

## USING REAL DATA IN CLASSROOMS – EVALUATING ITS EFFECTIVENESS

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*We assume that teachers of statistics find real datasets a useful teaching resource. Three kinds currently available to New Zealand teachers include those from real experiments or surveys (on CD), a synthetic unit record file (SURF) created from an official statistics survey specifically for teachers (downloadable from the web or available on CD) and datasets from the internet based CensusAtSchool. Which of these datasets best meets the teachers' needs? Do they each address different teaching needs? Do they raise students' learning? The number of schools or teachers accessing a dataset is a crude basic indicator of its usefulness. Surveys of teachers' views (following the 2005 CensusAtSchool and in progress for the SURF) give indicators of usefulness and/or whether the dataset helps raise statistics learning. To determine the actual impact on student's learning requires pre- and post-testing of student, or, ideally, quasi-designed experiments.*

### INTRODUCTION

In the New Zealand school curriculum there is a learning stream called *Mathematics and Statistics* that goes right through from new entrants at primary school to the end of secondary schooling (Ministry of Education, 2007). We have assumed that teachers of statistics would find real datasets a useful teaching resource for the statistics component of this stream. However, what is not known is what types of dataset best meet teachers' needs or what impact using real datasets has on students' statistics learning. This paper discusses three different types of datasets that are currently made available to teachers as classroom resources to assist the teaching and learning of statistics. These are provided either free or on a cost-recovery basis.

### DESCRIPTION OF DATASETS

The first type of dataset discussed is a collection of nine sets of data from real experiments or surveys collated and downloaded on to a CD by John Harraway at the University of Otago (funded by a New Zealand Statistical Association grant and the University of Otago Higher Education Development Centre). The CD containing the data is accompanied by a DVD which has nine video presentations describing the research projects that have generated the nine data collections (University of Otago, 2007). These are distributed to teachers on request for the cost of producing them (NZ \$15). The datasets include:

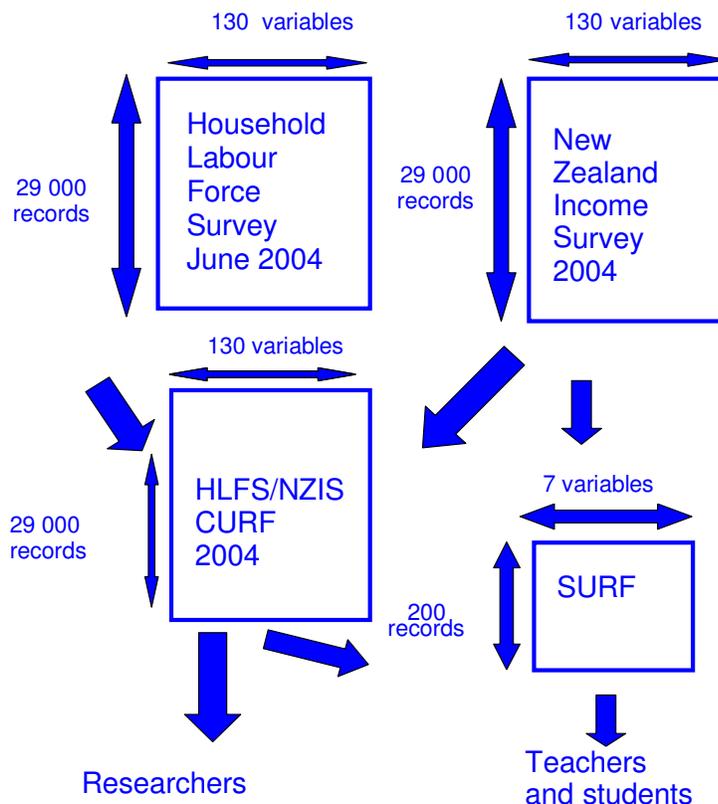
- Human nutrition (Prevalence of iron deficiency in New Zealand children)
- Epidemiology (Herpes data from the Dunedin multidisciplinary health and development longitudinal cohort study)
- Marketing and Tourism (Attitudes of Australian, Japanese and German tourists to New Zealand attractions and activities)
- Ecology (Biomass estimates from commercial cockle harvest inlets)
- Ecology (Effects of investigator disturbance on hatching success in endangered Takahe)
- Psychology (Human behaviour during aircraft incidents and accidents)
- Physical Education (Impact of group rejections on physical self-esteem)
- Economic time series (Application of the X12 time series model to Retail Trade and Building Consents data)
- Environmental Performance Measures (Natural resource accounts).

DVD clips for the Human nutrition and Epidemiology data sets can be viewed at <http://www.maths.otago.ac.nz/~jharraway/Presentation1.avi>, <http://www.maths.otago.ac.nz/~jharraway/Presentation2.avi>

All nine datasets are available as EXCEL worksheets and vary in size and type of data (e.g. Human nutrition has 324 records by 26 variables, Epidemiology has 1891 records by 9 variables, Economic time series contains graphed raw and seasonally adjusted data, etc.). The datasets are most appropriate for the final year of secondary schooling (year 13, average age = 17 years) but they have also been used in first year university classes.

The second type of dataset is a synthetic unit record file (SURF) created from official statistics survey data at the national statistics office (Statistics New Zealand) by staff with recent experience as secondary school teachers. Official Statistics agencies produce many datasets, but need to keep the information provided by both individuals and businesses confidential. The first SURF for schools was designed to be small enough for classroom use but also to reflect the characteristics of the real people responding in the June 2004 annual NZ Income Survey supplement (HLFS/IS04) to the Household Labour Force Survey (HLFS). From this supplement a Confidentialised Unit Record File (CURF) intended for use by researchers and tertiary students was created. 29,000 people were involved in the June 2004 HLFS. There were 27,800 respondents to the HLFS/IS04 and 14,500 of these were aged between 15 and 44. This is the age range used in the SURF and defines the sub-population of the CURF used to generate most of the variables contained in the SURF (others, e.g. sex and ethnicity were generated from Census 2001 demographics). Figure 1 demonstrates how the original survey dataset, the CURF and the SURF are related. The SURF was restricted to comprise seven variables (sex, highest educational qualification, marital status, ethnicity, age, hours worked and income) and 200 synthetic people. The variables were chosen so the dataset could be used for the range of statistical activities (from construction of tables and graphs through to simple regression) in the new curriculum.

Figure 1: Relationship between the HLFS, the NZ Income Survey, the CURF and the SURF



The validity of the SURF was assessed for results that learners would get using it (as compared to using the CURF). There were only minor differences for the univariate and bivariate analyses that the students would be exposed to (however, this may not be the case if multivariate analyses were done using the SURF. The SURF is downloadable from the Statistics New Zealand website <http://www.stats.govt.nz/schoolscorner> and available on CD on request. Included with the dataset are suggested classroom activities for students at different levels of both primary and secondary schooling.

The third type of dataset is available from the CensusAtSchool. This is an internet based survey of school students begun in the UK (<http://www.CensusAtSchool.ntu.ac.uk>) but based on a trial project held in New Zealand in 1990, 'A Children's Census' (Forbes, 1996). The CensusAtSchool was first run in 2003, then in 2005 and 2007 under contract by the University of Auckland. Funding is provided jointly by the Ministry of Education and Statistics New Zealand. A random sampler provides access to samples of 255 CensusAtSchool participants and a table-maker allows users to create univariate and bivariate tables which may be viewed graphically. Suggested classroom activities are available in the 2005 report and are also downloadable from the CensusAtSchool website (<http://www.censusatschool.org.nz/>). CensusAtSchool is targeted at, but not restricted to, primary and early secondary school learners.

### EVALUATION OF EFFECTIVENESS OF DATASETS

How can we determine which of these types of dataset best meets the teachers' needs or whether they each address different teaching needs? The number of schools or teachers accessing a dataset can be viewed as a basic indicator of a dataset's usefulness. In 2006 there were 2049 primary schools, 142 composite schools and 335 secondary schools in New Zealand (Ministry of Education, 2006). The total number of school students was 760,761; 482,769 in years 1-8 (approximate ages 5 – 12 years respectively) and 277,992 in years 9 and above (approximate ages 13 years and over). The new Mathematics with Statistics curriculum (Ministry of Education, 2007) covers all levels of schooling but participation in some subjects is optional from year 10 (usually year 11 for mathematics).

Table 1 gives the numbers of 'real' dataset and SURF CDs distributed to teachers and of schools and students participating in CensusAtSchool.

Table 1: Uptake of datasets

<b>Data collection</b>	<b>Number distributed/ participating</b>
CD of 'real' datasets	210
Statistics NZ SURF	
- requested via the internet	85
- distributed at conferences, etc.	approximately 350
- downloaded from the web	181
- visits to the SURF main page	734
CensusAtSchool 2003 -schools	400
- students	Over 18000
CensusAtSchool 2005 -schools	725
- students	33205
- downloaded data files	8437 (as at 3 Jan 06)
CensusAtSchool 2007 –schools	505
- students	25048 (as at 30 Sept 07)

Teachers can, of course, use more than one type of dataset and data is not readily available on the exact number of classes being taught statistics so the proportions of statistics classes using each resource cannot be calculated. The numbers above are, therefore, very crude measures. As one

would expect, the number of schools or teachers accessing a dataset decreases as the level of schooling to which it is targeted increases (and the number of students studying statistics decreases). Although there is some overlap, the datasets are targeted at different groups of students and they may be being accessed by different teachers and serve different learning purposes. There does seem to be a reasonable level of access to all the datasets (for example 20% of all schools and 30% of all students in 2007 accessed the CensusAtSchool) which could imply that either New Zealand teachers find them useful or that they have few other statistical resources available for use in their classrooms.

Another (subjective) measure of the usefulness of these datasets can be obtained by surveying teachers to get their perception of the dataset both as a teaching resource and of its impact on their students' learning. They could also be asked if they used more than one of the datasets and, if so, for their relative merits. The level of response obtained to this type of survey, the questionnaire design and the mode of data collection (face-to-face, mail-back, internet based, etc.) would impact on the quality (reliability) of the results obtained.

Teachers who have requested the CD/DVD pack have not been surveyed scientifically. Anecdotal evidence, however, suggests that the concept is worthwhile from the point of view of showing school students interesting applications of statistics at work. The data files are complicated for use in schools and for this reason the data may be more appropriate for individual project work rather than for illustrating standard procedures taught in the school syllabus. We want to get answers to these questions. A second CD/DVD pack is currently being prepared and an evaluation of both the effectiveness of this teaching aid and of the first DVD is planned. Projects for inclusion in the new CD/DVD pack will include research in ecology, injury prevention and health among others. A high school teacher will assist with the final presentation of the data.

The SURF created by Statistics New Zealand was 'launched' at the National Numeracy Facilitators Conference in February 2007 (Forbes & Stuart, 2007). Teachers who have requested CDs of the SURF and associated teaching resources are currently being surveyed to determine whether they view it as being useful as a teaching tool and/ or to raise the statistical learning of their students. This survey comprises questions on whether:

- it is used in the class or elsewhere?;
- it fits the curriculum?;
- it is easy to use and understand?;
- suggested activities are used or teachers create their own?;
- students work independently or with teacher input?;
- students enjoy the activities and these are appropriate?

Teachers are also asked for what subjects and years they have used the SURF and how often in addition to their perception of whether its use increases students' learning. Preliminary analysis of the results should be available by the end of December 2007.

Those teachers who had pre-registered an interest in taking part in CensusAtSchool and whose classes took part in the 2005 CensusAtSchool (280 teachers) were surveyed in 2005, together with those who had pre-registered but whose classes did not participate (50 teachers). Of teachers who had classrooms participating:

over 90% reported that

- *'the class appeared to enjoy the activity'*
- it was *'a worthwhile activity'*
- the *'teacher support pack was useful'*

and roughly 50%

- intended using CensusAtSchool *'products in the following years statistics programme'*.

About half of the teachers whose classes did not take part also intended to use *'CensusAtSchool products in their following years programme'*. Examples of individual free form text responses from both groups are given in the project report (Florence, 2006).

## FUTURE RESEARCH

The evaluations discussed above all involve, or will involve, surveying the group of teachers that access these resources. This is a biased subset of all statistics teachers, and they may, as a group, be more skilled or more highly motivated than other teachers. A survey of all teachers of statistics (or a sample of these) could be used to determine which of the datasets teachers preferred, whether they used more than one of the datasets, and their perceptions of the impact of these resources on students' learning. However, there may be difficulties accessing an appropriate and adequate sample frame of statistics teachers (particularly of teachers in subjects other than *Mathematics with Statistics*) and a survey of this type would be an expensive exercise.

To determine the actual impact on student's learning would require pre- and post-testing of students at a minimum. This could relatively easily be undertaken by teachers in the classroom (and may already have been done by some teachers). Ideally, quasi-designed experiments where some students are exposed to the datasets in the classroom and some are not should be used. However, the ethics of restricting a student's access to a resource that may assist their learning needs to be considered before using this form of experimental design.

Some innovative mix of several of the above research approaches above (e.g. a survey of teachers accessing resources together with a control group of teachers not accessing resources to obtain attitudes and perceptions, plus pre-testing of students before using one of these resources then post-testing of the same students after use of the dataset) could be considered. This would give a comparison of the types of datasets and also provide information that could be used for future planning and investment in the creation and provision of real datasets as statistics teaching resources.

## CONCLUSIONS

While there is some overlap between the school levels targeted by the datasets discussed in this paper they may be being accessed by different teachers and serve different learning purposes. Simple counts of teachers or schools accessing the datasets provides some evidence that all these types of dataset are being used, but this could also just imply that teachers have few statistics learning resources available to them. Another measure of the usefulness of teaching resources can be obtained through a survey of teachers' perceptions but these are subjective and the reliability of the results is affected by the response rate, questionnaire design and mode of data collection. The one survey (for the CensusAtSchool products) which has produced published results does indicate that these are very positive from the teachers' perspective. Although the results are likely to be biased by the way the sample is selected (from pre-registered teachers) they do give an indication of 'usefulness'. If teachers accessing each type of dataset were surveyed about their perceptions of the dataset (including its impact on their students' learning) this could be used to justify further investment in the creation of similar products, or not.

An expanded survey of teachers (for example, to all teachers of statistics in New Zealand schools) could determine whether they used more than one of the datasets and, if so, for the relative merits of each. A comparison between the types of datasets could provide information for future planning and investment.

The actual impact on student's learning could be measured by pre- and post-testing of students. It is not known whether this has already been done by any of the teachers currently using the datasets. Quasi-designed experiments where some students are exposed to the datasets in the classroom and some are not could also be used but have some ethical constraints. Further research on methods for evaluating the usefulness of real data as a resource for statistics teaching and learning needs to be undertaken.

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