knowledge from data, best captures our vision. We are confident graduates from our programme are well prepared for whatever lies ahead for them. They will have advanced analytical capability, and skills in problem solving, critical thinking, teamwork, and communication.

The appeal of the programme is because of its relevance to the employment market, and attractive prospects for graduates in the current environment where there is an increased value placed on the use of data, and a growing skills shortage. The concentrated nature of the programme is also of appeal to students, because it allows students to complete it in an accelerated timeframe. This is particularly attractive to international students. And finally, the delivery method of the programme as a taught degree with an industry project – that provides students with workplace preparation and skills – is appealing to students looking for employment.

The success of the programme is best described by the data and the students. When the proposal was developed we envisaged 5 enrolments in the 2017, our first year. In reality we had 40 enrolments between the two start dates (semester 1 and 2) with 20 of these being international students. Enrolments for 2018 are tracking at three times this number, with 60 having started in semester 1 in February and another 60 starting in semester 2 in July. These enrolment numbers certainly presented some fresh challenges for us, but that's the role of the leader: turning challenges into opportunities. Of the first year group, all the students had summer projects supplied by local industry, or local internships. Ten students completed the programme in February 2018, and of these three had job offers well before February, four have set up their own start up company, one more has since found employment, and two are starting PhD study. Some comments from the graduating students are:

"I am so glad I came here, I had offers from three other universities and it was a big leap to come to NZ and to University of Canterbury. Thank you for everything you have done – we have learnt so much and I can't wait for the summer project." (Student, 2017)

"This programme is full of really good choices in courses, you can learn about anything you want that you think is important. That's what I like, the flexibility, what is important for me maybe different from what is important for someone else." (Student, 2017)

SUMMARY

We envisaged an Applied Data Science programme that would capitalise on the rapid expansion of data science and the need for analytical capability of graduates. The skills gained by students in this programme would be applicable in graduate positions across a wide range of organisations, industries, and countries. Graduates would be ready to work in industries including: government, corporates, the IT sector, market research and finance, agriculture and transport.

We now have a well resourced, and effective programme in Applied Data Science at University of Canterbury. Our graduates have the skill set and creativity to fully contribute in this rapidly expanding profession. The leadership role in developing the new programme of study can be described by four deliberate and clear steps:

- Articulating the vision, clearly and relentlessly.
- Encouraging discussion, creative discourse and empowering everyone to share and contribute,
- Supporting and mentoring staff to allow all staff to contribute fully,
- Letting go of the reins and creating a collaborative, creative and supportive environment within which the programme can evolve, adapt and grow.

There has been a change in culture in our School, staff share their ideas, fully contribute and are responsible for each other and our School's future. We are now in a better position, open and adaptable to whatever comes next (Nilikant & Ramnarayan, 2006).

REFERENCES

Brafman, O., & Beckstrom, R. (2006). *The starfish and the spider*. New York, NY: Penguin.

Clarke, A. (1998). A practical use of key success factors to improve the effectiveness of project management. *International Journal of Project Management, 17*, 139 – 145.

Fullan, M. (2001). *Leading in a culture of change*. New York, NY: Falmer Press.

Heifetz, R., & Linsky, M. (2002). A Survival Guide for Leaders. *Harvard Business Review, 80*(6), 65 - 74.

Hill, L., Brandeau, G., Truelove, E., & Lineback, K. (2014). Collective Genius. *Harvard Business Review, 94*(6), 94 - 102.

Jansen, C., Cammock, P., & Conner, L. (2011). Leadership for emergence: Exploring organisations through a living system lens. *Leading and Managing, 17*, 59 - 74.

Katzenbach, J., Steffen, I., & Kronley, C. (2012). Cultural change that sticks: Start with what's already working. *Harvard Business Review, 90*(7/8), 110 - 117.

Kotter, J. (1995). Leading Change - Why transformation efforts fail. *Harvard Business Review, 73*(2), 59–67

Kotter, J. (2012). Accelerate: How the most innovative companies capitalize on today's rapid - fire strategic challenges – and still make their numbers. *Harvard Business Review, 90*(11), 45 - 58.

National Research Council, Committee on the Mathematical Sciences in 2025, Board on Mathematical Sciences and Their Applications, Division on Engineering and Physical Sciences. (2013). *The Mathematical Sciences in 2025*. Washington D.C: The National Academies Press.

Nilikant, V., & Ramnarayan, S. (2006). *Change Management - Altering Mindsets in a Global Context*. Thousand Oaks, Calif.: Sage Publications.

OECD (2011). *Skills for Innovation and Research*. OECD Publishing. *http://dx.doi.org/10.1787/9789264097490*

Pascale, R., Millemann, M., & Gioja, L. (1997). Changing the way we change. *Harvard Business Review, 75*(6), 126-39.