PROMOTING THE USE OF DATA ANALYSIS AND STATISTICAL PROJECTS IN IRELAND

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Changes in the way statistics and probability are being taught in secondary schools are evolving at different rates throughout the world. Considerable progress has been made in the United Kingdom, and aspirations are high in the United States. In Ireland, however, progress is only now starting to evolve, and this is in spite of (perhaps to a certain extent because of) a very strong tradition in mathematics. In recent years Irish statisticians (through the new Irish Statistical Association) have attempted to promote statistics, probability and data analysis through various activities in general, and in secondary school education in particular. Efforts of the Irish Statistical Association to promote statistics through Transition Year Activities in secondary school and in the annual Irish Young Scientist's Exhibition are highlighted.

STATISTICS IN THE SECONDARY SCHOOL CURRICULUM IN IRELAND

Although statistics is very much an interdisciplinary subject, in most countries students are taught the basics of statistics and probability in their mathematics curriculum. Historically, the subject of mathematics has been viewed as a very important subject in the secondary school education of students in the Republic of Ireland. The standards of teaching and of the curriculum are both very good. Recently (1994) a new syllabus (which is the same for all schools in the country) in the secondary school higher mathematics course was introduced, but the content in statistics and probability changed very little and continues to be very old fashioned (the core consists of (1) *Fundamental Principles of Counting*, (2) *Discrete Probability* and *(3) Statistics - (weighted means and standard deviation*)). Also, there is practically no emphasis on data analysis (or data handling). Students in the higher mathematics course also study one (selected by the teacher) of four optional topics (Further Calculus, Further Probability and Statistics, Groups, or Further Geometry), but only 5% of the teachers select Further Probability and Statistics mainly because they have little or no formal training in it.

TRANSITION YEAR AND THE STRUCTURE OF THE IRISH SECONDARY SCHOOL SYSTEM

Students in the Republic of Ireland usually commence their secondary school education at the age of 11/12. There are two important sets of exams taken by the students in secondary school: (1) Junior Certificate Exam (usually taken at age 14/15 after three years), and (2) Leaving Certificate Exam (taken at the end of secondary school). Up until

recently most students spent 5 years in secondary school, but in the early 90's the idea of a Transition Year (between the Junior and Leaving Certificate Cycles) was introduced, and this is now very widespread (although not universal or compulsory). During the transition year (when students are normally 15/16), the standard curriculum for students is set aside. Instead a special Transition Year Programme is run in most schools which "*aims to promote the personal, social, educational and vocational development of pupils and to prepare them for their role as autonomous, participative and responsible members of society*".

Students who enter the Transition Year have just finished a rigorous series of exams (Junior Certificate Exam) and are certainly ready for a change from traditional schoolwork. However, in spite of this, it is quite a challenge for schools to put in place a programme which successfully addresses the specified aims - and as a result many schools are still experimenting with the content of their programme. It is perhaps not surprising that the teachers who are having the most difficulty in introducing relevant material into the Transition Year are the mathematics teachers. In many ways, the Irish Transition Year provides an ideal setting for the introduction of statistical projects into schools, but of course, there are many considerations to take into account:
(1) mathematics teachers are not confident, nor for the most part trained, in statistics and are often not computer literate, (2) mathematics teachers are not used to promoting or encouraging projects of an interdisciplinary (and statistical) nature that may often not have a clear and concise answer, (3) students at this age are often very enthusiastic and willing to get involved in projects, but they have few "statistical skills" and would not be able to go far in the areas of modelling, and (4) given that projects of a statistical nature may vary considerably even within a single class, there are many challenges to the teacher in how much and to what extent classroom time is spent on these activities and projects.

STATISTICAL EDUCATION AND THE IRISH STATISTICAL ASSOCIATION

The Irish Statistical Association was established in 1997, and presently has about 55 members from Northern Ireland and the Republic of (Southern) Ireland. However, a very successful annual conference on Applied Statistics in Ireland (CASI) has been held every year since 1981 in various locations in Ireland. Given the relatively small number of statisticians in Ireland together with the fact that many Irish statisticians are members of much larger societies (e.g. either the RSS or the ASA), it was not felt necessary to have

a separate association until quite recently. In the past few years however Irish statisticians have become aware of the necessity of educating the public more generally about the importance of statistics in society, and this has I believe been the principal reason for the establishment of the Irish Statistical Association.

STATISTICS IN THE TRANSITION YEAR OF SECONDARY SCHOOL

The Transition Year in the Irish secondary school system provides a valuable opportunity for teachers to encourage projects and data analysis in statistics. Members of the Irish Statistical Association have made various efforts to promote such activities. In 1996 at the annual summer in-service week for secondary school teachers of mathematics in Ireland, two presentations were made on *Statistical Activities and Projects for Transition Year*. These presentations highlighted: a) material that might be used to understand data (much of this was of a graphical nature), and b) examples of some ideas for projects and/or surveys which in themselves generate data for investigation. Some of the material came from the very useful publication, *Data Analysis and Statistics - Grades 9-12* (NCTM). Other good sources included *Practical Exercises in Applied Statistics*, by Charlton and Williamson, and *Activity Based Statistics* by Scheaffer et al. (1996). Two things became quite clear following these presentations: a) the best projects and exercises would probably result from students collecting their own data, and b) the teachers themselves need considerable help in data analysis and in particular in basic computer literacy.

This led to the formation in the academic year 1997/98 of a pilot group of teachers wishing to develop a set of guidelines for *Practical Statistics: Projects and Exercises in Statistics and Data Analysis for Transition Year Students*. A preliminary document was prepared giving a list of possible projects and exercises (together with some discussion of how they might be developed). It included topics such as: student birthdays, ages of parents at birth of students, ages of Oscar winning actors and actresses, pulse rate study, random rectangles, social and cultural factors influencing junior certificate performance, Olympic winning times, guessing heights and weights, habits in the home, getting to school, comparing prices, car registration and mileage, population trends in Ireland in recent times, and the index finger length and height of a person. The teachers involved in the pilot project agreed to encourage statistical projects in their Transition year classes, and the best one or two projects from each of the schools would be put forward for poster

style presentation at a Statistics Day to be held in the National University of Ireland in the Spring of 1998. It was hoped that the experiences gained would lead to the production of a useful publication giving ideas for statistical projects, and additionally guidelines for teachers about supervising and encouraging projects in the future.

The need to assist teachers to progress in this direction has led to the establishment of workshops whereby the teachers enhance their computing and data analysis skills. The first such workshop emphasized: (1) Generating random numbers in various ways (in particular using Excel) and using them to select random rectangles, (2) Drawing Stem-and-Leaf Plots to compare two sets of numbers (for example the ages of Oscar winning actors and actresses), (3) Using Excel to draw plots and investigate linear relationships between variables (such as the weight (in carats) and the price (Singapore dollars) of diamonds), and (4) Simulation through the software package *Interactive Probability*.

STATISTICS AND THE IRISH YOUNG SCIENTIST'S EXHIBITION

In 1965 the first Young Scientist's Exhibition was held in Dublin, Ireland. This annual exhibition (which is now sponsored by ESAT - Telecom, but up until this past year was sponsored by Aer Lingus, the National Airline of the Irish Republic) has since become a highly publicised and very important event in the secondary school calendar year. In January of each year students from all over Ireland come to the Exhibition to display projects (often on the basis of work done over a couple of years) in the various sciences (broadly classified as (1) Chemical, Physical and Mathematical, (2) Social and Behavioural, and (3) Biological and Ecological). The standards are in fact quite high, as is ascertained by the fact that an unusually high proportion of the winners (from the diverse categories) have gone on to win prizes at international science competitions).

Over the years it has been interesting to observe the increasing role that statistics has played in the projects of these young scientists. There has been a swing in recent years away from the more traditional areas of the physical sciences (chemistry, physics and mathematics) towards the social, behavioural and biological (including environmental) sciences. This, together with the increasing availability of computer software, has contributed to the existing situation where the vast majority of projects have a statistical content (varying from the display of conclusions using charts, graphs and

other descriptive statistics to projects which make extensive use of survey information or use a basic experimental design).

In 1994 a group of Irish statisticians wrote to the organisers of the Young Scientist's Exhibition acknowledging the importance of the event and expressing how generally impressed we were about the work and enthusiasm of the young scientists themselves. We also suggested, however, that the quality of their work and the value of the whole exercise in the context of the student's education would possibly improve tremendously if they were given better guidance on fundamental principles in modern experimentation and sample surveys. This led to a well received series of annual presentations (now sponsored by the Irish Statistical Association) to science teachers at the Exhibition on the following topics:

1995	The Role of Statistics in Scientific Experimentation (Philip J. Boland)
1996	Displaying Quantitative Information (Yudi Pawitan)
1997	Statistics on Spreadsheets (Michael Stuart)
1998	How to Draw a Good Graph (Catherine Hurley)

At the same time, Irish statisticians (now through the Irish Statistical Association) offered to sponsor two prizes at the exhibition for the projects making the best use of statistics. Unfortunately although the organisers of the Exhibition are aware of the increased use and importance of statistics, there are still no statisticians amongst the panel of judges for the competition (even for the Irish Statistical Association sponsored prizes for the best use of statistics).

Many scientists still view good statistics as mathematical statistics or probability, and it has been a difficult task for Irish statisticians to try to convince other Irish scientists that good statistics at a basic level can be done without the use of complicated mathematics. For example, a surprise (for Irish statisticians) winner of the first prize (1995) was a (very modest) project on Lotto done in the Irish Language ("An Lotto - Conas Cur Le Do Sheans?"). This year (1998) the winning projects were of a much higher quality. The Irish Statistical Association individual prize winner (and also the overall Exhibition winner) was for a simulation study (using Markov Chain Monte Carlo methods) of the game of Monopoly. The winning student made claims on the best Monopoly properties to own and estimated the long run frequencies of landing on various places. The Irish Statistical Association group prize went to two girls who completed a

project analyzing depression in adolescence. They surveyed 590 students in the West of Ireland and demonstrated (justifying this with nonparametric statistical methods) a marked rise (an increasing trend) in symptoms of depression over the six years of secondary school. Other interesting projects making good use of statistics included: (a) Breast Feeding - Attitudes and Intelligence Aspects, (b) The Influence of Birds on the distribution of Xanthoria-Parietina (where in particular a chi-squared test was performed on the hypothesis of a uniform distribution for visiting spots of birds), and (c) A Study of the Questionnaire as an Instrument of Social Science.

In order to assist the exhibition judges in the selection of good projects in statistics, the Irish Statistical Association now issues the following Guidelines for Judges of its Prizes:

Guidelines For Special Prizes In Statistics

A Prize for Statistics could be awarded in any scientific discipline. A winning project does not necessarily have to use statistical or probabilistic formulae. In fact a clear presentation of complex statistical data may deserve an award. The ideal project is one with enough complexity where there are issues of bias and variability, and there is an awareness and some treatment of those issues. In addition the judges should look for a project where: (1) The Experiment or Survey is well designed and carefully thought out, (2) A clear identification of the problem and objectives of the study are given. In the case of a survey the population of interest must be well defined, (3) The method of collection of data is well understood and explained, and the data are collected in such a way as to be representative of the population under study, (4) There are clear and sometimes innovative uses of graphs, plots and charts to illustrate the aspects of the data and to support any conclusions of the study, and (5) There is a recognition of the scope of the applicability of the study due to the restrictions on data collection.

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