The Inevitable Need to Cater for Non-Mathematicians in Teaching Statistics

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1. Statistics via mathematics : an open debate

Few mathematicians are great believers in statistics but most statisticians are great believers in mathematics. This may be contested by either party but it is because mathematicians deal with "certainties" whereas statisticians deal with "uncertainties".

If we distinguish between mathematicians and mathematical teachers, then the gulf between "statisticians" and "mathematicians" becomes larger. Mathematical teachers do not see any reason to specialise in statistics or to learn about the subject; they feel that they can survive without it and without teaching it. They believe that they have a discipline of their own which should be upheld and safeguarded against dilution. They want to belong to, and be identified with, only mathematics and feel that they can derive enough pride and satisfaction from within their discipline and that they have enough substantive matter within the discipline to generate its perpetuation.

In contrast, statisticians can hardly deny that mathematics is the origin and the base of statistics. They believe that without mathematics, their discipline would degenerate. In common with mathematicians they uphold mathematics and cling to it but with varying degrees of closeness and intimacy. Statisticians with or without a mathematical background all believe that the fermentation of statistics and their own flourishment as statisticians depend on mathematics.

Thus, the opening statement of this paper should not sound strange nor be considered unusual. It is true that there are fewer mathematical disciples of statistics than there are statistical disciples of mathematics. Indeed it would have been strange if the opposite had been the case. For even if there were as many mathematical believers in statistics as there were statistical believers in mathematics, in absolute numbers the former would still seem less because of the larger population of mathematicians.

Mathematics is being taught to a larger audience than is statistics. It is taught to all students of mathematics regardless of whether they might later specialise in statistics

or not. Although mathematics courses are sometimes designed to serve other disciplines, they are not often designed to serve the teaching of statistics and university students who want to take statistics are often required to take some mathematics as a pre-requisite before they proceed to study statistics, but very few of these mathematics courses are tailored for students of statistics.

2. The need for non-mathematical teaching of statistics

While mathematicians have no problem learning statistics one way or another, non-mathematicians certainly do have difficulties learning statistics from mathematicians and/or mathematical teachers.

Mathematically-disabled statistical clients and audiences exist not only within universities (e.g. students of humanities and university employees), but also outside universities in ministries, in administrative structures of society, in all managerial levels of institutions and establishments, whether privately or publicly owned, and in all socio-economic groups including labour unions and employers' associations. The demand for learning statistics by this audience is much greater than the demand for learning mathematics and those who want to learn it in a non-mathematical way outnumber those who want to learn statistics mathematically.

This raises an important question, namely how safe is it to teach or learn statistics in a non-mathematical way under (a) mathematicians and/or (b) non-mathematicians? This is a serious issue which has to be tackled by the well-established teachers of statistics who should have had teaching experience with a variety of groups including those who are or are not mathematically equipped.

It should be realised that the insistence on teaching mathematics in under-developed countries the way it is taught in advanced countries is actually driving students in these countries away from learning mathematics and statistics, yet if we turn our attention away from formal to informal education and training, the picture becomes even more dim.

Experience reveals that in less developed countries there is a real need for a sincere and honest effort to simplify the teaching of both mathematics and statistics. Mathematics is a *must* because it is a pure science of "certainty" on which is based the cultivation of "realism". Statistics is also a *must* because it inculcates in the student a sense of organisation, a love for analysis and a commitment to wisdom in making predictions under conditions of "uncertainty".

The challenge which teachers of statistics face is that there is a need for a less mathematically oriented statistics syllabus. This is not a luxury that can be refused. Our response must meet the needs of:

(i) the young and the old;
(ii) the formal and informal setting of teaching and training;
(iii) the student, the employer, the employee and the practitioner;
(iv) the educated and the less educated;
(v) the mathematically and the non-mathematically equipped.

3. Towards a non-mathematical syllabus for teaching statistics

A simplified syllabus for any subject must be inspired by the ultimate use and application of the knowledge and information which has to be delivered to the audience. Other considerations include the teaching environment, the background of the audience, the specific field of application, the duration of the course, the teaching facilities and aids, job stability, and levels of job responsibilities.

Before outlining a syllabus for the simple teaching of statistics, it should be emphasised that we cannot deny the right of academic institutions to be academic, nor can we deny that academicians have an obligation to reproduce academicians in all the subjects taught, including statistics, but we cannot neglect the fact that neither the world nor the labour market is made only for academicians. Non-academicians in all fields of specialisation have to exist and be produced. Fortunately, or unfortunately, the production of these non-academicians is the task of the academicians.

Accordingly, there is a real need within the teaching profession to distinguish between orthodox rigid teaching and other forms of flexible and informal group teaching. Such flexibility should force us as teachers/trainers to care and cater for the demand for statistical learning at pre-university, university and post-university levels.

Even at university level there must be some differentiation between the statistical needs of each group or audience, i.e. academicians and non-academicians. In the latter case there should be some distinction between professional and non-professional statisticians, also between producers and users of statistics.

Taking these considerations into account, it seems obvious that a simplified statistical syllabus may, and indeed can, be designed in a less mathematical form and will contain such topics as:

(i) methods of data collection including the practical methods of sampling without teaching any sampling theory;
(ii) methods of data presentation, both tabular and graphical, which needs very little mathematics;
(iii) methods of simple calculations of statistical parameters without mathematical proofs;
(iv) methods of forecasting with a minimum of simple mathematics.

4. Children's statistical education

This syllabus has merits for the teaching of statistics at the early schooling ages and the early employment years. Children will be better able to develop their own skills in data collection, data presentation and calculation of elementary indices in statistics. They should become more attracted to the study of statistics and develop an aptitude for learning how to organise their knowledge and any type of information which they may have to handle and/or process, regardless of the area of specialisation. They will develop the skill to distinguish between values and variables and to accept the fact that values change over time and also in space from place to place. Their faculty of judgement and interpretation will be strengthened. If children develop a taste for statistics in their early schooling years they will be able to choose a statistical career without fear or horror.

The above syllabus does not require a base of mathematics. It could be absorbed by the child through simple examples that can be delivered by any teacher with or without a mathematical background.

The need for this training is necessary, for children face a continuously changing world and an information revolution as they grow up.

It is not difficult to meet this need for statistics in a non-mathematical way because it is not difficult to find graphs, tables, ratios, rates, proportions, averages, lines and curves that are needed by laymen. A few applied areas may be added like health, agriculture, labour, finance, tourism, sports.

Executives and administrators need statistics and they have to be helped by teachers of statistics to acquire the skills that enable them to plan and formulate policies and to develop compatible methods of performance in the light of sets of data or files which have to be organised, tables and graphs which they have to understand, and summaries which they have to prepare and submit to meetings and boards.

5. Difficulties in promoting non-mathematical teaching of statistics

Statistical teachers who are trained only as mathematicians may not want to accept the above syllabus and may attempt to minimise its value, demolish it, or ignore it. This is an attitude that can be tolerated from professional teachers who are only teachers and who devote full time to teaching. This kind of professional deformation can be tackled by introducing teachers - during term or during summer vacations - to the real world of work and management in the various economic sectors of the society.

Some teachers may think that simplification of material or of presentation threatens their discipline and that there is a minimum level (which, incidentally, is a subjective concept), below which they cannot risk any further simplification of their material and of their presentation.

These are possible difficulties facing the teaching of non-mathematical statistics. They are legitimate difficulties even if we call them by their proper name, objections. But we should try to overcome the difficulties and smooth the objections in the years to come.