

STUDENTS' EXPERIENCE OF BECOMING A STATISTICAL CONSULTANT

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ABSTRACT

Developments in computer software have made it easier to carry out statistical procedures, leading to a widespread use of statistical outputs in many fields. However, the need for statisticians, and statistical consultants in particular, has also increased, since the numbers and graphs that can be easily obtained from packages need to be interpreted into meaningful information. We can help statistics students to develop the required professionalism by giving them opportunities to work as statistical consultants while they are still studying: we were able to do just this in two recent offerings of a final-year 'capstone' unit of study. As part of their summative assessment, students wrote reflections on the process of applying their previous learning to a range of research and consulting problems. In this paper, we use these reflections to discuss students' experience of becoming (and being) a statistical consultant.

BACKGROUND

The 'capstone' unit for our statistics major provides opportunities for students to work as statistical consultants. It integrates the core concepts of undergraduate statistics units into the practical context of solving real research problems by applying statistical ideas and methods. In particular, the unit aims to give final-year students exposure to the statistical and non-statistical issues that arise in statistical problem solving, and to provide them with an experiential background in consulting by working on authentic statistical problems. Students develop the ability to: appreciate the nature of statistical problems and discuss the statistical problem solving cycle; listen to a client's statement of a problem and ask appropriate questions for clarification; recognise appropriate statistical techniques for use in a variety of problems, and apply these techniques competently; recognise situations in which familiar techniques do not apply, search the literature for appropriate alternatives, and develop their expertise in using them; prepare written reports at an appropriate statistical level for the client; present a verbal summary of a statistical investigation at a level appropriate for the audience; and discuss the ethical aspects and implications of professional statistical work (Bilgin et al., 2011).

While students are completing their consulting projects, they not only apply their statistical skills to solving the problem at hand, but they also develop and improve their 'soft skills'. Such generic capabilities include the more obvious ones such as communication and problem solving (Chatfield, 1995; Derr, 2000), but also less clear-cut ones such as ethics and sustainability (Finney, 1991; Reid, Taylor & Petocz, 2011; Petocz & Dixon, 2011). The improvement of such generic capabilities is one of the goals of the capstone unit, and is an important aspect of the development of professionalism for beginning statisticians. Students become aware that these soft skills may be more important than specific knowledge of statistical techniques, since the techniques themselves can be learnt as part of the process of solving a consulting problem.

Students in the Statistical Consulting unit carried out several small assignments, but their main task was a consulting project that spanned most of the semester. In the first cohort (2011), students were put into groups of three and made a cooperative decision as to which project they undertook. In the second cohort (2012), they were put into pairs, each individual choosing a project and undertaking it with the help of their partner as second consultant. One of the final assessment tasks of the unit asked students to reflect on the process of developing their expertise in the field of statistical consulting. In this paper, we report on three themes coming out of two

student cohorts' final reflections on becoming a statistical consulting: the importance of communication, the need to extend their learning of statistics, and their development of a professional and personal identity as a statistician and a consultant.

METHOD

Students were asked as part of their assessment to write reflections on their experiences of statistical consulting in response to a number of questions: how their team worked together, what their particular job for the project was, what were the best and most problematic aspects of their project, whether they had problems communicating with their client and within their consultant group, and if so how they solved these problems, and what they would do differently next time. They were also asked how carrying out the consulting project helped them (or didn't help them) in their learning about statistical consulting, and what advice they would give to future students and lecturers of the unit.

For our analysis, we only used the reflections of those students who gave us written permission to do so (12 out of 15 students). Although this is a small number of participants, and a non-random sample, there is value in such a pilot study to identify aspects of becoming a statistical consultant that could be useful for future groups of statistics students, and that could be investigated more formally with larger cohorts. Our analytic method was to read iteratively through the complete collection of reflections in search of common themes. Such 'thematic analysis' is a fundamental form of qualitative analysis (Boyatzis, 1998). It aims to identify common ideas from the shared emphases and concerns put forward by participants, and to use these common ideas to further investigate each text. The two authors read through the material independently and noted essentially the same themes (though under different labelling). An ensuing discussion clarified the three main themes, and these are the subject of the following sections. Supporting quotes have been labelled with pseudonyms for confidentiality, and the writing has been left as the students presented it, except for modification of identifications. We have used ellipses (...) to indicate where we have left out sections of a quotation.

THEME 1: COMMUNICATION

One of the most important soft skills identified by students is communication. There is regular mention of communication in their reflections, and not only in those questions that specifically asked them about this. The ideas can be summarised under two headings: communication between team members and communication with the client. Lee's statement sums it up nicely:

Lee: Communication is the key point ... either with client or group members or lecturers. Dealing [with] such real-life project will definitely come up with a lot of questions to be answered and a lot of uncertainty to be clarified. It is important to solve problems in the early time because some problems would not be uncovered until the previous ones [are] solved. There could be problems group members [are] unaware of, they do not know. To communicate for help will buy lots of time for the upcoming problems, and also can solve the problems better.

Communication with clients

Communicating with clients could be through face-to-face meetings, by e-mails and over the phone or Skype. The majority of the students seemed to prefer face-to-face meetings to any other method, especially in earlier stages of the project. Larry pointed out that it is important to clarify the aims of the project with the client before starting any analysis, avoiding any 'errors of the third kind' (Kimball, 1957): "I would also recommend asking [the client] for several clear aims for the report and address them specifically in your report."

Larry also emphasised the importance of understanding the client's level of statistical knowledge so that the correct level of language for the statistical report could be used: "Find out how much statistical knowledge they have, and tailor your report to their individual level of understanding." Most commonly, a client's statistical knowledge would be more limited than the statistical consultant's, and being able to understand this is an achievement for students, since they become aware of their own statistical jargon and the need to modify their language. Anton stated: "The project taught me how to communicate my statistical ideas in simple ways so that the

client could understand” and “I had to really simplify things to get my message across. Surprisingly this also helped me to more deeply understand factor analysis.”

Another high-achieving student talked in detail about communicating with her client.

Kate: Dealing with a client - how to express ideas that they did not know and how to talk about data. Somehow my previous prattling to ‘statistically-deprived’ friends and family had not prepared me for this - perhaps due to nerves, or dealing with someone else’s interest rather than work and subjects that ignite my own irritations and fascinations. In the latter case, the lesson may have been ‘how to express matters when you do not know the subject’.

Communication within the consultant group

Some students reported that they worked easily and efficiently with their team members; for instance, Sandy wrote about her team of three that *“Our group meetings were positive and I feel that we worked well together.”* In the second cohort, there were some pairs who agreed to focus on their own project with only general input from their team mate. Robert wrote: *“we were mostly willing to work separately on our individual projects and therefore didn’t actually provide much help to each other.”* However, most groups had some problems in communication between team members. For instance, Kate identified communication problems as a source of inefficient time management: *“This (miscommunication) meant that time was wasted on work that had already been done, and work that needed to be done was not always done in time - or at all.”*

Maria became more aware of the importance of communicating and stated: *“this project has given me an insight into the challenge of communication between two parties (both client and student and student and peers) which in turn has further developed the effectiveness of my communication skills.”*

To improve communication skills, we asked students to make a short conference-like presentation to the class. Several times we observed anxious students just before their presentations, although they knew that they were in a safe environment with their peers. We were able to help some of them overcome this anxiety by talking to them. However, the pep-talk did not work for all: one student became almost paralysed during her presentation and another one sent a pre-recorded presentation instead of attending the session. Both these students were high achievers but lacked the confidence for a calm presentation; it is hard to know what to do in such cases.

THEME 2: LEARNING TO LEARN

As part of the ‘capstone’ unit we gathered possible projects from academics and doctoral students. Only one criterion was used for inclusion in the pool of projects from which students could choose: whether the project could be carried out during one semester. No project was discarded on the basis of statistical techniques required. Due to the structure of our statistics major, students could have studied different units prior to enrolling into the capstone unit, and this diversity was apparent in their reflections.

For example, although factor analysis is covered in one of our third-year units, Annie had not previously studied this technique and wrote that *“I had the chance to learn factor analysis, which is a very useful and interesting technique”*. Her learning was not alone but within her group, aided by her peers who had studied this technique previously, such as Anton. Learning to teach peers was also an important aspect for some of these students.

Anton: Since my colleagues were not familiar with factor analysis, one of my jobs at the onset of the project was to try to explain to them the basics of this technique. I realised that the best way to do this was via an example and I used our client’s dataset to demonstrate how to carry out a factor analysis using SPSS.

This was not the only new statistical technique that the neophyte consultants had to learn about. Ruby summarised her statistical work as *“My task for the project was designing a survey”*, while Robert wrote that *“It was suggested that a market basket analysis would be appropriate, and this was relatively easy to learn and implement.”*

Some students were eager to meet the challenge of expanding their statistical horizons. Marco was determined to acquire a competitive edge by learning methods that were not taught as part of his degree, but that are commonly used by researchers in education and marketing. The

project he selected required him to become familiar with a new technique. This was both a good and a bad experience, as highlighted by his reflections at the end of the semester.

Marco: *Learning structural equation modelling has not been as fulfilling as I hoped. I have not only struggled with learning this new technique all by myself ... but I also struggled with fitting the data to a model. This project really did drain all the confidence out of me, but I did learn that you are not able to do everything that people want but it is always possible to learn the things you don't know.*

Although he had access to an academic who is doing research in the area and was part of the teaching team, Marco tended to struggle on his own, and sometimes needed to be reminded that help was only an e-mail away.

The last part of Marco's quote shows that his focus moved from learning specific statistical techniques to the more generic 'learning to learn'. Several students developed confidence during this process. For instance, Sandy had never considered becoming a statistical consultant because she was scared by the thought of facing a client and not knowing what to do. Working with a real client as part of this unit gave her increased self-assurance.

Sandy: *This project forced me to investigate new statistical techniques. This turned out to be not too difficult and I enjoyed the challenge. Through this project I learned about repeated measures analysis, inter-rater reliability and I gained a little understanding of time series. This project taught me not be intimidated by new and/or unknown techniques.*

THEME 3: PROFESSIONAL IDENTITY

The third theme identified in the students' reflections was concerned with their development of a professional identity as a statistician and their growing awareness of personal meaning in the discipline of statistics. Although these ideas are connected, we can conveniently discuss the professional and the personal aspects separately, before combining them again.

Developing professional identity

Many of the students reported that the unit had helped them build their confidence as a professional, particularly by giving them an insight into the authentic work of a statistical consultant. Some students wrote this quite succinctly; for example Sam said "Overall I can confidently say that I am a better, more confident statistical consultant thanks to this project." Some expressed their amazement at the process; for example, Anton wrote "It was quite frightening how the lecturers allowed us to be in charge of the statistical consultation process from beginning to end." Others gave more detailed descriptions:

Maria: *After undertaking this unit, my apprehension and anxiety associated with the topic of statistical consulting has now faded. I can now conclude that I have the confidence and belief in my own abilities to be able to undertake work in the area of statistical consulting with success if I chose to do so. ... Without Statistical Consulting and this project, my presumptions of statistical consulting being difficult and my apprehension towards working with real clients would have prevented me from exploring this area once in the workforce.*

Some students realised, in retrospect, that they had stepped back from a professional identity as a statistician and responded to the demands of the work more in their role as students:

Anton: *I felt that with this project we relied too heavily on the client's advice and forgot that we are the statisticians. In the future it would be better to have our own opinion and input as professionals in the area of statistics.*

But several students reported that the experience of participating in a statistical consulting course had opened up possibilities for their future professional work:

Annie: *This type of project helped me to get a real picture about statistical consulting. The experience I got would be very helpful for my future career. It also gave me the idea of doing business as a consultant (together with peers) via [an] online website or based in universities in the future.*

Developing personal meaning

Many of the students described their growing awareness of the personal meaning of their work as a statistician. They talked about being able to look at the results of their statistical

analysis from other people's viewpoint – most commonly, their clients' viewpoint. For instance, Larry wrote: *"This project taught me to look at things from the client's perspective, and how to tailor the project to the client's individual needs."* They talked about the affective aspects of their statistical work, expressing their satisfaction with being able to make a difference for other people using the knowledge and experience that they had gained at university. Here is one such example:

Ruby: *I truly enjoyed every bit of the project. It was a good opportunity to get involved from the beginning. ... It felt good that I could help my client with the knowledge that I have learnt from the university.*

Another student was obviously very pleased with their consulting report and the way that it was received by their client:

Larry: *I was very proud of my project as a whole. I consider my report to be one of the best pieces of work I have submitted. ... I sent an electronic copy of my report to my client who went on to use the graphs and the results contained in it in a presentation she gave mere days later.*

The increase in personal connection with the statistical aspects of the work not only enhanced the intrinsic satisfaction of the process of consulting but also set up a direct link to future professional work possibilities. This is nicely expressed in the following excerpt.

Maria: *Another aspect of my project that I thoroughly enjoyed was using my statistical knowledge to help my client by performing the statistical analyses and interpreting the results. These analyses would provide valuable statistical evidence that offers an answer to the client's basic question of interest. It also provided an insight into the possible work I would be doing if I chose to work in this area after I finish my course.*

DISCUSSION AND CONCLUSION

One of our students summarised his views on this unit with the following sentences.

Larry: *[Statistical Consulting] is a unit unlike any other I have ever participated in. The content taught in the unit is more relevant to the future careers of the students who take it than any other I have completed. It is also more interactive and interesting than any other unit I have completed.*

There is an increased emphasis at universities on authentic learning, participation in professional activities beyond the university, and learning in the form of work experience. The overall impression from our students' reflections is that they believe that the Statistical Consulting unit provides a safe and fulfilling learning environment for their professional and personal development. They are sheltered from the real-world business aspects but they are thrown onto their own resources to solve real clients' problem. Very soon they realise that becoming a statistician/statistical consultant is less about knowing more statistical techniques, and more about developing the professional and personal capabilities that enable professional interaction with a wide range of colleagues and clients (Petocz & Reid, 2010). We are privileged to read our students' reflections and see them developing as statisticians and statistical consultants.

We leave the last word with another of our students, writing advice to future students.

Sam: *This is definitely a capstone unit and should be treated as such, it's a unit that may change the way you think, approach and understand statistics. It can build your character and confidence. It requires work, but the result is incredibly beneficial. Please dedicate your time for this unit, if you do not you will miss out on a good opportunity!*

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