

# The role of Statistical Education in Developing Graduate Qualities

Brenton Dansie

*University of South Australia*

*School of Mathematics and Statistics*

*Mawson Lakes, South Australia, 5095*

[Brenton.Dansie@unisa.edu.au](mailto:Brenton.Dansie@unisa.edu.au)

## 1. Introduction

An increasing number of Universities are moving towards using general statements about the qualities of their graduates as a part of their policy and quality assurance frameworks. These general qualities (sometimes also referred to as attributes, abilities or capabilities) provide a statement about the outcomes that the Institution values in its graduates. These institutional statements are being increasingly used to guide the development of curriculum at both the program and course level.

Much of the recent discussion about the development of the first course in Statistics has advocated a wider view of Statistics as a discipline, with particular emphasis on the development of statistical literacy and statistical problem solving skills and teaching and learning processes which emphasize collaborative, active learning approaches. Many of these contemporary directions for the introductory course are in good alignment with the general move towards outcomes based education and statements of graduate qualities. In this paper I will give a brief summary of key aspects of the graduate qualities approach to curriculum design and discuss some of the opportunities that this provides for the introductory Statistics course with particular emphasis on students from other disciplines. I will give examples from a course provided for approximately 120 students in their first undergraduate year of studying physiotherapy to illustrate how some of these opportunities might be incorporated into the teaching of the first course. The opportunity to teach students from a single discipline is relatively rare and so I will comment on the challenges that graduate qualities pose for large, multi-discipline first courses in Statistics.

## 2. Graduate Qualities and curriculum design

There is a lot written by Universities on the outcomes they desire of their graduates. This is driven by a number of factors which include the need to

1. specify how the Institution defines the quality of its graduates as a pre-cursor to identifying the quality assurance systems they have in place to re-assure key stakeholders that they are producing high quality graduates and
2. identify advantages in the marketing of the institution with a particular emphasis on the employability and / or research capabilities of their graduates.

There are a wide variety of statements made by Universities about their graduate qualities. The University of South Australia, for example, states that its graduates will have the ability to work with and upon a body of knowledge, engage in lifelong learning, be effective problem solvers and communicators, have the ability to work autonomously and collaboratively, are committed to ethical action and social responsibility and demonstrate international perspectives. (see <http://www.unisanet.unisa.edu.au/gradquals/vstrs/default.asp#the> for fuller descriptions).

This collection of statements is similar in nature to those of many institutions. The list of qualities / capabilities, represent general categories which act as a broad framework for identifying the outcomes of student experiences within the Institution. As Barrie (2003) notes, there are

significant qualitative differences in the ways that academics view statements of graduate qualities. These differences relate primarily to the complexity of the skills being represented and the extent to which they are viewed as separate from or integrated with the development of discipline based knowledge and outcomes. As a consequence the impact of statements of graduate qualities on curriculum development continues to be quite varied.

As a framework for curriculum development the notion of graduate qualities poses a number of challenges. The statements are written at a very broad level. They identify general processes e.g. problem solving and communication and assume that students will be able to apply them in a range of contexts e.g. within a profession, as a global citizen and individually as a lifelong learner. There is generally a sense that these are transferable capabilities that go beyond just the discipline context. In more detailed specifications these general statements need to be elaborated within these different contexts. Within a discipline for example, we need to identify ways in which generic processes such as problem solving take on particular forms and integrate with discipline based knowledge and practices. In addition there is considerable doubt about the extent to which skills developed in one context can automatically be transferred into another. Often significant effort is required to develop the ability to be an effective problem solver or communicator in a range of new and different contexts. The higher level outcomes also require the ability to integrate a range of skills, knowledge and attitudes into strategies for dealing with complex situations.

Another significant challenge is that a statement of program level outcomes naturally encourages, or perhaps assumes, a stronger sense of program coherence than exists in many institutions. In many situations, for the good reason of allowing students the flexibility to choose courses according to their own interests, it is difficult to identify a coherent program of study. This is less of a problem for institutions that have an orientation to providing education for the professions where program coherence is required to meet the requirements of professional societies and employers. At the course level the framework requires academics to consider the contribution that their individual course content and teaching and learning processes, including assessment, make to the development of overall outcomes. This can be a challenge for staff generally but perhaps particularly for teachers of the first course in Statistics, when confronted by a large class of students from a range of different disciplines.

Some particularly difficult but important questions relate to where the skills development to support these more general capabilities takes place within a program of study and how you can get more coherent development of these capabilities across a range of courses and contexts. The use of generic models for processes such as problem solving which can be used in a range of courses to reinforce basic approaches, develop more complex approaches and illustrate application across a range of contexts, requires significant levels of co-operation and co-ordination that are not likely to be available in many circumstances.

Of all of the challenges provided by the use of graduate quality frameworks I would like to focus on two aspects which I think are a particular challenge to teachers of the first course. These are the need to connect our view of the things we regard as being 'Statistical' to

1. the generic processes that are used in these frameworks and
2. the discipline, individual and social contexts which are used to interpret the generic framework.

### **3. Opportunities for the Introductory Statistics Course**

The summary of the directions provided to curriculum development by the adoption of a graduate qualities framework clearly provide some challenges and opportunities for the introductory statistics course. These challenges impact broadly on not only the content of courses but also on the design of learning activities and associated assessment processes. Recent discussion of the reforms in first courses in statistics (see for example Garfield et al (2002)) identify a number of trends which align well with these challenges. In particular I will focus on developments in the areas of statistical thinking, problem solving and statistical literacy.

Arising initially from within the quality movement there has been considerable discussion about the role of statistics in process and product design and improvement. Various problem solving strategies which emphasize the collection of meaningful data, a focus on variation and its causes and the importance of systematic problem solving approaches have emerged. From this consideration of the role of statistics in quality the notion of statistical thinking has evolved to try and define the way in which statistically trained people approach situations or problems across a range of contexts. A detailed model for these processes is provided by Wild and Pfannkuch (1997). One of the key aspects of this model is the bringing together of specific problem solving activities and tools, statistical thinking habits and a range of attitudinal factors or dispositions which are important for successful problem solving.

The connection between this line of development and the graduate qualities framework is reasonably clear. The development of more effective statistical problem solving skills has the potential to make a significant contribution to the general goal of producing graduates with good problem solving capabilities. The challenge to statistics educators is to be able to make the connections between the models being developed to support statistical approaches with the experiences that students have in other courses within their degree and within other contexts.

As an example of how this might be done consider the McMaster Problem Solving (MPS) model (Woods et al (1997)). The core problem solving model (represented on page 3-11 in Woods (1994)) presents a general problem solving process along with a summary of the key cognitive and attitudinal skills required for effective problem solving. The program developed at the Chemical Engineering department at McMaster University is an excellent example of how problem solving skills can be developed systematically within both personal and discipline contexts.

It is possible to see how the model suggested by Wild and Pfannkuch (1997) provides a statistical elaboration of this model. For example the dispositions mentioned by Wild and Pfannkuch maps well into the first step of the MPS process (Engage : I want to and I can) and the various attitudinal skills of the MPS model. The interrogative cycle and the particular types of thinking link well with the cognitive skill descriptions. Whilst applicable at any stage of the problem solving process, they are particularly useful in the Define and Explore stages of the MPS model. The general investigative cycle maps easily onto the 6 stages of the MPS model.

In a similar way it is also possible to draw parallels between 'statistical problem solving' and more general forms of problem solving models within individual disciplines e.g. the clinical reasoning models which are currently emerging within various health disciplines. Exposing students to various forms of the problem solving process across a number of contexts within a general framework such as the MPS model would perhaps allow the development of genuine transferable skills and would also position the introductory statistics unit at the core of the development of a key graduate quality. As an example I use the MPS model to introduce the design of questionnaires. It provides a useful framework for students to connect with the context of the problem as they think about the key questions which they would like to use to structure their questionnaire.

The focus on statistical literacy is also clearly linked with a number of key graduate qualities. Whilst there are many definitions of what constitutes Statistical literacy (see for example the list maintained by Carol Blumberg as a part of the International Statistical Literacy project at <http://course1.winona.edu/cblumberg/islpdef.htm> ), Gal (2002) provides a useful definition of the concept as involving students abilities to be able to interpret and critically evaluate statistical information presented to them in a range of contexts and their ability to communicate statistically based information. These abilities sit very clearly within the key generic qualities of effective communication, critical thinking and information literacy. In terms of linkages with other discipline contexts there are a wide range of opportunities for the use of these skills. In the health sciences, for example, there is a growing emphasis on evidence based practice. The ability to be able to critically read and synthesize a number of journal articles on a topic is a central skill in this area. Linking statistical literacy with general communication and critical thinking processes in other courses

presents significant opportunities for expanding the influence and impact of the first course. Similarly the focus on teaching statistical literacy within the more general context of students as citizens positions the first course as being able to make a contribution to the transfer of these skills across a variety of contexts.

In my course I spend the first four weeks of the course teaching students about the key aspects of reading journal articles. Their first assignment is to prepare a summary of the research approaches used in an area of interest to them in their discipline with some analysis of the research methods. Their second assignment requires them to perform an analysis of a fairly complex data set and construct a written report to communicate the results of the study. I provide some guidance on constructing quantitative arguments and give them the opportunity to submit their assignment for feedback before they formally hand it up. I recognise the need to develop a more formal model and teaching approach in this area.

There are a number of other ways in which activities with the first course might usefully connect with the graduate qualities framework. The use of collaborative teaching methods and team based projects promotes students abilities to work together. The use of studies which have important international contexts has the potential to contribute significantly to the development of international perspectives. Dealing with the ethical issues associated with the conduct of studies helps expose students to thinking about this area.

#### **4. Conclusion**

This paper has shown that there are likely to be a number of key opportunities for teachers of the first course in Statistics to link current reform directions to the curriculum development models that flow from a graduate qualities framework. To be successful in this endeavour statistical educators will need to be able to locate their ideas about statistical thinking and literacy, for example, into broader generic frameworks and be able to integrate them with discipline based elaborations of these generic graduate qualities.

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