

1. INTRODUCTION

1.1 The Australian Bureau of Statistics (ABS) Education Services provides statistical services and resources to Australian schools across all states and territories and all sectors (Government, Catholic and Independent). It does this in an attempt to increase statistical literacy in students and teachers and promote the access, understanding and use of ABS statistics in the schools sector.

1.2 One of the ABS' corporate objectives is to encourage the 'informed and increased use of statistics'. As part of this objective, the ABS aims to 'increase statistical literacy in the community, with a special focus on the schools sector'. Through the work of the Education Services Unit, the ABS acknowledges that the set of skills required to be statistically literate needs to be addressed during the school years if we expect children to become informed members of our community.

2. THE NEED FOR STATISTICAL LITERACY

2.1 The ABS is very committed to providing access to statistics to all members of the community. However increased use of statistics per se, does not automatically lead to an increased understanding of statistics. It is becoming well recognised that 'statistical literacy is a critical, though neglected skill, that should be addressed if children are to become more informed members of the community' (Gal, 2004). 'Statistical literacy is becoming fundamental for living in a full democracy. There is no doubt that, in the age of information and computers, if we really want to render the citizens as independent as possible and free of influence and conditioning, the only real course of action is to have them attain a higher degree of statistical ... literacy' (Biggeri and Zuliani, 1999)

2.2 On a daily basis we all encounter statistical information: from advertisements ('4 out of 5 doctors recommend ...'), media reports ('polls show the incumbent leading by 4 points') and even in general conversation ('half the time I don't know what you're talking about'). Given that numerical claims can be misrepresented to strengthen an argument, statistical literacy is an important skill to have if one is to be capable of evaluating claims and deciding what to believe (Ben-Zvi and Garfield, 2004; AAMT, 1997). Understanding statistics encountered in everyday life, from the media to the workplace, is as much a basic skill as reading. Such understanding helps enable citizens to make sense of a complex world.

2.3 Statistics are required to make sense of societal functioning, such as crime rates, the spread of diseases, population growth, employment rates, educational achievement and assessing chance based situations such as insurance policies. Developing an understanding of these trends from the earliest possible age is necessary, since this information is essential to understanding society (Gal, 2004). Knowledge of how to use and communicate statistics is therefore necessary if students are to become intelligent consumers of our society, capable of making critical and informed decisions (NCTM, 1989; Wallman, 1993).

2.4 Further though, a lack of statistical literacy can lead to '... misunderstandings, misperceptions, mistrust and misgivings about the value of statistics for guidance in public and private choices.' (Wallman, 1993) Citizens and organisations need to use statistical information to make informed decisions. To have statistics itself discredited because of such

misunderstandings and mistrust makes sound decision making at all levels that much more difficult.

2.5 Data and information are becoming increasingly important assets in many industries where statisticians are essential for proper design, collection, analysis and interpretation of statistical information. More statistically literate students may also lead to more who want to study statistics further. The ABS and other organisations that rely on statisticians are concerned about the future availability of such graduates.

2.6 Statistics is currently taught in a fragmented fashion in Australian schools and typically by teachers with little or no formal education in, or proper appreciation of the subject. Teachers also need to understand statistical subject matter at a depth greater than the content they need to teach if they are to feel confident in teaching statistics (Ben-Zvi & Garfield, 2004)

3. STATISTICAL LITERACY AND ABS CORPORATE OBJECTIVES

3.1 The ABS' Mission Statement underpins the ABS work program and clearly addresses the place of statistical literacy:

We assist and encourage informed decision-making, research and discussion by leading a high quality, objective and responsive national statistical service.

3.2 Measures taken to build a statistically literate society directly support the key ABS objective 'informed and increased use of statistics'. It is largely through the NESU that ABS statistics and information about statistics, are made accessible and understandable to teachers and students. Encouraging appropriate and valid use of statistics by students in the classroom will foster a deeper understanding and appreciation of statistics later in life.

3.3 Strategies that ABS Education Services currently uses to achieve these goals include:

- increasing the visibility of ABS statistics to teachers across all curriculum areas
- providing information on how to use ABS statistics
- developing resources for teachers using ABS statistics
- improving processes that allow teachers to manipulate ABS data in order to create their own solutions and better understand statistical processes
- providing the mechanisms of 'self help' for users to access and analyse ABS data;
- placing a special focus on improving statistical literacy in the school sector
- providing specific large scale programs for teachers, such as Census@School.

3.4 The Education Services Unit is already active in promoting access to, and the understanding and use of ABS statistics in the schools sector. Resources for the schools sector have included some ambitious and highly regarded products including the A Tale of Two Worlds CD ROM and the CensusAtSchool web resource. In August 2006, the ABS announced the collaborative StatSmart project, partly funded by the Australian Research Council to investigate statistical literacy in the classroom. As a leading statistical organisation, the ABS considers it important to share with teachers its expertise in the development and promotion of best practice statistical processes.

4. DEFINING AND ACHIEVING STATISTICAL LITERACY

4.1 Statistical literacy is a term that has yet to be definitely defined. Broad, generic definitions such as that of Dennis Trewin: '...the ability to understand, interpret and evaluate statistical information...' (Trewin, 2005) or Katherine Wallman: '... the ability to understand and critically evaluate statistical results that permeate our daily lives - coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional and personal decisions' (Wallman, 1993) are useful statements. However they do not help delineate concepts, skills and competencies that are useful in classrooms, nor to ascertain levels of statistical literacy.

4.2 Some researchers have made the distinction between statistical literacy, statistical reasoning and statistical thinking (eg Chance, 2002; Ben-Zvi and Garfield, 2004). Yet others distinguish between statistical literacy and statistical competency (Rumsey, 2002). There is general agreement though that statistical literacy involves information that is communicated through text, graphical and tabular displays and through numbers and symbols. Increasingly information is also displayed through mapping. For someone to be considered statistically literate they need to be comfortable and competent with all these forms.

4.3 According to Milo Schield (2004), statistical literacy is 'typically more about words than numbers, more about evidence than about formulas' (p 9). Statistical literacy is more a liberal art than a mathematical science. Data and statistical reasoning are more important than mathematical recipes (Biggeri and Zuliani, 1999). Watson and Kelly (2003) also highlight this point: 'Statistics requires the basic understanding of statistical concepts ... whereas literacy requires the ability to express that understanding in words, not in mathematical formulas'.

4.4 The need to improve statistical literacy has been discussed by the International Statistical Institute which has established the International Statistical Literacy Project. Although much is said about the need for a statistically literate society, acceptable levels and methods for achieving this at the school level are rarely addressed. Certainly however, the term 'literate' suggest a minimal set of 'basic skills'. Further there are different levels of basic statistical skills across the education sector: primary school students for example would not be expected to have the same skills as secondary students and beginning secondary students would not be expected to have the same skills as those completing their secondary education. All these issues need to be addressed.

4.5 In the debates around statistical literacy, there are several concepts that are common to all definitions. These fall into four key areas that consistently appear in some form or other in definitions of statistical literacy. These are outlined below and could be considered in a practical manner as 'criteria' to be addressed if students are to become 'statistically literate'. Skills for each criterion have been classified into basic, intermediate and advanced which broadly speaking translates as primary, junior secondary and senior secondary levels (see Appendix 1). Statistically literate adults need all of the skills classified under 'advanced'.

Criterion 1: Data awareness.

It is important that the data used for a particular study is suited to the investigation in which it is being used. One needs to have an awareness of data sources, associated metadata, data availability and data accessibility when examining statistical claims. It is also important to understand that statistics is contextual.

Criterion 2: The ability to understand statistical concepts.

Rumsey (2002), Watson (2005), Wallman (1993), Garfield (1999) and Ben-Zvi & Garfield (2004) all suggest the need to understand basic statistical concepts and terminology, including statistical symbols. However they (and others) also point out that understanding statistical concepts is not the same as understanding the mechanics of statistics (eg plugging numbers into the correct formula). Understanding statistical concepts requires the ability to read and use tools such as percentage, ratio, measures of spread, central tendency and variability, as well as tables, graphs and maps.

Criterion 3: The ability to analyse, interpret and evaluate statistical information.

The ability to organise data, construct and display graphs and tables and work with different representations of data is fundamental to the achievement of statistical literacy (Ben-Zvi & Garfield, 2004; Garfield, 1999; Watson & Kelly, 2003). Students need to reason and make sense of statistical information. This skill ranges from describing and summarising basic data to understanding and explaining statistically complex concepts such as trends. It requires being able to extract, understand and explain data that is presented in a variety of ways: in words, tables, graphs and increasingly in maps. To be statistically literate one must understand that how data is organised can contribute to how it is interpreted.

A common theme in the literature is that statistical literacy should not just be about understanding statistical concepts such as distribution, probability and sampling, but should also be about critically evaluating when concepts have been applied without proper statistical foundation (Gal, 2004; Gal, 2002). The critical evaluation of statistics essentially requires an understanding of the entire statistical process, from data collection through to data analysis, testing of assumptions and evaluation of results (Ben-Zvi & Garfield, 2004; Pfannkuck & Wild, 2004).

The ability to evaluate statistical information also requires an understanding that all data and data collection is contextual.

Criterion 4: The ability to communicate statistical information and understandings.

'Statistical information needs to be communicated in an effective manner that can impact upon decision making' (Watson, 2005). Part of being statistically literate is the ability to discuss personal understandings of data, reactions to data and concerns over conclusions (Gal, 2002). This aspect relates not only to statistical terms but also to the appropriate expression of information: turning data into information using words. It includes the ability to organise and manage data sets, report data appropriately and question how data is reported. It also includes recognition of ethical issues such as confidentiality.

4.6 All students must develop the above skills to be considered to be statistically literate. However, the sophistication of statistical understanding that students display on each of the above criteria will vary according to the year level and capabilities of the student. (See Appendix 1: Key Competencies for each Criterion by level.)

4.7 It is important that ABS Education Services work closely with teachers in defining 'statistical literacy', and the competencies expected to be achieved for each of the above criteria. By ensuring students are statistically literate, and by helping to construct a framework

Statistical Literacy

for using and understanding statistics, Australian schools can build upon the foundations that make students informed citizens .

4.8 Appendix 1 provides a table of competencies for each criterion that provides a framework for embedding statistical literacy in the design and teaching of educational programs and for assessing the statistical literacy of individuals. Through discussion with education stakeholders, it is intended that these standards and outcomes can be used to influence national curricula standards for teaching statistics.

5. EDUCATION SECTOR

5.1 For it to have an impact on the improvement of statistical literacy among students, the ABS needs to engage the whole education community: teachers, teacher educators, researchers and curriculum developers. As mentioned above, improving the statistical literacy of students also requires that the statistical literacy of teachers be addressed. No matter how good the resources that the ABS develops, if teachers are not comfortable with their own statistical skills and knowledge, they will not use them.

5.2 The ABS proposes to use the above four criteria to progress consultations with educational stakeholders. It is also proposed that the table of competencies inform that discussion as well as act as a framework for achieving statistical literacy. Incorporating statistical literacy into curricula requires a collaborative effort of intermediaries from each state/territory education department, academia, teachers and members of various other education bodies. Feedback will be used to modify and strengthen the definition of statistical literacy proposed in this paper.

5.3 Statements from many curriculum areas (eg Technology Studies, Science, Studies of Society, etc) now specifically recognise the necessity of statistical skills. This presents a great opportunity for the ABS to have a significant input into what statistical skills are taught and how.

6. CONCLUSION

6.1 This paper has summarised key components of 'statistical literacy' and its relevance to the ABS and the teaching community. A literature review has highlighted key skills and competencies that students require to be considered statistically literate. Though definitions vary slightly between authors, criteria that are frequently highlighted as necessary to achieving statistical literacy are:

1. Data awareness.
2. The ability to understand statistical concepts.
3. The ability to analyse, interpret and evaluate statistical information.
4. The ability to communicate statistical information and understandings.

It is planned to use these criteria as benchmarks for achieving statistically literate school students. Strengthening student skills in these areas through engaging educational programs will lead to more use and a greater understanding of statistics in primary and secondary schools, and promote the uptake of tertiary studies in statistics. Through the increase of

statistical literacy among Australian school students, society benefits by having better informed citizens, the ABS benefits by meeting in part its mission statement and the individual benefits by being a better informed citizen.

REFERENCES

- Australian Association of Mathematics Teachers (AAMT) (1997), Numeracy equals everyone's business, Adelaide.
- Ben-Zvi, D. & Garfield, J. (2004), 'Goals, Definitions, And Challenges', The Challenge of Developing Statistical Literacy, Reasoning and Thinking, edited by Ben-Zvi, D. and Garfield, J., Kluwer Academic Publishers, pp.3-15
- Biggeri, Luigi & Zuliani, Aberto (1999) 'The Dissemination of statistical literacy among citizens and public administration directors', Paper presented at the ISI 52nd Session, Helsinki, Finland <http://www.stat.auckland.ac.nz/~iase/publications.php?show=5>
- Chance, Beth L. (2002) 'Components of Statistical Thinking and Implications for Instruction and Assessment' Journal of Statistics Education, Volume 10, Number 3
- Friel, Susan N., George W Bright, Dargan Frierson and Gary D. Kader (1997) 'A Framework for Assessing Knowledge and Learning In Statistics (K-8)' in Gal, I and JB Garfield (ed) The Assessment Challenge in Statistics Education, IOS Press
- Gal, Iddo (2002), 'Adults' Statistical Literacy: Meanings, Components, and Responsibilities', International Statistical Review, Vol 70 (1)
- Gal, I. (2004), 'Statistical Literacy - Meanings, Components, Responsibilities', The Challenge of Developing Statistical Literacy, Reasoning and Thinking, edited by Ben-Zvi, D. and Garfield, J., Kluwer Academic Publishers, pp.47-78
- Garfield, J. (1999), 'Thinking about Statistical Reasoning, Thinking, and Literacy', Paper presented at First Annual Roundtable on Statistical Thinking, Reasoning, and Literacy
- National Council of Teachers of Mathematics (NCTM) (1989), 'Curriculum and evaluation standards for school mathematics', Reston, VA
- Rumsey, Deborah J. (2002) 'Statistical Literacy as a Goal for Introductory Statistics Courses' Journal of Statistics Education, Volume 10, Number 3
- Pfannkuck, M. and Wild, C. (2004), 'Towards an Understanding of Statistical Thinking', The Challenge of Developing Statistical Literacy, Reasoning and Thinking, edited by Dani Ben-Zvi and Joan Garfield, p.17-43
- Schild, Milo (2004) 'Information Literacy, Statistical Literacy and Data Literacy', IASSIST Quarterly, Summer/Fall 2004
- Trewin, D. (2005), Making Maths Vital, Key note speech, AAMT conference

Statistical Literacy

Wallman, K. (1993), 'Enhancing Statistical Literacy: Enriching Our Society', as cited in the Journal of the American Statistical Association, Vol88, No 421

Watson, J. and Kelly, B. (2003), The Vocabulary of Statistical Literacy, sourced: <http://www.augsburg.edu/ppages/~schild/>

Watson, J. M. (2005), 'Is statistical Literacy Relevant for Middle School Students?', Vinculum Vol 42 (1)