THE CHALLENGE OF COMPUTERS IN TODAY'S STATISTICAL EDUCATION

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Summary

This paper begins with a brief discussion of the role of the statistician and how this is changing, particularly in view of the microcomputer revolution. Historically the training of the professional statistician has been undertaken within academic institutions and has often incorporated little practical training. The advent of relatively cheap and accessible computer power has allowed more applied elements to be incorporated into statistical education, in particular larger and more realistic data sets may be used, models fitted (and compared) with greater ease, and so on. There are numerous ways in which this computing power may be exploited in the education of statisticians and this paper outlines a number of these and discusses their usefulness.

Role of a Statistician

In recent years the number of designated statistical Sections in a wide range of organizations is decreasing and the demarcation of roles is also becoming, statistically speaking, vague. There is a continuing demand for suitably qualified personnel for what may be termed "technical support" or "advisory" groups and these groups come under such headings as "Statistical Support", "Research and Intelligence", "Management Services" and so on. However, they all undertake essentially the same principal functions, namely to provide and interpret information and to assist in the decision making or planning processes. The practitioners employed within these groups assume a range of collective titles – Applied Statisticians, Systems Scientists etc., according to their job descriptions and training. The easy access to various computer facilities, intelligent packages, and expert systems has greatly accelerated the process of change and with the help of such facilities almost anyone nowadays can relatively easily carry out many of the mechanical information processing tasks in an organization that were in the past, a part and parcel of the statistician's life. It is therefore clear from the technological development taking place in our modern society that the previous traditional role of the practising statistician is in the process of changing, and a new perception of the role has yet to be defined. The need to change is not unique to the statistics profession, and it is therefore to be expected that most educators will face these challenges and in particular develop the paths of continuing education. There is no doubt

that modern technology is changing our working environment and creating demands for new skills. It is evident that mere knowledge of statistics is not enough for the modern working life of an applied statistician, but in addition they require the skills of an "information analyst".

Skills required for a Statistician

The types of technical and personal skills required these days from new graduates, in statistics are diverse and include: (i) a solid grounding in one or more areas of statistical subjects, (ii) a less detailed understanding of the other subject areas, allied perhaps to semi-statistical disciplines, (iii) a familiarity with aspects of statistics sufficient to use and to carry out changing tasks, (iv) the capability to capture data, transfer it and finally to analyse it, (v) problem solving skills, and (vi) the ability to communicate.

If we accept the above then (iv) clearly indicates that in recent years the applied statistician, has already began to embrace the role of information analyst and that of decision maker.

It must be remarked that in modern society the Statistician as an information analyst will not only provide the "number-crunching" facilities but also the packages necessary for statistical investigations; and indeed they will also provide statistical advice by using expert systems (see Hand, 1985) although these are still in relatively early stages of development.

Challenge to a Statistical Educator

In this changing world it is essential for the educators of statistics to respond and provide proper training for the budding statistician (see Kanji 1983). For this to happen, it will be necessary for the educators to prepare curricula which integrate both the knowledge and skills set out in the previous section in a systematic way and which incorporate the help of modern technology. For example, some subjects in statistics can be threaded through the various themes of modelling, inference, design, analyses, decision making, communication and practical skills.

As we have remarked, in the past the training of professional statisticians has been undertaken within the academic institution and has often incorporated very little or no practical training.

The usual structure of statistics courses was developed in the absence of electronic computing facilities and the courses were dominated by the need for students to have technical numerical skills. As a result the courses were produced with less than adequate time to give proper attention to statistical concepts, underlying designs of investigations, data collection, feedback procedure or the development of other necessary skills.

In recent years the development of sophisticated mainframe statistical software systems has gone a long way towards reversing the situation and consequently helping students to devote most of their time in areas other than

numerical methods. However, it is the advent of cheap electronic computers that has created the real challenge to the statistical educator which has at the same time provided budding statisticians with the opportunity to develop their necessary skills. The educators therefore require to alter and modify the course structure and to incorporate various other important aspects into the applied statistics curriculum. This modified course structure can provide more time and emphasis on the objectives and design of investigations and also on model construction. The burden of the numerical procedure can be easily discarded to the mainframe or microcomputer and the time saved could be used for the analysis, conclusions, report writing and development of problem solving skills. Thus, with some innovative approaches, courses could be designed to remove the burden of number-crunching. A general discussion of a course development in applied statistics at Sheffield City Polytechnic, U.K., is as follows.

Course Development

The general aim of the Sheffield course are to provide students with an appropriate education in applied statistics (see Kanji & Gilchrist, 1981). Some of the specific aims and objectives relating to the course are as follows (a) to provide a full coverage of concepts and methodology, (b) to illustrate the application of methodology in various areas and how it extends to complex data structures, (c) to develop an appreciation of the practice of statistical investigations, (d) to give an appreciation of the role of computer packages, (e) to develop an ability to define problems, to modify techniques and innovate in the solution of statistical problems, and (f) to engender statistical integrity.

As we know, it is not possible to teach applied statistics in the true sense but it is possible to develop courses which will meet some of the challenges created by this electronic age. Some use of the computer in teaching statistics has been described by Mead & Stern (1973). Mead (1982) has also discussed the teaching of Design of Experiments liberated by the computer from restrictions imposed by the need to analyse the data. Recently Speed (1984) in discussing the teaching of statistics at University level, has pointed out that the computer-intensive method (ie simulation and monte carlo method) can be used for understanding statistical concepts and realistic modelling.

Teaching Methods

(i) Lecture. There are various areas in which computers can be used to improve students' understanding and appreciation of statistics. Host of the basic statistics lectures are devoted to graphical representation but also a graphic package may be used for this purpose, and consequent educational benefits of doing this through the medium of a microcomputer can be seen in such uses as: (a) presentation of recent data, (b) curve fitting and approximation (doing desired calculation quickly and accurately), (c) residual, plots and graphical representation of likelihood function, (d) boot strap and jacknife (computer intensive method), and so on.

It is essential that software developed for use in the lecture integrates the lecture programme and retains its supporting role.

(ii) Tutorial. The role of computers in tutorial work must be organized differently – it can be used to store a large amount of information which may be recalled rapidly for student use. Random samples can be generated from a known distribution and the estimates calculated can be compared. Hence a flexible system of software capable of dealing with different tasks needs to be adopted, and the new generation of general purpose tools e.g. electronic spread sheets should be accommodated.

(iii) Practicals/Case Studies/Projects. The role of practicals and projects are discussed in great detail by Kanji (1974, 1977) and case studies by Harris and Kanji (1986). The important use of computers in this area will be the processing of data into information. It will provide students with more time to devote to their design problems and findings. In a practical class teachers can provide realistic examples to demonstrate the art of problem solving in the real world.

Conclusion

In conclusion, we do not regret the gradual changing roles of statisticians. Undoubtedly the developments of computing facilities are providing us with new opportunities and new challenges. Statisticians can make themselves extremely useful members of organizations by using the available tools and adopting a wider application of the subject. However for this to happen the educators of statisticians need to change with the times. They must take advantage of the potential benefits of computers and develop courses to train both specialist and non-specialist statisticians. If we fail to alter and do not accept the challenges created by computer technology we as statisticians will stagnate. It is up to the members of the profession to prove themselves useful and necessary members of society for, as we have remarked earlier, the amount of information (data) being collected is increasing far more rapidly than any of us can realise or estimate. We believe that the challenge created by the computer is of a technical nature rather than of a scientific one and it helps us to study or gather information of something which changes over time or space. It is also true that certain areas of statistics have grown hand in hand with technology and therefore we feel that statistics should be a part of a much needed philosophy of modern science and technology (which it lacks at present) where the computer can play the catalytic role.

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