Learning Statistics in an Australian Mega-class: The view from students, lecturers and researchers

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Abstract

Since its early days, almost 50 years ago, Macquarie University, Sydney, has run a large Introductory Statistics course open for students from all disciplines. Current numbers are in excess of 3000 students a year. I will present some ideas about the Introductory Statistics course from the viewpoint of the various participants: the students who are taking the course, the lecturing staff who are involved in its teaching and administration, and the academics who are involved in researching aspects of statistics pedagogy. I will highlight some successful features of the course and also mention some of the tensions and challenges that we will have to face to keep this mega-class vibrant and relevant for contemporary students.

Keywords: Conceptions of statistics, introductory statistics, statistics pedagogy, student engagement, peer learning

1. Introduction – the context

At Macquarie University in Sydney, the Department of Statistics runs one of the largest Introductory Statistics courses in Australia. Over 3000 students per year from all around the campus take 'Stat170 Introductory Statistics'. The initial conception of Macquarie University, almost 50 years ago, was that students were free to compose their degree from whatever courses they wished to take from any area of studies. This idea has been diluted with the creation of many specific degree courses following a set pattern of study, and more recently by the withdrawal of participation by some discipline groups (such as psychology and business administration), motivated by academic, timetabling or financial ones. However, the vision of an introductory course in statistics, accessible and useful to students from across the academic spectrum, is still a current view at Macquarie.

The unique features of a mega-class in Introductory Statistics remain: a large and diverse enrolment, multiple lecture streams (each of 4-500 students), tutorial and laboratory classes, large numbers of teaching staff working together under a course convenor to present a consistent offering, and a comprehensive assessment schedule that is always constrained by resources.

Recently, Macquarie has introduced a curriculum initiative to encourage students towards a breadth and flexibility in the composition of their degree. Various subjects have been designated as 'people'(understanding the world through learning about the challenges of modern society), 'planet' (looking at the physical environment in its fullest sense) or 'participation' (bringing learning out into the community; improving the student's expertise whilst contributing towards the community), and (most) students are required to choose at least one of each from outside their department and faculty during the course of their studies (Macquarie University, 2013). Introductory Statistics has been designated as a 'planet' subject, which means that students who do not have it as a compulsory part of their degree can select it to satisfy this requirement.

In this talk, I will present some ideas about the Introductory Statistics class from the viewpoint of key participants in the enterprise: the students who are taking the course, the lecturing staff involved in its teaching and management, and the academics in the department who are involved in researching aspects of statistics pedagogy.

2. The view from students

There are various sources of information from students who undertake the Introductory Statistics course. The classic end-of-course survey is used regularly, although it has become less relevant and useful. The increase of student surveys has affected students' engagement and participation in such exercises, and the move to online surveying seems to have reduced the response rate even further. Recent surveys have had a lower than 10% response rate, not nearly enough for any meaningful appraisal. Although there are separate assessments for the teaching and for the course itself, students often conflate the two, and responses are more directed towards the perceptions about the lecturers and tutors than the course itself.

We have been undertaking a research project looking at students' ideas about peer learning of statistics, particularly the aspect of peer learning that is carried out 'beyond the curriculum', that is, organised by the students themselves, rather than arranged by academic staff as in group work within a tutorial or laboratory class. An initial exploration of the ideas was carried out during the early stages of the project (Petocz, et al., 2012). Several students applied and joined the project as (paid) co-researchers, and were put into pairs to lead focus groups of other students from their statistics class. They began by investigating specific questions:

- How would you typically learn statistics in an individual study session?
- What about a group study session in class (lecture or tutorial)?
- How would you typically study statistics when you were with a group of friends from the same class?
- Are your ways of learning different from each other's?
- How would you explain to others your approach to learning statistics?
- What would you say about your statistics learning if you were with a group of friends who were not studying statistics?

An unstructured discussion followed from these questions, notes were taken by the student leaders and the whole session was recorded. The student leaders were then asked to crystallise these discussions into a short video t one for each group, that would be appropriate and useful to show to future cohorts of students.

Although the research material from this project is still in the process of being analysed, some points are immediately apparent. Most importantly, students are clear about the importance of the social aspect of the Introductory Statistics class. This is not only for social interaction in what could be a large and impersonal context, but also for the specific purpose of forming socially-cohesive study groups. Such groups will work together throughout the semester, maintaining contact using a variety of social media, as well as live meetings during and around class times. Members of the group support each other through the process of engaging with and understanding the statistical material.

The students pointed out that "practicals are a great place to meet a group to study with", much better than lectures, in which attendance is much lower. They also talked about the importance of being prepared for group meetings, and pointed out that they were more likely to do this that to prepare for other classes, so that they didn't let down the other members of their group. The extent to which students utilised social media, such as Facebook study groups, might come as a surprise to some lecturers unfamiliar with contemporary electronic life; it is clearly illustrated in the video clips.

3. The view from lecturers

In such a mega-course, the only feasible approach is to have it taught and run by a team. For Introductory Statistics there is one course convenor, several lecturers for the multiple streams, and many tutors for the tutorial and laboratory classes – most of them later-year students in some quantitative discipline, such as finance or business, and including statistics majors. The team also includes a senior academic who critiques the course materials, and the whole enterprise is overseen at a distance by the head of department. The following paragraphs are taken from statements solicited from various academics who are or had been involved with the process.

Current course coordinator:

The best feature of the course is that everything is very structured. There are clear learning activities, and materials and assessment tasks associated with each learning activity. Students seem to have little problem seeing how everything hangs together. It's very important in such a large unit to have a clear structure. The learning materials used are tried and true, they have been around for a long time, and they are built on earlier successes with the course. They are regularly being refined and improved, to increase students' interest in the subject matter and to show them its relevance in their lives. For instance, more material concerning climate change and sustainability has recently been included in the exercises and examples in response to the listing of the course as a 'planet' subject.

In terms of aspects that need improvement, we are seriously questioning the effectiveness of the current mode of delivery, and particularly the use of lectures. We are considering developing an e-book (or modifying a currently-available one) that would include explanatory text, examples, quizzes and exercises, and would also integrate short video clips – mini-lectures – on particular topics. We think that this might better suit our contemporary audience.

Making changes is not an easy process, and there is a certain amount of resistance from some members of the teaching team: despite this, we have already started. Tutorials are now held in 'active learning spaces', designed for groups of students working together with computer and tutor support. Practical classes are now held for the first three weeks only, after which students work in their own time and access help when they need it; the materials are written in a self-directed learning format.

Previous head of department:

During my time as HOD, Introductory Statistics was run with clockwork perfection to around 3000 students a year by a team of academics. My very immediate concern as HOD was that the needs of students and customer departments were satisfied with the program. Information gleaned through meetings with them indicated that this was the case. Each year the teaching team met to consider updating of material, but this amounted to merely tinkering with a well-oiled machine. The course taught a traditional syllabus, with very well-prepared materials and a text written by a staff member. This unit was the Department's flagship, with roughly one in three students passing through the university taking it at some stage in their degree.

In the past, I had taught such a course in a different style, entirely using current issues, with a very positive response from students. This we mooted from time to time, but a quantum change in this direction did not come until after my term as HOD. Even then it did not survive, as other troublesome winds were blowing by then, with Psychology successfully lobbying to take over the first-year statistics teaching of their students. Regular updating of materials, regular liaison with served departments, together with support at the highest levels, is needed to ensure that Introductory Statistics is taught, as is appropriate, by professional statisticians.

Previous course coordinator:
Introductory Statistics is a mega-class that covers the traditional statistics topics that have been taught for two generations. I was the coordinator of this class for two years, and inherited a well-oiled, well-administered course, a well-delivered, if very traditional, curriculum, and an engaged group of lecturers. In addition to the very large number of students (around 3000) taught each year in lectures, tutorials and practicals, there was an additional small group who took the class entirely on-line. For all students, all lectures were recorded, so every student could review the lecturer's audio and slides of the week's topic.

My original idea was to slowly transform the course content to be in line with more modern statistical practice. However, the inertia of the lecturers and the department in general was quite marked, and any changes had to be introduced slowly and debated extensively. This was particularly true for those lecturers who had only a lower level of training in statistics, whose ideas about the subject were often quite restrictive. An example of this was the resistance to eliminating the use of paper Normal tables. This was eventually done, but upon my departure from the university, this practice was immediately re-introduced.

It is an interesting subject for discussion to think about how very large classes might become too resistant to change, mostly due to the difficulty of changing all the slides, notes, related materials and lecturer habits that become ingrained over time. We generally take for granted in smaller classes that instructors have the freedom to modify curriculum or delivery quite quickly, and forget that the larger the class and the more complex the delivery, the more difficult it is to make changes.

Themes
Several themes are evident in these comments, listed here for further discussion:
- the importance of structure in a large introductory course in statistics
- the tension between tradition and innovation, between team and individual ideas
- the changing nature of the student group, and of the (electronic) teaching and learning landscape
- the importance of deeper statistical background in the teaching team
- political and economic aspects of running a mega-course in statistics

4. The view from researchers
Another talk in this session will look specifically at the research needs and directions concerning mega-classes in statistics education (Iddo Gal and Irena Ograjenšek). However, I would like to briefly present some ideas from previous research carried out by various groups (including me) investigating students' and teachers' conceptions of the discipline of statistics, and learning in statistics. The results have implications for the effective organisation and running of mega-classes in introductory statistics. They have been obtained from analysis of interviews with diverse groups of students and teachers of statistics. This material is available in Reid et al. (2012), and a discussion specifically focusing on statistics in Petocz and Reid (2010) (from which some of this material is taken directly, and which also contains further references).

We identified six qualitatively distinct conceptions of statistics, which can be grouped into three levels from the most limiting (1) to the most expansive (6):
- *Focus on techniques:* (1) statistics is individual numerical activities, (2) statistics is using individual statistical techniques, (3) statistics is a collection of statistical techniques.

- *Focus on using data:* (4) statistics is the analysis and interpretation of data, (5) statistics is a way of understanding real life using different statistical models.
- *Focus on meaning:* (6) statistics is an inclusive tool used to make sense of the world and develop personal meanings.

We also identified six qualitatively distinct conceptions of learning in statistics, which can be grouped into three levels, from the most limiting (A) to the most expansive (F):

- *Focus on techniques:* (A) learning in statistics is doing required activities in order to pass or do well in assessments or exams, (B) learning in statistics is collecting methods and information for later use.
- *Focus on subject:* (C) learning in statistics is about applying statistical methods in order to understand statistics, (D) learning in statistics is linking statistical theory and practice in order to understand statistics, (E) learning in statistics is using statistical concepts in order to understand areas beyond statistics.
- *Focus on student:* (F) learning in statistics is about using statistical concepts in order to change your views.

These levels are empirically hierarchical and inclusive. Students who described the more limiting views of statistics or learning in statistics seemed unable to appreciate features of the more expansive views. However, students who described the more expansive views seemed to be aware of the narrower views, and were able to utilise them where necessary.

Although the results were obtained initially from interviews with statistics majors, later investigation with students in service statistics classes revealed an unexpected fact – that they showed the same range of ideas about statistics and learning statistics. A mega-course such as Macquarie's Introductory Statistics will contain some students who will major in statistics, but the bulk of them will be studying statistics as part of another discipline. The levels of understanding are likely to apply to them also.

Also relevant in this context are the results from a study of teachers' conceptions of teaching service statistics courses (Gordon, Reid & Petocz, 2007). Most respondents talked about introductory courses (some at postgraduate rather than undergraduate level). Again, we identified three levels of conception, from the most limiting (α) to the most expansive (γ):

- *Teacher:* (α) The focus is on the qualities, expertise, resources and strategies brought by the teacher into the classroom. Teaching is in the foreground, students further back, carrying out the tasks assigned to them. Statistics is viewed as a body of concepts, skills and techniques, shaped by the teacher's perceptions of essential statistical knowledge – while the serviced discipline is placed on the periphery.
- *Subject:* (β) In this category the focus moves to the course content or subject matter itself. The role of the teacher shifts to providing illumination of the statistical material and facilitating students' understanding of that material. The serviced discipline is the context for the statistics and provides the relevance of the enterprise, while statistics is viewed as a body of knowledge that illuminates the serviced discipline.
- *Student:* (γ) In this broadest conception, students are placed in the foreground, highlighting their voices, perspectives and concerns. The teacher is seen as part of the overall teaching context but is not the privileged aspect of the teaching/learning experience. The discussion is about the serviced discipline as a profession, with statistics viewed as an approach and a way of thinking for use by a professional in the serviced discipline.

5. Conclusions – putting it all together

So what lessons do these views from the students, from the lecturers and from the researchers have for teaching and managing a large class in Introductory Statistics? First, students are quite clear about what works best for them, and many are able to set up and use support networks for peer learning. We can encourage them in this direction, and facilitate the formation of such support groups.

An important point from the research results is to recognise the range of variation in views of statistics and learning. In the same class, there will be students who think of statistics solely in terms of techniques and others who see it as a way of understanding the world; there will be students who aim to acquire statistical techniques and others who aim to use statistics to change their views of the world.

The way that we approach teaching such a course can influence the conceptions of our students. Since these conceptions are inclusive, we will aim for the broadest level in each case. The 'traditional' view is that an introductory statistics course should focus on the technical and basic aspects of the discipline; this will satisfy those students with the narrowest conception and frustrate those with the broadest, maybe even leading them to declare that "statistics is boring" and not engaging further with it. If instead we focus beyond the techniques, beyond even the discipline itself, to the personal meanings that statistics can have for students, and on the future role of statistics in their professional life, then we can encourage many of them towards the broadest views of statistics and learning, and reinforce these broad views in those students who already see statistics in this way.

However, the views from the lecturers and course coordinators point out the difficulty of making changes from a traditional approach to one that takes a broader view of the nature and role of statistics, utilising the contemporary landscape of learning familiar to students who have spent most of their lives in the 21st century.

There are many specific ideas for improvement, but the over-arching feature is a focus on students themselves – on the way they can become statisticians or professionals who utilise statistics as a professional component. The broadest, student-focused conception (γ) of teaching gives a good summary. In a course such as Introductory Statistics, with over 3000 students each year, it is difficult for us as academics to get to know more than a few students individually. But these research results concerning students' conceptions of statistics and learning can provide us with a useful guide about the range of ideas of the students that we face, personally or electronically.

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