A STATISTICS COURSE FOR ALL STUDENTS AGED 11 - 16

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Background

In England and Wales all pupils take major examinations at the age of 16. Until recently these were either the General Certificate of Education (GCE) for the more-able pupils and the Certificate of Secondary Education (CSE) for those not taking the GCE. As from courses starting this year there will be only one set of examinations, the GCSE, which are aimed at pupils of all abilities. Whilst combining the two systems the opportunity has been taken to rethink all the syllabuses and the purposes for which they are devised. This rethinking shows in published national criteria. All syllabuses have to conform to general criteria, many individual syllabuses have their own extra subject specific criteria (but statistics is not one of these).

GCSE General Criteria

This is a major document, but the following criteria are those which have very obvious relevance to syllabuses in statistics.

> *19e. The principle of fitness for purpose must be observed: all examination components and assessment procedures should reflect and be appropriate to the nature of the subject, its educational aims and its assessment objectives.*
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> *(iv) The syllabus should normally offer an appropriate combination of board-assessed components and centre-assessed course work;*
>
> *(vi) The syllabus should, as appropriate, take into account any relevant criteria for other subjects for which subject-specific criteria are available.*
>
> *19k All syllabuses should be designed to help candidates understand the subject's relationship to other areas of study and its relevance to the candidate's own life. Awareness of economic, political, social and environmental factors relevant to the subject should be encouraged wherever appropriate. Questions seeking to test this should be in the context of the subject concerned and not independent of it.*
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> *33 Any scheme of assessment and moderation must (a) be compatible with the assessment objectives; (b) not be allowed to dominate the educational aims or to inhibit good teaching and learning practice.*

These points raise a number of questions. What is the nature of the subject? What is the relationship of statistics to other areas of study and to everyday life? What are suitable educational aims and assessment objectives? How can we draw up an assessment scheme which will positively en-

courage good teaching, or at least not inhibit it? What is the appropriate balance between board based assessment and centre assessed work?

The Nature of the Subject

A few years ago there was a major national investigation into mathematics in British schools. The report, known as the Cockcroft report after the chairman Sir Wilfred Cockcroft, but entitled "Mathematics Counts" also had some relevant things to say about the nature of statistics and its teaching.

> *para. 775. Statistics is not just a set of techniques, it is an attitude of mind in approaching data. In particular it acknowledges the fact of uncertainty and variability in data and data collection. It enables people to make decisions in the face of this uncertainty.*
>
> *para. 781. Statistical numeracy requires a feel for numbers, an appreciation of levels of accuracy, the making of sensible estimates, a commonsense approach to the use of data in supporting an argument, the awareness of the variety of interpretation of figures and a judicious understanding of widely used concepts such as means and percentages. All these are part of everyday living.*
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> *para. 776. Its (i.e. statistics') study should be based on the collection of data . . . work in . . . biological science, geography and economics can therefore contribute to the learning and understanding of statistics . . . . In mathematics courses too much emphasis is often placed on the application of statistical techniques rather than on the discussion of the result (and) the inferences which should be drawn in the light of the context. . . The work can become dry and technique oriented and fail to show the power and nature of statistics.*
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> *para. 780. The introduction of electronic calculators . . . provides opportunity to emphasize the interpretation of data rather than the techniques of calculation . . . . Microcomputers and the visual display which they provide . . . also offer opportunities to illuminate statistical ideas and techniques.*

The clear implications here are that statistics courses at the school level should use real data, be oriented to practical work and should emphasize the power of statistics to aid decisions rather than a preoccupation with the accuracy of the detailed techniques.

Relationship with Other Subjects and Everyday Life

Much has been written on this topic and I shall not repeat it here. I wrote about it in "Teaching Statistics 11 - 16". Professor Gani covered many of the ideas in his plenary session at the first International Conference on Teaching Statistics. Jim Swift also spoke on this subject at the fourth International Conference on Mathematical Education. (See references.) People working on GCSE syllabuses had this sort of background in mind.

We shall consider the questions about assessment, aims etc. when we look at what has actually been proposed.

Proposed Courses for GCSE Statistics

To show how these ideas are being put into practice I shall refer in all that follows to the course developed by the Northern Examining Authority – one of five groups developing syllabuses.

The Aims show a determination to make the courses practical and realistic.

A course based on the syllabus should enable students to

(a) develop an understanding of the basic concepts of probability and statistics, their power and limitations, the confidence and experience to write and talk about them,

(b) interpret statistical information presented in a variety of forms and to communicate their interpretation by written and/or oral report,

(c) appreciate where data are suitable for statistical analysis, apply relevant techniques and be able to make deductions and inferences based on them,

(d) develop the confidence and ability to conduct a practical investigation,

(e) be aware of the importance of statistical information in society,

(f) acquire a foundation of knowledge, skills and understanding appropriate to the applications of probability and statistics in everyday situations familiar to the pupil, in other disciplines and to a further study of the subject, if desired.

The objectives show how these aims will be assessed. They are to test the ability of the candidates to:

(a) recognise statistical problems and to recall statistical techniques appropriate to the context of the situation,

(b) interpret statistical information presented in written, tabular and graphical form,

(c) organise and present statistical information accurately in written, tabular and graphical form,

(d) perform relevant calculations to an appropriate degree of accuracy using a calculator where suitable,

(e) analyse a problem and apply the methods necessary to enable its solution and relevant deductions and inferences to be made.

The subject content shows a much greater emphasis on using statistics in a context. For example the general description before the detailed list of techniques required states:

> *Candidates should be acquainted with general areas of application of statistics such as population, conservation, national censuses, cost of living, industry and commerce, advertising, gambling and weather. Questions may be asked that arise in these and similar contexts.*

Practical aspects of obtaining data show in phrases such as "Obtaining information from a large population". This includes the difficulties of questionnaire distribution and collection, of identifying the total population, of non-response, of errors in answers and of ensuring that questions are interpreted in the same way. The same emphasis on practical aspects shows also in the section on sampling with "sampling from a small well-defined population" and "sample frame, simple random sample, systematic sampling, stratified sampling. Some practical problems encountered in large-scale sampling."

As well as the usual summary statistics (the mean, median and mode) there is also reference to index numbers, with the Retail Price Index being given as a specific example. There is also a section on crude and standardised birth and death rates. Time Series are referred to and include "identification of seasonal variation. Calculation of average seasonal effect" using graphical methods.

Probability includes odds and simulation with "Betting odds. True odds. The relationship between true odds and probability" and "The use of random numbers in simulation ."

There is a major section on interpretation and inference. This includes "Interpreting statistics presented in tabular form: comparison of individual frequencies, row or column totals", "Identifying types of misinterpretation", "Spotting possible errors in a data set" and "Estimating population values from samples, allowing for variability in estimates and a qualitative treatment of the effect of sample size".

From the specimen examination questions you will see that there is indeed an emphasis on interpretation or real data as they will be seen in everyday life. The first example is of a question for the lowest ability pupils on reading a table of data from our national census results. The second example is for the middle ability pupils and requires some searching in a newspaper representation of data on breweries to find the appropriate data and interpret them. The third example, for the high ability pupils, requires them to identify a particular form of misrepresentation and draw a proper form for the same data.

Conclusion

This course is for pupils of all abilities in the 11 - 16 age range, though the bulk of the teaching will probably be done in the last two years of this

range. Our experience through previous curriculum development exercises is that pupils are able to cope with the ideas described, provided that there is plenty of discussion and suitable practical work. In this case the practical work is part of the compulsory assessment, though it is expected that other non-assessed practical work will be done by pupils to help them learn more thoroughly particular parts of the syllabus. It will be seen from the syllabus and the assessment questions that the emphasis is on statistics as a subject of major use in solving real problems. We look forward to seeing how the courses develop in practice.

References

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