Teaching and Learning Statistics

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1. Introduction

At a meeting such as this, held in September 1940 - therefore almost 50 years ago - Harold Hotelling told the story of "The rise of Jones" as he called it. Department X, aware of the essentiality of Statistics and convinced that without it their students lagged behind, introduced a course in "Research Methods". Jones, recently graduated and intelligent, was considered to have a bent for figures, and was instructed to present the course. Hotelling described how pleased Department X was with this decision: how economising was linked to a post for Jones, and how certain they were that this auxiliary area would never overshadow discipline X. At the same time they were certain that there would be no discrimination against students of X (which would be the case if they were sent to the Department of Statistics). He described Jones's preparation: in the library only Biometrics and very few textbooks could be found. But the mathematics in these was too obscure for him. Finally, already desperate, he decided to write his own handbook. His spirit of enterprise soon got the better of him and as he was a better economist than statistician, his textbook was reprinted time and again. And Jones himself: one promotion after the other! Does this sound like a story told half a century ago? I very much doubt that courses in Psychology, Sociology, Economics or Engineering, for example, would ever be presented in any Department of Statistics at any university or technical institute. However, the opposite is not rare at all - no, it is quite commonly found that these departments, without exception, present courses in Statistics.

What are we to conclude from this: that Statistics is either presented very badly by statisticians, or is too important to be left to the statisticians? Or should we agree with Kendall (1955):

> "University teachers are unique among professional men having no training whatsoever in their profession. They have to learn by experience and some of them never do learn. One would expect that in such circumstances a good deal of thought would have been given to the technique by which statistical ideas should be introduced to students ...".

Criticism of, exposure to, and justification of the educational task of universities is escalating. The era of the untouchable ivory tower has gone forever. Universities are experiencing an increasing loss of status. The reason for this is that functionality is used as criterion for efficiency and effectiveness. The value and meaning of universities for society, in terms of the provision of manpower, contribution to the national economy, planning, and the solving of problems, are of prime importance. In addition, the democratisation process requires increasingly more claims on and participation in the management and control of universities by *all* interested parties, whether parents or students or donors or the community (as ratepayers) or the professions. Whatever the case may be, the searchlight is directed more and more at the lecturing function of universities. Present-day universities are no longer "elite" universities, but mass universities. Because of this, as well as the ever-increasing cost of equipment and facilities, the claims of the ratepayer are growing, and therefore he or she looks more and more critically at the effectiveness of universities, which, according to him or her - inadmissably oversimplified - is measured in pass and fail figures.

In its great and unique task, namely the provision of high-level manpower, only *one* guarantee for success exists for the educational task of universities: to strive for excellence at all levels; and only one successful reality: a healthy balance between the timeless - striving for intellectual and academic progress and the contemporary - meeting the demand of relevance.

For the lecturer this means the optimum allocation of his or her time to teaching, research, and rendering of professional service, and to build and develop these tasks on excellence.

What are criticisms in the case of statistics students? We mention only a few.

(i) A total lack of true understanding.
(ii) Passive teaching versus active learning.
(iii) Supplying "handy" formulae.
(iv) Students are taught to use techniques which they do not understand.
(v) Statisticians do not realise that scientists have a different perspective on statistics.
(vi) The assumption that a practical course is nothing more than a watered-down version of a first course in Mathematical Statistics.
(vii) The discouragement of critical thought and creativity.
(viii) The language used in teaching statistics is unintelligible to scientists in other disciplines who want to use statistics in their research and especially to know why, when, and how statistics can be used.

How can we, and how will we meet these criticisms, some against the content and some against the technique, in our presentation?

Educational effectiveness brings the following to the fore:

(i) What is the purpose of training?
(ii) What is being taught?
(iii) How is it taught?
(iv) What is the purpose of evaluation?

2. Formulation of objective

A statement that no-one can dispute is that universities as such are moving away drastically from the traditional, and in order to understand this change, extensive analysis of the situation is essential. Given the creed and mission of your institution, it is important to take note of the powers that have an influence on undergraduate teaching, including:

(i) change in students regarding age, sex, numbers, race, politics;
(ii) change in lecturers regarding numbers, remuneration, permanent appointments;
(iii) change in curricula regarding demands of profession-orientated and professional training, i.e. market-orientated curricula;
(iv) change in demands regarding research: contract versus free research;
(v) change in technology: compare computer-based and computer-assisted teaching;
(vi) change in management: under financial pressure, more sharply attuned to effectiveness and efficiency.

It is therefore clear that a department, in striving for excellence in its teaching and training, should see the formulation of objectives as the result of situation analysis: everything is directed at the establishment of a learning-improvement course with process objective (I am going to show you these things), subordinate to product objective (you must be able to do these things).

3. Selection of learning content

For the different teaching and learning management approach of today, purposeful academic planning is essential. It begins with the scientifically justifiable planning of curricula, where clear aims and objectives are determined and relevant learning contents and learning experiences are selected. Selection and organisation of learning content at macro-level involve the total programme, while at micro-level it refers to a course or part of a course that is presented by the lecturer. It is extremely important, because it helps in guiding the student to the basic principles of the science in general and of a specific part thereof, as well as to their applications, so that it makes a contribution to the student's ability for analysis, synthesis, argument, forming an opinion, defining, planning and formulating a method. It is also important that the selection of learning content be dealt with in good scientific balance, avoiding on the one hand being untrue to the creed and mission, and on the other hand being unrealistic about the expectations of, for example, society and its careers or professions.

Selection of learning content involves collecting the learning content in the first place, and structuring it (making it available) in the second place. However, there is a third task that is very important, namely to help the learners to discover what the learning content means to them, so that their actions and behaviour are changed as a result of the teaching. The learning process is the discovery of this *meaning*.

Selection of learning content also refers to the *ability* of the lecturer to avoid conveying everything he or she knows or can find in textbooks and other sources to his or her students. As a lecturer's knowledge, experience and self-confidence increases, he

or she becomes more able to distinguish which learning content is essential for a specific group of students in a given course or class, and which is incidental or superfluous.

Finally, the lecturers should have enough self-confidence to tell themselves that they will not try to convey "everything". One must be so self-confident that in the preparation of one's teaching content one can venture to simplify, eliminate or construct methods that are suitable for the learning content that one conveys to one's students. This requires not only an excellent knowledge of one's subject, but also outstanding knowledge of content analysis, arrangement, association and structuring on the part of the lecturer. What is logical and understandable to the lecturer is not necessarily logical and understandable to the student. After all, that is why the students are in the class!

As meaningful learning is the objective of any teaching, it is necessary to look critically at the objective that introduced the analysis of learning content. Has it influenced the subject and the presentation of the learning content to such an extent that meaningful learning cannot take place? Has the objective perhaps led to unrealistic selection of learning content?

For most lecturers selection of learning content is the most difficult component of course design, and undoubtedly it causes most problems between lecturers and students in their courses at all levels of teaching and training.

4. Effective learning : learning theories

The importance of *motivation* in the learning process is being accepted to an increasing extent as the essence of learning and an essential prerequisite for the learning process. It is even taken a step further when it is claimed that the emphasis in tertiary education has shifted from what the lecturer does, to the motivation (or involvement) of the student on the learning process.

Motivation is the *activation* to achieve an objective. It is the single most important quality of a good student. In order to realise optimum learning conditions, we ask questions about:

(i) what motivates students;
(ii) academic motivation and career commitment;
(iii) student development and motivation;
(iv) learning styles and academic motivation;
(v) role of lecturers in subject motivation.

Different types of motivation can be classed as positive or negative in relation to student achievement.

Positive	*Negative*
A degree is essential	Wish of parents
Training for career	Enjoyable place
Interest in subject	Meet friends
Development of potential	Get away from home
Intellectual stimulus	Sport and student activities

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A distinct and very strong correlation exists between a student's academic motivation and his or her choice of and commitment to career. A student who studies a discipline that falls outside his or her field of interest can hardly be motivated. (Please feel sorry for those colleagues who have to present compulsory service courses!)

Several researchers (Bigge, 1982) have described the course of development of students at university, amongst others: cognitive-ethical development, intellectual development, moral development, development of ego. Obviously, the nature of a student's motivation is affected by his or her level of development. As an illustration; cognitive development as described by Bloom (Chickering, 1981), with the attendant motives for academic education, is presented as follows:

Stages	*Motives*
Knowledge and memorising	Usefulness value of education dominates.
Understanding and application	Tries to impress others with education.
Analysis and synthesis	Gains skills through education which increase ability to fulfill social responsibilities.
Evaluation and autonomy	Education intensifies self-understanding and understanding of the world in which he or she lives. Helps to develop ability to determine and achieve own destination.

The implications are that lecturers cannot expect students who are still at the knowledge and memorising levels of cognitive development to have deeper and stronger motivation levels.

Individual learning styles distinguished by inherited abilities, experiences, the demands of the environment, are identified in known and accepted learning theories, for example those of Bandura, Piaget and Kolb (Entwistle, 1983). Such styles include:

(i) students who can assimilate facts to formulate theories;
(ii) students who can deduce hypotheses from theories;
(iii) students who can reason logically;
(iv) students who can become involved in active experience.

Each of us develops a unique learning style that has strong and weak points. People do become more analytical and reflective as they grow older, but constant and distinctive cognitive styles that are unique to each person remain stable throughout life.

Different disciplines require different learning styles, and students who do not feel at home in the learning climate of a particular subject often experience discomfort and disinterest.

5. Involvement of lecturer

What is *my* attitude?

Do I let the student know that I am interested in him/her as a unique person?

Do I convey to him/her my expectations and confidence that he/she can do the work; can learn; has ability?

Do I give well-defined standards of values, demands on abilities, and guidance for the solution of problems?

My conduct - Do I serve as a model of sincerity?

Do I use opportunities to have a high degree of private or semi-private communication with students?

Do I have respect *and* warmth?

Do my students have freedom to develop?

Do I have natural control in class?

Do I give opportunities for experiencing of success?

Which strategies do I use to increase motivation in students?

- clear objectives
- enthusiasm
- realistic aspiration levels
- competition and cooperation
- information feedback
- public recognition to achievers
- variation in lecture activities

Do I understand the students and do I apply this knowledge to guide them to

- cooperation and academic involvement
- academic achievement?

PS The first twenty-five years are the most difficult!

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