

## STATISTICS EDUCATION IN NEW ZEALAND, AND ITS INFLUENCE ON THE IASE

FORBES, Sharleen

Victoria University of Wellington  
Wellington  
New Zealand

Contact email: [Sharleen.forbes@vuw.ac.nz](mailto:Sharleen.forbes@vuw.ac.nz)

### **Abstract**

*For some time, New Zealand has been leading the world in terms of the focus and scope of its statistics curriculum in schools. The curriculum is characterised by its data handling, and in more recent years, data visualisation approach. In 2013 bootstrapping and randomisation will be added to the curriculum achievement objectives for the senior secondary school (Ministry of Education, 2012). This paper gives an historical perspective of the people and groups that have influenced the development of the New Zealand curriculum and outlines the influence and impact of some of these New Zealanders, such as Professors David Vere-Jones and Chris Wild together with Maxine Pfannkuch and John Harraway, on the International Association for Statistical Education (IASE). The roles of both the IASE and the local professional statisticians' association, the New Zealand Statistical Association (NZSA), are discussed together with the possible long-term impact of new statistical literacy based school curriculum in New Zealand on tertiary statistics teaching.*

**Key words:** *history of the IASE, statistics education in New Zealand, school statistics curricula, data handling, data visualisation*

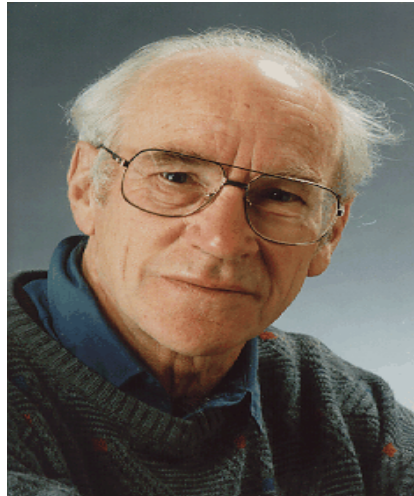
### **INTRODUCTION:**

In his 1995 paper Vere-Jones stated that “*One of the most notable achievements of western societies in the last few decades has been the extension of modern education, including mathematics, to a very substantial proportion of the population*”... “*It is within this context that the movement for statistics education has taken root*” (Vere-Jones, 1995, p.13). Phillips (2002) states that the beginning of an International Statistical Institute (ISI) interest in statistics education began with the formation of its Statistical Education Committee in 1949. This committee initially focussed on academic statistics and the training of official statisticians with involvement in three types of activities: teaching/training projects, publications and sponsoring of conferences and roundtables (Vere-Jones, 1995). However, according to Vere-Jones (1995), by the 1970s the activities had expanded to include statistics education in schools with several task forces being established. Two of these were the Task Force on Teaching Statistics at School Level (that helped establish the “*Teaching Statistics*” journal) and the Task Force on International Conferences in Statistical Education (that initiated the four-yearly International Conferences on Teaching Statistics – ICOTS). The ICOTS conferences are described by Vere-Jones as “*arguably the most important project initiated by the Education Committee*” bringing “*together statistics teachers at all levels, from within all disciplines, and from all continents*” (Vere-Jones, 1995, p8). Phillips (2002) describes David Vere-Jones (New Zealand), Joe Gani (Australia) and Lennart Rade (Sweden) as the main proponents for the creation of a new section of the ISI for statistics education issues. Each was an eminent statistician with influence in the ISI but it was the New Zealander in this group, David Vere-Jones, who was the Chair of the ISI Statistical Education Committee (1987-9) when IASE was established and who became the IASE Interim Executive President (1991-1992) until the First Scientific Meeting of the IASE in 1993, Perugia, Italy where David Moore (USA) was elected as the first IASE President. During this time David was also the International Program Coordinator of the Third International Conference on Teaching Statistics and

the editor of its proceedings. He was active in New Zealand too, being President of the New Zealand Statistical Association (NZSA) from 1981-1983 ([http://stats.org.nz/archive\\_office\\_bearers.shtml](http://stats.org.nz/archive_office_bearers.shtml)) and founding President of the New Zealand Mathematical Society from 1974-1975 (<http://nzmathsoc.org.nz/?historylists>).

David now has at least 16 international publications in statistics education as well as being the author of, or a major contributor to, a number of influential reviews of mathematics and statistics within New Zealand [e.g Vere-Jones (1981), Clarke and Vere-Jones (1987) and Ministry of Research, Science and Technology (1988)]. From 1987-90 he chaired the Education Committee for the Royal Society of New Zealand. However, David is also an active and internationally respected mathematical statistics researcher making major contributions in point processes and earthquake modelling in particular. He has been a Fellow of the Royal Statistical Society since 1969 and a Fellow of the Royal Society of New Zealand since 1982. In 1995 he was awarded the International Statistical Institute Henri Willem Methorst Medal and in 2000 the New Zealand Royal Society's Science and Technology Gold Medal ([www.stats.org.nz/Newsletter61](http://www.stats.org.nz/Newsletter61)). In 2009 he received NZSA's most prestigious award, the Campbell Award, named after Professor James Campbell.

David Vere-Jones is an exceptional person (both as an academic statistician and as a statistics educator) but he is also part of a wider New Zealand movement in statistics education, both nationally and internationally. For example, presidents of IASE are elected every two years and, of the 10 elected so far, three have been New Zealanders (Chris Wild from Auckland University and John Harraway from Otago University in addition to David). This is disproportionately large compared to our population size (currently just over 4 million). This paper examines, from an historical perspective, the New Zealanders (both individuals and groups) that have influenced statistics education in this country, in particular the focus and scope of our schools' statistics curriculum.



David Vere-Jones (1936- )

#### **EARLY NEW ZEALAND INFLUENCERS:**

David was a student at Victoria University under Professor James (Jim) Campbell who was described as giving '*a remarkable amount of time to consulting in statistics*' (Roberts, 1999, p84). Campbell was also well known for actively promoting mathematics and statistics as a field of both research and practice and being '*devoted to teaching and his students*' (Roberts, 1999, p85). He also actively encouraged the participation of women in mathematics and statistics '*vehemently*' challenging '*the idea that women could not do mathematics*' (Roberts, 1999, p83). He was the first president (1949-50) of NZSA ([http://stats.org.nz/archive\\_office\\_bearers.shtml](http://stats.org.nz/archive_office_bearers.shtml)), was awarded life membership of the association in 1983 and in later years provided the association with generous financial assistance. Campbell was also instrumental in David Vere-Jones obtaining a Rhodes Scholarship to Oxford and Moscow. David studied probability theory at Oxford under Professor D.G. Kendall then went to Moscow University as an exchange scholar (New Zealand Mathematical Society, 1982).

David's first statistics education publication (Vere-Jones, 1966) stems from his time spent in Moscow. Campbell's wider influence on David is seen in David's statements such as that the '*special feature of statistics...breaks away from the vision of mathematics as a male-oriented subject*' (Vere-Jones, 1995), in his concern for '*people from less fortunate situations*' (Phillips, 2001, p4) and in his active participation of the New Zealand Statistical Association, being President from 1981-83.



Jim Campbell (1906-1994)

David had significant influence internationally on statistics education, particularly after his appointment as Professor of Mathematics, with special responsibility for statistics, at Victoria University from 1970–2000. Within New Zealand he was one of a group of statisticians working both independently and together to change the school curriculum.

Another of these statisticians was Professor Geoff Jowett, appointed in 1964 as the first Professor of Statistics at Otago University. He had been a consultant statistician at Sheffield University in the United Kingdom and advocated the use of '*practical experimentation as a teaching method in statistics*' (Jowett and Davis, 1960). Among the classroom tools that he used were a shove-halfpenny experiment, sampling bottles and a Galton Board (or Quincunx - figure 1) for demonstrating the binomial distribution and the normal approximation to the binomial. His colleagues report that he employed a carpenter in the department – the position later becoming a computer technician. He also had some notoriety at Otago University for taking a class in the car park when the lecture theatre was locked. He was reported in the local paper (Otago Daily Times, 9 March 1971) as sitting in his van playing a ditty of his own creation "*The mean mean*" (Figure 2).

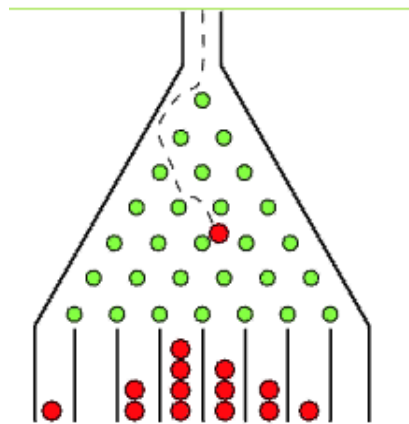




Figure 1: Galton Board or Quincunx


## The Mean Mean

GH Jowett GH Jowett

**Verse 1.**

Voice  I don't mean what you mean said Sam - ple Mean to True Mean

Vo.  How can you tell how mean a mean can be? To tell the var - i -

Vo.  a - tion use the stan-dard de - vi - a - tion. Star-ting out to find how mean a

**Verse 2**

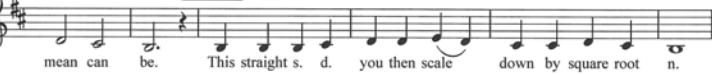
Vo.  mean can be. This straight s. d. you then scale down by square root n.

Figure 2: Segment of Jowett’s music

Jowett continued to be heavily involved in consultancy work while at Otago University and was the first proponent of a statistics curriculum for the senior secondary school in New Zealand, producing a complete draft that was read out by a colleague at a secondary schools teachers’ conference in 1964. Jowett and Roberts became close friends and in 1971 statistics was included in the senior secondary school subject, Additional Mathematics. This has been described as a ‘*turning point for statistics in secondary schools*’ (Roberts, 1999, p122) in New Zealand schools.



Geoff Jowett (1922- )



Stan Roberts (1920–2000)

Len Cook, a past New Zealand Government Statistician, stated that it ‘*was only after we left Otago that I appreciated the full depth of Geoff Jowett’s impact on statistics education, through friends who became teachers and whose keenness for statistics was enriched by his holiday programmes for school teachers, along with Stan Roberts, for more than a decade*’. (Roberts, 1999, p115). Both Jowett and Roberts were also involved with NZSA with Roberts being Secretary (1951-

53, 1970-72) and Treasurer (1970-73) and elected as the first life member of the association (in 1981). Although Jowett never served on the executive committee he was described by Roberts (1999) as one of NZSA's most active, liked and respected members, known for his '*entertaining and original conference papers*' (Roberts, 1999, p114). Jowett was also elected to life membership in 1984. In 1999 Stan Roberts was the first recipient of the NZSA's most prestigious award, the Campbell Award (<http://stats.org.nz/honours.shtml>).

Jowett and Roberts were also well-known to Vere-Jones who in 1978 became Subject Convenor for Mathematics for New Zealand's University Entrance Board of the University Grants Committee (a position he held until 1985) ([www.stats.org.nz/Newsletter61](http://www.stats.org.nz/Newsletter61)). In 1980 a new paper, Mathematics for Statistics, was introduced for the final year of secondary school. A feature of this paper was that it included a practical statistics project worth 20% of the final mark. Begg, 2000 (cited in Phillips, 2001, p11) stated that David '*obviously supported this increasing emphasis on statistics in school mathematics*' speaking to '*teachers at many meetings*'. Phillips (2001) describes David as recognising that teachers' lack of statistical knowledge was a major problem holding back the teaching of statistics in schools and that '*David was early to recognise the place of technology.*' (Phillips, 2001, p12). The first national examiners for Mathematics with Statistics (1980-89) were all members of the Department of Mathematics and Statistics at Victoria University where David Vere-Jones was Professor.

A common feature of all four of these early pioneers was that they were all involved in applying statistics in real world projects and advocated hands-on 'playing with the data' in the statistics classroom at all levels. For example, Vere-Jones co-supervised (with another Victoria University staff member) a postgraduate student project that developed a programme for randomly generating a small data set containing mothers' smoking habits and babies' birth weights from a population with known parameters. This allowed each student in the large first-year statistics class to then be given a unique data set that was used in all their tutorial exercises, enabling them to work collectively but be assessed individually. This programme was used for approximately twenty years, from the mid-1980s until 2006.

Around this time also, NZSA became increasingly concerned with, and involved in, school statistics education. In 1987 its Education Subcommittee, convened by Sharleen Forbes, was formed and current membership includes internationally well-known and respected statistics educators such as Mike Camden, Maxine Pfannkuch and Professor Chris Wild. One of the committee's early projects was the 1990 Children's Census run in conjunction with the Third International Conference on Teaching Statistics (ICOTS III) held at Otago University, Dunedin (Forbes and Harte, 1994; Forbes, 1996a). This was the precursor of today's international CensusAtSchools. NZSA became a powerful lobby group for change in the school statistics curriculum and in 2007 a new Mathematics and Statistics curriculum for all levels of schooling, from new entrants to the senior secondary school, was introduced. This described statistics as '*the exploration and use of patterns and relationships in data*' (Ministry of Education, 2008).

New Zealand is a small country, both in terms of area and population (currently just over 4 million) so there are opportunities for statisticians and statistics educators to interact and influence each other. It is perhaps at ICOTS III in 1990 that the interconnectedness between these early New Zealand statistics educators is most clearly demonstrated. David Vere-Jones was Chair of the ISI Statistical Education Committee responsible for the conference and also Vice-Chair of the Programme Committee and Editor of the Proceedings (Phillips, 2001). Geoff Jowett was one of the plenary speakers giving a paper entitled '*Expanding Statistical Education - A New Zealand Retrospect*' (Jowett, 1990). Sharleen Forbes was a co-organiser of one of the sessions, '*Statistics in Her Education*', and also one of several members of the Wellington based Equity in Mathematics Education research group delivering papers (Forbes and Robertson, 1990; Clark, 1990).



## STATISTICS EDUCATION RESEARCH:

While changes in the school curriculum were influenced by a number of New Zealand statisticians it was primarily David Vere-Jone's promotion of statistics education as a field of both research and practice that influenced the growth of statistics education research in New Zealand. Not surprisingly one of the first groups involved in mathematics and statistics education research was based at Victoria University in Wellington. This was a collective of women, Equity in Mathematics Education (EIME), who were interested in examining disparities in educational outcomes between different groups of students. Over the period from 1987-2000 they produced a number of publications. Some of this research could be viewed as the application of statistical analysis to education data, such as *Mathematics for All?* (Forbes et al, 1990) but other projects such as Clark et al (1994) and Forbes (1996b) investigated the differential impact of assessment mode and content on achievement. Forbes' (2000) doctoral dissertation developed a longitudinal index for accumulating participation and achievement differences to measure disparity growth over time, as well as examining the influence of assessment context on student choice and achievement. Most of the members of EIME were either school or academic teachers of statistics and all were active in presenting at teacher conferences, helping teachers develop classroom resources (in particular, for the senior secondary school Mathematics with Statistics project) and lobbying for change in the school statistics curriculum. Several were also active members of the NZSA Education Committee and in 2008 Sharleen Forbes received the associations' Campbell Award.

Another group of statistics education researchers was established at Auckland University in the mid- 1990s. This group includes both Professor Chris Wild (a past President of IASE) and Maxine Pfannkuch. Their early interest (Wild & Pfannkuch, 1999; Pfannkuch and Wild, 2000) was in developing models for the way statisticians think to underpin research in, and the development of pedagogy for, statistics education. An important component of these models was the inquiry cycle, PPDAC (Problem, Plan, Data, Analysis, Conclusion). They have been advocates for the use of visual tools in the classroom, including using dynamic displays of box-plots to develop informal inference concepts in the junior to middle secondary school (Wild et al, 2011), and developing a dynamic visualisation tool, iNZight (<http://www.stat.auckland.ac.nz/~wild/iNZight/>) and VIT (Visual Inference Tools, <http://www.stat.auckland.ac.nz/~wild/VIT/>) for new material (randomisation, bootstrapping and time series) that has entered the senior secondary school in 2013. Since 2005, the Auckland team has been funded jointly by the New Zealand Ministry of Education and Statistics New Zealand to deliver the New Zealand CensusAtSchools project. This not only allows school students to enter their own data biennially and to take random samples from the overall data set but has been extended to provide a linking mechanism for teachers between the statistics curriculum and teaching resources and research. Members of the Auckland group have also been strong advocates for, and had close connections, with changes in the school curriculum running teacher workshops and presenting to teaching conferences in addition to writing reference material for teachers at all levels [e.g. Wild & Seber (2000), Forbes & Pfannkuch (2009), Pfannkuch et al. (2010), and Arnold et al. (2011)]. Several members, including both Chris Wild and Maxine Pfannkuch, are currently active in the NZSA Education Committee and in 2012 Chris Wild received the Campbell Award. Chris is also a Fellow of both the Royal society of New Zealand and the American Statistics Association. The Auckland group continues to grow in both the scope of its research and the number of researchers involved expanding in the last few years to include both Sharleen Forbes of Victoria University and John Harraway of Otago University (the current IASE President) and to include tertiary and workplace education (Pfannkuch et al (2011)).

Not surprisingly, the research undertaken by both groups of researchers focuses mainly on aspects of statistics in schools; curriculum, assessment and pedagogy. A common feature of all the above researchers is their efforts to pass on the knowledge gained from their research to the classroom teachers.

### **CHARACTERISTICS OF NEW ZEALAND STATISTICS EDUCATORS:**

The people mentioned above share some common characteristics. One is that a number are respected international academics in their own fields in mathematical statistics (e.g. David Vere-Jones in point processes and earthquake prediction and Chris Wild in non-linear regression and sampling theory). Almost all have been or are active members of national and international associations, doing hands on work in organising conferences or serving on executive committees. The New Zealand Statistical Association has become a powerful lobby group advocating curriculum change in schools in particular. Many have also been willing to serve on national committees implementing changes, for example participating in the oversight or actual drafting of national standards. They all also share a concern for the classroom teacher. This was perhaps best described by (Phillips, 2001, p11) with reference to David Vere-Jones as recognising '*that one of the main problems holding back the teaching of statistics in schools was the lack of statistical knowledge of the teachers*'. In the longer term the success of the school statistics curriculum in New Zealand may well depend on the investment by the Ministry of Education in teacher development.

### **CONCLUDING COMMENTS:**

Individual statistics educators in New Zealand are noted for exhibiting their passion for statistics and developing creative ways of making it accessible to students, including having a common view of the power of students having 'hands-on' experiences of playing with data. Their periods of major activity overlap and collectively they have formed a critical mass of consistent opinion that has been effecting change in our schools for the past 50 fifty years. It also needs to be acknowledged that the above individuals are not the only New Zealanders involved in statistics education. Support for change in schools has been widespread. The New Zealand curriculum is characterised by its data handling, and in more recent years, data visualisation approach. In 2013 bootstrapping and randomisation will be added to the curriculum achievement objectives for the senior secondary school (Ministry of Education, 2012). It is too soon to know if we are moving too far, too fast for our teachers to keep up.

We have yet to see a long-term impact of our new statistical literacy based school curriculum on tertiary statistics teaching in New Zealand. While a few universities have made changes to their first-year courses these seem to have been driven by pressures other than the school curriculum. For example, Auckland University's innovations in 2003 that led to a national Tertiary Teaching Award were, in part, a reaction to large class numbers and Canterbury University's radical changes to the content and delivery of their first year courses following the devastating earthquake in February, 2011 (David and Brown, 2011). To date, there has not been the same emphasis on changing university curricula as was seen in the school system. While there may be many reasons for this, including the autonomy of individual universities, we may be in danger of disenchanting potential statistics students if we continue to have a mathematics dominated statistics curriculum at the tertiary level.

New Zealanders have been influential in IASE, both in terms of their contributions to the administration of the organisation and to the body of statistics education research. The New Zealand school curriculum serves as a working model for other countries to adapt to fit their particular circumstances. In addition, there is a pool of younger New Zealand statistics educators that can continue this influence into the future.

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