



Australian
Bureau of
Statistics

'Careers in Statistics' Guide

An Interactive Qualifying Project Report
Submitted to the faculty of
Worcester Polytechnic Institute
In partial fulfilment of the requirements
For the degree of Bachelor of Science by:

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Abstract

This interdisciplinary team developed a promotional strategy for the National Education Services Unit of the Australia Bureau of Statistics. Through extensive background research and with the feedback from interviews the group established the existence of a problem with an insufficient number of *qualified* statisticians in Australia's job market. This strategy recommends brochures, school visits, work experience, and training for math teachers to help raise the awareness and profile of careers in statistics for students, teachers, and parents.

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Executive Summary

The demand for statistical skills has grown persistently over the past years as more professions require the utilization and critical assessment of data. However, in modern Australian society, statistical illiteracy continues to be a problem. Adults and children do not understand statistics well enough to make informed decisions in their daily lives.

The main goal of this Interactive Qualifying Project is to develop a strategy and related promotional materials for the provision of appropriate statistical careers guidance and advice for schools, parents, and students. The purpose is to raise the profile and awareness of statistical careers and to encourage secondary school students to explore the various career paths available to them in this field.

The WPI group took two general approaches. The first was to determine the extent of the problem by analysing the Australian labour market and engaging in a mock job search. The group also held several interviews and one focus group with professional statisticians and recent graduates at the ABS to find out what motivated them to enter this field and their experience in finding a position.

The group found that job prospects for statistics are good, but not excellent. The unemployment rate of statisticians is the same as the overall unemployment rate in Australia. Large employers of statisticians, such as the ABS, have hundreds of applicants each year for only ten to twenty statistics positions. Contrastingly, it was found that graduating statisticians were finding positions relatively easy. Thus, the group concluded that **the problem is the quality and not the quantity of professional statisticians**. There are enough applicants for statistics positions, but many are rejected as they do not have the skills that employers require.

The second approach was to explore the perceptions of statistics held by different people in the education sector. Career advisors and math teachers in the seven states/territories outside Victoria were interviewed by phone and email. Career advisors, math teachers, university professors, and members of educational organizations within Victoria were interviewed face-to-face. The team conducted focus groups with year 9 and 10 students as well as with teachers. The team also

surveyed these students, teachers and career advisors to determine what types of activities might help promote careers in statistics among secondary students.

The team examined comparable school curricula and programs promoting careers in statistics, mathematics, and the sciences from the United States, New Zealand, and the United Kingdom. The school curriculum and university programs in New Zealand were given a special emphasis, as this country continues to produce many statistics graduates. The source of the problem of declining qualified statisticians was identified by evaluating and comparing the education system in Australia to that of New Zealand. The group found that secondary students in New Zealand have a stronger statistical background. **The source of the problem with the supply of qualified statisticians lays within the Australian school curriculum which leads to an insufficient amount of students entering statistics programs at universities.**

Another main issue is the general unawareness of students, career advisors, and even math teachers about the various careers in statistics. There is very little information about statistics getting to the education sector in Australia. **A majority of year 9 and 10 students do not have a clear idea of what statistics are, even after having studied it in math class.** Career advisors expressed that there are no identifiable paths for statistics. According to them, statistics seems boring and unattractive to students because they know very little about it.

The WPI team also identified that years 10, 11, and 12 are the most effective levels to target. This was what all the career advisors, math teachers, and members of educational organizations identified as being the best target levels. The students in these grades are those who are actually thinking about career choices. **It is reasonable to reach students in high-level math courses** because it is where those who are good at math and/or enjoy math will be found.

Considering these findings, a strategy made up of primary and secondary recommendations was developed. **The first recommendation is creating a brochure that contains basic information about careers in statistics.** A brochure is a simple, easy, and effective way to get basic information to students, advisors, and teachers. It should include ABS and NESU (National Education Services Unit) logos, a catch phrase such as “Become a Statistician”, and basic information such as what a

statistician is, what different the different careers in statistics are, and how to become a statistician. This brochure should be sent to career advisors and math teachers in secondary schools, who can then pass the information on to students and parents. An electronic version should also be made available at the NESU website.

The second recommendation is for the ABS to carry out school visits to year 10, 11, and 12 math classes in Australia. School visits complement the brochures as they create a personal connection between the student and the visitor. Because it is difficult to send representatives to 2,600 schools, the group suggests that the ABS collaborate with universities to send undergraduate students to visit the secondary schools.

The two final recommendations are providing work experience to students and professional development programs to math teachers. Although the ABS already provides work experience to secondary students, it is not promoting this unique opportunity. This was the most popular choice among students, teachers, and advisors. Professional development programs are also of vital importance as many math teachers confessed discomfort when teaching statistics. Thus, this group recommends that the ABS carry out the guidelines for professional teacher development proposed by last year's WPI Interactive Qualifying Project. Finally the WPI group wants to leave the ABS two secondary recommendations: case studies of interesting statisticians and contests involving statistics.

In the future Australia will have better informed students, teachers and advisors, meaning that more students will consider statistics as a career path, if the recommended strategy is executed. If the ABS can effectively implement these recommendations, then statistical literacy in Australia could be enhanced, strengthening the development of informed opinions among the Australian population.

Introduction

In today's technological society there is an ever growing demand for students who are proficient in science and mathematics, including statistics. It is important to continue the promotion and education of careers in mathematics and science. As times expand it is necessary to implement new forms of educational involvement with students in order to ignite interest. In recent years, Australia has seen a dramatic decrease in the number of statisticians that are graduating from universities, as well as those entering universities to pursue statistical degrees. Moreover, in the Science at the Crossroads? report for the Australian Council of Deans of Science, Ian R. Dobson states a decline in mathematical sciences enrolments overall in Australian universities from 4045 students in 1989 to 2787 in 2002 (2003).

The Australian Bureau of Statistics (ABS) is the organization that is responsible for not only the collection, but also the distribution of statistics in Australia. The ABS believes that the level of the general public's statistical knowledge affects the decisions they make. They also believe that statistical literacy can allow the general population to make better informed decisions (Fisher, 2003). As a result, they have asked this WPI group to develop a strategy and related promotional materials for the provision of appropriate statistical careers guidance and advice for schools, parents, and students.

The ABS, along with other non-government and private sector organizations, is concerned with increasing the number of students interested in statistical careers. There is a growing discomfort with the level of scientific, mathematical, and statistical skills, and some countries such as the United States, have embarked on programs to try to address this problem. Some of the initiatives to increase awareness and interest in statistical careers in Australia are CensusAtSchool and the Proposal for an Australian Statistics Educational System (ASES). CensusAtSchool is an internet census for students to learn how to work with real statistical data. The ASES proposal is a joint project of the ABS and Statistical Society of Australia, Inc. (SSAI) to introduce statistics into the educational system in Australia. More recently the SSAI published the Statistics at Australian Universities report, in which the ABS actively collaborated. It provides a comprehensive and an authoritative view of the problem. The project team has also researched further initiatives undertaken by the ABS and

other organizations and identified relevant stakeholders to ensure the strategy is inclusive and complimentary.

According to the ABS and the SSAI, Australia currently does not have an effective strategy for the promotion of statistical careers to students. By working with the ABS, this project:

- Clarifies the needs of teachers and students.
- Evaluates the experience with programs conducted in Victoria as well as in other states, territories and countries.
- Examines the findings of educational literature to identify possible alternative strategies.

This project was carried out by completing five tasks:

1. **Gathering background information:** To have a well-formed perspective of the problem the group compiled research from different sources. Educational and mathematical organizations, schools, and universities in Australia, New Zealand, the United Kingdom and the United States were the main sources.
2. **Planning interviews, focus groups, and surveys:** The team identified three groups of people which it intended to reach, developed the questions together with an ABS team, and then contacted different professionals. As part of this development, the team conducted investigations with key stakeholders including career advisors, teachers, members of other relevant organizations with similar interests to the ABS, and mathematical departments at several Australian universities.
3. **Interviewing and surveying:** The group interviewed and surveyed math teachers, career advisors, university professors, members of educational organizations, ABS staff, and students. The team asked specific questions about their opinions of the problem, programs being carried out to promote careers, and which of a proposed set of strategies they would recommend and why.
4. **Conducting focus groups:** The group conducted 3 focus groups with students, math teachers, and ABS staff respectively. These were follow-ups of interviews. The team raised aspect and/or issues that remained unclear from the interviews.

5. **Gathering and analysing data, and recommending a strategy:** After gathering a large quantity of data the group developed a strategy. The main components are brochures, school visits, work experience and brochures.

The strategy includes information that can be provided to all schools, and can easily be distributed by the National Education Services Unit (NESU). It outlines major topics such as who to direct the strategy to, how the statistical careers should be promoted, the intended timeframe of the strategy, and then the anticipated results of the team's proposed strategy.

1 Background

From the year 2002, many organizations such as the Australian Bureau of Statistics (ABS) and the Statistical Society of Australia, Inc. (SSAI) have dedicated their research efforts to finding solutions to a growing problem: the increasing shortage of professional statisticians in Australia. This problem is arising at a time when there is a growing need to collect, record and analyse information from various sectors. Statisticians are of vital importance to many countries around the world, including Australia. However, in spite of this demand, the supply of statisticians has been decreasing over the past years. At this time, there are not enough people pursuing degrees in statistics, and those currently in statistical careers are near retirement. Reduced intakes into mainstream mathematics and statistics courses in turn lead to reduced or static numbers of specialists taking honours and graduate courses (Figure 1) (SSAI, 2005). Because of this, many people are concerned with the growing need for statisticians, since they fulfil many vital needs in the public and private institutions (Fisher, 2003).

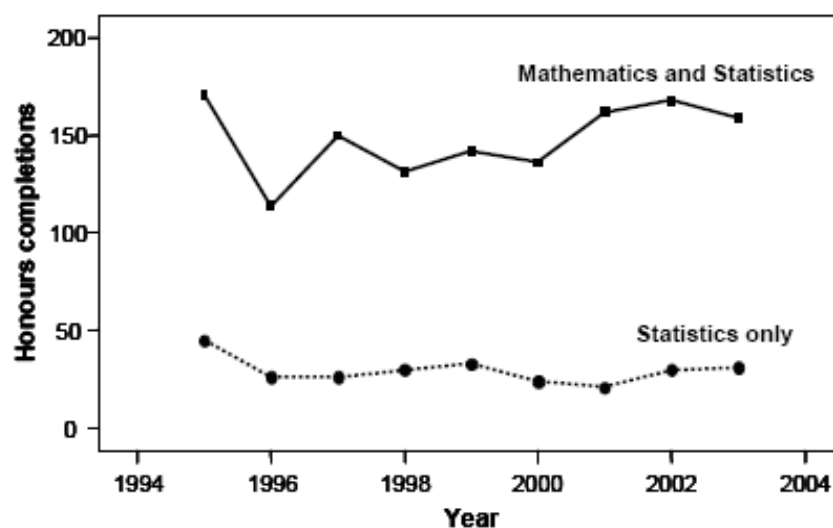


Figure 1: Honours Degree Completions

In response to the concerns of the private and public sectors, several programs have been created and put in place to try to address them. In the public sector, educational institutions have seen a continual decline in the number of students majoring in statistics with no clear answer as to why (Fisher, 2003). In response to this, the ABS and SSAI have developed a three-pronged strategy to promote statistical

understanding and abilities among the general population. The three components of the strategy are:

- To interest primary and secondary students in statistics, through targeted educational programs.
- To encourage interested students to pursue a major in statistics at a university.
- To guide college graduates to pursue postgraduate study, or go into the workforce in a statistical field.

(Fisher, 2003)

The main focus of this interactive project is to assist the ABS in pursuing the first component of this strategy, with a special focus on secondary students. By targeting this age group, the team believes the impact of any outreach program will be more immediate and effective. This is the age at which students are just beginning to explore options for college and career opportunities available to them.

This chapter discusses the necessary background information required for a complete and thorough understanding of the project. The first portion deals with the factors that affect the choosing of a career, and more importantly, why some people choose to go into statistics. The next section describes the job of a statistician and the opportunities available to them. It is important to understand what they do, and how diverse their field is. The next portion of research discussed deals with the educational system of Australia, and the high school curriculum and competency testing, as well as some governmental and organizational initiatives to place statistics into the curriculum. The last portion of research ties into the promotional programs already in place, and the findings on their success.

1.1 Choosing a Career

An important aspect for being successful in encouraging people to pursue careers in statistics is understanding when and how they make decisions concerning their future careers. Career development is a widely studied field that encompasses psychology and education. The book *Career Choice & Development* by Duane Brown and Linda Brooks (1996) describes many of the current theories about how people make career decisions.

For example, Holland's theory describes six types of people: realistic, investigative, artistic, social, enterprising and conventional. The aptitudes of the investigative and conventional types would make them the most suitable people to go into statistical careers. According to Holland, investigative people have the greatest abilities in the scientific area while conventional people have the greatest ability in business (Brown & Brooks, 1996). If the ABS and other statistical organizations were to target their efforts towards these two personality types the outcome would probably be better than making a more general promotion for every student in Australia.

Another theory that applies to this project is the life-span, life-space approach to careers. One of the major parts of this theory that is useful in this project is the life-span perspective of a person's career. The life-span consists of five life-stages: growth, exploration, establishment, maintenance and disengagement. The demographic group (secondary students) the project is working with is primarily in the growth and exploration stages. The growth stage is the time from ages four to fourteen when individuals start concerning themselves with the future, taking control of their lives, and acquiring work habits necessary to achieve in school and work (Brown & Brooks, 1996). The next stage is the exploration stage from ages fourteen to twenty-four, when "individuals encounter the career development tasks of crystallizing, specifying, and implementing and occupational choice" (Brown & Brooks, 1996, p. 132). The ages of transition from one life-stage to the next are not set in stone but vary from person to person. Few will not be in one of these two stages in the range of our project. The people in the exploration stage are those who the ABS and similar organizations should be trying to get into statistical careers.

Gottfredson's theory of circumscription and compromise also covers certain aspects of career development that apply to the project at hand. This theory has practical application in career education. An example given in Brown and Brooks (1996) suggests that in elementary school years, career education should focus on giving knowledge of all occupations as a base for future evaluation of careers. In years 6-8, individuals should begin to think about job-self compatibility but should not be expected to make any permanent decisions because they have not discovered their talents entirely yet. In years 9-12 individuals should develop their abilities and figure out which careers suit them best. (Brown & Brooks, 1996)

Krumboltz's learning theory of career counselling introduces some of the factors that influence career paths that people follow (Mitchell, Jones, & Krumboltz, 1979, p. 20). The factors which it says affect career path are genetic endowments and special abilities, environmental conditions and events, learning experiences and task approach skills (Brown & Brooks, 1996). The first factor, genetic endowments and special abilities, is not something that can be affected by the ABS in an attempt to increase the number of people going into statistical careers. Environmental conditions and events are things that happen during a person's life that end up shaping their career decisions. These are not things that the person can control but are instead things like job opportunity, required training, technological developments and occupational rewards. Learning experiences are moments throughout a person's life when they learn something about a career. Task approach skills include standards of performance and work habits. They help to affect what careers people can attain by making them better than the competition (Brown & Brooks, 1996).

Probably the most important part of this theory for our project is learning experiences. There are two types of learning experiences, instrumental learning experiences and associative learning experiences. Instrumental learning experiences are when "the individual acts on the environment in such a way as to produce certain consequences" (Mitchell, Jones, & Krumboltz, 1979, p. 23). Basically, this means that when someone does something and there is a response to it, it affects their career decisions. The author's example is that when Roger is assigned a paper he writes a good essay and receives an 'A' on it. Roger therefore realizes that writing is a trait that will help him in his career (Mitchell et al., 1979). Associative Learning Experiences are experiences that associate a previously neutral stimulus with one that is either positive or negative. These experiences can be either verbal or written and can have a significant impact on career decisions. An example given by Mitchell et al. (1979, pp. 23-25) is "Lawyers are crooked". Hearing stereotypes such as this one or positive comments affect the attractiveness of the career (Mitchell et al., 1979).

Students, however, continually steer away from statistics as a result of deterrence. 75% to 80% of students appear to experience high levels of discomfort when presented with statistics. Statistics anxiety for some is not necessarily due to the lack of training or insufficient skills, but due to the negative experiences in a statistical class (Pan, 149). Three main types of factors are identified:

- Situational factors, such as math experience (Betz, 1978).
- Dispositional factors, such as math or self-esteem (Zeidner, 1991).
- Personal factors, such as learning style (Onwuegbuzie, 1998).

Knowing how people choose a career alone is not enough to help the ABS in their goal of increasing the number of professional statisticians. Factors such as the number of employment opportunities, benefits, and level of job satisfaction are very significant. An important thing to keep in mind as well is embedded stereotypes of certain professions.

1.2 Job Description of a Statistician

In order to be able to inform those looking into careers in statistics, one must also know the career choices and employment outlook for those going into these specific occupations. To do so, it is very helpful to look at other statistical organizations that are trying to encourage students to pursue careers in statistics. These organizations include the ABS, the American Statistical Association (ASA) and the SSAI. Looking at these organizations and the promotional materials they currently have has assisted in finding an accurate job description and other information.

The American Statistical Association has precise statistical job characteristics (American Statistical Association, 2006). With the introduction of new technologies and job opportunities, the jobs of a statistician expand beyond what existed several years ago. These characteristics include applying mathematical and statistical knowledge to social, economical, medical, political and ecological problems, travelling to consult with other professionals or to attend conferences, seminars, and continuing education activities. Often, the duties of a statistician may entail working as part of an interdisciplinary team. In addition, working in a statistical profession includes advancing the frontiers of statistics, mathematics, and probability through education and research and using data to solve problems in a wide variety of fields. The diversity of statistical opportunities is surprisingly large, which in return could help attract students interested in almost any other field in science, technology or business, including but not limited to, agriculture, astronomy, biology, computer science, economics, engineering, finance, manufacturing, medicine, political science, psychology and sports (ASA, 2006). With the growth of different technologies, and careers, statistics has been able to branch out of the traditional views, into newer

forms incorporating different industries. Figure 2 shows the movement of the statistical ideas outside their core fundamentals, and branching out into different sections.

From Medicine to The Big Bang via FDR

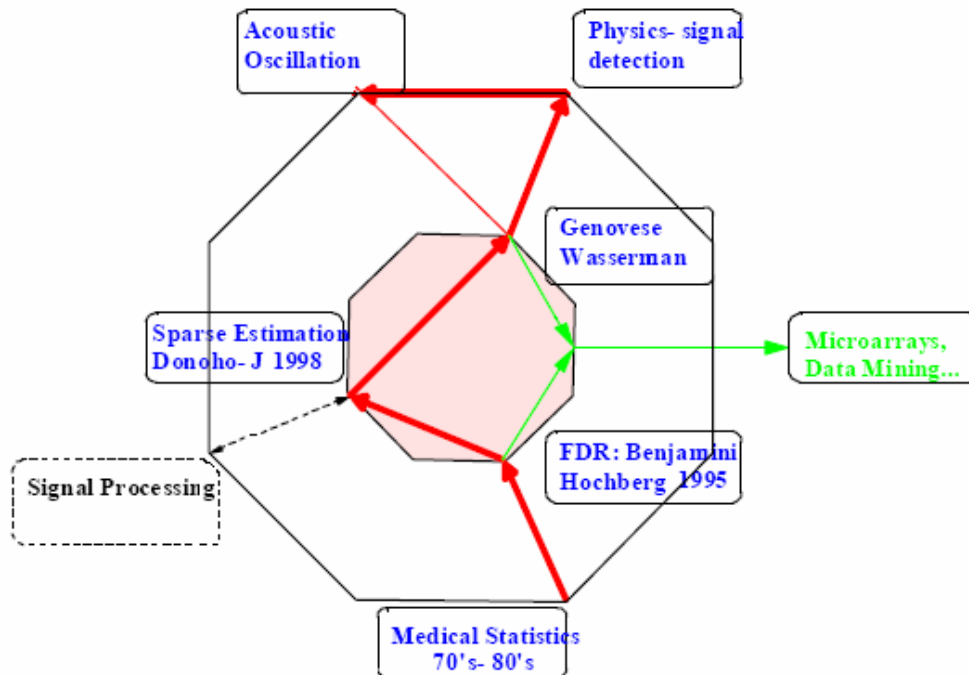


Figure 2: Migration of statistical ideas (Lindsay 2004)

The respondents to the ASA's Survey of Doctorate Recipients in 1993 with statistical degrees reported that of the many different occupations possible 44% were post-secondary teachers, 23% were statisticians, and 15% were managers (ASA, 1993). In the United States at that time, only 17% of full-time employed individuals with degrees in statistics reported a salary under \$50,000 compared to 31% of those with degrees in any scientific field (ASA, 1993).

The employment outlook of statisticians in Australia varies greatly from that in the United States. In Australia, their employers include the following.

- Australian Bureau of Statistics regularly recruits honours graduates in statistics (averaging approximately 0.8 recruitments per year in a statistics Honours cohort averaging 2.4 per year).
- Data Analysis Australia, a statistical consulting firm based in Perth, frequently recruits one of four honours graduates (average approx 0.7/year).

- Bioinformatics research teams (including Telethon Institute for Child Health Research, WA Institute for Medical Research, university research groups, Walter and Eliza Hall Institute) have recently started recruiting statistics graduates (short term average 0.4/year).
- The Western Australia (WA) state departments of Fisheries and of Agriculture have statistical teams and recruit postgraduates as well as Honours graduates (average 0.3/year).
- The WA Treasury also recruits statistics honours graduates (0.2/year).
- CSIRO Mathematical and Information Sciences recruits statistics graduates, usually at PhD level, but occasionally at bachelor level.
- Other frequent employers include actuarial and insurance firms, DSTO (Defence Scientific and Technological Organisation), Insurance institutions, and market research companies (average 0.2/year).
- Other departments at UWA are frequent employers of graduates, including the Schools of Agriculture and of Public Health. The latter is a large employer of statistics graduates (approx 30) on soft research money.
- The Five Universities in Perth employ new statistics graduates as teaching assistants and as data analysts.

(Baddeley, 2004)

According to the SSAI website, there is currently a noticeable shortage of professional statisticians across Australia. Many positions have remained unfilled for years, with the greatest shortage in financial modelling, survey design, and biostatistics/bioinformatics (Smyth, 2005). Australia is now realizing that the number of graduates in statistics is no longer sufficient to fill the annual recruitment needs. This realization comes at a time when there are far more job opportunities than ever before. Every year, for every honours graduate in statistics, there are several job openings for them to fill (Smyth, 2005). At this point in time Australians are confused as to why the number of students graduating in statistics is decreasing rather than increasing (Smyth, 2005).

However, the statistical career still holds a negative stigma. This perception is reinforced by many information sources including secondary teachers, university

staff, and student handbooks. For example, the Good Universities Guide has an extremely unfavourable treatment of the statistics discipline (Good Universities Guide, 2005). It lists statistics as a specialisation of mathematics, giving scant consideration to the activities of a professional statistician, and no hint of the role of applied statistics (Baddeley, 2005).

1.3 Statistics in Schools

One main approach to interest students in following statistical careers is through the school curriculum. In order to pursue a particular career, one must be fully prepared. At the secondary level, students should be incorporating statistical classes into their curriculum. This will promote interest, and help students pursue those majors at university. As with any career choice, the student must take certain classes, in order to reach a level of success. According to the American Statistical Association (2006), to pursue a career path in statistics, one must follow a certain path of education. In high school, the ASA suggests students take all of the statistics, mathematics, science, computer, and English courses available. Scientific knowledge will help them understand the subject matter and technical background of the problems they work on and will make them an effective problem solver. The student will use the computer not only for calculations, but also to create visual displays of data. Command of written and spoken English will help communicate the results of the analysis in an effective manner (ASA, 2006).

To continue on a path to a statistical career, the ASA suggests majoring in statistics, applied mathematics, or a closely related field in college. If the student majors in a non-statistical field, the student should minor in mathematics or statistics. One must develop a background in mathematics, science, and computers in order to gain knowledge in a specific field of interest (Section 1.2). A Master's degree or Ph.D. is very helpful and often recommended or required for higher-level positions. Scholastic statistics programs range from theoretical to applied, and can be found in departments such as mathematics, biostatistics, public health, psychology, engineering, education, business, and economics in addition to traditional statistics departments.

1.3.1 United States

American mathematical literacy goals can be used as an effective basis of comparison for understanding the desired mathematical literacy level on a global educational scale. Benchmarks for Science Literacy: Project 2061 is a study of curriculum design and the education system in the United States. Benchmarks for Science Literacy focuses on “what all students should know and be able to do when they leave high school” (Benchmarks, 1993). The five main topics in mathematics are “numbers, symbolic relationships, shapes, uncertainty, and reasoning” (Benchmarks, 1993). By the end of 8th grade students are required to have a familiarity with numbers, negative and positive along with computations, basic algebra, geometry of lines in multiple dimensions, and the beginnings of probability (Benchmarks, 1993). Focusing on statistical literacy, Table 1 lays out the goals, or benchmarks, outlined for probability and statistics in particular for the United States (IQP, 2005).

Benchmarks for Probability and Statistics:

- How probability is estimated depends on what is known about the situation. Estimates can be based on data from similar conditions in the past or on the assumptions that all the possibilities are known.
- Probabilities are ratios and can be expressed as fractions, percentages, or odds.
- The mean, median, and mode tell different things about the middle of a data set.
- Comparison of the data from two groups should involve comparing both their middles and the spreads around them.
- The larger the well-chosen sample is, the more accurately it is likely to represent the whole. But there are many ways of choosing a sample that can make it unrepresentative of the whole.
- Events can be described in terms of being more or less likely, impossible, or certain.

Table 1: Benchmarks for Probability and Statistics (Benchmarks 1993)

Providing a basic statistical competence is a very important factor in the benchmarks. Basic statistical competence, involves the following components:

- Data awareness.
- An understanding of certain basic statistical concepts and terminology.

- Knowledge of the basics of collecting data and generating descriptive statistics.
- Basic interpretation skills (the ability to describe what the results mean in the context of the problem).
- Basic communication skills (being able to explain the results to someone else).

The first component, data awareness provides a motivation for students to want to learn statistics. The United States incorporates several key aspects of data awareness, which include the following:

1. Data are a part of everyday life and are an important component of all aspects of the working world.
2. Data are often misused, leading to misinformation.
3. Decisions made based on data can have a strong impact on our lives.

(AMSTAT, 2002)

In mathematics departments of four-year colleges and universities, elementary statistics enrolments were about 56% higher in 2000 than in fall 1990. In 2000, statistics departments climbed to 80% above their fall 1990 level. In two-year college mathematics programs, enrolments in statistics courses in fall 2000 were 37% higher than in fall 1990. Comparing 2000 enrolments to those of 1995, two-year colleges saw an increase of only about 3%. The mathematics and statistics departments of four-year colleges and universities both saw double-digit increases in their statistics course enrolments (Scheaffer, 2004). Some professionals and educators attribute this to the fact that many high schools now offer Advanced Placement (AP) Statistics, which provide college/university credit while still in high school.

Since knowledge in these statistical areas is so important, accurate examinations should be performed to test the students' abilities. Testing the competency of the students after taking the class will help strengthen the student's knowledge of statistics. In demonstrating this competency learners would be:

- Clarifying objectives and selecting mathematical ideas and techniques.
- Judging the precision and accuracy required.
- Applying mathematical ideas and techniques to achieve an appropriate outcome.
- Checking that the outcome makes sense in context and evaluating the process.

1.3.2 Australia

The overall education system in Australia is very different than the education system in place in the United States. In Australia, each of the eight states and territories has their own Department of Education. Each Department of Education has specific standards for each subject area, and for how and when they are presented. There is also a National Department of Education, but it has not established a national curriculum, and there are very few national standards. This makes it very hard for Australia to have material presented to students in the same way throughout the country.

Mathematics and science have been identified as two of the eight key learning areas for Australian school students (Ministerial Council Education, Employment, Training, and Youth Affairs, 1999). Mathematics and science skills are part of a broader skill set that can assist young people in further education, participation in home and life activities, and in obtaining employment. Students who achieve higher grades in literacy and numeracy in year 9 are more likely to stay at school until year 12. Thus, they have a higher tertiary entrance performance, and will be employed and earning more when they leave school (Penman, 2004). Unlike the United States, where statistics is a more widely taken class by students, Australia does not have a set statistical course. Instead, statistics is skimmed, and students are not fully exposed to statistics. The ABS recommends that students with a strong interest and aptitude in mathematics, schoolwork should focus on the core mathematical skills in order to form a solid foundation for the later study of statistics (or indeed many other science disciplines) at tertiary level. For these students, who might later enter the core mathematical disciplines, statistics and statistical data analysis/inference problems should be used only as examples of applications and as motivating examples for the underlying technical tool set skills being taught (Trewin, 2004). Since the number taking mathematical courses has greatly decreased in universities, the output of the numbers of statisticians leaving with degrees has decreased as well. The implementation of a statistics class across the curriculum is something that has been of interest to many Australians.

To implement new statistical classes, the Boards of Education and Standards must incorporate them into their plan. According to the South Australian Curriculum

Standards, one key idea of middle school education is that students use statistical methods to reduce, analyse, and interpret data while critically evaluating the cultural and social inclusivity of the samples used. The standards include such learning as:

- Interpreting and analysing information found in the media, multimedia, and commercial promotions.
- Determining and justifying central tendency measures (mean, median or mode), and indicating measures of spread (range, interquartile range including ‘middle 50%’) in order to represent and communicate data in ways that best suit their audience/purpose.
- Scanning to see if any data points are outliers and evaluating the effects of the inclusion or exclusion of outliers and how these might bias or affect conclusions drawn from data.
- Addressing issues related to sampling and design, and discussing and ascertaining whether samples enable inferences or conclusions to be drawn about the population in general.
- Developing, through simulations, an understanding of when differences in data indicate an actual difference in the population from which the data was collected and when the difference results from variation in samples.
- Analysing data distribution with attention to the ‘shape’ of the data, and its symmetry or skewedness.
- Appraising and using data to answer questions and through trial and error, understanding the limitations of the answers.
- Making conjectures beyond the data set that could support positive change.

(South Australian Curriculum Standards and Accountability, 2006)

Levels of enrolment at the different universities of students pursuing statistical degrees have decreased. Table 2 shows the number of honours degree completions in statistics (i.e. Mathematical Statistics or Applied Statistics). Also the total number of honours completions for students at the School of Mathematics and Statistics, at the University of Western Australia, for the decade 1995-2004. The numbers are small and highly variable, with an annual average of 2.4 (Statistics) and 8.9 (total) completions. This represents approximately half of all Honours graduations in statistics in Western Australia (Baddeley, 2004).

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
STATISTICS	3	1	1	7	4	0	0	3	2	1
TOTAL	15	6	7	12	8	8	5	9	12	7

Table 2: Honours degree completions 1995-2004 in statistics and in mathematics (Baddeley, 2004)

Since the level of enrolment are decreasing, it is important to begin to take initiatives and implement programs worldwide that will help with the promotion of statistical careers, recruitment and retention of statisticians.

1.4 Initiatives

A key aspect of this project is to be able to fully understand the scope of the problem. By looking at how the different educational and statistical organizations in Australia and other countries around the world have defined and approached the problem. Seeing the common trends in programs as well as the results of the program will allow the group to make more informed recommendations.

1.4.1 United States

In the United States, many initiatives have been put into place to try to promote careers not only in statistics and mathematics, but also in science and technology. These initiatives are important, and many are being provided with government funding as well as being recognized at the national level.

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national [defence]..." (NSF, 2006). The NSF has many different programs to achieve its mission. A key part of the mission of the NSF is to provide support for different forms of science and engineering education, beginning in pre-kindergarten and continuing through graduate education. They achieve this through partnering with various organizations to provide programs and initiatives for students and teachers as well. The research and programs that are funded for this mission are integrated with the education. In this way, there will always be a supply of skilled people to work in new and emerging scientific, engineering, and technological fields. Also, there will be plenty of capable teachers to educate the next generation of scientists and engineers (NSF, 2006).

One such partnership is called the Math and Science Partnership (MSP) program. The program responds to a growing national concern about the educational

performance of children in the United States in mathematics and science. The philosophy of the MSP is that collaborations between school systems, higher education, and other partners will increase the capacity of preK-12 educational systems, thus providing requisites for learning to high standards in science and mathematics (MSP, 2006). Through MSP, the NSF awards competitive, merit-based grants to teams composed of institutions of higher education, local K-12 school systems, and their supporting partners. Figure 3 shows the flow of the program.

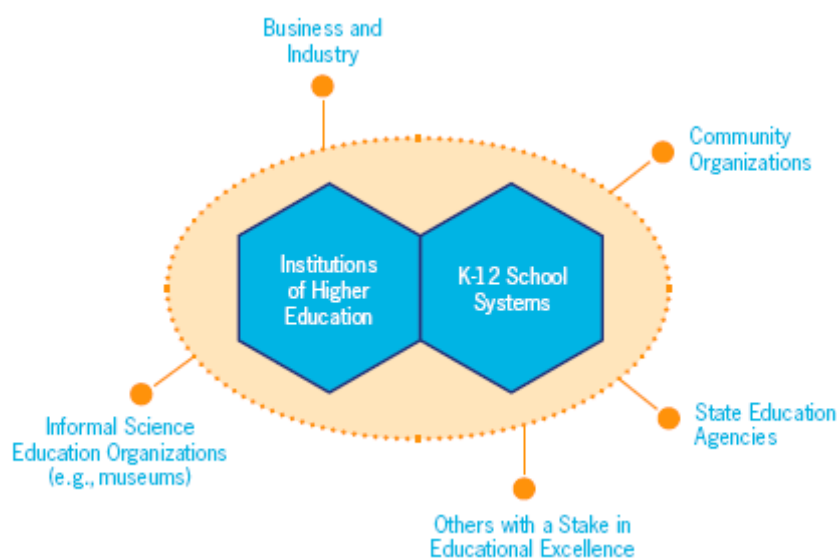


Figure 3: National Science Foundation's Math and Science Partnership (NSF 2006)

MSP serves students and educators by emphasizing strong partnerships that tackle local needs and build grassroots support to:

- Enhance schools' capacity to provide challenging curricula for all students and encourage more students to succeed in advanced courses in mathematics and the sciences.
- Increase the number, quality and diversity of mathematics and science teachers, especially in underserved areas.
- Engage and support scientists, mathematicians, and engineers at local universities and local industries to work with K-12 educators and students.
- Contribute to a greater understanding of how students effectively learn mathematics and science and how teacher preparation and professional development can be improved.

- Promote institutional and organizational change in education systems — from kindergarten through graduate school — to sustain partnerships’ promising practices and policies.

(NSF, 2006)

The main way that the MSP achieves this is through the four components that make up the program. These are:

- Comprehensive partnerships implement change across the K-12 continuum in mathematics, science, or both.
- Targeted partnerships focus on improved student achievement in a narrower grade range or disciplinary focus in mathematics and/or science.
- Institute partnerships develop mathematics and science teachers as school- and district-based intellectual leaders and master teachers.
- Research, Evaluation, and Technical Assistance (RETA) activities assist partnership awardees in the implementation and evaluation of their work.

(NSF, 2006)

These partnerships and components of the program help develop and implement pioneering ways of advancing mathematics and science education for students. They bring innovation, inspiration, support, and resources to educators and students in local schools, colleges, and universities. Participating in MSP benefits the partner organizations as well. Active partners cultivate and enhance their own strengths as they contribute to their MSP teams. In addition, their efforts result in better prepared students, and, ultimately, a better prepared American workforce (NSF, 2006).

An initiative put into place by the National Science Foundation is called the Science Technology Engineering Mathematics (STEM) program. The mission of STEM is to identify, assess, and promote effective programs designed to dramatically increase student interest in, and preparation for, careers in the STEM related fields of science, technology, engineering, and mathematics. The STEM program is designed to enhance this community experience for students majoring in the STEM fields by first creating a casual and open learning environment through organized social events and peer mentoring, and by instituting learning experiences within this community through tutoring programs and summer bridge programs. This initiative through

partnerships with different universities and companies produce ‘pipeline’ programs, which are targeted towards preK-12, hoping to filter them into the STEM related fields.

The Massachusetts Board of Higher Education recently announced the creation of the Massachusetts Mathematics, Science, Technology and Engineering Grant Fund, referred to as the Pipeline Fund. The Acts of 2003 Economic Stimulus Trust Fund legislation established this fund under the direction of the Board of Higher Education. The process includes all community colleges, state colleges, the University of Massachusetts, independent colleges and universities, business and industry partnerships, workforce investment boards, public and private schools, and school districts (WPI, 2006).

The purpose of the Pipeline Fund is:

"to increase the number of Massachusetts students who participate in programs that support careers in fields related to mathematics, science, technology, and engineering... to increase the number of qualified mathematics, technology, engineering and science teachers in the Commonwealth and to improve the mathematics, technology, engineering and science educational offerings available in public and private schools."

(Chapter 141 of the Acts of 2003, Section 13, paragraph c)

Universities then take part in the pipeline programs by hosting and co-sponsoring programs at their university. One university that participates in the STEM pipeline program is Worcester Polytechnic Institute, which has produced several programs and many of which have been of great success to the university.

WPI reaches every possible combination of students with their programs, and have found the majority of them to be very successful. The programs can be seen in Table 3.

Project Name	Year Level	Type of Program	Duration of program	Elements	Successful?	Why?
Kids to College Program	Elementary school	After school program	6 weeks	Hands-on activities Information on College	Yes	Students participate in other programs
Math and Science technology Educational Resource Program (MASTER)	High School	After School program	9 months	Hands- on projects, Tutorials, Academic Enrichment, College Advising, Team Competitions	Yes	Students from program apply and are accepted to WPI
Frontiers	High School	Summer Program	2 weeks	Academic Workshops, Research Experience, Team Competitions, Field Trips	Yes	Students from program apply and are accepted to WPI
Understanding of Engineering Roadshows	High School	School Visits	2 hours	Hands-on projects, Overview of Engineering, Interaction with College Students	Yes	Mentor/mentee bonds formed, students apply to engineering schools

Table 3: Worcester Polytechnic Institute Pipeline Programs

The level of success of these programs is measured in the number of students who participate from that program in a different program the next year, and with how many of those students apply for undergraduate admissions to WPI. However, the first measure of success that WPI considers is how many students they have participating in the program and the general level of interest for that program based on inquiries about the program, and applications.

The American Statistical Association (ASA) has a vision statement to be a world leader in promoting statistical practice, applications, and research; publishing statistical journals; improving statistical education; and advancing the statistics profession (ASA, 2006). Its mission is to:

- Support excellence in statistical practice, research, journals, and meetings.
- Work for the improvement of statistical education at all levels.
- Promote the proper application of statistics.
- Anticipate and meet the needs of its members.
- Use discipline to enhance human welfare.

- Seek opportunities to advance the statistics profession.

(ASA, 2006)

The ASA has several projects in place to promote statistics to younger children. This is to ensure the growth of the profession as well as promote statistical literacy. Programs that are available directly from the ASA include poster competitions for students of all grade levels, as well as project competitions. For older grades and levels they provide educational assistance and preparatory information for the Advance Placement Statistics Exam. A project that is run by the ASA is called the Quantitative Literacy Project.

The Quantitative Literacy (QL) Project comprises a series of special NSF-supported projects undertaken during the past decade by the American Statistical Association in collaboration with the National Council of Teachers of Mathematics. The QL projects have developed materials and a workshop format that instruct teachers in the elementary, middle and high schools about QL by presenting fun, hands-on ways to teach. The current project, Science Education and Quantitative Literacy, focuses on ways to incorporate data analysis into the science curriculum. Teachers from grades 6-12 participate in a four-week workshop during the summer learning new ideas which they then share with colleagues during the school year (ASA, 2006).

For professional statisticians, there are several outreach programs, such as the Adopt-A-School program. The purpose of the Adopt-a-School program is to enable professional statisticians to help schools in their efforts to include statistics in the curriculum. Many teachers are enthusiastic about bringing quantitative literacy to their classrooms but lack the background and formal training to do so with confidence. Through this, statisticians make direct contact with teachers and administrators to arrange visits to the classroom. The key to the success of this program is the statistician's close work with the classroom teacher. Teachers welcome the assistance of professionals in the field (ASA, 2006).

The Statistics Teacher Network is a newsletter published three times a year by the Joint Committee on the Curriculum in Statistics and Probability of the American Statistical Association and the National Council of Teachers of Mathematics. Begun in 1982, the Statistics Teacher Network is mailed to over 7000 teachers throughout

the world. It contains reports on new developments in statistics education book reviews, software reviews, requests for information, and contributed items to be shared among statistics teachers (ASA, 2006).

In the United States, the National Council of Teachers of Mathematics (NCTM) has developed a program that has recommendations of expectations of students' statistical literacy at different age levels. The document Data Analysis and Probability, the NCTM suggests that from kindergarten to 12th grade students should be enabled to:

- Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
- Select and use appropriate statistical methods to analyse data.
- Develop and evaluate inferences and predictions that are based on data.
- Understand and apply basic concepts of probability.

The program suggests that for developing these abilities statistical reasoning should be included into the curriculum and be advanced through statistical projects in school (Data Analysis and Probability, 2001).

1.4.2 United Kingdom

In the United Kingdom, many different initiatives have been put into place to try to help promote careers in statistics and mathematics. The most successful project in place to promote statistical careers is in conjunction with the Royal Statistical Society Centre for Statistical Education (RSSCSE), based at Nottingham Trent University. The RSSCSE started the CensusAtSchool project in 2000 in conjunction with the National Statistics Office in the United Kingdom. This project was originally linked to the population census of 2001; however it has now developed into an international project. The project in UK aims to:

- Involve students in collecting data about themselves and improve understanding of a data gathering process, its purpose and benefits to society.
- Foster a positive attitude to statistics through using real data that is of interest to students.
- Enhance the process of statistical enquiry across the curriculum.
- Encourage effective Information and Communication Technology (ICT) teaching and learning, including the use of the Internet.

- Provide access to large and meaningful data sets.
- Make comparisons between the student responses in different countries.

(CensusAtSchool UK, 2006)

The original CensusAtSchool questionnaire (Phase 1, Autumn 2000) consisted of a single sheet with simple questions covering information about pupils, their households and their school life. While some of the questions were identical to those in the UK population census, others were designed to appeal to the pupil's own interests and enthusiasms. Over 2000 primary, secondary and special schools registered for the project and over 60,000 children took part using the internet site. Since then many other countries have embraced the project with necessary adjustments to reflect local culture and traditions (CensusAtSchool UK, 2006).

In Queensland, Australia, the Office for Economic and Statistics Research have carried out two phases of the CensusAtSchool project in 2001 and 2003 with great success (Section 1.4.4). In October 2001, another CensusAtSchool was created when Statistics South Africa implemented the project across all nine regions of the country, resulting in data from over 3.5 million children. The office now has a policy to integrate this data into their forward-looking Curriculum 2005. The Royal Society of New Zealand, the University of Auckland and Statistics New Zealand funded the project in New Zealand schools in 2003. Over 18,000 records were returned and Phase 2 is currently being run. During 2003 Statistics Canada implemented the project in Canadian schools as a forerunner to encouraging their adult population to use the internet for their next population census in 2006. They are currently implementing a Phase 2 and developing many excellent curriculum resources (CensusAtSchool UK, 2006).

With the growing success of the program, the RSSCSE has continued its implementation, running a new phase of the program every academic year since the project's beginning. One teacher stated:

“Real data from CensusAtSchool enables pupils to reach the higher levels of attainment (level 6/7/8) through exercises in identifying correlations between variables; form and test hypotheses; reviewing the plausibility of conclusions. It is also an ideal introduction to the real use of web-based data collection. For the non-specialist teachers of ICT, CensusAtSchool provides a range of worksheets and online Flash tutorial on Minitab - a free data handling package if your school participates in CensusAtSchool's data collection exercise. Even when you have to pay for the Random Data Selector and the Data Handling Toolkit, the worksheets and the

real data would make the product excellent value for the (small amount) of money you are paying.”

(CurriculumOnlineUK, 2004)

Teachers enjoyed using the program in their classrooms. The above quote gives validation of the success of the project, and the impact that it is having not only on the students, but also on the teachers. The results of the project are used by other governmental organizations including the Department for Education and Skills, which uses the results in their training teachers.

1.4.3 New Zealand

In New Zealand, some steps are being taken to make people aware of the opportunity in statistical careers, and also to raise statistical literacy. Like many other places including Australia and the United Kingdom, New Zealand has a CensusAtSchool program. The program is run by Statistics New Zealand and was first run in 2003. CensusAtSchool New Zealand provides participating schools with 11 activities, as well as online statistical tools for teachers and students to use (CensusAtSchool NZ, 2006).

Universities are also helping to spread the word of statistical careers that are available. The Victoria University of Wellington has a regular Career View newsletter which has information about degrees, courses, and employment opportunities for various careers. In this newsletter they produce case studies on different people who are associated with that career. It then discusses the options at that particular university for studying careers. Other areas that are covered include how degrees and courses relate to employment opportunities and life/work planning, graduate destination information, and current issues or material relevant to the employment scene (Victoria University of Wellington, 2002).

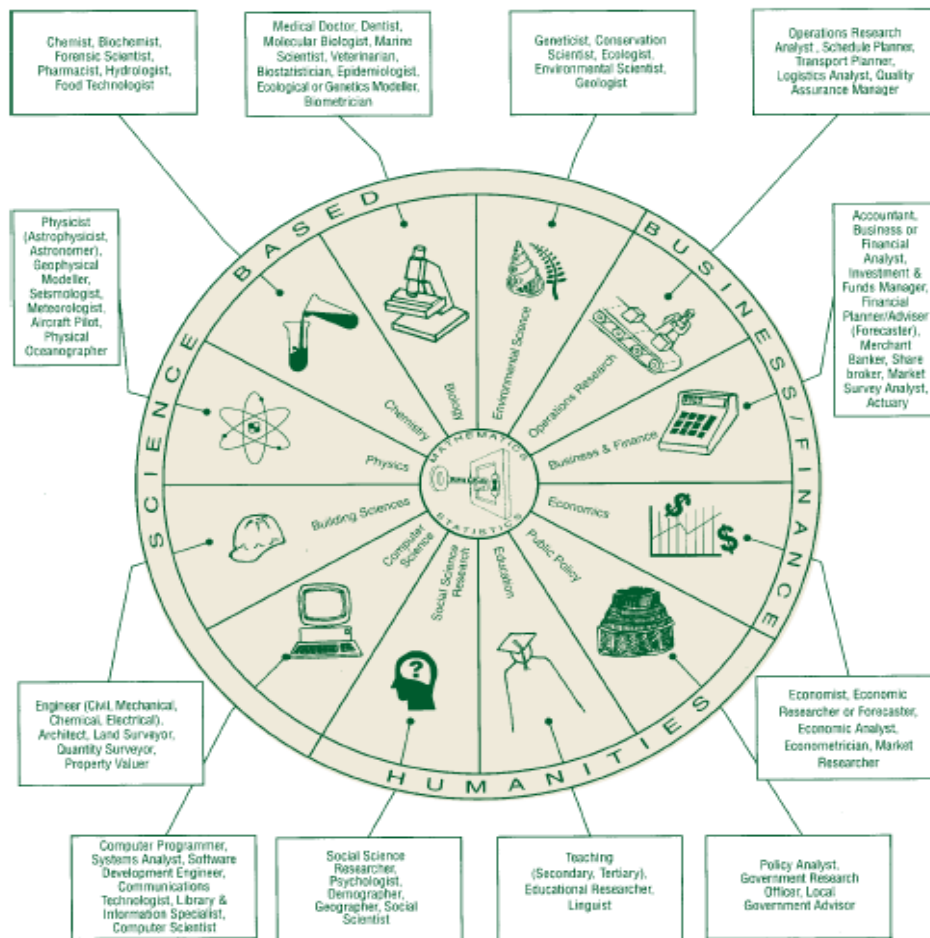


Figure 4: Maths Stats Wheel (Victoria University of Wellington 2002)

In one particular edition of the newsletter, statistics is considered as a career and attention is drawn to it specifically. Included in the newsletter is the Maths Stats Wheel (Figure 4), which shows how many careers relate to mathematics and statistics degrees (Victoria University of Wellington, 2002).

1.4.4 Australia

The Australian Bureau of Statistics has proposed the creation of the Australian Statistics Educational System (ASES) to combat statistical illiteracy throughout Australia. ASES is a project by which the ABS and SSAI intend to introduce statistics into the school curriculum in Australia. The main purpose of ASES is to be able to identify what statistics material needs to be taught at each level from kindergarten to 12th grade and find out the best way for this material to be taught. This project reiterates the importance of targeting students at young ages in order to influence their future decisions (Fisher, 2003). However, it does not state precisely how to generate interest in statistical careers later on in these people's lives.

Programs such as CensusAtSchool, which is run by the ABS' National Education Services Unit, are examples of ways in which governmental organizations are getting involved with school communities in Australia. CensusAtSchool is consistent with the ASES project's call for better statistical education from kindergarten to 12th grade. CensusAtSchool is an internet based collection project for students to learn about statistics by working with real data. The CensusAtSchool project is aimed at students in grades 5 through 10 (ABS, 2006).

In *Shaping Statistics for Success in the 21st Century*, Jon R. Kettenring suggests that the most important task in increasing the number of people in statistical fields is image reconstruction. Kettenring (1997) proposes to change the stereotype of statistics from “a dull and impenetrable subject and of a statistician as a numbers nerd”. Kettenring states that in order to create a better image of statistics, one must better the communication with the public thus creating a better understanding of statistics. This outreach should be done by statistical organizations as well as practicing statisticians (Kettenring, 1997). Along with image reconstruction Kettenring (1997) also recommends the use of increased advocacy of science and statistics. He advises an increase in the amount of outreach done not only to students but to other scientific organizations.

The Australian government program Backing Australia's Ability has provided \$8.3 billion of funding to a handful of projects geared towards developing and maintaining the science, mathematics, and innovative skills of Australia's population. The programs for secondary school students range from online learning, to presentations about career opportunities, and competitive events. Some of the programs also target university students in order to raise the number of science and engineering graduates (DEST, 2005).

The Le@rning Federation initiative was granted \$34.1 million from 2001-2006 to “help develop online learning materials and accompanying services and systems for schools.” (DEST, 2005, p. 80) By 2004 the initiative had developed 27 new projects in science, mathematics, numeracy, studies of Australia, languages, literacy, innovation, enterprise, and creativity (DEST, 2005). They also created a thesaurus which “helps teachers to search for content that is suitable for their curriculum requirements” (DEST, 2005, p. 80).

The National Youth Science Forum (NYSF) is a two week residential program in Canberra, where students are involved in scientific and social activities, and learn about career opportunities in science, engineering, and technology. Some of these activities include visits to institutions such as the Australian Commonwealth Scientific and Research Organization (CSIRO), the John Curtin School of Medical Research, and the Australian Defence Force Academy. The NYSF hosts 288 year 12 students (DEST, 2005). After the two weeks end, NYSF follows up with university seminars and industry visits 2-3 months later, “as a long term personal network of people with common aims” (NSF, 2006).

The Smart Olympiads is an initiative to allow an Australian team to compete in the International Mathematical Olympiad in Athens. The Australian team in 2005 placed 27th out of 85, and won four medals and an honourable mention (DEST, 2005).

The number of Australian science and engineering graduates as a percentage of total Australian graduates has increased from 18.9% in 1989 to 22.7% in 2002. This percentage is still lower than the Organisation for Economic Co-Operation and Development (OECD) average of 26.1% (DEST, 2005). Along with the secondary school programs to increase the interest in science and engineering, the Australian government has also backed programs to increase the number of graduates in these subjects at universities.

There are also programs to support postgraduate students working in both research and non-research programs. The Research Training Scheme aims “to strengthen Australia’s knowledge base and research capabilities by enhancing the higher education research training system.” (DEST, 2005, p. 84) The Postgraduate Education Loans Scheme (PELS) is a loan program for postgraduate students who are taking fee-paying, non-research courses. “[PELS] is designed to remove barriers to national investment in education, training and skills development.” (DEST, 2005, p. 84) The Australian Postgraduate Awards program supports research training and provides financial support to students doing exceptional research. Students who receive Australian Postgraduate Awards also receive funding through the Research Training Scheme (DEST, 2005).

The Australian government is also funding programs for obtaining professionals through migration and keeping Australian professionals in Australia.

One such program is the Federation Fellowship. “The Fellowships are designed to support and encourage researchers to stay in or return to Australia by providing an internationally competitive salary.” (DEST, 2005, p. 86) Immigration initiatives started in 2001 to increase the number of information and communication technology (ICT) professionals, but they have been suspended due to the demand for ICT professionals from overseas has subsided (DEST, 2005).

The most important programs for this project, in the Backing Australia’s Ability initiative, are the ones that aim to foster awareness of science and innovation. The National Innovation Awareness Strategy (NIAS) is a program run by the Department of Industry, Tourism, and Resources and the Department of Education, Science, and Training. NIAS has contributed money to the Professor Harry Messel International Science School, ABC Science Online, and other national science programs (DEST, 2005). The program also awards the Prime Minister’s Prize for Science to “recognize and reward the outstanding contributions of Australia’s exemplars of science and science teaching” (DEST, 2005, p. 88).

One program funded by NIAS is the University of Newcastle’s Science and Engineering Challenge, which is a competition to encourage students to take math and science courses. In its first year, the challenge had 14 schools competing and in the six years since then, this number has increased to 140 schools. The events in the Challenge are intended to apply the principles of science and mathematics to problem solving and building exercises (DEST, 2005). The events also “promote teamwork, inspire leadership, encourage self-confidence and dispel myths about what a career in science and engineering actually involves.” (DEST, 2005, p. 89) In New South Wales, enrolments in science and mathematics courses have increased at rates greater than the rest of the state. For physics courses this rate is six times greater than the average for the state (DEST, 2005).

A program that fosters the awareness of science and innovation is Questacon. Questacon is Australia’s National Science and Technology Centre (ANSTC) which offers interactive exhibits and science performances across Australia. In 2003, Questacon ran 10 exhibitions in Australia and overseas with over 600,000 visitors, and also ran more outreach programs which had 276,074 participants. In addition to attracting students to the sciences, Questacon is good experience for science communication graduates (DEST, 2005). Smart Moves, a part of the Questacon

program, is “designed to raise awareness of science, technology, innovation and related careers in regional and rural secondary schools” (DEST, 2005, p. 91). In 2003, Smart Moves was involved with 87,076 students in four states (DEST, 2005). The shows put on by Smart Moves promote cutting edge research, and entrepreneurship in science, engineering, and technology (Australia’s National Science and Technology Centre, 2006).

1.5 Summary

Many different organizations have dedicated their research efforts to finding solutions to a growing problem; the increasing shortage of professional statisticians in Australia. This problem is similar to the problem arising in several countries with different professions, such as engineering, technology, and other forms of mathematics. To counteract these problems, one must first understand the factors that affect the choosing of a career, and more importantly why some people choose to go into statistics, and why others do not. Also, the different organizations must be fully aware of the job that they are trying to promote, which for this project is statistics. To encourage students to go into different careers, it is important that the educational system help in some way encourage those subjects early on, either through projects or classes. Often times, governmental and professional organizations assist in the promotion of careers through different programs that are put on and sponsored for students.

2 Methodology

In order to complete this project's goal, a significant amount of data was required. Data was needed to determine the educational and promotional preferences of secondary school students, and the methods and techniques of promoting statistics. The group identified five main tasks in order to fulfil the goal:

1. Extending the literature review through archival data.
2. Planning the interviews, surveys and focus groups that were carried out from weeks two through four.
3. Interviewing and surveying Australian school teachers, career advisors, ABS employees, university professors, and students, and members of organizations.
4. Conducting focus groups ABS staff, secondary school teachers and students, in order to complement the results from the interviews.
5. Analysing data and recommending a promotional strategy to the ABS.

These tasks were performed during the seven weeks from March 14th to May 2nd. Table 4 shows the timeline of when specific tasks were started and completed during this period and includes what was done prior to going to Australia.

Task	Week in Melbourne							
	Worcester	1	2	3	4	5	6	7
Literature review	Shaded							
Plan Interviews, Focus Groups and Surveys		Shaded	Shaded	Shaded				
Perform Interviews			Shaded	Shaded	Shaded			
Perform Focus Groups					Shaded			
Recommend promotional strategy						Shaded		
Finalize written report and presentation							Shaded	

Table 4: Timeline of Project

2.1 Continue Literature Review

The first task that the group carried out when it arrived in Melbourne was to continue the research that began in Worcester of archival records. Two major areas were investigated:

1. Information from the ABS about the defined problem.
2. Documentation from other institutions in Australia, New Zealand, Canada and the United States such as the Statistical Society of Australia, Inc. (SSAI), the Australian Department of Education, universities with statistics programs, and other institutions recommended by the ABS.

The group initially focused on the first two tasks. First, doing more extensive archival research and then putting the new and old information together into the literature review. The team researched within the ABS going through statistical data about careers in statistics and other projects that went along the same lines as the project being developed. These included the ASES proposal, and other information about what has been done in the past. The interactive team also focused on getting information that the ABS could not provide or that had another point of view.

The purpose of continuing the literature review in this specific way was to further analyse the nature of the problem. The group looked for some type of numerical data or statistical information that supported the problem, such as the number of students that have obtained degrees in statistical majors year by year, over the past ten years. This information is available at some Australian universities such as the University of South Wales and La Trobe University. It was vital to establish coherency between said the problem given by the ABS and the facts the group found during this time period. Other important aspects of the problem that were analysed through the literature review were:

- Magnitude:
 - If there is a shortage of professional statisticians, how big of a problem is it?
 - Is it only a problem in a specific region or in the entire country?
 - To what extent are organizations, such as the ABS, willing to go in order to find a solution?
- Scope:
 - Who does this problem really affect?
 - For how long has this been happening?
- History:
 - How can the group know that this is a problem of the present, and not one of the past?

- How long has this problem been going on?

Along these lines the group considered situations, changes, or events that might have caused major outcomes, such as the number of graduating statisticians during the past years. The group evaluated specific factors such as the Australian school curriculum, the corporate environment, and job availability in the past, to try to track some of these changes.

Furthermore, the team attempted to establish which activities had been effective. To this end, the group considered how the ABS and others who had taken action against the problem measure the success of their actions. Success might be measured in different ways such as the number of students enrolling in statistical majors each year, the changes in statistical competency of primary and secondary students, or the amount of people that apply for jobs in statistics.

2.2 Plan Interviews, Focus Groups and Surveys

The second task was planning the interviews and focus groups that took place in weeks two through four. The ideal situation would have been that all of the information needed by the group already existed but this was not the case. The group planned these interviews and focus groups to obtain information not available through archival research. It was agreed with the sponsors that the best way to obtain the missing information was to perform an extensive set of interviews and complementing with focus groups. These two tasks were important because by learning what different people think, the group was able to eliminate bias and acquire a first-hand perspective of the problem.

Two factors that were kept in mind before proceeding were the targeted audience and the information needed from that audience. The team interviewed three specific groups with the intention to fill in remaining gaps from archival research. The groups are:

1. University professors
2. Secondary school teachers and career advisors
3. Professionals in statistics and ABS recent recruitments

The first set of questions, in Appendix A, was aimed to gain information about the personal experiences as professionals in statistical fields from university professors. During these interviews the group asked the professors for their opinions

regarding the problem of the declining numbers of professional statisticians in Australia, as well as their perspectives about the various programs in Australia and other countries.

Teachers and career advisors were interviewed to gather their opinions. The questions for these interviews can be seen in Appendix B. The goal of this set of questions was to get first hand information about what is currently going in Australian schools regarding the promotion of statistics and other careers. Finding out the different ways in which the educational system and organizations such as the ABS can contribute towards these efforts was also important.

The last set of questions (which can be seen in Appendix C) was directed toward professionals in the field of statistics. The team was interested in talking to statisticians, data collectors and analysts in the ABS. The purpose of these questions was to gather information about the job market and the factors that made them pursue a career in statistics. These same questions were asked to some of the ABS recent recruitments as well. The main purpose was to get a sense of their personal experiences and what drove them into a profession within a statistical field.

The three focus groups that the team planned were with secondary math teachers and year 10-12 students. The focus groups were intended to complement the interviews and were held in week four. A set of questions (Appendix D) was developed to provide the group with some guidelines for discussion. Among the teachers, the purpose was to gain a greater understanding of the classroom experience and what best way was to reach out to students with new career information. The focus group held with students was geared at finding out their perception of statistics, the factors influencing these perceptions, and why they enjoy certain classes. The questions for this focus group are in Appendix E. Because the focus groups were intended to complement the interviews, the group decided that they would take place after all the interviews have been completed. Thus, the interviews took place during weeks two, three, and four, and the three focus groups were held in week four.

Surveys were given to participants of focus groups to obtain numerical data on what students and teachers felt would promote careers in statistics. The survey consisted of the same questions found in the interviews given to career advisors and university professors. A sample can be seen in Appendix F.

2.3 Conduct Interviews and Surveys

The next step was to interview math teachers and career advisors. Interviews were face-to-face in schools in Victoria and through phone and email in the other seven states/territories. Approximately five public and five private schools were contacted in each state. The group also carried out interviews with ABS employees and professionals in statistics (Appendix G). Personal interviews with school teachers and career advisors in Victoria took place in weeks three and four, as well as those with university professors and employees from organizations, as these personal interviews were harder to set up. In order to arrange the meetings, the group had a list of contacts that was provided by several employees at the ABS at the group's request.

All of the interviews were semi-structured with open-ended questions and lasted about 15 to 30 minutes. The names of people interviewed were kept confidential to ensure an honest assessment of the interviewees. Interviews were recorded to allow review of each person's responses. For ease of collection and playback, an iPod was used for recording the personal interviews. Phone interviews were scribed in a notebook and email interviews were printed. While reviewing the different interviews the team took notes and identified common views and discrepancies.

Lastly, a survey was given out to every participant in the focus groups. The results were counted and the data was entered into an excel spreadsheet. This facilitated the accurate collection and analysis of results.

2.4 Conduct Focus Groups

As mentioned before, the objective of the focus groups was to match the interviews. The discussions that took place were geared towards the recommendations of a promotional strategy itself and aspects that remained unclear, rather than towards understanding the problem. The idea was to have the teachers and students discuss the promotional options such as summer programs, websites, etc., to get a more specific scheme for the strategy. The focus groups were held in schools throughout Victoria. Each focus group had approximately 10-20 volunteering students or teachers.

Before each focus group session the group members introduced the project and stated the purpose of the project. Then, the members started asking the discussion questions that had been previously prepared. The three sessions were successful. The

group's debate clarified significant issues like the teacher's general discomfort when teaching statistics.

2.5 Recommendations to the ABS

After tasks one through four were completed, the group used all of the collected data to find commonalities about the existence of a problem. At week five, the group had a good idea about this issue and therefore was able to recommend what the ABS should do about it. The team also had an idea of the amount of effort that the ABS was willing to put into an outreach program or strategy in order to solve the problem. In other words, the group knew more precisely what the ABS wanted, which enabled the WPI group to create a feasible strategy that adapts to their needs.

Several factors were considered in recommending an effective strategy to the ABS. These factors include:

- Who: What group of people to target, if it is students from year 5-12 or another age group?
- How: The way in which statistical careers should be promoted to this group.
- Timeframe: When to start and how long it will take.
- Where: Place where the strategy should be carried out, such as in math classes.
- Expected results: Explain how the strategy will contribute towards solving the problem, when the program has been completed.
- How to evaluate results: Suggestions of ways to measure the results of this strategy, in order to determine how successful it is.

3 Data & Analysis

This chapter presents the data collected as well as the analysis of it. It is in accordance with the group's project goal which is to develop a strategy and related promotional materials for the provision of appropriate statistical careers guidance and advice for schools, parents and students. The data that the group collected can be categorized into three main areas: careers in statistics, Australia's education system, and existing promotional programs. In order to fully understand the scope of the problem as well as the outlook on the job market for a graduating statistics major, the group needed to examine the different aspects of a statistical career and degree, as well as the paths that can lead to them as a student. The group examined the different methods of education in Australia, continuing the preliminary background research, and placing it into a proper context. The WPI team also collected data on the school curriculum in Victoria to understand how statistics is being taught and how this leads to the problem. The curriculum was then analysed and compared to the New Zealand's curriculum. The last category of information that was collected was the components of promotional programs, existing promotional programs, and the determinants of success of these programs.

3.1 Results

The WPI team compiled data from many different sources. The background information obtained during the first weeks of this interactive project about existing programs, projects, and initiatives in different countries was complemented with the opinions, experiences, and the general knowledge of different groups of people. The summary of the sources of the data is shown below:

- Background Research
 - Programs, projects and initiatives
 - Australia
 - United States
 - United Kingdom
 - New Zealand
 - School Curricula
 - Australia
 - New Zealand

- Job Market
 - Government data/figures about statistics employment
 - Recruiting Companies
- Interviews
 - University Professors
 - ABS Staff
 - Math Teachers
 - Career Advisors
- Focus Groups
 - ABS Staff
 - Math Teachers
 - Students
- Surveys
 - Teachers
 - Students

Each group contributed something different as each sees statistics from a different point of view. Nonetheless, every opinion was a great contribution as it aided the group in getting a more realistic and local perspective of the task. During the first four weeks of the project, the group conducted several phone interviews with career advisors and math teachers outside Victoria. It also visited six different schools within the state, conducting different interviews and three focus groups with year 9 and 10 students and math teachers. Table 5 and Figure 5 display the number of schools contacted and the response rates in each of the seven states (all except Victoria).

State	# of Schools	No contact (Voicemail/Message)	Agreed to respond (Phone/ email)	Have responded (Phone/email)
Western Australia	8	5	1	2
Tasmania	6	3	1	2
New South Wales	19	12	6	1
Aus. Capital Territory	9	1	3	5
Northern Territory	6	3	2	1
South Australia	13	4	6	3
Queensland	8	2	6	0
Total	69	30	25	14

Table 5: Number of Schools Contacted for Phone Interviews

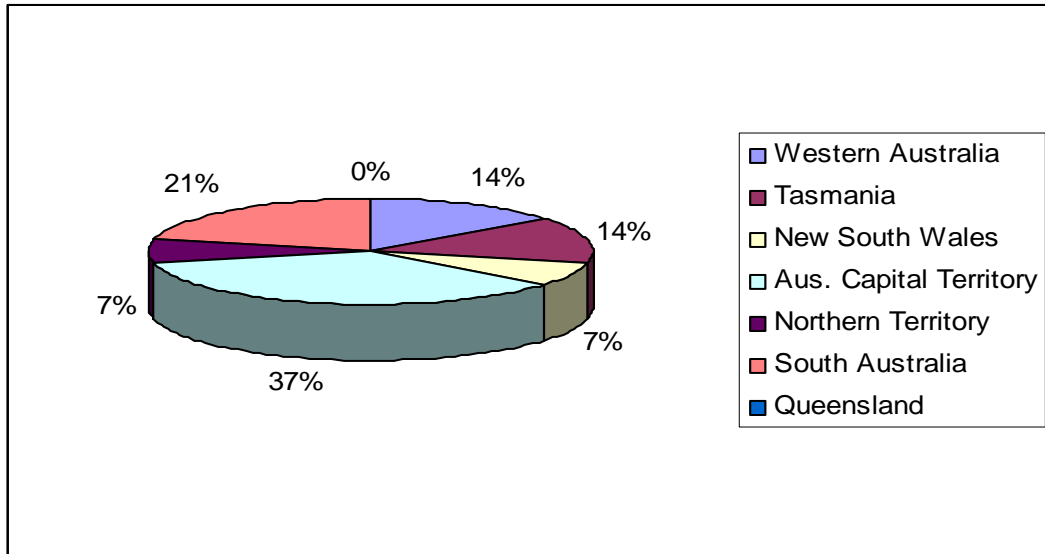


Figure 5: Response Rate for Phone Interviews

The major findings from the 47 phone, email, and personal interviews and 3 focus groups conducted throughout the nation are summarized in tables below. Table 6 shows the major issues raised by career advisors and math teachers and Table 7 presents those raised by the students. For more detailed information, refer to Appendix N.

Career advisors & Math Teachers

- Math teachers in secondary schools in Australia are not comfortable teaching statistics.
- All math teachers feel that school visits would be work well for promoting careers.
 - The group actually tested this and many students very interested.
 - It changed student view of a statistician (mainly because most of them did not even know what it was).
- Career advisors and teachers do not think summer programs are effective.
- Adults think students are too busy for after school programs.
- Career advisors also think work experience would be an effective method of promotion.
- People do not know about what statisticians do.
- Career advisors are generally not aware that there is a shortage of statisticians.
- Career advisors get career info through universities.
- Schools get info about events through e-mail.
- CensusAtSchool is a good learning tool.

Table 6: Data from Career Advisors & Math Teachers

Students

- Students do not think summer programs are effective promotional methods.
- Students enjoy doing schoolwork that they can relate to something they like (i.e. sports, fashion, art).
- Many do not know what a statistician is, when they do stats in class they do not even know that they are doing stats.
- Students feel more strongly about work experience than career advisors.
- Students do not feel as strongly as adults about work experience.
- Think contests would promote statistics well.

Table 7: Student Responses

The team also contacted people from 5 universities in Australia, 1 university in New Zealand, and 9 individuals in mathematical and educational organizations to

get a better idea of how careers are promoted amongst students and the best way is to approach them.

Universities

- Math teachers in secondary schools in Australia are not very proficient at stats, and not even well informed sometimes.
- Students need at least math methods (year 11) to get into a math & science major.
- Information about careers in statistics is not getting to students.
- Universities send students to talk to HS students and get them interested.
- La Trobe University in Victoria has a pamphlet with jobs in stats available for students.
- The number of third year students majoring in statistics in New Zealand is substantially higher than that in Australia.
- The five of the seven state universities in New Zealand offer a statistics major, while only a few offer it in Australia.

Table 8: Responses from universities

The WPI group interviewed 7 recent ABS recruits, 2 individuals from the Methodology department, and conducted a focus group with 5 other people from this department as well. These talks were important in order to understand what drove these people to work for the ABS. It was also important to know how these individuals became involved with statistics. Table 9 summarizes the main findings from their responses from the recent recruits at the ABS. Table 10 and Table 11 summarize those of statisticians at the ABS and of employees or members of mathematical and educational organizations. Each is separated into a different table as the questions asked to each group were not exactly the same ones, as mentioned in the methodology section of this report.

ABS Recent Recruits

- Most of the recent recruits interviewed did not major in statistics at university and did not study statistics beyond the requirements of their major program.
- A very small percentage of the ABS' recent recruits are actually statisticians.

Table 9: Responses from ABS Recent Recruits

Statisticians at the ABS

- They don't often use stats learned beyond the first 2 years of university.
- They use skills that they developed from working with statistics at the ABS, versus the statistics they learned throughout their education.
 - Only 2 of about 250 Victorian ABS employees work with survey design (higher level statistics).
- Many overqualified people don't get jobs at the ABS because high level statistics are not necessary.

Table 10: Responses from the Statisticians at the ABS

Mathematical and Educational Organizations

- Need to make students aware of the options.
- They aren't going to make a career decision at years 10, 11, 12 and probably not even a decision about their major.
- Need to show all the opportunities statistics offers, to students.
 - Let them know that statisticians are WELL PAID.
 - Need to make the career transparent for this age.
- Need to identify career paths.
- Need to portray statistics to be exiting to generate interest in the students.

Table 11: Responses from Mathematical and Educational Organizations

The full transcripts of the interviews and focus groups, and the numerical results are compiled in Appendices N-T and discussed in detail in the analysis section. Finally, the group performed a job search for a position as a statistician to get a sense of the difficulty of finding a job in statistics. Table 12 below summarizes the main results.

Job Search

- ABS does not seem to need too many statisticians.
- According to university professors, students in third year of their statistics major (last year of undergraduate school in Australia) get jobs relatively easily, even if their grades are not excellent.
- Consulting Companies
 - Three out of four have noticed that it is harder to get people for jobs.
 - Hard to find qualified people to fill position.
 - Are filling positions in with unqualified people.
 - Have high degrees, but no real job experience.
 - High degrees not necessary for most jobs involving statistics.
 - Employers generally prefer employees to complement their statistical knowledge with other skills such as business and communication skills.
- Mathematicians, Statistician, and Actuaries (all one category) Job Prospects (Labour Force Survey, 2005) (DEWR, 2005)
 - As of Feb. 2005 → 5,100 employed in Australia.
 - Down from 2000, -12.2% → 5,800 employed in Australia.
 - Up from 2003, +38.4% → 3,700 employed in Australia.
 - Unemployment is average (the same % as for other occupations in Australia) as of Feb 2005, but was above average for Feb 2004.

Table 12: Job Search Data

3.1.1 Types of Programs

Understanding the different types of promotional programs is an essential part to understanding what would work in Australia, and what would not work. Through background research, many types of programs were found. These programs include, but are not limited to the following:

- Summer Programs
 - These programs can range anywhere from a week or less to the entire span of summer vacation.
- Offering statistics as an elective course
 - This involves incorporating statistics into the Australian curriculum.

- Educational website/video
 - Creating a website or a video that would be a resource to teachers, career advisors, parents, and students.
 - This website or video does not have to be limited to statistics. It can incorporate many math and science exercises.
- Interviews/Case studies of interesting professionals that use statistics
 - Incorporating interesting bios on statisticians that are using statistics in a very different and unique way.
- School visits - talks
 - Professionals in the area give a talk about the career, and have students engaged in conversation and ask questions.
- After School Programs
 - The student is involved after classes for a certain period of time.
- Contests (something like a science fair, but with statistics)
 - Corporate or school-sponsored contests in which students work on a project which is then judged.
- Reading material such as books, brochures, and posters
 - Material that is distributed to a teacher, career advisors and students. This is a visual aspect of a program, which connects with people through the visual promotion.
- Work experience
 - Students working with a corporation or a government organization for a set period of time to fully understand not only the career, but also the company that they are working with.

The programs mentioned above were all discussed with each of the career advisors, teachers, and students that were interviewed. All of these different types of programs can be interconnected in some larger promotional strategy. Each program has its pros and cons. Also, some of these programs that works for one career may not necessarily work for statistics.

3.2 Analysis

The information gathered from around Australia has many common trends. These trends helped the team in understanding more about the educational system and

careers promotion throughout Australia. The information also helped the team to determine what knowledge students require about jobs in statistics in order to consider careers in them.

3.2.1 Employment

The first aspect that the group analysed was careers in statistics. It was important to further explore careers in statistics, and the difficulty of obtaining one of these careers to then develop a better understanding of the problem. To this end, two main areas were looked at. The first was finding about people's perceptions of the problem and of statisticians. The opinions gathered are those of ABS statisticians and recent recruits, career advisors, math teachers, university professors, and people who work in educational or mathematical associations. The group looked at what these individuals had to say about the insufficient supply of statisticians, their perceptions about statistics as a career, and statistics in general. On the other hand, the group decided to perform a job search to attempt to experience how hard it was to find a job as a statistician. It is important to make clear that this could only be done in a very superficial way and up to a certain point since none of the members of the group are legally qualified to apply for a position as a statistician in Australia.

3.2.1.1 People's Perspectives

The group developed a view of the shortage of professional statisticians in Australia and careers in statistics from interviews, focus groups, surveys and archival data. In summarizing this material, it was found that not everyone had the same perception of what a statistician was and even less about the careers in statistics. The first impression was that this is a very big problem in Australia and an important one in some other countries around the world such as the United States and the United Kingdom. The background research suggested that Dennis Trewin, head of the ABS and an authority in the field of statistics, is concerned about the declining number of professional statisticians. In his submission to the Review of the State of Statistics in Australian Universities held in February 2005 Trewin stated:

At present ABS is experiencing difficulty in obtaining an adequate supply of statistics graduates who fulfil our requirements...From discussion with other large employers of these graduates, it is clear that they are also suffering similar difficulties in attracting graduates and are concerned that universities are not providing enough graduates with sufficient skills in mathematical statistics.

Other important individuals such as Neville R. Bartlett, Vice-President of the Statistical Society of Australia, expressed the same concern. In the Statistics at Australian Universities Report released in December 2005 he stated:

... the demand for statistical skills has grown consistently over many decades and the areas of application have increased markedly...with a fundamental underlying increase in demand for statistical skills, one would expect growth in the supply of suitably trained graduates coming through our universities but this has not been the case.

Faculty Perspectives

This view was a persistent theme expressed by many of the career advisors and math teachers that the group interviewed. Although most of the interviewed faculty were not aware that there was an actual problem with the declining number of professional statisticians, several mentioned that they were not surprised about it. The general feeling was that it was not clear what a career in statistics even was. Unlike other more traditional vocations such as policemen, doctors, or sports athletes, many people in Australia do not even know what professionals in statistics even do. According to career advisors, students ask about careers they know about. They get this knowledge from their everyday lives; they know what a doctor is because they go to the doctor several times a year, they know what a teacher is because they go to school every day, and they know what a detective is because they have seen one on TV. However, this does not happen with statisticians. The students in the three focus groups held with year 9 and 10 students in Victorian schools confirmed this. The great majority of the students looked puzzled when asked about what a statistician was. If students do not know about the applications of statistics in real life, and what people who work with statistics do, it is hard for them to want to pursue this path in their future lives.

University Perspectives

Professor Paul Kabaila, head of the Statistics Department and professor in various third year (final year in Australia) courses at La Trobe University, expressed the same concern. This is a small department (there are only 14 third year students) meaning that he is in close contact with his students. He was aware that there was a problem with the declining number of professional statisticians to the extent that the first sentence of the Statistical Science Student Handbook 2006 of La Trobe University is “There is a continuing shortfall of graduates from professional statistics programs”. From his experience, many of his third year students discarded the idea of

doing an honours degree, although the university strongly encourages it, and decided to go directly to work. Even students with average grades got good job offers very easily. Again, university professors interviewed by the Review Team from the Statistical Society of Australia Statistics in Australian Universities 2005 have very similar opinions to what the WPI group found. They stated:

The problem is not, of course, simply one of declining numbers of students proceeding to higher-level courses. More generally, there has been a substantial decline in the perceived attractiveness of academic positions in Australia (and elsewhere), not only in terms of comparative salaries, but also in terms of working conditions. For many who would be capable of taking up such positions, academic jobs no longer necessarily appear attractive by comparison with research or consulting jobs in industry and government agencies. This, of course, has a knock-on effect on the choices made by potential graduate students, who more and more weigh up the costs and benefits of PhD training versus immediate (and often well paid) employment.

One method of promoting careers in statistics used by La Trobe University is a job booklet. The booklet is titled Job Listings for Statisticians in Australia and New Zealand. In its latest edition, dated February 22, 2006, the booklet lists 97 positions available in the past 5 months, 94 of which are in Australia (97%).

Professional Statisticians' Perspectives

The focus group held with five statisticians from the Methodology Department at the ABS, however, did not have the same opinion about the shortage of statisticians. They were very conscious of the different career pathways that were available to them but did not feel that it was easy for them to get a position in statistics. According to one of the statisticians “[if] companies and organizations that employ professional statisticians are having trouble to find people with strong mathematical backgrounds and good statistical knowledge, then it would’ve been very easy for us and other qualified statisticians to get a job and this isn’t the case.” The majority of these individuals mentioned that many statisticians had high-level skills that were not necessary in their jobs. Statements such as “here at the ABS we don’t need to do anything beyond first or second year university statistics” evidenced that the general feeling was that many were overqualified in statistics. Furthermore, they believed that “[they] have spent so many years in school getting Masters Degrees and PhD’s” that they “lacked other crucial business skills”. They mentioned as an example that the ABS gets hundreds of applicants to fill these positions each year but only a few positions are available. The group contacted the recruiting department and found some figures that back this up as shown in Table 13.

Year	Applicants	Interviews	Non-short Listed	Offer Accepted
2003	227	25	178	8
2004	-	-	-	-
2005	200	64	96	17
2006	48	-	-	0
Total	475	89	274	25

Table 13: Employment levels at the ABS

The tables in Appendices H, I, and J show that in 2003, 2005 and the first three months of 2006 there were 227, 200, and 48 applicants respectively for positions that are involved working with statistics, econometrics and mathematics, and 8, 17 and none this year have been hired. Yet, in 2003 and 2005, most of the applicants were in the “not short-listed” status. This means that they did not qualify for an interview for a position at the ABS. There were more than sufficient applicants but most of them were not qualified, meaning that they did not have the mathematical, business, or communication skills required for the job, as Trewin stated.

The group also searched the ABS website and found that the recruitment section mentions career opportunities for graduates with many different degrees but statistics is not one of them:

ABS Graduates are drawn from a wide range of degree disciplines. The major requirements are a strong academic background, an understanding of Australian economic and social conditions, an ability to think logically, to examine issues critically, and an understanding of the value of statistics as a research tool. There are a number of stream options for applicants to the ABS Graduate campaign.

- Information Technology Graduates
- Research Officers
- Graduate APS - Social Sciences
- Graduate APS - Economics
- Graduate APS - Other - Human Resource Management
- Graduate APS - Other - Financial Management
- Graduate APS - Other - Information Services
- Graduate APS - Other - Environment/Geography
- Graduate APS - Other - Public Affairs/Marketing
- Graduate APS - Other - Policy, Legislation and Planning

(ABS, 2006)

The requirements above do not mention any mathematical or statistical requirements other than understanding the use of statistics as a tool. Yet, this does not mean that a person would need to be a statistician to be qualified for the position.

3.2.1.2 Job Search

The mock job search that the team performed showed that there are a growing number of opportunities for professional statisticians in the market, and that job prospects in Australia are good. As mentioned previously, the group decided to put

itself inside the shoes of a statistician looking for a position and see what finding a job was like.

The job search was done in different ways. The first approach for the job search included calling specialized recruiting companies. These are consulting companies that search for qualified job applicants for specific positions for other firms. Consequently, they have a good general idea of the market. The group contacted four major companies that looked for applicants with specific mathematical and statistical skills. Although the companies were not able to provide any figures about the job market in this field, the group spoke to several consultants. All of them agreed that the number of positions for statisticians has been increasing during the past years and that each time the market demanded more qualified applicants. Not only did they need to have good mathematical skills, but companies also wanted them to be proficient in other aspects such as communication skills and understanding of business in general. This goes along with what the employers interviewed by the Review Team of the Statistics at Australian Universities Report 2005 for the Statistical Society of Australia mentioned in the document. According to them “...many employers went so far as to say that graduates acquiring their quantitative skills in traditional mathematics/ statistics courses were less attractive in terms of their communication, team-working and problem-solving skills than, for example, students with significant exposure to economics and business course components” (Statistics in Australia Universities 2005). According to anecdotal information provided by the consultants at recruiting companies, most of the applicants did not have these qualifications, which resulted in companies having to fill in positions with individuals that were not experienced enough.

Again, the problem was clearly defined as being not the number of applicants, but their qualifications. The applicants either do not possess the level of mathematical skills required or have very high level specializations in statistics but no experience and most importantly no business skills. Government reports also suggest that the problem is definitely not the number of applicants, or even the number of people who actually get the positions. The most recent edition of Job Outlook Youth Edition report published by the Department of Employment and Workplace Relations (DEWR) describes the job prospects for Mathematicians, Statistician, and Actuaries (all one category) as being average. A section of the Job Prospects Matrix in the

Australian Jobs Report 2005 published by the DEWR shows that there is a slight future growth of positions in this category and classifies the job prospects in this field as good as seen in Table 14 (DEWR, 2005).

OCCUPATION	Job Prospects	Employ't Feb 2005 '000	Gender		F-T Share of Employ't 2004 %	Employ't Growth 5 yrs to Feb 2005		Unemp Feb 2005	Earnings Decile 1-10	Future Job Growth 1-5
			M %	F %		'000	%			
Civil Engineering Associates	average	4.9	90.0	10.0	96.8	-6.7	-57.6	low	7	*
Civil Engineers	good	22.3	90.7	9.3	95.9	-3.4	-13.3	below average	10	**
Electrical and Electronics Engineers	average	24.0	95.7	4.3	95.9	0.0	0.1	below average	9	***
Electrical Engineering Associates	average	6.4	95.3	4.7	98.2	-1.3	-16.9	average	9	*
Electronic Engineering Associates	average	21.5	91.5	8.5	90.0	3.8	21.5	above average	6	**
Engineering Managers	very good	8.1	89.1	10.9	92.3	2.7	49.3	average	9	****
Engineering Technologists	below average	0.2	100.0	0.0	92.3	-0.3	-59.1	high	n/a	**
Mechanical Engineering Associates	below average	4.2	99.1	0.9	92.4	-3.0	-41.5	average	5	*
Mechanical, Production and Plant Engineers	average	20.3	95.7	4.3	96.9	1.5	8.1	low	10	*
Metallurgical Technicians and Mine Deputies	average	9.0	85.4	14.6	95.4	2.9	47.9	low	8	***
Mining and Materials Engineers	good	4.6	90.8	9.2	97.1	0.4	9.9	low	10	**
Science and Environment	good	83.6	57.7	42.3	85.3	-5.6	-6.3	average	8	***
Chemists	average	7.3	68.4	31.6	93.7	-1.6	-17.7	low	9	**
Environmental and Agricultural Scientists	very good	16.6	71.5	28.5	90.6	4.2	33.4	below average	8	*****
Forestry and Soil Professionals	very good	4.1	71.5	28.5	90.6	1.0	33.4	below average	8	*****
Geologists and Geophysicists	good	7.1	79.9	20.1	85.4	0.6	9.2	below average	10	***
Life Scientists	average	6.4	58.9	41.1	93.0	-0.2	-2.9	below average	8	***
Materials Scientists	average	0.2	69.5	30.5	86.1	-0.1	-28.2	low	10	*
Mathematicians, Statisticians and Actuaries	good	5.1	47.2	52.8	85.9	-0.7	-17.7	average	8	***
Medical Scientists	very good	14.9	30.7	69.3	75.4	-0.3	-1.7	average	8	*****
Metallurgists	average	1.6	69.5	30.5	86.1	-0.6	-28.2	low	10	*
Meteorologists	average	0.7	69.5	30.5	86.1	-0.3	-28.2	low	10	*
Park Rangers	very good	3.4	71.5	28.5	90.6	0.8	33.4	below average	8	*****
Physicists	average	0.7	69.5	30.5	86.1	-0.3	-28.2	low	10	*
Science Technical Officers	below average	15.5	54.5	45.5	81.9	-8.1	-34.4	above average	6	*

Table 14: Job Prospects Matrix

Figure 6 below from the ABS Labour Force Survey shows the unemployment for statisticians when compared to unemployment for all occupations.

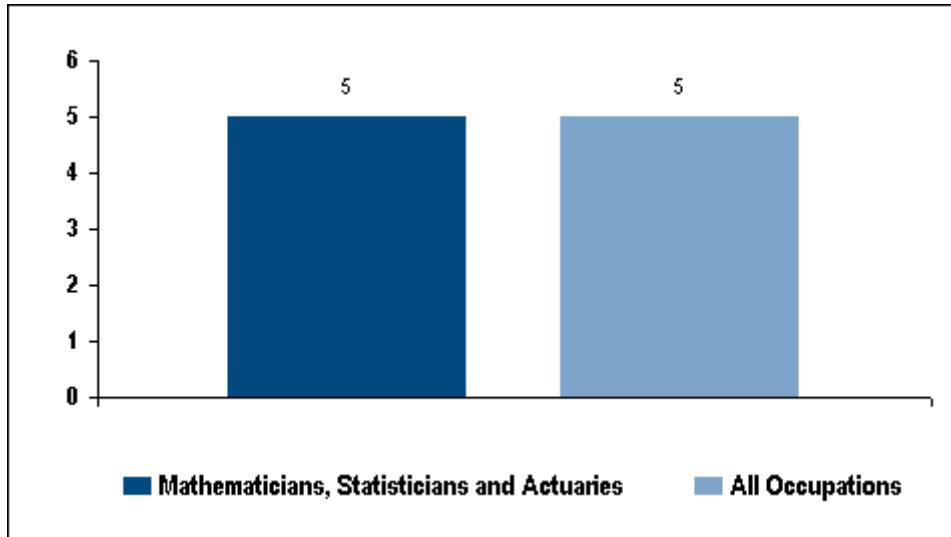


Figure 6: Unemployment for Statisticians versus Unemployment for All Occupations

In February 2005, Australia employed 5,100 people in the category of mathematicians, statisticians and actuaries, 12.2% less than in 2000 but 38.4% more than in 2003. This can be seen in more detail in the following figures.

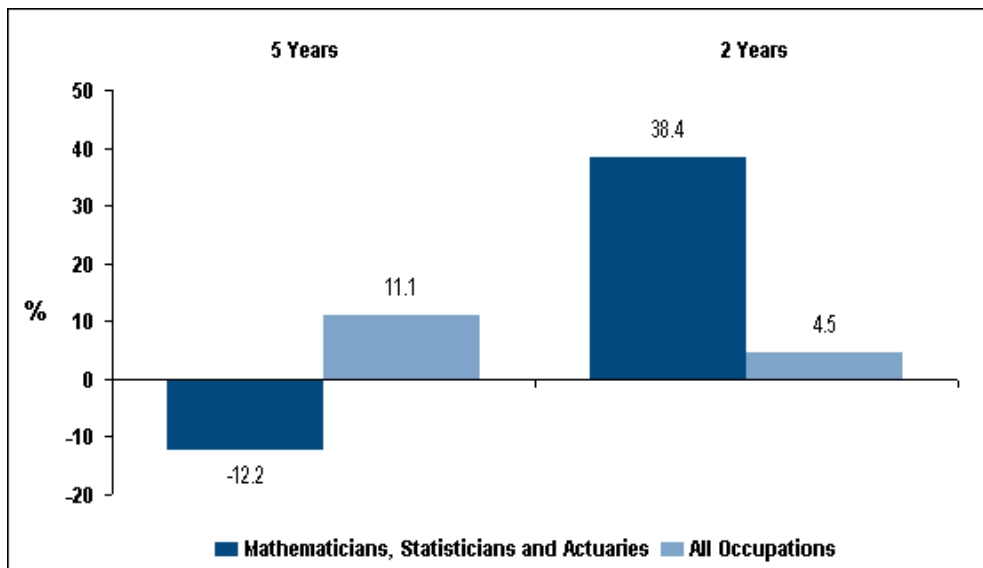


Figure 7: Employment Growth

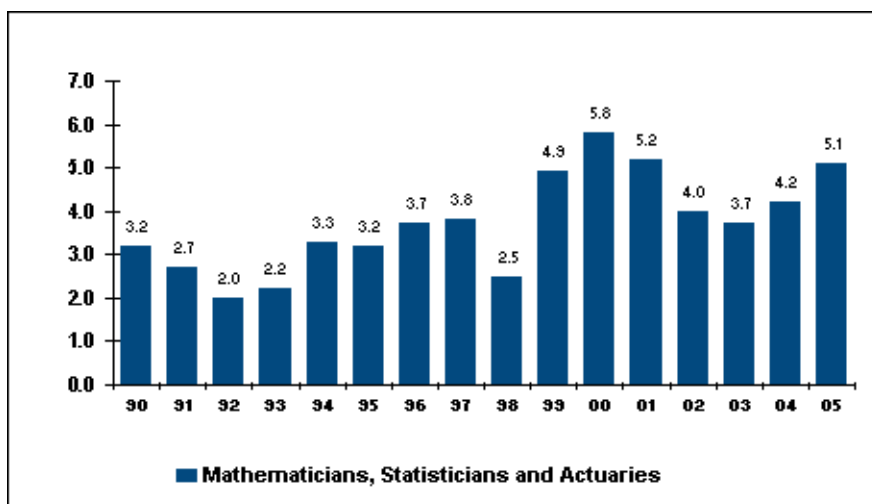


Figure 8: Employment Level ('000) for Statisticians from 1990-2005

Figure 7 from the ABS Labour Force Survey shows employment growth (per cent) over the past five years and two years for this occupation, compared with all occupations. Figure 8, from the ABS Labour Force Survey, shows the employment level (in thousands) for statisticians from 1990-2005. This shows that in although the market for statisticians has grown, the number of statisticians employed has not.

3.2.1.3 Status of the Problem

Some discrepancies are evident from the data analysed above. However, there is a consensus in the data collected about the job market that the declining number of professional statisticians is a problem as seen summarized in Table 15 and Table 16.

Points of Agreement in Job Market Data

- Employers of statisticians are having a hard time finding what they define as “qualified statisticians”.
- “Qualified statisticians” are those that not only have strong mathematical and statistical backgrounds, but also good communication and business skills.
- The demand for “qualified statisticians” is increasing in Australia.
- Careers in statistics do not have a clear and identifiable path.

Points of Disagreement in Job Market Data

- Some consider the problem to be exaggerated.
- This case is similar or even worse in other industries, as Table 14 demonstrates.

Table 15: Points of Agreement and Disagreement

Main Conclusions

- The problem is not a shortage in the number of statisticians, but that most are not considered “qualified” as defined above.
- Statistical work is not only done by statisticians; there are other professions that have different names and still involve a great deal of statistics.
- People generally confuse descriptive and inferential statistics and it is important to establish the difference.

Table 16: Status of the Problem

The problem, as mentioned in the previous section, is not the supply of statisticians itself, but the fact that most do not have the skills required by employers. Companies and organizations have to hire individuals that often do not fulfil their expectations, as mentioned by the consultants at recruiting companies. This is the reason why employment rates are not higher than average, as people might still be needed to do the job.

On the other hand the different sets of interviews and focus groups held with students, career advisors, math teachers, employees of organizations, and ABS staff, and some of the archival documents researched, suggest that careers in *statistics do not have a clear career pathway*. This explains why career advisors and math teachers rarely are asked about becoming a statistician. It also explains why most of those who decide to pursue careers in statistics make up their minds while studying at university. The most important conclusion to be drawn about careers in statistics is that statistical work is not only done by statisticians, but that there are many other positions and career opportunities that involve fun and complex statistics and do not have the name tag “statistician”. It is also important to identify the difference between descriptive and inferential statistics, and the applications of each.

3.2.2 Education

Australia and New Zealand have very different school curricula. This is one of the major reasons why these two countries that are so similar in culture and location have such a different number of professional statisticians available. In Australia, each of the eight states has their own curriculum, but the group focused on the Victorian curriculum.

In Victoria, the math curriculum up until year 10 is split into five strands: number, space, measurement, chance and data, working mathematically and structure. The statistics aspect falls under the “measurement, chance and data” strand. These five strands are covered at six different levels (Table 17). Statistics are learned throughout their education, and at the highest level students learn to “...apply probability concepts to aspects of chance and risk in everyday life. They represent event spaces that show the nature of events and their probabilities, and use these representations to assist in the computation of the probabilities of compound, independent and dependent events. They apply the concept of mathematical expectation to describe expected gain or loss in games of chance” (Victorian Essential Learning Standards, Mathematics, 2005).

Standards	Stages of Learning
Level 1 – End of Preparatory Year Level 2 – End of Year 2 Level 3 – End of Year 4	Years Prep to 4 – Laying the foundations
Level 4 – End of Year 6 Level 5 – End of Year 8	Years 5 to 8 – Building breadth and depth
Level 6 – End of Year 10	Years 9 to 10 – Developing pathways

Table 17: VELS Stages of Learning

Following year 10, students may take Victorian Certificate of Education (VCE) courses to continue their mathematical education, although math is not required. In the six VCE math courses offered to years 11 and 12, only three include statistics in the syllabus, as well as up to five more areas of study. One of these courses, Further Mathematics (for year 12 students), includes a “compulsory area of study in data analysis”, which is the currently the best option for students interested in statistics. Table 18 shows the VCE math courses offered to students in years 11 and 12.

VCE Math Courses:

- Unit 1 and 2 (year 11)
 - Foundation Mathematics: does not include statistics in the 4 areas of study.
 - General Mathematics: includes “Statistics and Probability” and 5 other areas.
 - Mathematical Methods: does not include statistics in the 4 areas of study.
- Unit 3 and 4 (year 12)
 - Further Mathematics: includes a compulsory area of study of “Data Analysis” and 3 other areas.
 - Mathematical Methods: includes “Statistics and Probability” and 4 other areas.
 - Specialist Mathematics: does not include statistics in the 6 areas of study.

Table 18: VCE Math Courses Offered

The New Zealand mathematics curriculum is split into five strands as well; numbers, measurement, geometry, algebra, and statistics. The statistics taught in New Zealand are taught at eight different levels over the course of the 13 years in primary and secondary school (Appendix L). The statistics that are covered in year 12 and 13 include confidence intervals, explaining differences between sample and population means and choosing appropriate distributions for the given situation (Appendix M) (binomial, Poisson, and normal) (New Zealand Ministry of Education, 2003). For those interested in furthering their education in statistics, the University of Auckland offers the largest statistics department in all of New Zealand and Australia. In 2005, the 946 full time students enrolled in the statistics department made this department the third largest branch of the science department. Of the other six state-funded universities, four more have statistics departments (University of Waikato, Victoria University of Wellington, University of Canterbury and University of Otago).

A major issue in the statistical education of students lies within the Australian curriculum, and the education department. Australia's statistical education in secondary schools is comparable to New Zealand's level 4 statistics, which is covered

by year 9. In addition, the SSAI believes that there are two serious current problems concerning the teaching of statistics in school:

The first relates to issues in curriculum design and implementation, including possibly inappropriate content and level of material and missed opportunities to provide close linkage with relevant data handling and display information and communications technologies

The second relates to the absence of specific and sustained initial teacher training and subsequent continuing professional development to ensure that teachers of mathematics in school have the background and resources to be able to convey statistical concepts and tools effectively and with competence and confidence to the students in their classroom.

(Statistics at Australian Universities, 2005)

The issues stated by the SSAI, concurs with the information that the team has gathered elsewhere. The proper education early on plays a major role in the number and quality of statisticians being produced. New Zealand does not have a lack of statisticians mainly because the education in schools promotes statistics.

3.2.2.1 Faculty Perspectives

From the interviews with professors, teachers and career advisors, there is a consensus that teachers do not feel comfortable teaching statistics. They felt that they were not educated enough in the subject to be able to teach the students anything beyond a certain level. The majority of teachers said that they do not teach beyond the basic “mean, median and mode” of statistics, because anything beyond this would require the teachers to intensively learn the subject. This is also a point of concern, because if there are any students interested in statistics, the teachers would not be able to further their knowledge.

There is a considerable general concern about what is seen as the inadequate supply of properly qualified teachers of mathematics in high schools and this is seen as implying an even more acute shortage of teachers with the competence to teach statistics, informed by a proper awareness of modern applications of quantitative methods and the resulting employment opportunities.

(Statistics at Australian Universities, 2005)

80% of teachers interviewed agreed that offering an elective course would be an effective way of promoting statistics (Figure 9). This number is much lower among students and career advisors. Offering a statistics course would alleviate the pressure of needing to know much about statistics as a math teacher, as a separate statistics course would probably be taught by a trained statistics teacher.

Elective Course Data

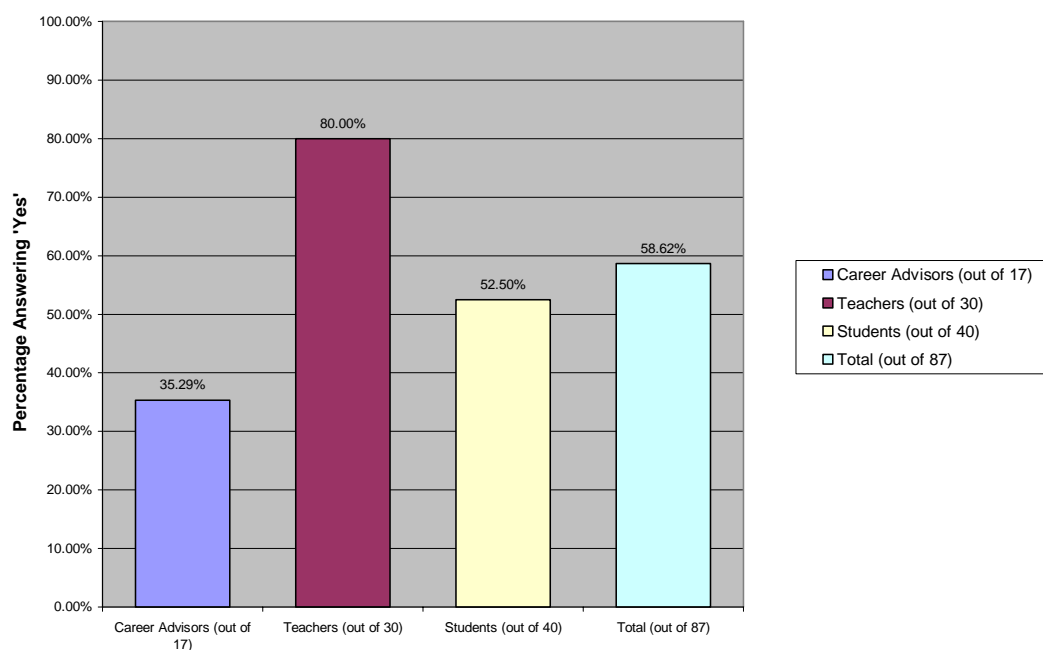


Figure 9: Elective Course Data Survey Results

When teachers and career advisors were asked which age group would be the best to target the promotion towards, almost all agreed that years 10, 11 and 12 were the optimal ages. This is because the students in year 10 need to be approached about continuing their math education even after it is not compulsory. In addition, most career advisors do not approach their students until year 10. In years 11 and 12 students have already decided that they are going to continue with their math studies, and they are now starting to think about what they would like to study at University. Students younger than year 10 have most likely only seen statistics in their math courses without knowing it was statistics.

3.2.2.2 Student Perspectives

In the several focus groups held with students many issues were discussed including, why they like classes, their perception of a statistician, and what they felt would be a good way to promote statistics among them (Figure 10).

The students all stated that they enjoyed classes and work when they were able to relate it to something they liked. In addition to the students, the teachers and career advisors all agreed that students need interaction, and hands-on experiences to be interested in something. One year 10 student remembered a statistics project he did in year 7, in which they were asked to calculate the statistics and make graphs of their

favourite cricket team. Many students also enjoyed courses, when they know that they are good at the subject and the material comes easily to them. When asked about what they thought a statistician was and did, most said that it was a person computing lines and lines of numbers, doing a lot of repetitive work, and making charts and graphs. Many times, students did not even realize they had learned some statistics in their mathematics course already, and had no idea of what statistics was. In addition, teachers and career advisors do not have much information on which careers are open if one studies mathematics or statistics at university.

This leads into a persistent theme, reinforced many times by students and recent graduates: the lack of understanding they encountered while at school – from teachers, parents and school career advisors – of the incredibly broad and exciting range of applications of mathematics and statistics in the ‘real world’ and the plethora of employment opportunities that this offered. Many career advisors both in school and in universities have little mathematics (or general scientific) background, and are liable to convey outdated and inaccurate information about the opportunities open to mathematics and statistics graduates in the broad sense.

(Statistics at Australian Universities, 2005)

When the students were given a survey asking them what they thought would be the best way to promote statistics among them, most agreed that work experience would be the best way (Figure 10).

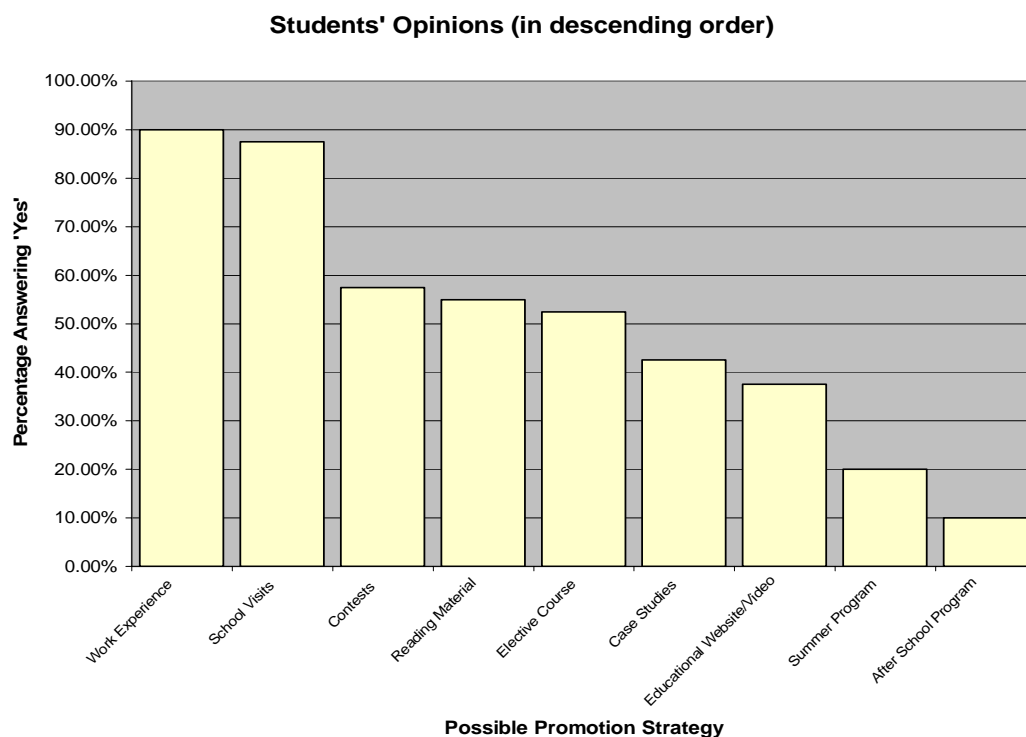


Figure 10: Results of Survey: Possible Promotion Strategy

The group found that many students in year 10, 11 and 12 have after school jobs, and therefore working at a business would be the best option. According to the ABS Census of Population and Housing-Australia's Youth, of the 883,811 full-time students aged 15-19, 334,194 were in the work force (37.8%).

The runner-up from the survey was holding school visits, where professionals would come in and talk to the students about careers in statistics and the many "real world" applications of statistics. According to students, teachers, and career advisors, offering an after school program was the worst option as a result of the many students with part-time jobs.

3.2.2.3 Career Advisors' Perspective

The group learned about the teachings and use of statistics in the educational system through interviews and focus groups with teachers and career advisors. One of the reasons that teachers and career advisors think the problem exists is that statistics is seen as a tool in math and not a career. Statistics is used in math classes as well as psychology classes, but it is not a standalone subject. The courses do not make connections to the opportunities that statistics present. Another problem is that, according to teachers and career advisors, statistics is associated with higher math and is therefore unattainable to most students.

The career advisors and teachers also gave ideas about how statistics can be promoted in the educational system. If the group decides to recommend changes that affect the educational system these responses would be very beneficial for the final recommendation. Almost 64% of the career advisors and teachers surveyed said that having statistics as an elective course and no longer only combined with the numbers section of the mathematics curriculum would be helpful for the promotion of careers in statistics. This is unfortunately not a very feasible change to make and it is biased against other disciplines. This suggests that multidisciplinary partnerships, like STEM and MSP (Section 1.4.1) in the United States, might be a good strategy for getting students into the pipeline. Also, teachers should try to convey the importance of statistics when that part of their course is run. They also mentioned that statistics in math courses is very basic and that if students did realistic problems that were interesting then they might like statistics more.

Teachers and career advisors also talked to the group about how year 11 and 12 math courses affect the students' university program placement. In order to enrol in programs at university, students must take certain courses to get in. To register in a math and science program at a university, students need credit for at least the VCE class, math methods. This is an important part of the pipeline. In order to get more students into statistics programs at universities, they must be encouraged to take higher math courses in their latter years of secondary school.

Interviews with math teachers have shown that some do not feel confident in their own statistical abilities, which makes it difficult for them to teach students. There is a lack of professional development programs and training before new teachers begin to teach classes. Programs for increasing teachers' knowledge and confidence in statistics would be a good way of increasing students' knowledge of careers because if the teacher is more enthusiastic about it then the students will be too. It is possible that this is a problem with other disciplines as well. Again, a partnership with other disciplines may help. This would not only make teachers more knowledgeable about statistics, but they would be able to demonstrate the role it plays in other courses.

3.2.2.4 Organizational Involvement

As in the United States, Australian universities are one of the largest promoters of careers. Thus, the group contacted professors at La Trobe University in Melbourne and Auckland University in New Zealand to get a sense of their view of the problem. The intention was to find out more about their statistics programs and to know in further detail what they are doing to promote these programs, if anything at all.

The number of people enrolling in the honours statistics program at La Trobe University has increased in the past year. The increase can also be seen in the number of statistics degree completions from the years between the years 2001 and 2002 for six Australian universities, which can be seen in Table 19. Although there is an increase in the number of students completing degrees, the demand for statisticians may be growing faster than the supply. Auckland University in New Zealand has the largest statistical program in all of New Zealand as well as Australia. In 2005 the program had 946 students enrolled and this number has been increasing.

Completions		Year	
State	Institution	2001	2002
ACT	The Australian National University	1	10
NSW	The University of New South Wales	0	6
QLD	The University of Queensland	1	3
SA	The University of Adelaide	0	13
VIC	The University of Melbourne	3	0
WA	The University of Western Australia	12	20
Total		17	52

Table 19: Statistical Degree Completions for Selected Universities

Universities are very involved with the promotion of careers but are not promoting statistics very well. 88% of career advisors stated that they get some of their information from universities. These universities send brochures and information to many schools about the course programs that are offered and the career opportunities they lead to. For statistics the universities do not advertise programs like this. Of the career advisors and teachers the group talked to, none had never received promotional materials for statistical careers. The Australian Bureau of Statistics advertises its careers in graduate publications at universities as well as on university websites.

The Australian Bureau of Statistics' CensusAtSchool program is doing well in promoting statistical literacy in schools, according to career advisors and teachers who have used it. CensusAtSchool works with the educational system to increase statistical literacy in schools by having students perform statistical tasks with real data. The students learn about both how data is obtained as well as what can be done with the data that they have. Because CensusAtSchool can be used at all levels of the educational system, it is an essential part of the pipeline (Figure 11). Also, people that have used CensusAtSchool have said that they feel it is a good tool for students to learn about statistics. The results of CensusAtSchool suggest that programs that are used in the educational system, although not necessarily part of it, could be used to increase statistical awareness and interest in statistical careers. By increasing students' statistical literacy at an early age, students will also better understand the promotional material that is given to them towards the end of their school years.

Brochures and other promotional items would be easy for the ABS to incorporate with some of their existing programs. The ABS currently sends an annual mailing to 2,500 primary and secondary schools with information about the many

products that they offer. Adding promotional material about careers in statistics or promoting higher education would be an inexpensive strategy.

Getting more universities and organizations such as the SSAI involved in the promotion of statistics would help to drive students to go into higher math courses and hopefully into statistics degree programs at universities. Students need to be made aware of the range of available statistical opportunities available to them in higher education and the careers that can be achieved through further study. Partnerships with organizations of other disciplines would be useful at the lower levels as well in order to get students into the mathematics and science pipelines.

3.2.3 Existing Promotional Programs

A major part of the project is to develop a strategy to promote careers in statistics throughout Australia. A pipeline program is a program used for purposes of ‘filtering’ students into particular career fields. The pipeline starts with a very large base, and then throughout the students’ education, they filter themselves out. Pipeline programs help keep students who might have otherwise left, continue through the pipeline and filter down to the end result, a career in that particular field. For purposes of this project, the pipeline program can be seen in the illustration in Figure 11.

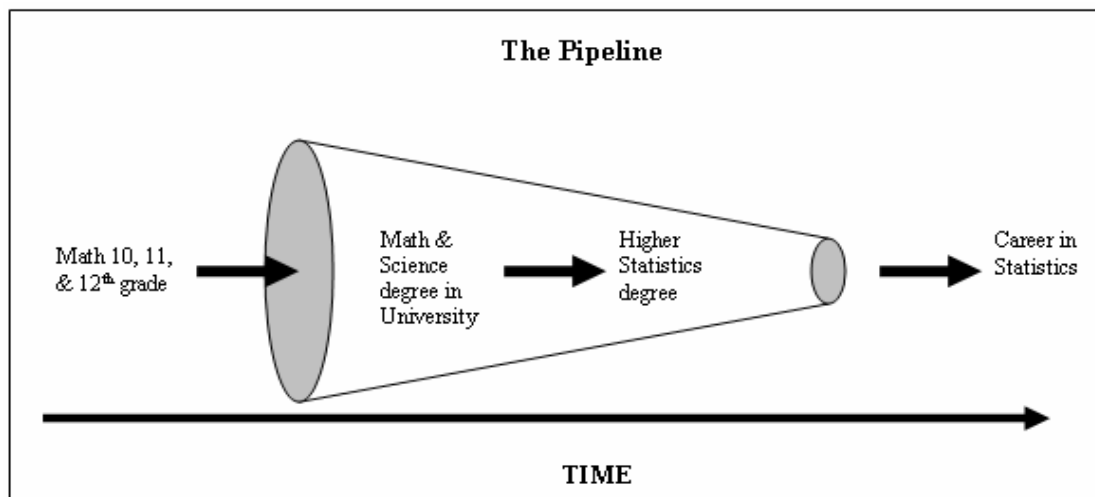


Figure 11: Statistical Pipeline

This pipeline is essential to understand. Similar programs are used for different careers, as in the US for STEM programs. In New Zealand, the earlier math courses incorporate statistics, thus making it easier for the students to continue down the pipeline. With the intervention of programs, students will then hopefully pursue a math degree in university, which will then lead them through the ‘pipeline’ into

careers in statistics. It is important to note that promotional programs are important along every arrow. These programs will help increase the likelihood of students moving on to the next phase or filter in the pipeline.

To develop the promotional strategy completely, the team examined the different factors that go into a program. It looked into the different programs in place in Australia from a first hand perspective, and analysed the determinants of success for programs. This data will allow the group to further analyse possible recommendations. Promotional strategies consist of different components or elements, which are implemented during certain stages of the strategy. Depending what the goal for the strategy was, the factors that determine the success of the program vary.

3.2.3.1 Components of an Effective Promotional Program

There are different types of promotional programs; however, there are many commonalities between them. Each of them serves a particular purpose and is geared towards a particular cause. Through the talk the team had with Gerard Torpy, an education officer from the Catholic Education Office, the team was able to learn much more about the importance of certain elements in a promotional strategy.

The team was able to have Gerard Torpy of the Catholic Education Office in Melbourne and discuss the different aspects of promotional programs. He said that to promote a career it is essential to show all of the different opportunities available to the students. All the potential career paths that a person can take with a statistics degree should be stated, since students will feel as though there are many different branches that they can go into with the degree. Also, when speaking to different children it is important for the career to be understandable. The factors and elements of the career need to be explained in a way that the students can understand and be comfortable with, since students will not necessarily be interested in it. The program needs to target the right group of students, those who are not only interested in mathematics, but proficient in it as well. Since resources should not be spent on students who do not want to study a higher level of mathematics. Another main aspect of promotional programs that students commented on is that the programs should be interactive. The students want to feel involved in the program, since it is through hands-on interaction that students learn the best.

3.2.3.2 Current Programs

As mentioned in the background research (Chapter 1), the Australian Bureau of Statistics has proposed the creation of ASES to combat statistical illiteracy throughout Australia. The ASES is a project by which the ABS and SSAI intend to introduce statistics into the school curriculum in Australia. The purpose of the ASES is to identify which statistics material needs to be taught at each level from kindergarten to year 12 and to find out the best way for this material to be taught. This project not only defines the issue of decreasing numbers of professional statisticians as a real and significant problem, but it also reiterates the importance of targeting students at young ages in order to influence their future decisions (Fisher, 2003). However, it does not state precisely how to generate interest in statistical careers later on in these people's lives. This document established a foundation for the level of recommendations to suggest, as well as place into context many of the previous findings. The main programs that the team considered as highly effective through comparisons are summed up in Table 20.

	Location	Year Level	Targeted Group	Type of Program	Elements	Successful?	Why?
CensusAtSchool	Worldwide	Year 5-12	Students & Teachers	In school activity	Online questionnaire & Teacher component	YES	Response and interest level are high
Questacon	Australia	All	Students	Exhibitions	Interactive exhibits & Performances	YES	Exhibitions had over 600,000 visitors
Adopt-A-School	United States	All	Students, teachers and professionals	School Visits	Teacher component & Student interactions with professionals	YES	Positive project outlook & positive feedback from parties

Table 20: Promotional Programs

The programs mentioned in the above table, are only a few of the many programs that the team looked into. The rest of the projects are listed in Chapter 1. Students need to be targeted in the classroom, outside the classroom, and with a form of interaction with an outside expert in the field.

The CensusAtSchool program mentioned in the table above is an ABS implemented program. It is also an international program, with different countries establishing their own CensusAtSchool programs. The program is consistent with the Australian Statistics Educational System (ASES) project's call for a better statistical

education from kindergarten to year 12. This is an internet based collection project for students to learn about statistics through working with real data that they can understand. From the talks with the NESU, the team was able to determine the main focuses of the program. CensusAtSchool is a unique classroom resource for Australian teachers that encourage students to respond to non-invasive questions of interest about themselves and then investigate the response data in an engaging learning environment. The program was launched in Australia in October 2005, and the questionnaires were ready for students to use at the end of January 2006. This program is making students, teachers, and parents aware of the upcoming Australian Census in August.

The program for fostering awareness of science and innovation is Questacon. Questacon is sponsored by the ANSTC which offers interactive exhibits and science performances across Australia. In 2003, Questacon ran 10 exhibitions in Australia and overseas with over 600,000 visitors. Also it ran outreach programs which had 276,074 participants. In addition to attracting students to the sciences, Questacon is good experience for science communication graduates (DEST, 2005). Smart Moves, a part of the Questacon program, is “designed to raise awareness of science, technology, innovation and related careers in regional and rural secondary schools.” (DEST, 2005, p. 91) In 2003, Smart Moves was involved with 87,076 students in four states (DEST, 2005). The shows put on by Smart Moves promote cutting edge research, and entrepreneurship in science, engineering, and technology (ANSTC, 2006). Although these programs are not particularly designed for mathematics, and more importantly towards statistics, it was still interesting to see the different ways of getting the attention of students. These programs were a more interactive program, when students would see performances and exhibits related to a particular field.

As mentioned in Section 3.2, a high percentage of people that the group interacted with said that school visits and talks would be a good idea. The WPI team was able to observe a school visit, in which an ABS staff member accompanying the team to the school talked to the students about statistics. The observations were that the students were very much engaged in what was being presented to them. School visits open students’ eyes to things they would have never known about beforehand and see things from a different viewpoint. Students began asking questions, laughing, and enjoying their time spent listening to the ABS representative. The career advisors

and teachers that the team spoke with said that school visits were a good idea, since students are exposed to something almost immediately, and then they remember what was said.

Another version of school visits is a program used currently in the United States, called the Adopt-A-School program. The purpose of the Adopt-a-School program is to enable professional statisticians to help schools in their efforts to include statistics in the curriculum (ASA, 2006). Many teachers are enthusiastic about bringing quantitative literacy to their classrooms but lack the background and formal training to do so with confidence. With this program statisticians make contact with teachers and administrators to arrange visits to the classroom. The key to the success of this program is the statistician's close work with the classroom teacher. Teachers welcome the assistance of professionals in the field (ASA, 2006). There has been positive feedback from the professionals involved.

However, it is necessary to target students at different levels as well with different programs. The programs need to be continued throughout the pipeline. This will help ensure that the students are still interested and stimulated in the subject. There is one for postgraduate students who work in both research and non-research programs. The Research Training Scheme aims “to strengthen Australia’s knowledge base and research capabilities by enhancing the higher education research training system” (DEST, 2005, p. 84). The Australian Postgraduate Awards program supports research training and provides financial support to students doing exceptional research. Students who receive Australian Postgraduate Awards also receive funding through the Research Training Scheme (DEST, 2005).

3.2.2.3 Feasibility of Programs’ Success in Australia

As mentioned in the previous sections, there are many different types of programs that can be incorporated into an effective promotional strategy. However, through the data collection with different sources, the team has analysed that some of these potential program options are not very feasible.

Some programs that work in the United States as mentioned in the background research are not necessarily the most effective programs in Australia. One such example are summer programs. Many of the career advisors surveyed said that summer programs were a bad idea since the summer in Australia is very hot and

students become involved in several outdoor activities. However, in the United States, students are more willing to participate in the summer programs. The team spoke with many people that felt that case studies would be a good idea. However, the group felt as though the limitations of the resources available are scarce and therefore, the team would not be able to provide accurate samples of case studies. Professional statisticians also expressed dislike of the idea of case studies as they would not accurately depict the career. Contests are easier to do with some fields of studies than others. In the statistical field, the team and other feel that a statistical contest would be overwhelming for students who do not know a lot about statistics.

3.2.3.4 Determination of Success

Every program needs to have determinants to establish the success of the program. The way that success is evaluated is different for every program, and it is different at the different levels or stages of the program.

The CensusAtSchool Program, which is still in its very early stages of delivery, is measuring success by the number of people calling the office with questions, and with the amount of people that continue to inquire about the program. These are valid ways to measure success at this stage of the program. When the program continues to progress, it will also be based on the number of questionnaires that have been answered and returned, and the feedback that the teachers will provide back to the ABS.

Successful programs incorporate many things that promote the development and learning of children. In the article Parental Ideologies and Children's After-School Activities:

Whereas respect for others was an important characteristic that many parents wanted to instil in their children, many also said that they thought it was very important for their children to learn other social skills such as getting along with others and being exposed to children outside the family and their immediate circle of friends,

(Dunn, Hoffeth, & Kinney, 2003, p. 1376)

Not only do academic based programs enhance learning academically, but also help children learn about themselves and their peers.

The promotional strategy that the team recommends will need to have its own method to determining success. Depending on the age that it will target, numbers on how many students applying to universities and study statistics will take a while.

Many programs determine success by the immediate feedback that they collected from the students. School visits are as classified successful if the students talk about it after the visitor has left, and with the teachers' reactions and responses. If the program is sponsored by a university, then the level of success is often times evaluated by the number of students that apply to the university from that program, or the number of students that participate in another program that is sponsored by the university.

3.2.4 Main themes

After some of the analysis done in the sections above, the group was able to find main themes in the information. These themes were either points of agreement among students, math teachers, career advisors, university professors, and members of organizations, or general points of disagreement among these groups. From these points, the group was able to draw some more specific conclusions and get a good notion as to what things might work for the promotional strategy and what things might not work. Some of the points of agreement are the following:

- **Best year levels to target are years 10, 11, and 12:** According all of the career advisors and math teachers in secondary Australian schools that the group interviewed, this is the best time to reach students because of two main reasons. The first reason is that it is the time when students are actually thinking about career choices and will thus be potentially interested about a career in statistics. The second reason is that year 10 is the time when students can decide whether they want to take math courses in year 11 and 12. These math credits are required by universities for students who want to pursue math, science, and engineering degrees.
- **Target students in math classes:** Math classes are a good place to reach students. This will ensure a higher success rate since the promotional materials developed will be reaching students that will be potentially interested. Students who are not in these classes are most probably not interested in math and/or do not like it, so a career in statistics will not be appealing to them and it could possibly create a negative attitude among all students.
- **Statistics needs to be seen as being fun:** It was also found that in order to get kids interested in statistics the subject needs to be fun and exciting. According to an employee of the Catholic Education Office of Victoria who has been promoting different career opportunities to students in years 10, 11 and 12 for

over 20 years, this factor attracts students the most. Career advisors and math teachers felt the same way and if people analyse this at a personal level it makes even more sense. People in general, and especially kids, are interested in things that seem fun and exiting, not boring and unattractive. This means that careers in statistics need to be presented in this way.

- **ABS has an influential image:** The great majority of career advisors, math teachers, university professors, and members of organizations, had a very high regard for the ABS. Most were aware of ABS programs like CensusAtSchool and used ABS statistics. Also, these people were more willing to help the group after knowing that this was an ABS project. This is important as it means that an ABS initiative has the potential of having a big impact on these groups of people.

On the other hand, there were two main points of disagreement. These were either points that the interviewees did not agree upon, or suggestions that had important issues and therefore are not practicable in Australia at this time:

- **Case studies are overall very popular, but might generate misrepresentations:** Case studies of professional statisticians were a very popular suggestion, especially amongst career advisors (100% approval) and math teachers (87% approval). However, professional statisticians were not fond of this idea as it might give a wrong representation of statisticians to students. On one hand, case studies need to be made fun and interesting to students, for example talking about a sports statistician. However, to be a sports statistician only a high school degree is required. On the other hand, making the case studies too specific, like those presented to university students, might confuse secondary school students. Talking about the type of research done by university professors might probably not interest students since they might not know enough to understand it. A right balance between making it fun and making it real needs to be reached, and it is not an easy task to embark on.
- **Contests are a good way to promote statistics; however, previous knowledge about the subject is required:** There was a general consensus about contests being a good way to create student awareness about careers in statistics. However, when comparing a possible statistics contest to contests in

other science fields, it was concluded that students need to have previous knowledge about the subject to be able to participate. A science fair is an effective contest because students already know about general sciences before doing the project. Considering the current Australian school curriculum, mentioned in section 1.3.2, it can be concluded that in general Australian secondary students do not know enough about statistics in order to participate in a statistics contest. There may be a few that know enough about statistics, but many do not even know what statistics is even after having studied it in math class.

After having mentioned the points of agreement and disagreement within the education sector, several main conclusions can be derived:

- **Brochures:** These have low cost, are short, concise, to the point, and can be included in the two mail-outs that the NESU does each year.
- **School Visits:** These have a great impact on students, as could be seen in one of the visits. They create personal connections with the students that generate interest at that time and open a complete new world of opportunities.
- **Work experience:** This was the most popular choice and the ABS already carries out some initiatives regarding this aspect, but they need to be better promoted as none of the interviewees was aware of them. However, they can only be offered to a small number of students.
- **Professional development programs:** Teachers need to be better prepared to teach statistics as many confessed they did not feel comfortable teaching statistics. Improving the quality of teaching will improve the quality and interest of the students.
- **Case studies:** Although very popular, it is difficult to find the right balance between making them fun and interesting and making them accurate and realistic. They are a good idea, but they are difficult to develop.
- **Contests:** Another popular idea with issues behind it. Right now, the general feeling is that students and teachers do not know enough about statistics in order to create and participate in a statistics contest.

4 Recommendations and Conclusions

This chapter presents the recommendations and conclusions that were gathered and are presented to the Australian Bureau of Statistics. Before proceeding with the recommendations some of the main conclusions of the data and analysis are restated in Table 21 below:

Summary of Data and Analysis Main Conclusions
<ul style="list-style-type: none">• The problem is not a shortage in the number of statisticians, but that most are not considered “qualified”; the problem is quality not quantity.<ul style="list-style-type: none">○ According to employers, qualified statisticians are those that possess a strong statistical knowledge that they complement with other skills such as business and communication.• Basic information about statistics is not getting out to students, teachers, and advisors.• Best groups to target are students in math classes in years 10, 11, and 12.• Statistics needs to be portrayed as being fun and exiting.• ABS and NESU programs have a significant image in Australian schools and should be taken advantage of.

Table 21: Summary of Data and Analysis Main Conclusion

It is also necessary to make clear that the strategy that will be recommended is an initial approach towards informing students, teachers, and career advisors of careers in statistics. Thus, it needs to be simple, fast and easy to carry out. The strategy needs to be achievable and effective in raising awareness of statistics and the career opportunities in this field. Other important factors that the group considered before developing the actual strategy are listed in Table 22 below:

Important Factors Considered for Developing the Strategy

- The strategy needs to be compatible with current programs carried out by the NESU and ABS.
- The strategy needs to raise awareness by getting basic information out to students, teachers, and career advisors.
- The strategy will promote careers; however, it will not solve the main problem.
- There are two larger issues that need to be addressed by the ABS and SSAI:
 - Modifying the Australian school curriculum.
 - Promoting training programs in statistics for math teachers.
- The strategy is targeting over 2,600 schools, 686,000 students around Australia (ABS Schools, 2005).

Table 22: Important Factors Considered for Developing the Strategy

The primary recommendations are the set of approaches that the team feels will be the most effective way of promoting statistical careers, including how to evaluate the success of each of these approaches. The secondary recommendations are measures that the team does not feel are as effective at this time. However, with more time and research these could possibly be incorporated into the primary recommendations.

4.1 Primary recommendations

The team's primary recommendations constitute a strategy with components that will be put into place with the current programming being done at the ABS and NESU. This strategy has four main components: brochures, school visits, work experience, and professional development programs. These components tie into one another; e.g. a statistical career brochure can be given out at a school visit or at a professional development program.

Before the strategy is introduced, the group emphasizes that it is essential to give careers a well-known name and image such as that of the CensusAtSchool program. Consequently, the group strongly recommends that the NESU develops a logo to be used on all of the promotional material, with a phrase such as "Become a Statistician". As mentioned in Table 21 above, the ABS is well recognized among teachers, career advisors and even students. It would make sense to take advantage of

this representation and start giving careers in statistics a prominent image as well. The ABS needs to show the public its concern for the decreasing number of quality statisticians and that as a consequence, it is strongly interested in promoting careers in statistics. Like the ABS and CensusAtSchool logos, the “Become a Statistician” logo could be added to existing promotion such as the website, publications, and in gifts such as pens, hats, t-shirts, and calculators.

4.1.1 Career Brochure

A brochure that displays general information about careers in statistics is an effective way to get information out to students, teachers, and career advisors. This type of promotion is short, concise, and straight to the point. It gets the very basic information to the reader in a quick and simple way. A brochure is small and easy to carry around, hard copies are reasonably priced and an electronic PDF version can be made available at the NESU website. Most career advisors that were interviewed reported that they got the bulk of their information about careers from brochures, which they could then pass on to their students. The fact that most careers are promoted in Australia using this simple method proves its popularity and its effectiveness related to its manageable cost.

The content of the brochure is the most significant aspect. It is important to balance between making it too broad or too specific. An effective brochure needs the right amount of information in the right places. A graphic designer is best qualified to lay out the material. However, the group has developed some specific content guidelines for the brochure as shown below in Table 23. The main points that the brochure needs to provide are:

- What statistics is
- What statisticians do
- Opportunities in the field
- How to become a statistician

The resources section is also very important as it is an opportunity for the ABS and the NESU to advertise related programs, the ABS and NESU websites. The most important message that the brochure should have is that it should present statistics as being fun and exciting. As discussed in the analysis section, this is the best way to make careers in statistics appealing to students. The group gathered an extensive

collection of brochures that promote statistics. These contain further examples as to the content, layout, and general presentation of brochures promoting careers. Although these samples are not included in the report, the group has provided these copies to the NESU. The WPI team recommends that the NESU analyse these brochures in detail for ideas with the design of the careers in statistics brochure.

“Become a Statistician” Brochure Content

- “Become a Statistician” logo
- What is statistics?
 - Descriptive
 - Inferential
- What do statisticians do?
 - Business and industry
 - Health and Medicine
 - Learning
 - Research
 - Social Sciences
 - Natural Resources
- Opportunities
 - Pay
 - Job flexibility
 - Long term outlook
- How to become a statistician?
 - Qualities and skills required
 - VCE requirements for Victoria and equivalent for other states and territories
 - Degree requirements
- Resources
 - Other ABS and NESU resources
 - CensusAtSchool
 - Stat Pack
 - ABS and NESU Website
 - Link to the printable version of the brochure
 - Information on scheduling a school visit
- Other contact information

Table 23: “Become a Statistician” Brochure Content

These brochures should be sent to career advisors and math teachers in the 2,632 primary-secondary and secondary schools around the nation (ABS, 2005). It is

recommended to send between 5 and 10 brochures to each school, depending on the size of the school. An electronic version should be made available at the NESU website. It should be clearly advertised in the website and a link should be presented at the back of the brochure as well. As mentioned in the analysis section of this report, most career advisors are unaware of what a career in statistics is. Thus, this brochure will get the basic information out to them so they can then pass it along to students who seem interested.

The portion that will be targeted of the 686,000 students in years 10, 11, and 12 around the nation, are the students that are good and/or interested in math and science (ABS, 2005). It is recommended that the brochures be sent by the NESU in the two mail-outs it conducts in February and October each year. As mentioned in Table 22, it is vital and logical to take advantage of the resources and initiatives that this unit currently has. The NESU could also consider including brochures when mailing the Australian Schools Calendar developed by Education.au. The brochures should be continuously sent in order to keep the information up to date.

The expected result is to have increased awareness and better informed students, advisors, and teachers. More informed advisors and teachers will be able to suggest the different options of careers in statistics to students interested in math and sciences. This does not guarantee that students will want to become statisticians, but that they will now have an idea of possible careers in statistics.

Evaluating the results is the most difficult aspect of this part of the strategy. For the brochure, success should be measured in the long term. A good indicator of success would be an increase in the number of people who contact the ABS to get more information about careers in statistics. Tracking the number of visitors to the NESU website and the number of people who access the electronic version of the brochure are also good ways of measuring success. It is imperative for the NESU to get feedback on the brochure so that they can continually improve it. However, the biggest test will be monitoring the long run number of enrolments in programs in statistics at Australian universities.

4.1.2 School Visits

Visiting schools is an important step for the promotion of statistics to students. Talking with a statistician helps the students create a personal connection with the

career. According to career advisors, Australian students often want to become doctors, handymen, and other professions with which they have contact during their life. During the school visits students are engaged in what the speaker is talking about and are encouraged to ask questions. The school visits should be targeted at year 10 through year 12 math students. The Adopt-A-School and Kids to College programs in the United States are good examples of how well school visits can work to promote courses of study (Section 4.2.3.3). In order for school visits to succeed they must be advertised to schools. This can be achieved through a mention on the brochures as well as a link to schedule visits on the ABS or CensusAtSchool website.

When the speakers visit schools there is specific information that needs to be addressed. An important point to discuss is the use of statistics in different careers and in everyday life. Once students can see how important statistics is to them they will be more open minded towards it. It is also crucial to tell students about the career opportunities available to them in statistics. This includes information about the flexibility, salary, and benefits of the career. Students who are interested in other areas such as medicine and biology might be interested to know that they can work in those fields combined with statistics. This also allows the speaker to mention that not all careers involving statistics are at the highest skill level of statistics. Nevertheless, the intention should be to attract the best students in math classes. During this entire interaction it is important to maintain a personal connection to the students and ensure that the information is presented in an interesting way.

Due to the large number of schools in the country, a method of reaching them efficiently must be developed. One way of easing the burden on the ABS is through partnerships with universities, employers, and other statistics, mathematics, and science organizations. Younger employees or students in statistics from these organizations can be sent to schools nationwide. Since the ABS has an office in every state, it is in a good position to organize this program.

Since the presenters will be from different places and backgrounds, a training program would be necessary. The information given by speakers should be the same regardless of where they are from. However each speaker must add a personal touch to their talk in order to captivate the audience. Multiple trial school visits should be run before the program is used nationally. These will help determine how future speakers should be trained.

It is expected that implementing a school visit program such as this one will help create students who are better informed about statistics and the career opportunities associated with it. This result might not be evident immediately, but can be seen through the enrolment of students in higher-level math courses and statistics programs at university. This strategy is a difficult one to get started, as it is vital to first establish strong partnerships with various universities in order to be able to visit a large portion of the 686,000 targeted students. Still, it can be extremely successful in the long run.

4.1.3 Work Experience

Of all the options presented to the students, teachers and career advisors, most agreed that work experience would be the best choice to promote careers in statistics to students (93.10%). Hence the group strongly recommends that work experience be an option offered to students in years 11 and 12.

Of the many responses to interviews and focus groups, one strong point reoccurred: students need hands-on experience in order for them to enjoy a subject. This work experience should be offered to students in years 11 and 12 that have chosen to continue their math education into Further Math or Math Methods. Offering students the opportunity to work at companies such as the ABS will not only look outstanding on future résumés, but will also give the select group of students an in depth look of what statisticians do on a daily basis.

Although the ABS already does offer work experience for students, it is not advertised. In fact, the group did not find any information about available jobs to secondary students on the website. It is vital that these facts are not only available, but easily accessible, through the ABS website, and the previously mentioned brochure or school visits.

The group realizes that this recommendation is only a possibility for approximately 40-50 students nationwide (5-6 students employed at each of the eight ABS offices). However, these 40- 50 students will be those with strong interests in statistics and therefore the ones that are most likely to pursue statistics in universities. The ABS can measure the success of the promotional program by comparing applications to the work experience positions in years to come.

4.1.4 Professional Development

Through the data that the team has collected from interviews with math teachers, it is clear that teachers are not comfortable with teaching statistics. The group understands that better trained teachers make for a better education. Teachers need to be taught the material in a better way so that they can relate the information back to the students effectively. Because of this, the group is also recommending a professional development program for secondary school math teachers.

This last component of the strategy should be a continuation of the Interactive Qualifying Project (IQP) developed by last year's Worcester Polytechnic Institute group and sponsored by the ABS. The purpose of this project was to design a professional development framework tailored toward teaching statistics to mathematics teachers. The executive summary can be found in Appendix V, and the recommendations section can be found in Appendix W. The program that was recommended by last year's IQP suggests teaching statistics to the teachers and thus making them better informed of the field and the material. This year's team recommends adding an element of including teaching the teachers new ways to teach statistics, and improve the students' statistical learning. By the implementation of this program, the group feels that a better educational experience in statistics can be had by students without directly implementing a statistics course into the Australian curriculum.

4.2 Secondary Recommendations

There were many different components of a strategy that were discussed among the people interviewed. However, there are some recommendations that would currently not be effective in promoting statistics or are simply not as feasible at this time. The team is recommending these as secondary recommendations to the ABS to leave the door open for future projects and ideas. The secondary recommendations are still valid effective components; however, they would need to be implemented correctly.

4.2.1 Case Studies

Case studies are an effective way of presenting career profiles. From the data and analysis, case studies are overall very popular amongst the various groups the team spoke to. Nonetheless, the team feels that case studies could provide many

misrepresentations of the careers in statistics. Statistics needs to be presented in a fun and exciting nature to the students; yet, the truth of the profession still needs to remain. The profession cannot be shown as something that it is not. Case studies that are done in different professions are presented in different ways depending on the audience. It is made exciting and new for younger students, but it is submersed in specifics for university students. The team feels that for the students that the strategy is targeting, years 10-12, case studies that are developed and presented will misrepresent the statistical profession, and will not be an effective strategy component at this time. A right balance between making it fun and making it real needs to be reached, and it is not an easy task to embark on. In order to carry out this recommendation, the ABS needs to carefully select the people to profile and find a way to make it fun, interesting, and realistic.

4.2.2 Contests

Contests are a good way to promote statistics. However, previous knowledge of the subject is required. There was a consensus that contests were a good way to create student awareness of careers in statistics. Nevertheless, when comparing a possible statistics contest to contests in related fields, it was concluded that students need to have previous knowledge about the subject to be able to participate. A science fair, for example, is an effective contest because students already know about general sciences before doing the project. Considering the current Australian school curriculum, it can be concluded that most Australian secondary students do not know enough about statistics to participate in a statistics contest. Contests would be a good suggestion for students in New Zealand, who are very proficient in statistics. Over time, this could be a good idea in Australia, but major changes in the way statistics is taught need to be made first. For now, it does not make sense to promote statistics contests when many of the students did not know what statistics was even after having studied it in math class.

4.3 Conclusions

The four main components of the primary recommendations are an effective way to promote careers in statistics. They are reasonable, attainable, and not very costly. The group made an effort to adjoin this strategy to programs and activities that are currently being carried out by the ABS and the NESU.

The group feels that it is very important to emphasize the fact that this strategy will not solve the problem that the group defined as being “the supply of *qualified* statisticians”. Brochures, school visits, work experience, and professional development programs will not alleviate the trouble that affects Australia’s labour market. What they will do is create awareness about careers in statistics and provide general information. To do this the ABS needs to give careers in statistics an image of its own. It also needs to identify the different career paths, and state the fact that many positions regularly use statistics but do not have the title “statistician”. These are also careers in statistics.

The WPI group believes that ABS, in conjunction with the SSAI, is on the right track to defining the problem. They are aware that the problem lies within the curriculum and the way that statistics is taught in Australia. Thus, the only thing left to do is embark on this task before it is too late and the solution becomes even harder. The strategy proposed by this WPI group will make this task easier as students, teachers, and career advisors will be more informed. The group hopes that the government continues to consider this problem a priority and that Australia can become the next country to put an end to this large issue that is affecting many countries around the globe.

Appendix A: Interview Questions for University Professors

1. Can you give us a brief description of your position and your involvement with statistics?
2. Are you aware there is a problem with the declining number of professional statisticians?
3. What do you feel is causing the problem?
4. What do you think can be done to solve this problem?
5. Do you work or have you worked with any programs or activities promoting specific careers that you have found successful?
 - Which program and who was it geared at?
 - How did the program work?
 - Where was the program used?
 - What did the program do?
 - Why do you feel that this program was successful, i.e. how is success measured?
6. In your opinion, how can the **educational system/your organization** support the promotion of careers in statistics?
7. Of the following options, which one do you feel would be the best to promote statistics amongst secondary students? Why is this the case?
 - Summer programs
 - Offering stats as an elective course
 - Educational website/video
 - Interviews/Case studies of interesting professionals that use statistics (i.e. sports journalists, sports coaches, TV executives)
 - School visits - talks
 - After school programs
 - Contests (something like a science fair, but with statistics)
 - Reading material such as books, brochures, and posters
 - Work experience (work on a report)
8. Do you know any other further contacts that would be helpful to our project?

Appendix B: Interview Questions for Secondary School Teachers and Career Advisors

1. Can you give us a brief description of your position at this school?
2. What types of careers do you usually get asked about?
3. Where do you get your information from?
4. When do you generally talk to students about careers?
5. Are there any programs that you feel are or have been successful in promoting particular careers? (e.g. teaching, military, engineering)
(If answered YES continue, if NO go to question 6)
 - Which program and who (what year level) was it geared at?
 - Where, in what environment, was the program used?
 - What did the program do?
 - Why do you feel that this program was successful, i.e. how is success measured?
6. Are you aware that there is a problem with the declining number of professional statisticians?
7. Why do you think this might be? (give some examples of options, like below)
 - Is it that students are not aware of the different options of careers in statistics?
 - Is it that these careers do not seem attractive?
 - ...
8. In your opinion, how can the educational system support the promotion of careers in statistics?
9. How do you believe the ABS could help in the educational system?
10. What do you think the best way would be to encourage students to pursue careers in statistics?
11. What student year levels or populations do you feel would be best targeted for the promotion of careers in statistics?
12. Of the following options, which one do you feel would be the best to promote statistics amongst secondary students? Why is this the case?
 - Summer programs
 - Offering stats as an elective course
 - Educational website/video

- Interviews/Case studies of interesting professionals that use statistics (i.e. sports journalists, sports coaches, TV executives)
- School visits - talks
- After school programs
- Contests (something like a science fair, but with statistics)
- Reading material such as books, brochures, and posters
- Work experience (work on a report)

13. Do you know any other further contacts that would be helpful to our project?

Appendix C: Interview Questions for Professionals in Statistics and ABS Recent Recruits

1. Can you give us a brief overview, in your own words, of what the organization does?
2. How do you personally contribute to this?
3. Can you tell us a bit more about your background and experience in the field of statistics? How has it been part of your professional life?
4. Are you aware that there is a problem with the declining number of professional statisticians?
 - What do you feel might be causing this problem?
 - What do you think would attract more students into pursuing statistical degrees in college and then professional careers in statistics?
5. What factors influenced your personal decision to become a statistician or get involved with statistics at your position?
6. Was there a specific event during your education that had a significant impact on your decision to pursue this career?
7. Have you been involved in any programs or activities that have promoted careers (i.e. statistics, medicine law)?
 - Which program and who (what year level) was it geared at?
 - What did the program do promote these careers?
 - Was the program successful?
 - How have you determined the level of success of that program?
8. In your opinion, how can the educational system support the promotion of careers in statistics?
9. Do you know any other further contacts that would be helpful to our project?

Appendix D: Focus Group Questions for Teachers and Career Advisors

1. Start with experience in the classroom regarding math and statistics:
 - How much time is devoted to statistics as part of your math course?
 - Do students enjoy this part of the course? How do they respond to this part of the course?
 - From your experience do students who are good with math go on to do the higher level math courses in VCE (e.g. methods, further)?
 - Why do you think this is?
 - Do students come to you for advice on VCE courses?
2. Teacher roles in career/university counselling with students
 - Do you talk to your students about careers?
 - What types of careers, if any, do you get asked about?
3. Students interest in careers
 - What gets students interested in careers?
 - What do you think the best way would be to encourage students to pursue careers in statistics?
 - What student year levels or populations do you feel would be best targeted for the promotion of statistics?

Appendix E: Focus Group Questions for Students

1. Do you enjoy doing math?
2. Do you think you are good at math?
3. What is the first thing that comes to mind when you think of a statistician?
4. What do you think a statistician does? Where can they be found working?
5. Have you taken a course with statistics in it yet?
6. Did you enjoy it? Why or why not?
7. Have you started thinking about what you want to study at University?
8. Why do you want to study this?
9. What factors affected or will affect this decision? (e.g. parents, friends)

Appendix F: Survey Questions

With the following options, please mark whether or not you believe that this would be an effective way to promote statistics amongst secondary students. In addition, feel free to leave any comments.

- Summer programs
 YES NO
- Offering statistics as an elective course
 YES NO
- Educational website/video
 YES NO
- Interviews/Case studies of interesting professionals that use statistics
 YES NO
- School visits – talks
 YES NO
- After school programs
 YES NO
- Contests (something like a science fair, but with statistics)
 YES NO
- Reading material such as books, brochures, and posters
 YES NO
- Work experience
 YES NO
- Other

Appendix G: School Calling List

	School Name	Phone #	Webpage	Status
	Western Australia			
	<i>Public</i>			
1	Applecross Senior High School	(08)9314 9393	http://www.axnet.wa.edu.au	Received response from Sylvia Barrie 04/04/06 sylvia.barrie@det.wa.edu.au
2	Balcatta Senior high	(08)9345 8200	http://www.balcattashs.wa.edu.au	Left voicemail
3	Cannington Community College	(08)9351 2400		Sent email with questions to Paul Turton paul.turton@det.wa.edu.au
4	Fremantle Fast Track	(08)9430 7376		Will call us
5	Yanchep District High	(08)9561 1155	http://www.yanchep.wa.edu.au	Will call us
	<i>Private</i>			
6	Bedford Chisholm Catholic College	(08)9271 9000	http://www1.chisholm.wa.edu.au	Left voicemail
7	Glen Forrest Helena College Senior School	(08)9298 9100	http://www.helenacollege.wa.edu.au	Received response from Kate Abbott 04/03/06 kabbott@helena.wa.edu.au
8	Ursula Frayne Catholic College	(08)9470 0900	http://www.ursulafrayne.wa.edu.au	Left voicemail
	Tasmania			
	<i>Public</i>			
1	Claremont college	(03)6249 6868	http://www.clare.tased.edu.au	Received response from Bill Duhig 3/22/06 bill.duhig@education.tas.gov.au
2	Bothwell	(03)6259 5518		Will call us
3	Skill Centre	(03)6257 4021		Phone interviewed Christiane Knight on 03/23/06
	<i>Private</i>			
4	Bridgewater	(03)6263 7131	http://www.bhs.tased.edu.au	Will call us
5	New Norfolk	(03)6261 7800		Sent email with questions to Lynne Logan lynne.logan@education.tas.gov.au
6	Roakeby	(03)6247 7800		Will call us
	New South Wales			
	<i>Public</i>			
1	Balgowlah Boys High School	(02)9949 4200	http://www.nbscbalgh.schools.nsw.edu.au	Left voicemail
2	Blakehurst High School	(02)9546 3281	http://www.blakehurst-h.schools.nsw.edu.au	Left voicemail
3	Casula High School	(02)9602 4270	http://www.casula-h.schools.nsw.edu.au	Left voicemail
4	Hurstville Boys High School	(02)9587 3199	http://www.grchurstville.bmcc.education.nsw.gov.au	Left voicemail
5	North Sydney Girls High School	(02)9922 6666	http://www.northsydgi-h.schools.nsw.edu.au	Left voicemail
6	Chifley College Senior Campus	(02)9625 9920	http://www.chifcolsnr-h.schools.nsw.edu.au	Sent email with question to Anne Baker chicolsnr-h.school@dtu.nsw.edu.au
7	Bidwill High School	(02)9628 2222	http://www.bidwill-h.schools.nsw.edu.au	Sent email with questions to Lynda Sranklin lyndasranklin170@hotmail.com
8	Killara High School	(02)9498 3722	http://www.killara-h.schools.nsw.edu.au	Sent email with questions to Colleen Clarke c.clarke@khs.nsw.edu.au
9	Parramatta High School	(02)9635 8644	http://www.parramatta-h.schools.nsw.edu.au	Received response from Tom McCosker 03/28/06 tmccosker@yahoo.com
10	Woolooware High School	(02)9523 6752 (02)9523 9077	http://www.woolooware-h.schools.nsw.edu.au	Sent email with questions to woolooware-h.schools@det.nsw.edu.au

	Private			
11	Ashfield De LaSalle College	(02)9798 7033	http://dls.ashfield.syd.catholic.edu.au	Left voicemail
12	Dural Redfield College	(02)9651 4066		Left voicemail
13	Lakemba Holy Spirit College	(02)9759 4855	http://www.holyspirit.lakemba.syd.catholic.edu.au/welcome.html	Left voicemail
14	N. Sydney Monte Sant Angelo Mercy College	(02)9409 6200	http://www.monte.nsw.edu.au	Sent email with questions to Sally O'Keefe sokeeffe@monte.nsw.edu.au
15	Cobbitty Macarthur Anglican School	(02)4647 5333	http://www.mas.nsw.edu.au	Left voicemail
16	Marian College Kenthurst	(02)9654 2118	http://www.mariancollege.nsw.edu.au	Left voicemail
17	Newington College	(02)9560 5355	http://www.newingtoncollege.nsw.edu.au/front/default.htm	Left voicemail
18	Redeemer Baptist School	(02)9630 6311	http://www.redeemer.nsw.edu.au	Sent email with questions to m.s.school@aussiemail.com.au
19	Waverly College	(02)9369 0600	http://www.waverley.nsw.edu.au	Left voicemail
	Australian Capital Territory			
	Public			
1	Alfred Deakin High	(02)6205 5566	http://www.alfreddeakinhs.act.edu.au	Sent email with question to info@adhs.act.edu.au
2	Gold Creek School	(02)6205 1814	http://www.goldcreek.act.edu.au	Sent email with questions to Lana Read lane.read@goldcreek.act.edu.au
3	Stromlo High	(02)6205 6166	http://www.stromlohs.act.edu.au	Received response from Kate Bolton 03/27/06 kate.bolton@stromlohs.act.edu.au
4	Copland	(02)6205 7622	http://www.coplandc.act.edu.au	Phone interviewed Margaret Kilhan on 03/23/06 margaret.kilhan@coplandc.act.edu.au
5	Lake Ginninderra College	(02)6205 7099	http://www.lakeonline.act.edu.au	Received response from Kerrie Sollis 04/04/06 kerrie.sollis@ed.act.edu.au
6	Calwell High	(02)6205 6884	http://www.calwellhs.act.edu.au	Contact Livia Tigwell livia.tigwell@ed.act.edu.au
	Private			
7	Covenant College	(02)6294 2455	http://www.covenant.act.edu.au	Received response from Herm Zandman 04/06/06 zandman@ozemail.com.au
8	MacKillop Catholic College	(02)6209 0100	http://mackillop.cangoul.catholic.edu.au	Left voicemail, and emailed Karen Hundy karenh@mackillop.cg.catholic.edu.au
9	North Parramatta The Kings School	(02)9683 8444	http://www.kings.edu.au/community/index.htm	Received response from Babs Helleman 03/27/06 bfh@kings.edu.au
	Northern Territory			
1	Gray Good Shepherd Lutheran School	(08)8932 2003	http://home.austarnet.com.au/sheep	No career advisor: Sent email to math department admin goodshep@latis.net.au
2	Yulara Nyangatjatjara College	(08)8956 2155		Sent email with questions to Daniel Lynch danjameslynch@gmail.com
3	Alice Springs St. Philip's College	(08)8950 4511	http://www.stphilips.nt.edu.au	Phone interviewed Leslie Tilbrook 03/30/06 leslie.tilbrook@stphilips.nt.edu.au
4	Nightcliff School	(08)8985 0850	http://www.nightcliffhigh.com.au	Left voicemail
5	Alice Springs Yipirinya School	(08)8952 5633		Left voicemail and sent email to Sue Wait sue.wait@latis.net.au
6	Berrimah Kormilda College	(08)8922 1611	http://www.kormilda.nt.edu.au	Sent email with questions to admin@kormild.nt.edu.au

	South Australia			
	<i>Public</i>			
1	Adelaide Secondary School of English	(08)8340 3733	http://www.adsecenglish.sa.edu.au	Sent email with questions John Tsiavlis john.tsiavlis@adsecenglish.sa.edu.au
2	Hallett Cove School	(08)8392 1020	http://www.hcs.sa.edu.au	Received response from Erica Parker 04/07/06 parker@hss.sa.edu.au
3	Parafield Gardens High	(08)8258 9855	http://pghs.sa.edu.au	Will call us
4	Ross Smith Secondary	(08)8261 5744	http://www.rossmithhs.sa.edu.au	Sent email with questions to Kathryn Pearce Kathryn.pearce@rossmithhs.sa.edu.au
5	The Heights School	(08)8263 6244	http://theheights.webzone.net.au/index.shtml	Received response from David Lymn 03/30/06 david.lymn@theheights.sa.edu.au
	<i>Private</i>			
6	St. John's College	(08)8645 8568	http://www.stjohns.pp.catholic.edu.au	Sent email with questions to Rob Dvorak rob.dvorak@stjohns.pp.catholic.edu.au
7	St. Mark's College	(08)8632 2800		Left voicemail with Robin O'Day
8	Tenison Woods College	(08)8725 5455	http://www.tenison.adl.catholic.edu.au	Phone interviewed Marie Hoare on 03/27/06
9	Unity College	(08)8532 0100	http://www.unitycollege.sa.edu.au	Will call us
10	St. Joseph's School	(08)8682 3655		Will call us
11	Scotch College	(08)8274 4333	http://www.scotch.sa.edu.au	Sent email with questions to Ryan Dyson rdyson@scotch.sa.edu.au
12	Tabor Christian College	(08)8292 3888	http://www.bcc.sa.edu.au	Sent email with questions to irodaa@taborcc.sa.edu
13	St. Mary's College	(08)8231 4347	http://www.stmaryscoll.adl.catholic.edu.au	Sent email with questions to enquiries@stmaryscoll.adl.catholic.edu.au
	Queensland			
1	Brisbane State High School	(07)3406 2200	http://www.brisbaneshs.eq.edu.au	Sent email with questions to Nathan MacPherson nacp2@eq.edu.au
2	Clontarf Beach High	(07)3480 4777	http://www.clonbeachhs.eq.edu.au	Sent email with questions to Julianne Hoskins jhosk7@eq.edu.au
3	Eagleby Learning Centre	(07)3382 9222	http://www.eaglebylc.eq.edu.au	Sent email with questions to John Kirkland jkirk38@eq.edu.au
4	Ipswich State High School	(07)3813 4488	http://www.ipswichshs.eq.edu.au	Left voicemail with Bryan Kennedy (guidance counsellor)
5	Sandgate District State High School	(07)3869 9888	http://www.sanddistshs.eq.edu.au	Sent email with questions to Scott Wishite swish1@eq.edu.au
6	Clayfield College	(07)3262 0262	http://www.clayfield.qld.edu.au	Sent email with questions to Judy Fenton jfenton@clayfield.qld.edu.au
7	Sheldon College	(07)3206 5555	http://www.sheldoncollege.qld.edu.au	Left voicemail
8	Toowong Brisbane Boys College	(07)3309 3500	http://www.bbc.qld.edu.au	Sent email with questions to Michael Johnstone mjohnstone@bbc.qld.edu.au
	Other Contacts			
1	Australian Mathematical Society	(07) 3365 1354	http://www.austms.org.au	Sent email to Dr. Diane Donovan dmd@maths.uq.edu.au on 03/23/06
2	Department of Education Science and Training (DEST)	(02)6240 811	http://www.dest.gov.au	
3	Mathematics in Industry Study Group	(03)9344 6762	http://macserver.maths.muoz.au/misg	Sent email to Dr. Kerry Landman k.landman@ms.unimelb.edu.au on 03/23/06
4	University of Western Australia – School Manager	(08)6488 2400	http://www.stats.uwa.edu.au/StatsOffice/unistats/2005#Faculty	Sent email to Val Moore val@maths.uwa.edu.au on 03/23/06

5	University of Western Australia – Admin. Assistance	(08)6488 3338	http://www.stats.uwa.edu.au/StatsOffice/unistats/2005#Faculty	Sent email to Annette Harrison annette@maths.uwa.edu.au on 03/23/06
6	University of Western Australia – Admin. Assistance	(08)6488 3340	http://www.stats.uwa.edu.au/StatsOffice/unistats/2005#Faculty	Sent email to Tania Blackwell tania@maths.uwa.edu.au on 03/23/06
7	La Trobe University	(03)9479 2594	http://www.latrobe.edu.au	Interviewed Paul Kabaila on 04/03/06 p.kabaila@latrobe.edu.au
8	University of NSW	(02)9385 7093		Sent email to Dr. Jim Franklin j.franklin@unsw.edu.au
9	Monash University –VIC Math dept.	(03)9905 4465		Nick is getting information from here enquiries@maths.monash.edu.au
10	Australia National University-Canberra	(02)6125 3593		Sent email to careers@anu.edu.au
11	CSIRO	1300 301 509		Sent email to Csiro-Careers@csiro.au
12	Career Education Ass. Of Victoria (CEAV)	(03)9865 7555	http://ceav.customer.netspac.e.net.au	Frank Thompson – Vice President
13	Career Education Ass. Of Victoria (CEAV)	(03)9865 7555	http://ceav.customer.netspac.e.net.au	Called Linda Barron – Executive Officer
14	Career Education Ass. Of Victoria (CEAV)	(03)9865 7555	http://ceav.customer.netspac.e.net.au	Left voicemail with Jacky Burton
15	Catholic Education Office	(03)9267 0253	http://www.ceo.melb.catholic.edu.au	Talked to Gerard Torpy on 03/22/06 (see minutes)
16	Career Advisors Association	(02)6205 8139		Phone interviewed Dianne Bradford 03/27/06 dianne.bradford@erindalec.act.edu.au
17	Victorian Education Department	(03)9637 2314		Sent email to Leela Darvall Darvall.leela.l@edumail.vic.gov.au
18	CAA NSW – VP for Gov. Schools		http://www.caa.nsw.edu.au	Sent email to Heather Dolton heather.dolton@caa.nsw.edu.au
19	CAA NSW – VP for Non-Gov. School		http://www.caa.nsw.edu.au	Sent email to Gwen Cartwright gwen.cartwright@caa.nsw.edu.au
20	CAA NSW – Executive Officer	(02)9618 1153	http://www.caa.nsw.edu.au	Sent email to Lynn Camp info@caa.nsw.edu.au
21	CAA NSW - President		http://www.caa.nsw.edu.au	Sent email to Mike Geeves mike.geeves@caa.nsw.edu.au
22	Institute of Mathematical Statistics			Sent email to Elyse Gustafson imstat@gmail.com
23	Canadian Bureau of Statistics			Received Response from Jock Mackay 03/29/06 rjmackay@math.uwaterloo.ca
	ABS			
1	ABS Recruitment Dept.	1800 675 125		Sent email to recruitment@abs.gov.au 03/27/06
2	ABS Methodology Department	x 7364		Held impromptu focus group with 5 members of the dept. 03/28/06
3	Recent Grad into ABS	x 7667		Interviewed Will Mason 03/21/06
4	Recent Grad into ABS	x 7904		Emailed Viv King with questions
5	Recent Grad into ABS	x 7207		Interviewed Sarah Simkim 03/23/06
6	Recent Grad into ABS	x 7591		Emailed James Russo
7	Recent Grad into ABS	x 7218		Emailed Mcgregor Dawson
8	Recent Grad into ABS	x 7636		Emailed Shane Maher
9	Recent Grad into ABS	x 7479		Interviewed Manal Nasr 03/23/06
10	Recent Grad into ABS			Emailed Samantha Ferguson
11	Recent Grad into ABS			Interviewed Doryan Gowty 03/27/06
12	Recent Grad into ABS			Emailed Mark Burkhart
13	Recent Grad into ABS			Emailed Michael Savio
14	Recent Grad into ABS			Interviewed Sean Crick 03/28/06

15	ABS Methodology Department			Interviewed Elsa Lapiz 03/30/06
16	Recent Grad into ABS			Interviewed Adam Thomas 04/04/06

Appendix H: Applicants Received in 2003 for the ABS

Status	Stat Name	Status	Home Phone#	Email	Total	Created
Cadet APS - Econometrics					13	
	09. Not Recommended				1	
	12. Not Short-listed				6	
	14. Interview Rejected				1	
	16. Unsuccessful After Interview				2	
	18. Offer Accepted				2	
	19. Offer Rejected				1	
Cadet APS - Mathematics/Statistics					38	
	05. Missing Doc.				2	
	12. Not Short-listed				23	
	13. Interview Confirmed				1	
	15. Reserved After Interview				3	
	16. Unsuccessful After Interview				5	
	18. Offer Accepted				4	

Status	Stat Name	Status	Home Phone#	Email	Total	Created
Research Officer Grades 1 and 2 - Econometrics					55	
	05. Missing Doc.				1	
	12. Not Short-listed				35	
	16. Unsuccessful After Interview				16	
	18. Offer Accepted				2	
	19. Offer Rejected				1	
Research Officer Grades 1 and 2 - Mathematics/Statistics					167	
	05. Missing Doc.				1	
	12. Not Short-listed				109	
	13. Interview Confirmed				2	
	14. Interview Rejected				3	
	15. Reserved After Interview				4	
	16. Unsuccessful After Interview				40	
	18. Offer Accepted				6	
	19. Offer Rejected				2	
Research Officer Grades 1 and 2 - Time Series Analysis					5	
	12. Not Short-listed				5	

Appendix I: Applicants Received in 2005 for the ABS

Name	Applied For	Home Phone#	E	Total
Acknowledged			1	
Cadet APS - Mathematics/Statistics			1	
Interview Rejected			1	
Cadet APS - Mathematics/Statistics			1	
Not Recommended			1	
Cadet APS - Mathematics/Statistics			1	
Not Short-listed			37	
Cadet APS - Econometrics			6	
Cadet APS - Mathematics/Statistics			31	
Offer Accepted			6	
Cadet APS - Econometrics			3	
Cadet APS - Mathematics/Statistics			3	
Offer Rejected			1	
Cadet APS - Econometrics			1	
Undecided			1	
Cadet APS - Mathematics/Statistics			1	
Unsuccessful After Interview			18	
Cadet APS - Econometrics			5	
Cadet APS - Mathematics/Statistics			13	
				66

Name	Applied For	Home Phone#	Em	Total
Acknowledged			9	
Research Officer Grades 1 and 2 - Econometrics			1	
Research Officer Grades 1 and 2 - Mathematics/Statistics			8	
Interview Rejected			5	
Research Officer Grades 1 and 2 - Mathematics/Statistics			5	
Not Short-listed			59	
Research Officer Grades 1 and 2 - Econometrics			13	
Research Officer Grades 1 and 2 - Mathematics/Statistics			46	
Offer Accepted			11	
Research Officer Grades 1 and 2 - Econometrics			2	
Research Officer Grades 1 and 2 - Mathematics/Statistics			9	
Offer Rejected			8	
Research Officer Grades 1 and 2 - Econometrics			4	
Research Officer Grades 1 and 2 - Mathematics/Statistics			4	
Pending for Short-listing			11	
Research Officer Grades 1 and 2 - Econometrics			2	
Research Officer Grades 1 and 2 - Mathematics/Statistics			9	
Reserved After Interview			4	
Research Officer Grades 1 and 2 - Econometrics			2	
Research Officer Grades 1 and 2 - Mathematics/Statistics			2	
Unsuccessful After Interview			37	
Research Officer Grades 1 and 2 - Econometrics			12	
Research Officer Grades 1 and 2 - Mathematics/Statistics			25	
				144

Appendix J: Applicants Received in 2006 for the ABS

Name	Applied For	Home Phone#	Email Total
Acknowledged			11
Cadet APS - Econometrics			4
Canberra			2
Home State/Territory Only			1
No Preference			1
Cadet APS - Mathematics/Statistics			7
Canberra			5
No Preference			2
Not Short-listed			2
Cadet APS - Mathematics/Statistics			2
Home State/Territory Only			2
Recommended			1
Cadet APS - Mathematics/Statistics			1
No Preference			1
Undecided			1
Cadet APS - Mathematics/Statistics			1
No Preference			1
			15

Name	Applied For	Home Phone#	Email Total
Acknowledged			18
Research Officer Grades 1 and 2 - Econometrics			5
Canberra			4
No Preference			1
Research Officer Grades 1 and 2 - Mathematics/Statistics			13
Canberra			7
Home State/Territory Only			2
No Preference			4
Pending for Short-listing			11
Research Officer Grades 1 and 2 - Econometrics			2
No Preference			2
Research Officer Grades 1 and 2 - Mathematics/Statistics			9
Canberra			1
Home State/Territory Only			2
No Preference			6
Reserved After Interview			4
Research Officer Grades 1 and 2 - Econometrics			2
Canberra			1
No Preference			1
Research Officer Grades 1 and 2 - Mathematics/Statistics			2
No Preference			2
			33

Appendix K: Enrolment Patterns

Enrolment Patterns

Statistics became the 3rd largest Department in the Faculty of Science in Efts terms in 2004 (after the School of Biological Sciences and Computer Science) and remained so in 2005. The numbers in courses in 2005 were very similar to 2004. The only change of any note is a drop in international students from 25% to 22%, mainly from changes in Stage 1 and 2. A drop in Efts of about 5% has been forecast for 2006 as a result of restructuring.

Note that the International/Domestic splits for 2003 and 2004 are based on August projections of end-of-year figures.

TOTAL Efts

Level	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	352	347	365	310	371	421	418	527	516
2	201	205	210	184	161	187	222	248	242
3	94	106	101	106	102	97	116	112	119
Grad	29	30	47	48	42	53	66	61	69
Total	679	690	723	649	675	759	823	947	946

PERCENT INTERNATIONAL Efts

Level	1997	1998	1999	2000	2001	2002	2003	2004	2005
1				8%	16%	25%	24%	24%	19%
2				7%	10%	17%	27%	30%	26%
3				5%	5%	9%	16%	26%	30%
Grad				10%	9%	11%	18%	15%	19%
Of Total				7%	13%	20%	23%	25%	22%

INTERNATIONAL Efts

Level	1997	1998	1999	2000	2001	2002	2003	2004	2005
1				24	59	103	99	124	98
2				13	16	31	59	75	62
3				5	5	9	19	29	36
Grad				5	4	6	12	9	13
Total				47	85	149	190	236	209

DOMESTIC Efts

Level	1997	1998	1999	2000	2001	2002	2003	2004	2005
1				286	312	318	322	403	418
2				171	144	157	164	173	180
3				101	96	88	97	83	83
Grad				44	38	47	55	52	56
Total				602	591	610	638	711	737

(University of Auckland Statistics Department, 2005)

Appendix M: Level 8 New Zealand Statistics Course Description

Statistics

Achievement Objectives

Statistical investigations

Within a range of meaningful contexts, students should be able to:

- plan a statistical investigation to estimate (2σ) confidence intervals (margins of error) for the estimation of population parameters;
- report on a statistical experiment to investigate the consistency of samples in a process which is continuous over time.

Interpreting statistical reports

Within a range of meaningful contexts, students should be able to:

- explain differences between sample means and the population mean;
- recognise and explain sources of bias and unreliability in sampling situations;
- evaluate and explain the meaning of confidence intervals in estimating population parameters and in using samples for quality control;
- identify situations where the sample may not have come from a clearly defined population, and discuss the relevance of the findings.

Exploring probability

Within a range of meaningful contexts, students should be able to:

- solve problems, using techniques which simulate a probability situation;
- define and use the basic terms and concepts of probability;
- choose the appropriate distribution (binomial, Poisson, or normal) to model a given situation, calculate probabilities and expected values, and make predictions using the model;
- calculate and interpret expected values for practical situations.

Suggested Learning Experiences

Statistical investigations

Students should be:

- discussing the sensible use of location, spread, and visual displays of data in a wide variety of applications, and interpreting their use in the news media, and in technical, business, and their own reports;
- performing practical experiments to verify sampling distributions and discussing the central limit theorem;
- using sample statistics:
 - as estimates of population parameters;
 - to calculate standard error and apply to confidence intervals using the 2-standard error rule;
 - to investigate large sample confidence intervals for the population mean, population proportion, and the difference between the means of two populations;
 - to consider bias and sampling error;
- simulating a continuous process, for example, by cutting pieces of string to a specified length, then analysing samples to determine the consistency of the process;
- investigating industrial applications of sampling to quality and/or process control.

Interpreting statistical reports

Students should be:

- investigating “margins of error” in survey reports and opinion polls;
- critically analysing data and reports to determine the point of view of the author, and re-presenting data for different target audiences;
- using appropriate technology to interpret data which does not assume any particular distribution.

Exploring probability

Students should be:

- using simulations to model real or imaginary situations;
- exploring the basic concepts of probability (trial, outcome, sample space, event) including disjoint (exclusive) events, complementary events, and exhaustive events, and should be calculating probabilities of combined events, conditional probabilities, and independent events;
- exploring discrete random variables and their use in, for example, life insurance, games of chance, events involving risk;
- formalising the expected value and variance of a linear function of a random variable and of sums of independent random variables;
- discussing, and experimenting with different probability distributions (rectangular, binomial, Poisson, normal), exploring their applications, developing criteria for the application of each and the relationships between them, and using tables of probabilities for these distributions;
- creating probability distributions for given variables and using them to solve problems;
- exploring the use of probability models in simulations. For example, they could investigate the use of a spreadsheet to apply the Poisson distribution in a simulation of queuing at a supermarket checkout during various time periods in a day.

Appendix N: School Teachers and Career Advisors Interview Responses

1. Can you give us a brief description of your position at this school?
 - Career Advisor (sometimes also a teacher)
 - 1 on 1 and group advice with career choices, aspirations, subject selection, skill shortages, labour market trends
 - Help to apply to universities, with resumes, interview techniques
 - Usually for years 10-12
 - Often coordinate work experience and VET programs
 - Run career expos
 - Head of business dept
 - Director of Upper School
 - Studies Co-ordinator
 - Computer assisted career guidance program for all year 10s (Job Ideas & Information Generator-Computer Assisted Learning – JIIG-CAL)
 - Available as a career advisor 15 hours a week
 - Manage work experience
 - Manage South Australian Certificate of Education (SACE)
2. What types of careers do you usually get asked about?
 - A lot of medicine (aspirations)
 - Apprenticeships
 - Business and commerce
 - Local jobs depending on location
 - Automotive
 - Law
 - Armed Services
 - Nursing
 - IT positions
 - Real Estate
 - Hair and Beauty
 - Building trades
 - In general, many careers are asked about, but almost never statistics

- Mainly “stereotypical one” Physio, Marine Biology, Forensic Psychology
 - Engineering
 - Police
3. Where do you get your information from?
- Mailing lists that send up-to-date information each year
 - Websites
 - DEST
 - Visiting universities and university brochures
 - Career expos
 - Specialist teachers
 - Past students experiences
 - Network of employers
 - Other career advisors
 - Career books such as the Job Guide
 - Sent from professional societies
 - MyFuture.com www.myfuture.edu.au
 - VTEC guide
 - Mandatory career nights
 - Attending workshops offered through TAFES and Unis
 - Career Education Association (CEA)
 - CIT (Canberra TAFE)
 - Past students that come back
 - Training providers
 - SATAC Publications
4. When do you generally talk to students about careers?
- Mostly years 11 and 12
 - Some in year 10, few talk to students younger
 - End of year 9
 - 10, 11, 12
 - Make appointments
 - Formal assemblies

- One school has a career expo in the early stage of year 9, which starts to get them thinking of what they might be interested in
 - Year 10 does a term of career research with a week of experience
 - Year 10 has Vocational Education Classes
 - Year 11, 12 have lunch time workshops
 - When they need to plan out their subjects
 - Year 8 does “the Real Game” www.realgame.gov.au
 - Advise to take topics that they are good at
 - Career Classes
 - Twice a year
 - Prior to work experience
5. Are there any programs that you feel are or have been successful in promoting particular careers? (e.g. teaching, military, engineering)
- (If answered YES continue, if NO go to question 6)
- Yes: 14
 - No: 5
 - Scholarships offered for engineering
 - Have CD’s with info (students are technologically aware, but would rather look at hard copies)
 - Nursing programs
 - Work skills → picked up at career expos and passed out to every student
 - Job Search Australia → gets sent to schools
 - ADF, Police and all VET Programs
 - Myfuture.com, where you can explore careers and find info. Is linked to the Jobs Guide
 - Kaleidoscope → Melbourne based, for students to find out what they are good at
 - Local forestry and logging promotion → came to schools and talked, showed videos and equipment
 - Women Science Promotion
 - Defence forces → have guest speakers that speak to years 9 and 10. Also spend a lot of money on advertising (X 3)

- Hair and Beauty → geared at year 10, 11, TAFE... not in classroom, with practical activities
 - Career expo for entire town where students can talk to all sorts of businesses
 - Nursing promotion through posters, courses and booklets. Build awareness of specific situations that are occurring e.g. the shortage of nurses (X 2)
 - Medicine → offered tests to see if you fit the profile
 - School Apprenticeship Link program aimed a year 11, 12 → students attend TAFE classes and go to employer once a week
 - “Math Multiplies your chances” slogan used in TV ads, and posters about 5-10 years ago
 - “Chartered Accounting”
 - Manufacturing Learning Centre program (MLC) → ran out of Mitsubishi motors, where students trained ON THE JOB for 6 months
6. Why do you feel that this program was successful, i.e. how is success measured?
- All the information is there, but it is difficult to get them to think more broadly
 - Their minds are made up by more internal factors than external
 - Students using information, materials and discussing it with the advisor
 - The kids have learned something, and now know pathways and are opening horizons
 - Students ask questions regarding the particular profession
 - Student feedback, and constant student interest
 - Willingness of business participants, attendance, and government funding
 - Unknown... but if one students goes, it could be considered success
 - Not measured, only based on feedback
 - Many students got apprenticeships out of it
 - “MMYC” had many students go into math, but also made the weaker kids think they didn’t have a chance without math (kind of backfired)

- Accounting had a decline in students enrolled, until poster came around, and in past 3 years have seen an increase
 - Students achieved nationally with recognised qualifications
7. Are you aware that there is a problem with the declining number of professional statisticians?
- Yes: 5
 - No: 16
8. Why do you think this might be? (give some examples of options, like below)
- Is it that students are not aware of the different options of careers in statistics?
Is it that these careers do not seem attractive?
- Most mathematically inclined students go into economics, engineering and commerce fields
 - They don't see it as a recognizable career → see math as a tool
 - No identifiable pathway
 - Not appealing → see it as a job that deals with numbers and research... most students are interested in more creative careers
 - AWARENESS
 - Many different careers in math and sciences aren't as attractive, with the exception of Actuarial studies
 - Career advisors and math teachers need more info
 - Stats sounds boring
 - Kids are visually stimulated and it has to be something that they see regularly
 - Kids don't like math
 - No teaching curriculum
 - People in the field are not publicizing it
 - Never had any promotion for it
 - Associated with high math, and unattainable for many students
 - Don't find statistics challenging
 - Need to know that statistics is important
 - Courses don't make the connections to the opportunities
 - Its not in their face, compared to other professions promoted in TV shows

9. In your opinion, how can the educational system support the promotion of careers in statistics?
- Give it a name, like an engineer, or doctor
 - Not recognizable
 - Get info out there and have students become familiar → Easy Access
 - Promote the range of occupations, features and benefits – pay, industry fit, etc
 - Have information in school newsletters
 - Have high profile speakers at year 12 assemblies
 - Sending representatives
 - Kids need pathways
 - Give training packets, videos
 - Inform teachers of educational requirements, options and working conditions students can expect
 - Make math easier
 - Talk about career opportunities
 - Design a school curriculum
 - Comprehensive training of teacher, with comprehensive teaching resources
 - Let the career advisors know, give info, and ask to promote it
 - Career Expos
 - Have stats not be lumped into “numbers” section of math curriculum
 - Get kids to do realistic problems
 - Directly target the Mathematics departments in school
 - Include the topic in broad spectrum presentations at school
 - Push the fact that there is a demand
 - Have Unis provide more courses
 - Convey to teachers the importance of stats, and have them point it out to students during that part of course
 - Make a DVD/posters and point out what makes it a great career to be in... e.g. Testimonials from young statisticians
10. How do you believe the ABS could help in the educational system?
- A document

- Put something on the website, so that career advisors can look at what exactly is need on the pathway to become a statistician, from High school
- Send out postcard with an idea, to give to math students
- Use info from ABS → not available to students free of charge (?)
- Make work more transparent and understandable for students
- Visits to pre-tertiary business, accounting and math classes
- Providing data on income and the variety of jobs available and opportunities for advancement
- Need to mail out information to careers and year 12 coordinators
- Run high profile seminars with excellent speakers
- Get materials
- Go to schools
- Have traineeships
- Have and easier website for students to understand when it is being used for classes
- Have ads on the website
- Give schools info and statistics on job availability in different fields
- Make subject exciting for choosey students
- Use ABS for many things, but never see anything about what the people the ABS do
- Career advisors are always willing to promote specific careers
- Make educational kit to give to teachers
- CensusAtSchool is very good, but needs to be better organized
- Having a guest speaker
- Sponsoring awards in schools
- Making career advisors aware of the different pathways available in the ABS
- Make teachers and students aware of what is available
- ABS needs to add a educational link to website that is student friendly

11. What do you think the best way would be to encourage students to pursue careers in statistics?

- Someone could come to career expos and talk about the possibilities (June 6th in Canberra)
- Deal with the IMAGE problem
- Provide INFO!!
- AWARENESS raising of wide range of interesting jobs
- Counsel Day
- Give country students a chance to get work experience
- Come to school and give out prizes/freebies at speech nights
- Prove that there are plenty of jobs available
- Flashcards from people from SONY with people working in Europe, to show off peoples ability to work anywhere
- Need to find out about it before they get to Uni
- Need to advertise to the right crowd
- Make sure they see it as interesting and important
- Make sure teachers talk it up → awareness of significance
- Awards in schools
- Possible cadetships
- Give lots of different pathways, to be included in career newsletters
- Offer School Based New Apprenticeships (SBNA) to year 11 and 12 students → attracts a lot of attention

12. What student year levels or populations do you feel would be best targeted for the promotion of careers in statistics?

- (Out of 21)
 - Year 7: 1
 - Year 8: 1
 - Year 9: 1
 - Year 10: 12
 - Year 11: 17
 - Year 12: 17
 - Other: 2
- Years 11 and 12 (either they are or are not at the correct level of math)
- After college, 25+ (??)
- Years 10, 11, 12

- Years 10, 11
- VCE and year 11 and 12 students in math areas
- Year 7 → start young and continue until graduation

13. Of the following options, which one do you feel would be the best to promote statistics amongst secondary students? Why is this the case? (Explain each option with examples)

- Summer program
 - YES: 3
 - But competes with science programs
 - Very hard to organize
 - NO: 13
 - Students are busy with sports and jobs
- Offering stats as an elective course
 - YES: 5
 - Have ABS collaborate with local or state government to conduct out of school action research programs that collect real data
 - NO: 11
 - Very difficult to make happen → locked into the curriculum
 - Would have to provide teacher
- Educational website/video
 - YES: 12
 - Yes to the website only then you don't have to resend information
 - Needs to be part of the education
 - But just talking heads in the video
 - NO: 4
- Interviews/ Case studies of interesting professionals that use statistics i.e. sports journalists, sports coaches, TV executives
 - YES: 16
 - Need a younger crowd, people who have made good progress in a short amount of time

- Very important!
 - Will allow students to get an understanding of what each of the different types of positions may entail
 - Will allow students to relate
 - There is currently someone making a CD with stuff like this for all sorts of careers
 - But how do you deliver it?
 - NO: 0
- School visits - talks
 - YES: 14
 - For country schools, you can go to one big school, where other schools can attend
 - NO: 2
- After school programs
 - YES: 1
 - Can only be geared at a very specific group
 - NO: 15
- Contests (something like a science fair, but with statistics)
 - YES: 12
 - Competition is a big career focus
 - Yes, but more for years 8 and 9
 - Need a range of different math though
 - NO: 4
- Reading material such as books, brochures, and posters
 - YES: 13
 - Needs to be catchy with references, brief but informative
 - Kids like stuff in their hands
 - Posters suitable for math classrooms would be useful
 - NO: 3
- Work experience (work on a report)
 - YES: 14

- Needs to be targeted and a program where you can rotate
- Send career advisors with a list of people who could arrange work experience for interested students
- Should be teamed with others
- If the ABS would do it, then yes

○ NO: 2

14. Comments:

- Outside of cities things are different
- Career advisors are always receptive to something new
- Have people go to open days at universities (July – August)
- DECS SA has a curriculum statement and program already constructed that focuses on action research but not many teacher know about it
- “Games Day” Contests are offered through the Mathematical Association of Victoria (MAV) (Math Talent Quest) → then you can take advantage of a big group together, and work with them to build in statistics

Appendix O: ABS Recent Recruits Interview Responses

1. Can you give us a brief overview, in your own words, of what the ABS does?
 - Provides reliable information to the government and public to help make informed decisions
 - Uses statistics to aid in decision making
 - Provides statistics: Surveys/census... client service role for government
 - Collect and present facts without commentary → impartial as possible
 - Official stat. agency for Australia that makes statistics available to public to plan the future of the country
 - Runs surveys that provide official statistics for Australia
2. How do you personally contribute to this?
 - Looks at economically significant businesses, and gathers information and compares to previous years, to help ABS conduct research
 - NESU objective is to improve statistical literacy → administers lesson plans, and CensusAtSchool program
 - Census training
 - Profiler in large business dept. Maintains register
 - Service industries
 - Managing a team of 30 preparing the census for this year
3. Can you tell us a bit more about your background and experience in the field of statistics? How has it been part of your professional life?
 - Had statistics since year 10, but doesn't actually use numbers at job
 - Studied Business Marketing → had no intention of going into statistics, and has no background in statistics
 - Studied quantitative methods and economics in Uni
 - Stats had always popped up throughout studies. Last year if Uni, concentrated on Stats, and Statistical Analysis methods. However does not use statistics at ABS, more business knowledge
 - Was always good at math, and majored in econometrics (Stats), and then ended up at the ABS

- Studied Information Sciences, but changed to Statistics → first intro class into Statistics got him hooked. Now deals more with people than stats
4. Are you aware that there is a problem with the declining number of professional statisticians?
- YES: 3
 - NO: 3
 - What do you feel might be causing this problem?
 - Perception at school and uni is that it is boring and uninteresting
 - Students have a negative attitude towards it
 - Career opportunities are not well paid
 - Currently it is only being taught to people with statistical literacy
 - Not given the importance
 - Not seen as a career
 - Not advertised
 - Many start out in actuarial Math first
 - Up until 8/9 months ago, when it came to recruiting the numbers dropped
 - People think it's nerdy
 - What do you think would attract more students into pursuing statistical degrees in college and then professional careers in statistics?
 - Greater rewards/pay
 - More information on what they do and how they contribute
 - Get rid of the negative stigma that comes with stats, even at ABS
 - Needs to be seen as a career
 - Show that there is a reward there and money there. Compare to business and actuarial
 - Have to get to schools and have talks and thing to get students attention → prolonged campaign

5. What factors influenced your personal decision to become a statistician or get involved with statistics at your position?
 - Enjoyable to see how information is used from statistics, and how decisions are made from statistics
 - Was open-minded and got interested in the job at the interview. Realized how important statistical literacy is.
 - Had good program for grads, and had used a lot ABS statistics in studies for economics → saw relevance
 - Forced into taking a “sandwich year”, and realized how important statistics is
 - Found it interesting at Uni
 - Decided to try it, but ended up sticking with it
 - Had good Uni courses
6. Was there a specific event during your education that had a significant impact on your decision to pursue this career?
 - Nothing specific, just found it enjoyable to study
 - Liked accounting and economics teachers and professors
 - Parent’s influence
 - Econ professor was big influence, who worked at ABS as well and then moved into economics
 - HS teacher said to take certain math... not a life-defining moment though
 - Careers Day → handed out flyers at Uni, and answered questions
7. Have you been involved in any programs or activities that have promoted careers in statistics?
 - At Universities, there were promotions for certain careers
 - CensusAtSchool: Students have access to data they create and then do activities with them. Was successful, because it is popular in the 2500 schools (over 25% nationally). But it is hard to measure statistical literacy.
 - In HS, Unis came to school, and in Uni, they had career fairs
 - In year 10, were forced to get work experience

8. In your opinion, how can the educational system support the promotion of careers in statistics?
- At the younger level (early HS) explain the importance and relevance of statistics: the research, the data, etc.
 - Kids need to know that it is not just math, but it is everywhere (Not Narrow)
 - Give students ideas of what the ABS does, and experience with large companies
 - Greater emphasis on statistics in math classes in earlier years
 - Include statistics in curriculum
 - Make it more exciting
 - People are not aware of what it is useful for
 - IMAGE
 - Promote it as something more dynamic
 - AWARENESS at schools
 - Schools only teach the very basics, and make it too obvious and not interesting
 - There are no real world applications in classes
9. Any further comments:

Appendix P: ABS Methodology Unit Interview Responses

1. Can you give us a brief background of your education?
 - Master of Applied Mathematics
 - Studied Economics at Monash uni → Econometrics honours
 - Graduated in Mathematics → Masters in Statistics
 - Majored in Econometrics/Business Statistics at Monash → completed Honours degree
 - Graduate Diploma in Statistics/Operations Research
 - Bachelor and masters in Stats → taught undergrad statistics courses → research assistant → ABS
2. Can you give us a brief description of your position at the ABS and your involvement with statistics?
 - Methodologist → sampling design, maintenance and data analysis
 - Designing retail/wholesale industry survey
 - Business Survey Methodology → provides methodological leadership and support to service industries branch
 - Sample design work for surveys
 - Involves a lot of common sense and problem solving
3. Can you give us a brief overview, in your own words, of what the organization does?
 - Provide statistical analysis
 - conduct census surveys
 - produce stats for business needs
 - collect, collate and analyse data in various areas of economic and social life
 - provide statistical service for government and private sectors to help with decisions with various matters
 - business of collecting data info which is given to legislatures to make decisions
 - determines economic performance of the country
4. Can you tell us a bit more about you background and experience in the field of statistics? How has it been a part of your professional life?

- Started to learn about statistics when employed by ABS → Stats background does not extend beyond first year at uni.
 - Did uni studies and went to ABS
 - Worked in statistics field for about 27 years → demography, sample design projects, etc...
 - Worked with government statistics and market research
 - Applies statistics at ABS → at uni made models of economy
 - Does not use everything she learned → more specialized on survey design
5. What factors influenced your personal decision to become a statistician?
- Application of Maths/Stats to real life project
 - Enjoyed econometrics subjects more than straight econ courses
 - Personal preference was to do something with applied mathematical skills
 - Always likes maths and figures → found that did best in those subjects at school and uni.
 - Interest in numbers
 - Final year of high school thought about going into accounting → wanted something in the area of maths
6. Was there a specific even during your education that had a significant impact on your decision to become a statistician?
- During master thesis, had to use covariance method to analyse some realistic problem.
 - After graduation, started working in a research institute and realised that they needed to specialize in a field of applied maths
 - Liked to analyse data
 - Teacher mentioned it, and got the idea from that

Appendix Q: University Professors Interview Findings

1. Can you give us a brief description of your position and your involvement with statistics?
 - Teacher and researcher at Uni
 - Leads statistics department
2. Are you aware there is a problem with the declining number of professional statisticians?
 - No → did not notice decline, since there has always been a small number enrolled
 - Yes
 - What do you feel is causing the problem?
 - Not enough high school students and early year students with an interest in maths are aware of the rewarding careers and the current demand exceeds supply
 - What do you think can be done to solve this problem?
 - La Trobe University is currently doing the following:
 - Produce a statistical science Student Handbook
 - Copy of recent jobs from the website
 - Gained accreditation of the statistics major through SSAI
 - Websites
 - Sending honours students to high school to talk about professions
 - Have offered 2 AMSI summer vacation scholarships to encourage the best 3rd year students to go into statistics honours
 - Would like to see happen:
 - Have large employers of statisticians provide prizes/scholarships to the best 2nd and 3rd year students
 - Provide paid summer vacation work experience to students interested in a career in statistics
 - Send representatives to Universities to talk to students taking statistics units about possible careers

3. Why do you feel that this program was successful, i.e. how is success measured?
 - The number of students enrolled in the program in 3rd year went from 4 students in recent years to 18 last year, and 12 this year
4. In your opinion, how can the **educational system/your organization** support the promotion of careers in statistics?
 - University of Waterloo (Canada) has tried many approaches
 - Highly mathematical approach or very applied approach
 - Neither really sparked interest in the students
5. Of the following options, which one do you feel would be the best to promote statistics amongst secondary students? Why is this the case?
 - Summer programs
 - Offering stats as an elective course
 - Statistics is poorly taught in HS. First priority should be to correct this
 - Educational website/video
 - Interviews/ Case studies of interesting professionals that use statistics (i.e. Sports journalists, Sports coaches, TV executives)
 - Would give students wrong impression of statisticians
 - School visits - talks
 - Send honours students
 - After school programs
 - Contests (something like a science fair, but with statistics)
 - Professor was recently involved with such a program
 - Students were good at making PPT presentations but the knowledge and understanding of statistics was awful
 - Didn't seem to be "cool" → especially seniors were not interested in the subject or project
 - Reading material such as books, brochures, and posters
 - Work experience (work on a report)
 - Very difficult to provide work experience for high schoolers that would motivate them to proceed with statistics studies at Uni

6. Comments:

- Best opportunity is to approach students after they arrive in the university
- Stats students get taken by employers very quickly

Appendix R: Teacher Focus Group Findings

- 26 Teachers out of 27 unaware that there is a shortage of statisticians in Australia
- Around 20% of time in classroom is devoted to statistics, but even less in years 9 and 10
- From years 7 through 10 it becomes repetitive
- Becomes a bigger part of “Further Math” course (8-10 weeks)
- Students do not like the number crunching of statistics, but are able to
- Makes more sense to them compared to algebra
- Like doing the analysis, survey, and presentation aspects of Statistics
- Kids enjoy it in years 7 and 8, but get bored with it in later years
- About 80% of students do math in year 12, even though they have the choice of dropping it at year 11. → to get into good Unis and because employers use it as a measuring tool
- Very many students go to math teachers and career advisors for advice on which math to take: Further Math, Math Methods or Specialist Math
- Of the 6 offered VCE math courses:
 - Unit 1 and 2 (year 11): Foundation Mathematics: does not include Statistics in the 4 areas of study
 - Unit 1 and 2 (year 11): General Mathematics: includes “Statistics and Probability” and 5 other areas
 - Unit 1 and 2 (year 11): Mathematical Methods: includes “Probability” and 3 other areas
 - Unit 3 and 4 (year 12): Further Mathematics: includes a compulsory area of study “Data Analysis” and 3 other areas
 - Unit 3 and 4 (year 12): Mathematical Methods: includes “Statistics and Probability” and 4 other areas
 - Unit 3 and 4 (year 12): Specialist Mathematics: does not include Statistics in the 6 areas of study
- Teachers are not advised to talk to students about careers, because they might provide wrong information → all advice to take global courses vs., just going down one pathway

- Math teachers get asked what students can do with the math they are taking → ask about engineering
- Students are interested in how much a job gets paid, excitement, advertising/exposure, seeing it in action (TV shows: CSI) and how it is delivered
- Need to find a way for students to enjoy math first. If they do not enjoy it, it is not worth pushing.
- Information needs to be clear to teacher, parents and students
- Should talk to only those going into math, otherwise it will bring negativity to the crowd

Appendix S: Student Focus Group Findings

- Students enjoy maths when they understand it and it comes easy to them
- Some think math is the “worst subject ever” → don’t gear promotion at them
- Students think that statisticians are people who
 - use lots of numbers and data
 - do a lot of repetitive work
 - calculate lines and lines of numbers
 - analyse information that is given to them
 - use tables and graphs
 - work at the ABS and big businesses
- Students don’t know when they took statistics → didn’t realize they were doing statistics when it was covered in class
- Some students enjoyed statistics, some didn’t
 - They enjoy it when it is easy, and can relate it to something they like
 - One student remembered a project done in 7th grade where data was gathered on their favourite cricket team, and made a report about it.
- Students all agree that it needs to be made more exciting and involved with things that they are interested in
 - Statistics is one of the easiest subject to be able to incorporate in any subject → can find statistics on almost any topic
- Many students in year 10 are still up in the air on what they want to study at uni.
 - Know that things may change
- Students want to study the subject they want, because
 - They like it → if you enjoy it enough, you will be successful
 - Enjoy it even if they aren’t necessarily good at it
- Students have not thought about studying maths further than their VCE courses.
 - They do not know that most majors require math in Uni as well
- After Nick talked to students about what statisticians do for about 10 minutes, 4 out of the 15 students stated that they would be interested in looking into statistics.

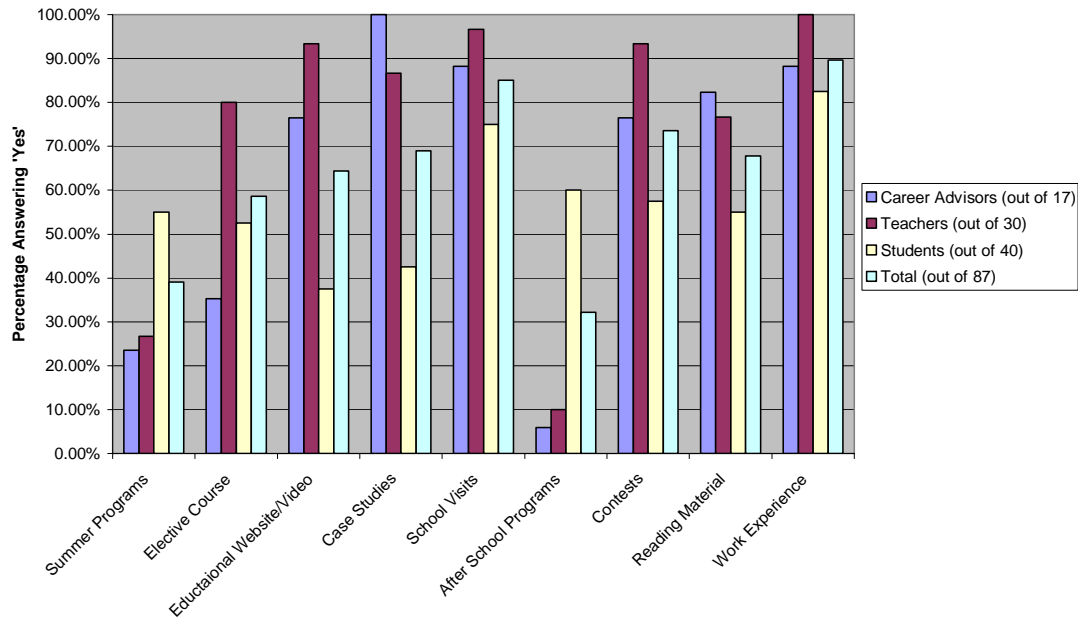
- Many students are aware of career paths, through family members (parents, siblings, etc.)

Appendix T: ABS Methodology Unit Focus Group Findings

- Think that problem with declining statisticians is exaggerated
 - More of a decline of *quality* of applicants
- Reasons for declining statisticians:
 - Profile of statistics → image of number-cruncher
 - Students are not aware of opportunities in high school
 - See it as a difficult subject, and choose something that looks more attractive instead
- Students need to be informed early on (year 6) before they make up their mind
 - Students strong in maths tend to go towards accounting and actuarial
- Students can't see the use of statistics → need to know where they can apply it
- Have an info session, where students can explore careers early on in secondary school
- Raise statisticians salaries and people will follow
 - If there is a demand for statisticians, why has the salary not gone up?
- Abs can help by:
 - Going to universities and talk about careers
 - CensusAtSchool
- Australia needs more people with analytical skills vs. statisticians
- Methodology unit barely uses statistics beyond level 2 from university
- Many people are overqualified for jobs with PhDs in Statistics
 - In Melbourne office of 250 employees, only 2 people that do survey design (beyond year 2) → no more are needed
- ABS chooses people based on how they think and work → A recent graduate could get job over a PhD
 - Looking for well-rounded people
- Having a degree in statistics does not make someone a statistician
- Statistics is a wide field, and people always go down the same path

Appendix U: Survey Results

Comparasion of Career Advisors,Teachers and Students



Possible Promotion Strategy

	Career Advisors (out of 17)	Teachers (out of 30)	Students (out of 40)	Total (out of 87)
Summer Programs	4	8	22	34
Elective Course	6	24	21	51
Educational Website/Video	13	28	15	56
Case Studies	17	26	17	60
School Visits	15	29	30	74
After School Programs	1	3	24	28
Contests	13	28	23	64
Reading Material	14	23	22	59
Work Experience	15	30	33	78
	Career Advisors (out of 17)	Teachers (out of 30)	Students (out of 40)	Total (out of 87)
Summer Programs	23.53%	26.67%	55.00%	39.08%
Elective Course	35.29%	80.00%	52.50%	58.62%
Educational Website/Video	76.47%	93.33%	37.50%	64.37%
Case Studies	100.00%	86.67%	42.50%	68.97%
School Visits	88.24%	96.67%	75.00%	85.06%
After School Programs	5.88%	10.00%	60.00%	32.18%
Contests	76.47%	93.33%	57.50%	73.56%
Reading Material	82.35%	76.67%	55.00%	67.82%
Work Experience	88.24%	100.00%	82.50%	89.66%

Appendix V: 2005 WPI Interactive Qualifying Project- Executive Summary

The ability to critically evaluate and apply statistical information can be a valuable skill in gaining a better understanding of society as a whole and can aid in the development of informed opinions. Furthermore, many professions rely on the utilisation and interpretation of compiled data. As a result, the ability to use statistics is a valuable skill for planning and evaluating both personal and professional decisions.

The Australian Bureau of Statistics (ABS), the organisation responsible for the collection and distribution of statistics throughout Australia, maintains that the ability of the general populace to make informed decisions is closely related to their level of statistical literacy. ABS has noted that the number of statisticians graduating from Australian universities is declining, suggesting an insufficient level of interest in statistics. In an effort to improve overall interest in statistics, the Bureau has chosen to focus on expanding statistical literacy among students in the middle years (8-10) of their education.

While the Australian curriculum contains statistical content, the training that mathematics teachers receive in statistics is less comprehensive than the training that they receive in other subject areas. As a result, many mathematics teachers tend to favour other areas of mathematics over statistics in the classroom. The ABS is of the opinion that improving teachers' interest in statistics will result in an increase in students' enthusiasm. Recognising that professional development programs have the capacity to influence how teachers educate students, the Australian Bureau of Statistics has chosen to create a professional development program for mathematics teachers, the goal of which is to expand upon these teachers' statistical literacy and help them incorporate statistics skills in the classroom.

The Bureau has not previously created a professional development program in the field of mathematics education. Thus, they have sponsored this project to develop an initial approach for the creation of a professional development program. The goal of this project was to design a professional development framework that includes recommendations for content, delivery mechanisms, and distribution paths, with the

purpose of creating an effective and appealing program tailored towards teaching statistics to middle years' mathematics teachers throughout Australia.

As the program will target teachers in the field of mathematics, we aimed to discover mathematics educators' opinions on effective professional development. Additionally, we examined professional development program content and delivery mechanisms. Finally, we researched and assessed the various paths that a program can follow from the Australian Bureau of Statistics to the mathematics teachers. Throughout our research, we identified the initial development costs of a program along with the recurring delivery expenses in order to later weigh them against their potential benefits. When all of the data were collected, we considered the advantages and limitations of the various options for the creation of a professional development framework and analysed how to combine these elements to create an effective program.

Our analysis indicated that there are several significant components that contribute to the content of an effective professional development program. **We recommend that all professional development programs created by the NESU include a combination of effective classroom practices, middle years' statistical theory, and practical applications of that theory.**

To the end of successfully circulating the program to a very large target audience, **we recommend that any program developed by the ABS adopt a combination of distribution through the Departments of Education and the Mathematics Teachers Associations.** While our findings indicated that the Departments of Education are capable of providing access to teachers in all areas of the country, publicising through the Teachers Associations will provide an additional motivation for many of the teachers to participate.

Our findings indicated that some teachers have attempted to access the ABS website for information to use in the classroom, but have been unable to find this information. Furthermore, experts believe that teachers should develop their own classroom materials to facilitate integration into their own classrooms. To this end, **we recommend that the Australian Bureau of Statistics work to improve the usability of the resources already available to teachers on their website, and to expand those resources.** The first step should be to make the website easier to

navigate. The second step should be the creation of an online tutorial for the development of lesson plans based on ABS resources.

Collaboration and networking between participants during a professional development program was highly favoured in our findings. Experts stated that if a network between teachers could be established, they would be able to use each other for support to clarify points of confusion or develop classroom materials. **We recommend that a discussion forum be implemented on the ABS website, and that participants in any professional development program be introduced to and trained in the use of this technology for their own benefit.**

Our analysis has shown that a face-to-face professional development program, while potentially the most effective type of course, may not be feasible for the NESU to implement immediately. As a result, we have concluded that an alternative program could be developed using another delivery mechanism that, while potentially less effective, would still result in some improvement among its participants. **If the resources for a face-to-face program are not available, we recommend that the ABS create an electronic professional development program for independent study to be distributed through a compact disk.** We also recommend that such a program contain a handbook that outlines solutions to common technological problems that the user may encounter. We suggest that a professional development program delivered through compact disks be divided into several modules, organised by topic, and contain a menu from which the participants can select what modules they wish to take based on their current knowledge level.

If it is within the resources of the National Education Service Unit (NESU), we recommend that the Australian Bureau of Statistics design a face-to-face professional development course. This course should range between three and five sessions, depending on the amount of content that is presented, with one to two weeks between each session. We also recommend that the first session last between three and five hours and subsequent sessions last between one and two hours. We discourage the ABS from creating a one-day face-to-face professional development program. If a face-to-face program over multiple days proves cost-prohibitive, the NESU should choose to implement the independent study program. Furthermore, in order to extend the reach of a face-to-face program, we recommend that any face-to-face course present the option for distance learning participation after the first session.

Classes should contain between thirty and fifty participants. The first session of a face-to-face professional development program should include the following elements: an overview of the goals of the program, a summary of middle years statistical theory, and an interactive activity. We also recommend that subsequent sessions of the course begin with time for feedback from the participants. Finally, the last session of a face-to-face professional development program should include an overview of the ABS resources available to participants after the class.

We recommend that the NESU first pilot a face-to-face program in the Australian Capitol Territory (ACT) and deliver this program in conjunction with the ACT Department of Education. If the NESU chooses to then develop a face-to-face course on a national scale, we recommend that the ABS choose between one of the two following options: collaboration with the state Departments of Education, or liaising with branches of the ABS outside of Victoria. Through collaboration, the recurring costs incurred upon the NESU will be reduced.

Appendix W: 2005 WPI Interactive Qualifying Project - Recommendations for a Professional Development Framework

This chapter discusses our integration of the data presented in the findings chapter and combines the information into a set of recommendations for the Australian Bureau of Statistics (ABS). This chapter begins with a section on the common distribution method that we recommend be used to implement any professional development program. The next section outlines strategies that the National Education Service Unit (NESU) could implement immediately to work towards their goal of improving statistical literacy in the middle years. The remaining sections contain two possible frameworks for professional development programs, one for an independent study program delivered through a compact disk (CD) and the other for a face-to-face delivery mechanism, as well as the steps that we recommend be taken to effectively implement each of them.

Important Attributes for Professional Development Programs

As indicated by our analysis, there are several significant components that contribute to the content of an effective professional development program. **We recommend that all professional development programs created by the NESU include a combination of effective classroom practices, middle years' statistical theory, and practical applications of that theory.**

Our findings also indicated three possible paths for the distribution of a professional development program implemented by the Australian Bureau of Statistics. The first path involves contacting the schools throughout Australia directly; this method contacts the entirety of our target audience, but professional development programs that are not distributed through a reputable provider of professional development may be seen as unreliable. The second path available is to contact the state Departments of Education. Our analysis indicates that this method involves multiple stages of assessment, which could hinder the implementation of the program. However, since the Departments of Education are seen as reliable providers of professional development, this method of distribution stands a greater chance of success. The third path available is to contact the Mathematics Teachers' Associations across Australia. This method, while facing less bureaucratic restriction than the

Departments of Education, stands to reach fewer teachers, as not all mathematics teachers are members of these organisations. Contacting the Mathematics Teachers' Associations could serve as an effective promotional tool that can supplement some other method of distribution.

To the end of circulating the program to a very large target audience with equal access for teachers in each state and territory, **we recommend that the NESU distribute any program created through a combination of the Departments of Education and the Mathematics Teachers Associations.** Contact information for these organisations can be found in Appendices F and G respectively. While the Departments of Education are able to provide access to all areas of Australia, publicising through the Mathematics Teachers' Associations will provide an outside motivation for many of the teachers to participate in the professional development program.

Online Resources for Teachers

A wealth of knowledge can be stored online; the Internet is an efficient medium for archiving and distributing information. However, many participants in our focus groups stated that, when attempting to access the Internet resources made available by the ABS, they found the website confusing and difficult to navigate. Also, the teachers held that they were not able to successfully utilise the information available because of the confusing manner in which the data was presented.

Teachers have expressed a desire to have access to lesson plans using real-world statistics in their classrooms. Our findings show that aiding teachers to develop their own lesson plans is more effective than providing them with lesson plans that have already been assembled.

We recommend that the Australian Bureau of Statistics work to improve the usability of the resources already available to teachers on their website, and to expand those resources, as teachers have expressed an interest in using ABS materials to develop lesson plans relating to statistical literacy. The first step should be to make the website easier to navigate; some teachers have attempted to access the site for information to use in the classroom but have been unable to find this information. The second step should be to create an online tutorial for the development of a lesson plan based on ABS resources. Some teachers have expressed

a disinterest in learning through web-based programs because they view them as a potential waste of their own time. However, this tutorial would be targeted towards teachers who have already decided to devote their own time to using ABS resources for classroom applications. As a result, an online lesson plan tutorial is expected to be effective because it would serve to aid teachers in accomplishing a goal that they have already elected to pursue. Furthermore, this tutorial can serve as a supplementary tool when an actual professional development program is implemented.

Collaboration and networking between participants during a professional development program was also highly favoured in our findings. Experts stated that if a network between teachers could be established, they would be able to use each other for support to clarify points of confusion or develop classroom materials. The Internet's ability to send and receive information on a global scale has had some impact on most aspects of education from research to teaching. Internet access allows for a networking of individuals over a large region; online discussion forums may be useful for collaboration. **We recommend that a discussion forum be implemented on the ABS website, and that participants in any professional development program be introduced to and trained in the use of this technology for their own benefit.**

Since the recommendations in this section do not constitute a professional development program, it is not necessary to distribute through the state Departments of Education. The Mathematics Teachers Associations alone should be a sufficient means to publicise this product.

Independent Study Professional Development Course

Our analysis has shown that a face-to-face professional development program, while potentially the most effective type of course, may not be feasible for the NESU to implement immediately. Depending on the resources available to the NESU for this professional development program, some compromises may need to be made. As a result, we have concluded that an alternative program could be developed using another delivery mechanism. While potentially less effective, another mechanism would still result in some improvement among its participants.

If the resources for a face-to-face program are not available, we recommend that the ABS create an electronic professional development program

for independent study to be distributed through a compact disk. Compact disks were selected in favour of an online professional development program because many teachers in our focus groups expressed an aversion to the expense of downloading large amounts of content from the Internet. A course delivered through compact disks for independent study was shown to be significantly less educationally effective than a face-to-face program, but it is currently capable of reaching the entire mathematics teacher population in Australia. Furthermore, although the developmental costs of an electronic professional development program are higher than those of a face-to-face program, the recurring costs inherent in distributing a CD are significantly less, which makes an independent study course a comparatively inexpensive national solution for the NESU to implement on its own.

We also recommend that an independent study professional development program distributed through compact disks contain a handbook that outlines solutions to common technological problems that the user may encounter. Some teachers may not have the technological expertise to readily learn through an electronic distribution method, which would severely limit the potential audience of this program unless this concern is addressed. By tailoring an electronic program specifically to those who are not comfortable using it, the number of potential users will increase.

We recommend that a professional development program delivered through compact disks be divided into several modules, organised by topic. Each module should end with examples that stress the real-world relevance of the material. Some modules should be strictly based on the technical aspects of statistics while others should address practices that can be used in the classroom. One of the modules used could be an adaptation of the online lesson plan tutorial recommended in Section 5.3. Our findings indicate that teachers benefit from being able to take time to reflect between concepts during a professional development course. Furthermore, teachers have expressed an aversion to reviewing material that they are already familiar with. To this end, **we recommend that a professional development course delivered through compact disks have a menu from which the participants can select what modules they wish to take based on their current knowledge level.** This technique also allows the users to proceed at their own pace, which increases the likelihood that the participants will absorb the knowledge.

Face-to-face Professional Development Course

Our findings indicated that *face-to-face interaction* is the most effective means of professional development education for teachers. This method can take advantage of a variety of teaching strategies and can be very flexible. As an alternative to an independent study program, **we recommend that the Australian Bureau of Statistics design a face-to-face professional development course if sufficient resources are available.** Personal interaction between instructor and audience allows for the participants to see the enthusiasm of the speaker and can increase the interest of teachers to learn the subject matter.

Experts agreed that a program should never consist of a single session over the course of an entire day; separating the program over multiple days allows the teachers to practice what they have learned and address their questions before the course has been completed. **We recommend that programs range between three and five sessions, depending on the amount of content that is presented, with one to two weeks between each session.** Our results show that teachers are unable to devote several full days to a single professional development course. Furthermore, teachers have stated that longer sessions cause them to lose interest as the day progresses. **Based on these findings, we recommend that the first session last between three and five hours and subsequent sessions last between one and two hours.** By dividing the course in this way, participants are able to complete all but the first day of the course after school hours.

We recommend that the ABS avoid creating a one-day face-to-face professional development program. Our findings have shown that a one-day program, while requiring significantly less resources, results in little or no long-term impact upon its participants. If a face-to-face program over multiple days proves cost-prohibitive, the NESU should choose to implement the independent study program described in Section 5.3.

Distance learning can be utilised to extend the reach of a face-to-face course. Research indicates that, barring technological restrictions, distance learning can be very successful. Furthermore, follow-up discussions with several focus group participants lead us to the assumption that some teachers may be willing to travel a farther distance for a single day program than they would for multiple days. As a result, **we recommend that a face-to-face course present the option for distant**

learning participation after the first session. Our analysis shows that rural areas of Australia have the resources to participate in distance learning courses. Those who wish to partake in this option should be required to remain at the first session for an additional period to be familiarised with the techniques utilised in this particular delivery mechanism.

We recommend that classes have between thirty and fifty participants.

Decreasing class size increases the expenses incurred to deliver the course to the same number of people. However, experts have cautioned against simply lecturing to an audience; group work is an effective method of learning because of the interaction between participants. For group work to be effective, large class sizes should be avoided. Larger classes tend to overwhelm the instructor and make it difficult for him or her to interact directly with each group.

The first session of a face-to-face professional development program should include the following elements: an overview of the goals of the program, a summary of middle years' statistical theory, and an interactive activity. Because it is important that the participants understand and relate to the purpose of the professional development program, we recommend that the course begin with a presentation of the goals of the program as well as the justification of these goals. Also included in the introduction should be an overview of the statistical methods that the program will include. Without the technical aspects to support them, any practices taught during the course will be ineffective. Lastly, we recommend that the introductory session end by having the participants take part in a hands-on activity that they can recreate in their own classrooms. This activity should be done in groups in order to help the teachers build networks that they can use for collaboration both between sessions and after the course is complete. Finally, our sources recommended that activities should demonstrate practical applications using data that is pertinent to real-world situations so that the participants can fully understand the relevance of the material that they are being taught.

We recommend that subsequent sessions of the course begin with time for feedback from the participants. Allocating time for feedback provides an opportunity for the teachers to report on what they have done in the classroom and how effective they felt it was. By collecting feedback of this kind, the instructor can identify the obstacles that the participants are encountering and attempt to resolve

them. We also recommend that these sessions involve the development of lesson plans that the teachers can use in their classrooms. Our findings indicate that, by developing their own lesson plans, teachers are more likely to adopt the techniques involved as their own.

Finally, **we recommend that the last session of a face-to-face professional development program should include an overview of the ABS resources available to participants after the class.** The instructor should solidify the networks that have been built during the course by identifying methods through which the participants can contact each other after the course is completed. Furthermore, a set of supplemental materials, such as a compact disk containing data from the ABS, should be distributed. These materials will aid the participants in developing their own lesson plans. We also recommend that the instructor demonstrate how any technology is used so that any technological resources at the participants' disposal do not intimidate them. This technology includes but is not limited to supplemental compact disk materials, online ABS resources, and online discussion forums.

Our findings suggest that having a face-to-face interaction is the most effective method of delivery in terms of conveying information to the participants. Unfortunately, since a face-to-face professional development program requires travel expenses, supplies, food, and many other recurring expenses, the cost associated with this method is very high. As a result, a face-to-face delivery on a national scale may not be currently feasible for the National Education Service Unit to implement.

To address this problem, we recommend that the NESU first pilot this program in the Australian Capital Territory (ACT) and deliver this program in conjunction with the ACT Department of Education. Our findings regarding the ACT indicate that their Department of Education is both willing and well suited to deliver a face-to-face program designed by the ABS. Since the ACT is relatively small, we can target the entire region to test the effectiveness of the program. Also, the ACT has venues the ABS can utilise which will decrease the cost involved. This implementation of the course would serve to assess the program for future endeavours and create a precedent for the development of strong working relationships between the NESU and state Departments of Education.

If the NESU chooses to develop a face-to-face program on a national scale based on the results of this pilot, it will need outside assistance. **We recommend that the ABS choose between one of the two following options for distribution of a national face-to-face professional development course: collaboration with the state Departments of Education, or liaising with branches of the ABS outside of Victoria.** Through collaboration, the recurring costs incurred upon the NESU will be reduced.

The first option is to collaborate with the state Departments of Education in the same way that the pilot program was implemented. The NESU should develop working relationships with the departments to jointly deliver a face-to-face course. This method could attract participants from each state or territory because the program would be tailored to their specific curricular needs. Furthermore, the recurring costs of delivery would be partially defrayed by Department of Education resources.

The second option is to work in conjunction with the other branches of the ABS. The NESU could identify an ABS staff member to serve as a liaison in each state and territory in order to facilitate the delivery of a professional development program in that state. If other ABS branches could provide greater support for a statistical literacy professional development program in their own regions, the cost of distributing a face-to-face program would be distributed throughout the Bureau, instead of resting solely on the NESU. Furthermore, travel expenses would be reduced, as professional development instructors could be locally trained. In addition, ABS facilities could be used as venues for the professional development course, which would decrease the total recurring costs.

These recommendations are intended to assist the NESU in completing its mission. Our hope is that the steps outlined in this chapter will foster improvements in the way statistics is taught in the middle years. If the ABS can effectively implement these recommendations, then statistical literacy in Australia could be enhanced, strengthening the development of informed opinions among the Australian population.

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List of Acronyms

AAMT – Australian Association of Mathematical Teachers

ABS – Australian Bureau of Statistics

ACT – Australian Capital Territory

AMSTAT – American Statistical Association

ANSTC – Australia’s National Science and Technology Centre

ASA – American Statistical Association

DEST – Department of Education, Science, and Training

DEWR – Department of Employment and Workplace Relations

ICT – Information and Communications Technology

IQP – Interactive Qualifying Project

NCTM - National Council of Teachers of Mathematics

NESU – National Education Services Unit

NSF – National Science foundation

RSS – Royal Statistical Society

SSAI – Statistical Society of Australia, Inc.

STEM – Science Technology Engineering Mathematics

VCAA – Victorian Curriculum and Assessment Authority

VCE – Victorian Certificate of Education

WPI – Worcester Polytechnic Institute