

TEACHING STATISTICS TO THE REST OF HUMANITY

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1. Introduction

Statistics is taught widely in the UK as an element of mathematics up to age 16. Over a quarter of a million children taking examinations involving statistics or mathematics with statistical elements. At the age of 18 the examinations involving the use of statistics show a different pattern. Some 50 thousand pupils take statistics or mathematics with statistical elements, but over 100 thousand take examinations in geography, biology, psychology, etc. involving significant elements of statistics.

Thus the prime interest in statistics comes not from those with a specialist interest but from the "rest of humanity" who need statistics to support their other interests. The aim of this paper is to explore some of the implications of this fact.

2. Why

A study some years ago in the United States examined the views of people on the purposes of education. Some statistical analysis at the end of this study suggested that three basic purposes were seen in education. These were most conveniently classified as the Career purpose the Knowledge purpose and the Human purpose. The Career purpose of education was to prepare children for their future world of work. The Knowledge purpose was to pass on to each new citizen the knowledge and experience of the previous generations. The Human purpose was the educational aim of growing human beings.

In looking in more detail at the purposes of statistical education these three headings of Career, Knowledge and Human purposes provide a convenient and meaningful classification. Many jobs currently require an increasing level of numeracy. Within this numeracy there is an increasing element of statistical knowledge. A study of this was carried out by the Centre for Statistical Education.³ It was found that the emphasis was on the collection and presentation of data, with very little use of the technical tools of statistics. However, at a more advanced level the growth of use of the micro and the ready availability of statistical packages is causing an explosion in the use (and mis-use) of statistical methods. This will increase the need for statistics teaching as part of the career aim of education.

The danger with the knowledge aim in relation to statistics is that people often regard the knowledge appropriate as knowledge about statistics. Statistics is seen as a subject that children should know. It has to be remembered that the rest of humanity is not interested in statistics for its own sake. Statistics is a tool for obtaining knowledge, for solving problems.

Statistics is essentially a methodology. The content of statistics therefore has to be an approach, a methodology, a way of going about collecting data, analysing data, solving problems using data. It is about being able to do things not about a body of theory. A related issue here is that of the link between statistics and mathematics. It has to be emphasized in the present context that statistics is not a branch of mathematics, its approach is different. Mathematics is in most teaching mainly deductive whereas statistics properly taught is inductive.

Mathematics is a subject of correct answers and incorrect answers. Statistics is a subject of uncertainty and ambiguity.

The Human aim of statistical education for the rest of humanity is that of helping future citizens to cope with life in a rapidly changing world. This involves living with uncertainty, living with data, living with ambiguity. The future citizens need views and tools that help them to make sensible choices against a background of chance, to use data to get out of the straightjacket of a purely personal view of the world.

3. What

The three aims we have discussed have immediate implications as to what we should teach, the career aim forces us to ask questions about what constitutes statistical skills the employee of the future will require at various levels and in varying contexts. It will be increasingly difficult to answer questions about future use without reference to the developments in statistical software. There will be less and less need to do lengthy numerical calculations and more and more need to have an understanding of the concepts involved in statistical analyses at a very wide range of levels. It is by no means accidental that statistical techniques required of 18-year-olds studying geography and psychology include some that are more advanced than those studied by specialists in statistics of that age. The choice of techniques is not a function of their difficulty but of the need for them in practice.

The computer provides a magnificent tool for the teacher to focus the pupils' attention on concepts and methods rather than on numerical techniques and algorithms. It should also be used to show the limitations of statistical techniques and teach people when to request further help from others more knowledgeable in statistics. In terms of the knowledge aim of statistical education the content becomes not a routine list of statistical theorems but the ability to look at the world through the "statiscope". This involves the development of the skills of using the statiscope and an appreciation of the types of creatures one sees through it. Skills in using the statiscope include the design and practice of data collection, reading tables and graphs and their interpretation, the general handling of data and data analysis, modelling, problem solving with statistics, inference and decision. the world we see through the statiscope shows two basic types of phenomena, data and uncertainty. The effective course will give the pupil a great deal of experience in looking at data and appreciating uncertainty. The teaching of the basic intuitions of probability is an important but much neglected asset of current education. We are surrounded

by education that emphasises the deterministic view of life with its consequent dangers and misunderstanding.

Our approach to the knowledge aim has ensured that there is some overlap with the content deriving from the Human aim of statistic teaching. We are helping the pupil to live in a world of uncertainty, we are helping them to live with data and ambiguity, we are helping them cope with choice and chance. There is another asset to statistical education that has great benefits in terms of supporting future citizens. This relates to the importance of information. Throughout almost all a child's school experience the pupil is a helpless receive of knowledge, there is little opportunity of influencing the world around. Statistics when used within the context of social science, environmental studies, geography, and perhaps psychology and biology, has immediate practical value. For example a class can carry out a survey of preferences for food in school meals or on the vehicles passing the school gate. They may then discover that such information will actually help them to influence the world and change it, for example to change the menus or introduce some traffic control system (both of which have happened as a result of children's statistical work). There has been much concern in recent years that much education educates people to be helpless, the careful use of applied statistics shows that information sometimes enables one to overcome such helplessness and influence the world.

4. The How of Statistical Education

The following lists some suggestions that might help in teaching statistics to the "rest of humanity".

- (a) The traditional mathematical approach has led to a teaching pattern in statistics with an emphasis on being able to use techniques oneself. Yet educationally reading comes before writing and most of the rest of humanity are more likely to have read and follow a statistical argument than to derive it themselves. Teaching the skills of "reading" statistics should play a larger role in our work.
- (b) The presentation of statistics needs to be changed. We need more positive images. In an age of Information Technology statistics can be seen as Information Analysis. Information comes to us as words, pictures, and numbers. Statistics is about finding the information content of numbers. Much of that activity can usefully be seen as detective work. The Survey and Experiment are part of the hunt for clues and the Hypothesis and the Estimate are natural elements in putting the evidence together.
- (c) Statistics is often seen, and presented, as a rag bag of techniques, often as bits of maths, which for many children, weak in symbolism and numeracy, makes it a non user-friendly subject. For the rest of humanity statistics needs presenting as part of the total map of their studies, as a user-friendly topic that helps them to find their way through the territories that interest them. This requires the teachers of various subjects to work together to drawn and present this map. A further aspect of presentation concerns the identification of key concepts in

statistics. So many of the apparently different methods and formulae of statistics are related to these key concepts. Examples are the analysis of observations into patterns plus purely random elements, the population/sample parallelism, and the occurrence of the deviation $(x_i - \bar{x})$ and sum of squares.

(d) Finally we need to be more careful in analysing the skills required of the pupil in doing statistical tasks. Evidence from current studies at the centre suggests that even with reading simple graphics we often underestimate the difficulties involved.

References

- (1) Reports obtainable from the Centre for Statistical Education 25 Broomgrove Road, Sheffield 10, UK.
- (2) Numbers of Candidates entered for the 16+ O and A Level Examinations in Subjects Which Contain Statistics. England and Wales 1979-1983.
- (3) Statistical Needs of Non-Specialist Young Workers.