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## EMERGING THEMES IN STATISTICS EDUCATION

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*This paper reports research in progress. It brings together some issues and themes emerging from the literature review (to date), preliminary interviews, personal reflections and earlier research. These will be extended and refined in further research and will be included in my thesis which focuses on the search for possible (shifting) paradigms within which statistics education (research and practice) is framed.*

### INTRODUCTION

This paper reports on the early stages of research in progress for a doctoral thesis which looks at statistics education from a cultural perspective. The definition of 'culture' that is used refers not only to ethnicity, but also to educational and workplace cultures. This paper begins by locating the study within my thesis. I then review and comment on literature related to Introductory Statistics courses – the focus is on the perspective taken by the statistics education community, specifically those concerned with service course statistics. The education perspective will be addressed later. Issues arising from this literature is discussed and combined with themes emerging from preliminary interviews, personal reflections and my earlier research in an attempt to identify possible constructs for a framework. A form of 'gap' analysis will then be used to identify possible directions for further research.

### BACKGROUND OF THE THESIS

Statistics has traditionally been taught at university level within mathematics departments. With the changing profile of the statistics practitioner we see an increased prominence of introductory statistics courses within university departments, and new influences being exerted on the nature and form of the statistics curriculum. Acknowledgement of these influences suggests new approaches to the design and delivery of these courses may be appropriate. Various approaches have been reported within the literature. What appears to be missing is a holistic view that simultaneously addresses cognitive, affective and volitional issues. I believe that a discussion of the issues from a cultural perspective will lead to a more holistic approach to statistics curriculum.

The meaning of 'culture' that will be used in this study is consistent with the definition provided by Stockton (1995, p5):

"I use it to describe an integrated complex of shared assumptions within a given society, manifesting itself in a distinctive pattern of behaviour accepted as 'normal', which is learned and transmitted by conventional symbols, adapting itself organically (in terms of the group's current values) to changed circumstances."

This description stresses:

- the internal core of values, attitudes, goals, ways of thinking;
- the external expression of these in behaviour and communication;
- the dynamic for change in new settings of environment, economy and social structure."

My preliminary research (Gunn, 1996) related to this topic identified aspects of Australian indigenous culture that were relevant to the development of culturally appropriate pedagogy. The aspects were beliefs/religion, values, world view, view of knowledge and social structures/communication styles. These provide a basis for the analysis of culturally appropriate curriculum. My present thesis, as a natural extension of this research, is a consideration of the cultures that interact in the learning/teaching environment. Of specific importance are the cultures of the intended workplace, the perceptions that statistics practitioners and statistics lecturers have of the culture of statistics, and how these cultures are negotiated within the classroom.

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The focus of the thesis is the introductory statistics curriculum (tertiary level) although it is envisaged that the findings will be generalizable. The tentative framework is based upon constructivism; enactivism; Jungian notions of the *I*, the *self* and types of consciousness; and socio-cultural views that acknowledge the complex dynamic that links man and environment.

The study is qualitative and explorative. My preliminary ideas will be clarified and developed by a critical analysis of the literature pertaining to the cultures considered and current educational and psychological theories. Further understandings will come from interviews and case studies that, at this stage of the research, have only been piloted. The researcher serves as the instrument for the data collection. The research is conducted in the constructivist paradigm and this implies that conclusions reached in the research will be coloured by the experience that I bring to the project. For the past ten years I have been designing and delivering service courses in statistics (University level) for diverse cultural groups (ethnic cultures and workplace and student cultures) and in learning institutes with different educational philosophies. It is this experience that has led me to approach the research from a cultural perspective.

Some of the issues that I will address in my thesis are:

- The connections between the statistics curriculum and shifting social paradigms
- Influences of specific cultural groups on the perceived nature of statistics.
- Values, motivation, purpose, goals.
- Lecturers and students implicit and explicit assumptions.
- Different ways of seeing the world – ways of perceiving
- Different ways of thinking and knowing, different types of knowledge.
- The role of the emotions in learning and intuition, imagination, inspiration – what are they and how do they ‘fit’ with learning and views of knowledge.
- How and to what extent do these issues influence the approaches taken in tertiary statistics courses.

As mentioned earlier, the purpose of this paper is to identify emerging themes that may be relevant to the larger study. I hope to identify some of these issues in the course of this discussion. I will focus on information obtained from preliminary interviews and personal communications with statistics lecturers and consulting statisticians and will look at issues and themes that have already emerged from the literature review. Later I plan to conduct further in depth interviews and case studies as the thesis progresses and other issues become apparent.

### **ISSUES ARISING FROM THE LITERATURE REVIEW**

I have grouped the approaches taken in the literature into three (partially) overlapping areas, based upon the perspectives taken and the issues that are addressed.

#### **Content and Context Approach**

The research that focuses on content and context issues addresses questions pertaining to the goals of the statistics curriculum. This implies that the researchers have given some consideration to the nature of statistics. In many instances (eg. Hogg, 1991; Vere-Jones, 1996) this extends into addressing the question of appropriate pedagogy for teaching statistics. In many, but not all cases, implicit assumptions are made about how students learn statistics – the decision about appropriate pedagogy is more often based upon perceptions of the types of skills that statisticians need and how the students will use statistics outside academia.

## Teaching and Learning Theory Approach

The issue that is prominent in this approach is how students learn statistics and factors that affect their learning. Gal and Ginsberg (1994), Garfield (1995) and Gordon (1997) all agree that student's negative attitudes and beliefs towards statistics present a major barrier to learning. Garfield also comments on the general resistance of lecturers to shift from their existing beliefs and practices about what constitutes 'good pedagogy'. Included in this approach are discussions on student misconceptions about statistical concepts (Shaughnessy, Garfield, Greer; 1996) and appropriate pedagogy for the learning of statistics (Moore, 1997). In all these papers the prevailing educational theory appears to be constructivism. The social dimension to learning is explicitly acknowledged by some (for example Gordon, 1997) but not by all. This emphasis on constructivism (in its various forms) means that scant attention is given to the place of informal knowledge or the role of intuition, imagination and inspiration in the construction of knowledge.

## Philosophical Approach

This approach in the research is gaining prominence as researchers move towards identifying the nature of statistics. The discussions revolve around what is statistics, what constitutes statistical thinking and who should teach statistics. (Hawkins 1996; Moore, 1997; Pfannkuch, 1999).

### What is Missing in the Research

Although this review is not exhaustive it is representative. There does not appear to be any work in statistics on the different types of knowledge (such as separated and connected knowing (Belenky, Clinchy, Goldberger & Tarule; 1986)). Discussion of these questions is being undertaken by the mathematics educators but not yet by statistics educators at the tertiary level.

Furthermore, the cultural dimensions of learning and statistics do not appear to have been considered. Ethnomathematicians, amongst others, acknowledge that learning is a cultural phenomenon (Pinxten, 1994). Within the statistics education community there is mention of the need for a "*differentiated curriculum that caters to the needs of many groups*" (Shaughnessy et al., 1996). However the use of 'culture' and 'cultural constructs' as a means for bringing about this differentiation is not considered.

In general, the research is not yet connected. No firm philosophical foundation or theoretical framework has been proposed that connects the research into a 'big picture' view. This lack of explicit connections in the research may be due to the fact that statistics and education are only beginning to meld. This can be seen in the different perspectives taken in the research literature. On the one hand we find the statistician (working with implicit assumptions regarding aspects of the nature of statistics) and on the other, the educator's perspective (based on learning theories).

I propose that Statistics Education is about a balance between statistics and education, in the *context* of the individual, society, culture, and the dynamics of the whole system. This implies establishing the links between statistics and education, and humanist and socio-cultural theories. In order for these links to be explicit there needs to be an awareness of the (shifting) paradigm within which statistics education is framed. *Paradigm* is used here in a similar context to that employed by Capra (1996) when he coined the term '*social paradigms*', that is "a constellation of concepts, values, perceptions, and practices shared by a community, which forms a particular vision of reality that is the basis of the way the community organises itself." It is the search for this shifting paradigm that motivates the current research project.

One possible way to begin this search is to discuss the issues relevant to statistics education

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from a cultural perspective. This acknowledges learning as a cultural phenomena and knowledge as culturally specific (Begg et al, 1996 commenting on the work of Pinxten, 1994). It allows for the possibility that other cultural groups such as business management etc may be exerting an influence on the form of statistics and on the statistics curriculum.

### **THEMES EMERGING FROM THE INTERVIEWS AND MY REFLECTIONS**

Some comments made in various communications have been broadly grouped on the basis of emerging themes. My observations and reflections are included to indicate the emerging framework. The source of the comments is identified as follows:

#### **Background**

M: [Ph D in Econometrics. Worked as a statistics lecturer in a university mathematics department for more than 20 years. Was involved in consulting work -both in-house and within the wider industry sector. Moved to industry where he was designing and delivering in-house statistics courses to chief executive officers. Returned to academia, consulting and lecturing in statistics.]

M is of interest to the research because his comments document changes in his perceptions of statistics and statistics curriculum that appear to be due, in part, to his active engagement with new cultural groups. M also talks about how his changed perceptions led him to experiment with alternative approaches to management statistics curriculum.

Q: [Consulting statistician who lectures in university statistics. Has been involved in the introductory statistics course and is strongly motivated to understand how his consulting experience can be used in the teaching of statistics.]

Most of the comments from Q have come from private discussions and seminars that he has delivered. I hope to be able to interview Q in depth at a later stage in the research.

H: [Consulting statistician in agricultural sector, lectures in applied statistics at university.]

L: [Themes from the literature]

H and L are referred to in Table 1. Comments in brackets are the researchers ideas.

#### **Comments from M**

##### **On Influences that Brought about a Shift in Perceptions**

M: Consulting helped but the recognition I think came out in industry that what we are teaching in University is totally irrelevant to what we actually do out in industry.

(This suggested a change in M's perception of what is statistics.)

M: Personal contacts – in particular the collaboration with a friend (with no formal academic training) who had been a trainer out in big companies.

(The influence of personalities already enculturated into the management culture seemed significant. It was also interesting to note M's comment that neither of these significant figures had any 'academic training'. That makes me wonder if he was also beginning to question 'what qualifies one to teach?')

##### **On the Changing Roles of Statisticians**

M: We (statisticians) don't mind if you crunch the numbers – in fact we developed software to make it easier for people out there to actually do their own technical work but our role now becomes one of facilitating the understanding of the concepts behind statistics. 'Think not crunch!'

(This indicated M's belief about how statisticians can respond to changes in society brought about by advances in technology. Also, about what is perceived to be important in the context of statistics education (a value statement)).

### **About a Particular Management Culture:**

M: Managers are concerned with asking the BIG questions.

(Perception of the way managers 'see the world, or make sense of the world?').

M: I think that managers are concerned with decision making, problem solving.

(Awareness of the type of thinking relevant to management).

### **Translating these Perceptions into the Curriculum Context**

M: Tests of hypotheses is quite subtle and conceptually difficult. My belief is that estimation is the only thing that managers need to know about. They need to know what the error is in their estimates and so on. So they are going to make decisions based upon the actual results that they got .... not if its significantly better.

We need to teach managers an awareness of the possibilities – conceptually open the vistas. But we also need to make them aware that being able to 'crunch' is not the same as understanding the statistical concept. 'Think not crunch'.

But then realistically, that is the situation they are going to be in when they start work so it would be a much better training for them I think to get into that way of working. (elaborating on his earlier comments on group work and team projects).

Relevance is more important for managers than rigor.

(He advocated using the statistical language that is used by the public provided it is doing the same job as statistical jargon. The example quoted was the use of 'margin of error' rather than 'confidence intervals' - a language issue.)

### **About the Sub-cultures within a Company**

M: Senior managers were much more interested in the BIG picture – the philosophy. Engineers or technicians were a bit more interested in some statistical methods. Shop floor workers were keen on a hands on sort of experience .... The shop floor workers in particular you couldn't stand up and lecture. You basically had to give them activities.

(Appears to be acknowledging the different philosophies, ways of thinking, ways of doing (with regard to statistics) of the sub-cultures within the company and how this influences the approach taken in the curriculum. This is consistent with later comments that M made regarding the content and context of the course.)

### **Personal Reflections**

Many of M's observations regarding the culture of management are consistent with my own experiences with mature-aged middle management students. Of course, the similarities in observations may just be a classic case of 'finding what you expect'. However, the interviews **were** conducted as informal discussions, a sharing of thoughts and reflections. Therefore, most of the comments that I have reported on in this paper were not (intentionally) solicited opinions.

### **Comments from Q**

Q: We need to accommodate for the changing 'youth culture'. (he went on to explain) this was reflected in the students preoccupation with assessment, unwillingness to think for themselves, the perception of statistics and its relevance to their life, and the general 'temperament of youth' which is a reflection of the times in which we live.

(type of knowledge that students have and shifting social paradigms?)

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## THE EMERGING FRAMEWORK

From the interviews, communications and reflections (to date), themes and issues are emerging that may be distilled into four interrelated and integrated constructs, namely world view, values, knowledge, and language and communication.

### World View (W)

- Ways of seeing the world, of making sense of the world
- The relationship between SELF and the world, includes the sense of SELF
- Spirituality, beliefs.
- Perceptions of 'how things are'.

### Values (V)

- What is considered to be important, to have value, to be significant.

### Knowledge (K)

- Focuses on the issues of 'What is knowledge?', 'How do we come to know?', different types of knowledge and ways of knowing.

### Language and Communication (C)

- Includes noticing, listening, body language, written language, spoken language, statistical language, and preferred ways of communicating.

To illustrate the distillation process I have taken a small sample of some of the more commonly recurring themes and identified the associated constructs. (see Table 1). The sources of the themes are also identified using the symbols M, Q, R, H and L.

These constructs are a modified version of those that were suggested in my earlier research. I originally identified Beliefs and Religion as a cultural construct of relevance (Gunn, 1996). However, I now believe that this aspect forms part of the larger construct of 'world view'.

The understanding of '*knowledge*' has been refined after my deliberations on women's ways of knowing (Belenky et al, 1986). I now believe it is appropriate to place a stronger emphasis upon different ways of knowing and the related issues of power and I include recognition of different types of knowledge.

These constructs have generally been affirmed by the literature, the most obvious being the importance of the construct of 'world view'. This can be seen in the relative prominence of the question 'What is statistical thinking?' in the more recent research on statistics education (for example, Moore, Pfannkuch, amongst others). Further confirmation has come from the preliminary interviews that have been reported upon in this paper and is continuing to be reinforced by interviews in progress.

## IN CONCLUSION

Yet to be identified within this emerging framework are non-cognitive issues such as intuition, imagination and inspiration; the role of emotions (other than fear) in learning. There are also ideas about the dynamic relationship between self and the world, ways of being and doing, that need to be 'located'. Exploration of these ideas will expand the dimensions of the study and bring a greater depth to the emerging framework.

*Table 1*  
*Emerging Themes and Associated Constructs*

Themes	Source	W	V	K	C
Statistics is about an understanding of variability.	L		√		
Statistical Thinking is about - understanding that any process is subject to variation ..... and knowing how to react to it.	M M	√	√		
We never end up with a definitive answer – only estimates; there is always a degree of uncertainty in our answer.	H	√			
Throughout the solution process a strong link is maintained with the real world problem.	H	√			
Maintaining connections between abstractions and the real world problem. Relevance of the problem solving cycle.	L	√		√	
Statistical Literacy	L	√			√
Statistical language of everyday language	L				√
Co-operative learning strategies	L			√	
Group work, team work, projects	L, M, Q			√	√
The relationship between maths and statistics:					
• Statistics is/isn't mathematics.	L	√	√		
• The maths language may 'work' for some students when they are coming to an understanding – but then again, maybe it doesn't.	L	√		√	√
• "We talk a lot about giving students the 'big ideas' but some of the 'big ideas' in statistics aren't mathematical."	Q	√	√		
Context is important (situated learning theory)	L			√	

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