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Using Research to Inform Holistic Curriculum Change: the case of statistics at tertiary level

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Abstract

Curriculum for tertiary-level statistics courses can be ‘narrow’ or ‘broad’. A narrow curriculum looks inward and focuses on the statistical techniques that will be used by students of statistics in specific situations. Many statistics courses rely on this type of curriculum, often resulting in disinterest or even trepidation. A broad curriculum looks outward and focuses on the use of statistics as an inclusive tool to investigate – and even change – the world. Fewer statistics courses are built on this approach, despite the benefits that it can bring in terms of enthusiasm and relevance. Research into students’ conceptions of statistics and learning statistics, and their perceptions of their professional role defines exactly what they recognise as a broad statistics curriculum. Such research indicates that a broad curriculum can increase their effectiveness as future professionals, and can incorporate important aspects of professional formation such as creativity, awareness of issues of sustainability, and an ethical stance. Although the discussion focuses on statistics, parallel research results are available from other subject areas. Our key job as educators in the early 21st century is to “do the public good” by translating this body of research into broader and more holistic curricula for our students.

Introduction

We start by putting forward our position in brief: we will amplify and support it with discussion and references in the following sections.

A curriculum for a tertiary-level statistics course can be situated somewhere between the ‘narrow’ and the ‘broad’. A narrow curriculum looks inward to the discipline itself and focuses on the statistical (mathematical, graphical, logical) techniques that will be used by statistics students in specific situations and limits the focus of course units to a few essential areas. Many statistics courses have relied on this type of curriculum, often resulting in students’ disinterest or even trepidation. A broad curriculum looks outward beyond the discipline and focuses on the use of statistics as an inclusive tool to investigate or even change the world. Fewer statistics courses are built on this approach, despite the benefits that it can bring in terms of students’ enthusiasm and relevance.

A broad curriculum is equally appropriate for statistics major students and those students taking a statistics course as a component of their studies. Statistics major students will support a broad study of statistics with subjects focused on specific aspects of statistics and the profession of statistics. Students taking a ‘servicing’ course in statistics have other subjects focused on their chosen profession, whether it be engineering, life sciences, psychology, sports science, tourism or medicine.

Our (and others’) research into students’ conceptions of statistics and learning statistics, and their perceptions of their role as a professional gives a clear indication of their view of a broad statistics curriculum. Such research indicates that a broad curriculum can make them more effective as future professionals in statistics or in areas that use statistics and can incorporate important aspects of professional formation such as awareness of issues of sustainability, development of an ethical stance and a creative approach to their work. Our key job as statistics educators in the early 21st century is to translate this body of research into broader and more holistic curricula for our students.

Background

In this section, we discuss the background research on learning statistics at the tertiary level, and learning in general, that we believe is relevant to our thesis.

Research on students' learning in statistics at the tertiary level has for the most part been oriented around investigations of the educational effects of sequencing of topics, learning approach and environment, and different types of assessment (Roiter & Petocz, 1996; Chance, 1997; Nicholson, 1998; Petocz, 1998b; Garfield & Gal, 1999; Yesilcay, 2000; Keeler & Steinhorst, 2001). Other research looks at the effects of students' attitudes towards the subject (Gal & Ginsburg, 1994; Gal *et al.*, 1997), while yet other projects look at students' statistical ideas of specific topics, particularly in the area of probability (Pfannkuch & Brown, 1996; Wild & Pfannkuch, 1999; Chance, 2000). In investigating the problems of statistics education, some writers currently refer to a pedagogical 'reform' (Moore, 1997; Garfield *et al*., 2002) and discuss changes in content, methods and modes of teaching (for example, Utts *et al*., 2003). Garfield (1995) lists aspects of the learning environment that seem to encourage student learning of statistics. These aspects include activity and group work, use of interactive computer software and computer simulations, and investigation of statistical "misconceptions". The "first statistics course" in particular has been much studied by statistics educators, and is a continuing theme in forums such as the on-line *Journal of Statistics Education* and the *International Conference on Teaching Statistics* (*ICOTS*) held every four years.

One feature of research on learning statistics at the tertiary level is that it often focuses on the ways that *lecturers* understand teaching and learning (for example, Ho Yu *et al*., 2002; Weinberg & Abramovitz, 2000; McLean, 2000; Roiter & Petocz, 1996). This is based on the view that the teachers are best placed to make changes to the learning environment, and the underlying assumption that changes and developments in teaching practice will result in changes – hopefully improvements – in learning. Teachers of statistics believe, not unreasonably, that they know what is critical for students to learn from their own experience of being learners and statisticians. Curriculum in statistics, as in many areas, is usually developed from this knowledge base of the teachers, the strategic requirements of the university and the demands of relevant industries (Bowden & Marton, 1998; Jenkins, 1995; Toohey, 1999), and the ways that students understand the discipline are often not even considered. However, this may be problematic, as much research shows that even fundamental statistical ideas are often misunderstood by students (delMas *et al*., 1999), and hence they are not likely to have a homogeneous understanding of the subject as a whole.

Exploring how *students* report understanding statistics, and then using this evidence for curriculum development is a less common approach, but one that may be educationally rewarding. Weinberg and Abramowitz (2000, para. 4) suggest that *"Our challenge is to find ways of presenting information to our students so that it is accessible, relevant, applicable, and even vital to their own areas of interest"*. Yesilcay (2000, abstract) reports enhanced student learning through the use of projects in their area of interest, writing that *"Students tend to learn more by doing such a project than in any regular coursework. The project is motivating and gives students a feeling of working in an almost real-life environment on a real problem."*

During the previous three decades, many studies have been carried out in tertiary education using a methodology known as phenomenography (Marton & Saljo, 1976) to investigate students' conceptions of learning in a variety of subject areas (a good summary is given by Marton & Booth, 1997). We give details of this method in the following section. Other studies have investigated academics' ideas of teaching in general (Kember, 1997, summarises these), as well as students' and academics' conceptions of specific subjects (eg, Hazel *et al*., 1996, biology; Morgan, 1999, theology; Lucas, 2000, accounting). We have carried out research that has added to these results, initially in the field of music (Reid, 1997, 2000, 2001), then in design (Davies & Reid, 2001), law (Reid, 2003) and mathematics (Reid *et al*., 2003). Of most relevance in the context of this paper are our investigations in the area of statistics (Petocz & Reid, 2001, 2003a; Reid & Petocz, 2002a, b).

Taken as a whole, the results of this research are quite clear: in every subject area, students learn in ways that range from limiting to expansive, teachers teach in ways that range from limiting to expansive, students and teachers view their subject in ways that range from limiting to expansive. These conceptions of subject and learning are hierarchical and inclusive, so those students and teachers who view their subject or their learning/teaching in expansive ways have access to the full range of conceptions, whereas those who view them in limiting ways are restricted in their access to the full range of conceptions.

Development of Arguments

We have developed our ideas of narrow and broad curriculum for statistics from studies that we have carried out over the previous five years with our students. Our approach in these studies has been to focus on our students' understanding of statistics and learning, rather than on our own ideas (as lecturers) of important content or pedagogy. We believe that this is essential in order to help our students to develop mature ideas about learning and to appreciate the role of statistics in their professional life. We started our project with a series of in-depth interviews with (20) statistics students from a cohort who were studying mathematics and statistics and planning to become professionals in the mathematical sciences. We designed the interviews to encourage our participants to think about statistics and their learning in statistics, and to describe the ways that they constituted meaning from their experiences as students. Our initial questions included: *"What is statistics?"*, *"What do you understand statistics to be about?"*, *"What do you do when you learn statistics?"*, *"How do you know when you have learned something in statistics?"* and *"How does your lecturer's teaching affect your learning?"*. They were followed by further questions that investigated responses in detail. We have reported some of our results in a series of papers focusing on students' conceptions of statistics itself, how students see learning in statistics, and their expectations of their statistics teachers (Petocz & Reid, 2001; 2003a; Reid & Petocz, 2002a, b). We have analysed the information from the interviews using a phenomenographic approach, one that looks at how people experience, understand and ascribe meaning to a specific situation or phenomenon (Marton & Saljo, 1976; Marton & Booth, 1997).

Phenomenography is a qualitative orientation to research, often used to describe the experience of learning, in which learning is seen as a relation between the person and the situation which they are experiencing. Phenomenography defines aspects that are critically *different* within a group involved in the same situation. It is these differences that make one way of seeing the situation qualitatively distinct from another. The aim is to discern the breadth and variation of students' experiences and understanding as indicated in the transcripts of their interviews. It may seem contradictory to investigate a quantitative discipline with a qualitative methodology: however, this approach is supported by recent discussion in statistics education. For example, Batanero *et al*. (2001) acknowledge the importance of qualitative, as well as quantitative, methodologies for investigating students' learning in statistics.

We summarised our analysis in *outcome spaces* for students' conceptions of statistics (described in Reid & Petocz, 2002a, where data in the form of student quotes are given) and students' conceptions of learning in statistics (described in Petocz & Reid, 2001 and 2003a, where student quotes are also included). Both these outcome spaces are conveniently summarised (though without illustrative student quotes) in Reid and Petocz (2002b), where we investigated the relationship between individual students' ideas of statistics and learning. (Three of these papers are available online.) 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.
Additionally, we identified six qualitatively distinct conceptions of learning in statistics, which can also 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.

In common with other phenomenographic outcome spaces, the conceptions that we have identified and described are hierarchical and inclusive. Students who describe the more limiting views of statistics or learning in statistics seem unable to appreciate features of the more expansive views: however, students who describe the more expansive views are aware of the narrower views, and are able to incorporate characteristics of the whole range of conceptions in their understanding of statistics and learning in statistics (transcripts of the interviews show this clearly). It is for this reason that we value the more holistic conceptions from our position as educators. It is important to consider the role that students' conceptions of their subject and learning in that subject play. These conceptions, along with the students' perceptions of their learning environment (Prosser and Trigwell, 1999) and their intended learning outcomes, contribute to the approach that students take to any learning task. Students who have a limiting conception of statistics and learning statistics will only be able to adopt narrow approaches to learning tasks. Students with more expansive views are able to utilise a wider range of learning approaches. In terms of curriculum design, learning activities, class discussions and the focus of assessment tasks should be set up to encourage students with the more limiting views to expand, reflect on, and assimilate different ways of thinking: at the same time, the learning of students with more expansive views should be supported.

University students will generally look beyond their classes and curriculum towards their future professional life. Their perceptions of their future profession influence their approach to their learning at university, as indeed their lecturers' perceptions of their professional world influence their teaching approach, and this link is important pedagogically. In the area of music education, Reid (1997) found a strong relationship between students' (and teachers') understanding of their instrumental and vocal learning and their perception of work as a musician. She carried out further studies in design (Reid & Davies, 2003), statistics (Reid & Petocz, 2002a) and law (Reid, 2003), and found similar results. The idea of the 'Professional Entity' (Reid & Petocz, 2003a) developed from a recognition that views of professional work and learning, and the relationship between them, had similarities across disparate disciplines. Although there was a commonality in the ways that students understood the nature of professional work across different subject, there was also a significant disciplinary variation.

The Professional Entity is a way of thinking about students' (and teachers') understanding of professional work using three levels of conceptions. The narrowest is the Extrinsic Technical level, in which people describe a perception that professional work consists of technical components that can be used when the work situation demands it. In statistics, this is shown by a view that statistical work is concerned with gathering statistical techniques for use in different situations. At the broader Extrinsic Meaning level, people hold that professional work is about developing the meaning inherent in discipline objects. In statistics, this is shown by the view that statistical work is focused on finding meaning in sets of data. The broadest view is the Intrinsic Meaning level, in which people perceive that their professional work is related to their own personal and professional being. In statistics, this corresponds to a view of statistical work as creating and modifying views of the world based on numerical evidence.

The Professional Entity is an important idea since each of its levels corresponds with a particular approach to the discipline and to learning or teaching in that discipline. For example, a limiting 'technical' view of the profession of statistician corresponds with a learning focus on development of atomistic and technical statistical skills – the "focus on techniques" conceptions. By contrast, an expansive 'personal' view of the statistical profession enables students to focus their learning on the meaningfulness of statistics – the "focus on meaning/student" conceptions. If students are encouraged to broaden their conception of statistics and the statistical profession, they will develop a correspondingly wider range of approaches to learning (see Reid, 2000, in music, and Reid & Petocz, 2002a, in statistics).

To this point, the research in statistics that we have reported was carried out with 'statistics major' students, that is, those who are taking statistics as their major subject and planning to become professional statisticians or professionals in some other area of the mathematical sciences. However, this represents only a small proportion of statistics students. Many more undertake 'servicing' statistics courses as part of their studies, so any changes to curriculum in servicing statistics subjects will have a greater potential effect on learning in a wide range of professional disciplines. We have carried out another series of interviews with students studying sports science (14) and engineering (16) asking them about their views of statistics and learning in statistics. We also asked them about their perception of the role of statistics in their future profession and the effect that this has on the way they go about learning statistics. A preliminary discussion of the engineering interviews is given in Petocz and Reid (2003b), and we are carrying out the full analysis presently. As another source of data in this area, we have asked groups of students in the areas of dentistry, nutrition and tourism to fill in brief, anonymous open-ended questionnaires incorporating questions such as *"What is statistics?"*, *"What part do you think statistics will play in your future studies?"* and *"What part do you think statistics will play in your future work as a ---- professional?"* (see Petocz and Reid, 2004, for a fuller description and analysis). Our results to date seem to indicate that students in professional disciplines that use statistics have essentially the same range of conceptions of statistics and learning in statistics as do the statistics major students.

We conclude from this that a broad curriculum seems equally appropriate for statistics major students and those students studying statistics as a professional component of their studies. In terms of designing curriculum for overview or introductory statistics courses, we claim that the traditional prevalent division of students into statistics 'majors' and 'minors' is essentially artificial and counter-productive. Our view is that majors will support their overall study of statistics with other subjects focused on specific aspects of statistics (such as mathematical or theoretical statistics) and the profession of statistics (such as statistical consulting skills): some of these subjects may also benefit from a holistic approach. On the other hand, those students taking a statistics course as a component of their studies have other subjects focused on aspects of their chosen profession, whether it be sports science, engineering, nutrition, tourism, dentistry or psychology. The traditional approach was for educators to design 'servicing' statistics courses to focus on pedantic aspects of statistics (such as finding the mean and median of a series of numbers by hand) and such courses are not hard to find today. Our research indicates that many students of statistics will be frustrated by an approach that focuses on the notion of statistics as a numerical hurdle without any relationship to reality or utility. By contrast, a broad or holistic approach that presents statistics as "an inclusive tool to make sense of the world" and views learning as "using statistical concepts to change one's view of the world" will be appropriate and effective for servicing or major students alike. Yesilcay's (2000) positive experience with projects for statistics majors seems to be very similar to the experiences described by MacGillivray (2002) for engineering students using projects to demonstrate their understanding of statistical ideas in the context of engineering or daily life.

Statistics education for future professionals can be usefully viewed as a higher-level numeracy, one of a range of key professional skills including other skills and dispositions such as communication, creativity, sustainability and ethics: this is particularly so in other discipline areas, but of course such skills are equally important for statistics professionals. A broad statistics curriculum gains synergies from such components of professional formation. A holistic approach allows students to develop and practice these skills, and the explicit inclusion of professional skills increases the relevance and interest of the course for the students. On the other hand, a narrow focus on statistical techniques would constrain students' development of professional skills and miss an opportunity to increase the relevance of the course for students.

Tertiary students in a wide range of areas will need statistics as a tool in their professional life (including statisticians, for whom this will be the central component). As graduates, they will be expected to be able to communicate effectively, to demonstrate creativity in problem finding and solving, to contribute to their company's policies for sustainable development and to be able to discuss ethical issues. From a university's pedagogical and curriculum perspectives, it could be assumed that the development of these 'generic skills' would be an important part of every student's learning program. Yet our recent studies of students' understanding of professional work and their conceptions of learning (Reid & Petocz, 2003a) show that students will only engage with those aspects of their university studies that seem to them to be relevant for their future careers. Students may have trouble understanding the role of professional attributes such as statistical numeracy, communication, creativity, sustainability and ethics. Educators, also, find difficulty integrating these ideas into curriculum and may claim that some other unit could deal more effectively with them (Chapple & Tolley, 2000).

In fact, students may be unaware that creativity, sustainability or ethics (let alone communication) will be important in their studies or their professional life. They may come across imprecise ideas of creativity in subjects where assessment criteria specify creativity as a high learning outcome (Petocz & Reid, 2002), even though their teachers show considerable variation in understanding of the concept (see for example Cropley, 2001; Reid & Petocz, 2004a). The recent World Summit on Sustainable Development gave a recommendation to *"Integrate sustainable development into educational systems at all levels of education in order to promote education as a key agent for change"* (United Nations, 2002). Our investigations into academics' ideas of creativity and sustainability and their role in teaching and learning (Reid & Petocz, 2004b) show that they have a wide range of ideas about the meaning of the terms, and find it difficult to incorporate the notion of sustainability in mathematics (and statistics) education (Petocz & Reid, 2003c). Another essential component of any professional activity is the ethical dimension (McPhail, 2001) but it seems difficult to get students to engage with this rather than with the primary content of a course, or even on the assessment tasks designed to focus their attention on the ethical aspects (Jebeile & Reid, 2002). It seems that the skills that contribute to professional formation often appear to be something that 'can be taught in other subjects'. Even if lecturers discuss such issues, their students may perceive them to be peripheral topics until they develop more realistic notions about professional work. A statistics course with a broad, holistic curriculum is in a good position to help students understand the nature of their future professions, and to benefit from students' increased engagement with their study of statistics.

Implications for Curriculum Development

The outcomes of our own and others' research in statistics education have several implications for the development of curriculum for statistics courses. There are some general principles to observe: students at tertiary level have a range of perceptions about their future work and these perceptions provide a focus for their learning at university; teachers also have firm ideas about the role that statistics plays for professional work and actively privilege those ideas within the curriculum; students sitting in the same class can have very different ideas about the nature of statistics and statistics learning and these ideas contribute to the approach that they adopt in any learning situation; and, finally, all statistics students, major or servicing, would benefit from a curriculum that enables them to take maximum advantage of the time they spend learning in preparation for work. These general principles can be utilised by considering curriculum development or review from various perspectives: the institution, the students' professional preparation and learning needs, the coherence of the individual units that comprise the course, and the teaching/learning strategies used in lectures and tutorials.

Most universities have long traditions and sometimes even entrenched interests surrounding statistics education. The curriculum changes in response to developments in the professional discipline, the characteristics of the student groups and the lecturers, and bureaucratic funding and quality assurance initiatives. Yet, these changes may be exceedingly slow, often focusing on individual units and lacking overall coherence: formal course reviews may only be undertaken every seven to ten years and may focus more on bureaucratic than pedagogic requirements. As an example, the recent interest in statistics courses in topic areas such as data mining has resulted in new units of study, new focus for doctorates, and appointment of staff interested in teaching and researching in the area: however, integration with the other subjects in a degree may not be obvious. In addition, when individual academics take on the teaching of a specific unit, they may focus on the important content components of the unit and the activities and assessments that they may use appropriately for that content. Often, they have no real idea of the features that are characteristic of their colleagues' classes, or the overall aims of a program of professional study (Watts, 2000).

Whilst focusing on the development of curriculum from the institutional perspective, it is essential that the curriculum allows flexibility for students to develop their professional capabilities. This is one of the most difficult and critical issues for designers of curriculum, as professional formation cannot occur simply in one unit, but occurs over time across the range of experiences students have (which include institutional learning experiences, work and social experiences). Our research has led us to conclude that the areas of statistical thinking, ethics, sustainable development, communication and creativity are essential components of professional formation. These attributes are aligned with the Intrinsic Meaning view of the Professional Entity and include the most expansive conceptions of statistics and learning as component parts. In any discipline area these attributes of professional formation take on different aspects and importance. For instance, if we take just the idea of creativity, we need to consider how the term and activity is construed by teachers, students, and others in the profession. In the context of a first statistics course (for instance), is creativity the ability to solve, or find, a problem? Practically, how can creativity be assessed within a learning task if it has not been defined within that task? Is creativity the ability to see unusual applications for a set of data? Is creativity in statistics an issue that is discussed, or assessed, or even recognised? And how would you set up learning situations where this can occur? The development of these attributes enhances students' ability to find professional jobs and contribute in meaningful ways to the professional workplace. Such attributes are highly valued by the workplace, yet they are components of study that are often ignored or glossed over to allow more time for 'essential' components of content.

In the development of curriculum at unit level we need to ensure that there are synergies between the expertise of the teacher, the aims of the overall curriculum, the professional components that are especially suitable in that course and the manner in which the unit supports other units within the curriculum. Previously we have looked at the notion of creativity as something that could be explored and agreed on at the whole curriculum level. In a sequence of units, such a professional skill needs to be introduced, worked with and expanded. (A common mistake made by educators is to repeat the introductory level of engagement with a professional skill from unit to unit rather than expanding the focus of that skill.) In a first-year unit, it may be appropriate to examine the statistically creative thinking of others using examples that integrate with a range of professional perspectives. It may be more appropriate in a second course to encourage students to try multiple forms of analysis to ensure that they are aware of the advantages of different models for different situations. In a final year course, creativity may be demonstrated by the students' abilities to first find the problem, then develop appropriate models and finally communicate the results of the analyses to other professionals who may or may not be familiar with statistics. Teaching materials need to be developed that engage students at a wider level with such an expanded notion of professional skills. One example is the book *Reading Statistics* (Wood and Petocz, 2003), which asks students to 'read' statistical papers, articles and research in a variety of areas of application, encouraging them to engage with the 'real life' meaning of the data, and to look beyond the data to communicate the meaning in a range of professional situations. It is essential that students are invited to acknowledge that these components of professional formation exist, can be learned, and are integrally tied to the work of a statistician.

In summary, students in professional disciplines at tertiary level will have some ideas about their future professional work, but in general they will not be aware of the relation between these ideas and their conceptions of their discipline, their learning and their overall approach to their studies. By discussing these ideas with them, we can make explicit the relationship between narrower and broader views of professional work and limiting and integrated conceptions of learning in a subject. We have found that the usual discussion about approaches and strategies for the first assessment task is a good point to introduce such ideas (see Reid & Petocz, 2003b, for a case study of such pedagogy) but they need to be referred to throughout the course. In particular, if a teacher presents a limiting view of the profession, this can reinforce students' limiting views of their subject and their learning. So a class environment that emphasises learning correct statistical definitions and techniques, and a rigorous examination that tends to reward rote learning may encourage students to focus on the acquisition of appropriate statistical techniques. Even those students who are aware of more expansive conceptions will be encouraged to work using the more limiting ones. On the other hand, if a teacher presents a broader view of the profession, students get an opportunity to see their future work in a more integrated way. As one obvious example, an assignment that asks students to carry out various investigations using a set of data and then explain the *meaning* of the analyses for the people involved (colleagues, managers, clients, interested readers) immediately expands students' focus.

Conclusion

The research that we have summarised forms an argument that supports our thesis that curriculum for statistics should be broad rather than narrow: results from other subject areas indicate that the argument may have a broader application in other tertiary areas such as law and design. The most expansive conception of the subject of statistics identified by our students was "an inclusive tool used to make sense of the world and develop personal meanings", and of learning in statistics was "using statistical concepts in order to change your views of the world" corresponding with the Intrinsic Meaning level of the Professional Entity. We need to present our subject to our students – statistics majors or those studying statistics as a component of their profession – in this holistic way in order to encourage the most inclusive forms of learning. Our conclusions are congruent with more general ideas about conceptions of learning (Marton & Booth, 1997) and with aspects of the 'reform' movement in statistics education (Garfield *et al.*, 2002).

In this context, it is natural to widen the scope of classes in statistics to include ideas of creativity, sustainability and ethics, whether this is in a class for statistics major students, or in a servicing statistics class, where statistics will be a component tool for the students' future professional life. Inclusion of such professional skills and attributes will increase the relevance and the interest of the course to students. Graduates who show a capacity for sophisticated thinking on these issues are the most highly regarded of employees. As educators we need to be aware of the different ways that we and our students consider the role of statistics for professional work. More expansive views of this role include the ability to take a range of approaches to learning and teaching, and limiting views lead to a narrower range of options. As we consider the rapidly changing education environment, it is critical that we support the professional options for our students through a holistic and integrated curriculum approach.

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