NEW PEDAGOGY AND NEW CONTENT: THE CASE OF STATISTICS

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Reported by

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David Moore is the Shanti S. Gupta Distinguished Professor of Statistics in the Department of Statistics, Purdue University. He is well know in statistics education for his many books including *Statistics: Concepts and Controversies* and *Introduction to the Practice of Statistics* as well as the video series *Against All Odds: Inside Statistics* and *Statistics: Decisions Through Data*. He was the inaugural President of the International Association for Statistical Education and is currently the president elect of the American Statistical Association. The report which follows summarises the key points from his plenary address at ICME-8. The central theme of David's talk was that there is a synergy in statistical education where technology, content and pedagogy are working together to bring about change and development.

Theme: Technology—content—pedagogy in synergy

In his introduction David discussed the way in which mathematics education has become 'democratised'. In the past mathematics was often used as a filter in the school program for selection to certain courses and careers. However it is now the domain of a much broader clientele for whom esoteric courses are not appropriate. Rather mathematics needs to be more closely linked to practical uses. In this 'quantisation of society' there is a larger place for statistics within the mathematics education framework in which people need to be more analytical, quantitative and have greater computing and statistical skills.

Furthermore, he questioned whether we, as mathematics and statistical educators, are keeping up with the rapid changes occurring in technology, including computing, communications and multimedia. He said that

"quantisation does not call for wider learning of statistical skills in the traditional or professional sense, and that our introductory courses tend to be too narrow for the new audience". Also, he pointed out how poorly we predict the future, especially in technology as recent developments have shown.

Comparing the old and new models

In comparing the old and new models of statistical education David sees that, in the *old model,* the students learnt by absorbing information which a good teacher transferred clearly and at the right rate. On the other hand, in the *new model,* students participate in their own learning activities; the role of a good teacher is to encourage and guide the learning. Here higher-order thinking, problem solving and flexible skills applicable to unfamiliar settings become important goals.

In discussing what helps students learn, he listed the following:

- Hands-on activities
- Working in small groups
- Frequent and rapid feedback
- Communicating results
- Explaining reasoning
- Computer simulations
- Open questions, real settings
- Learning to work co-operatively.

He quoted the example of a company executive who asked: *"All of our work is now done cooperatively in teams. Why do you keep sending us students whose only experience is individual and competitive?"*

Changing content in statistics

In directing his comments mainly at introductory statistics courses, David sees a need for a change in the content which is currently widely taught. This is influenced by a number of factors including technology, professional practice, research tastes and reformed pedagogy. Changes which have occurred in recent years include greater emphasis on data exploration and the understanding of statistical concepts and less on topics which often dominated introductory statistics courses in the past - for example the use of recipes for statistical computations and the learning of statistical proofs. In these days when statistical computations and graphics can readily be automated, little time should be spent on these topics. Also modern technology facilitates improved understanding through visualisation techniques, improved diagnostics and allow a greater focus on problem-solving and active learning tasks.

In concluding his comments on content he posed the following questions:

Is the probability based inferential approach often adopted the most appropriate or should we return to the roots of statistics, the data analytic approach?

Should more be made of the differences between experimental and observational data?

Should fewer proofs and more simulations be used? *If an audience is not convinced by proof, why do proof?*

Data in the school mathematics curriculum

There has been an increased emphasis on statistics at the school level. For example, in the USA, the National Council for Teaching Mathematics Standards state there should be: *"Increased Attention to probability and statistics at all grade levels"*. While in the United Kingdom: *"Data handling to be 20% of maths curriculum for ages 11-16"*.

David sees this as a synergy of statistics education at the school level with core mathematics instruction. This synergy is linked with changes in both technology and pedagogy.

Comparing old with new technologies

Video was described as one example of an *old technology* which is good for compressing time and space by the use of magnification and time delays. It is also useful for changing attitudes and motivating students. However it is bad at exposition and the viewers are generally passive.

Another old technology, the *computer,* has the big advantage of allowing realistic problems to be carried out thus emulating actual practice. David claimed that while computers are good for doing statistics they are not so good for learning it. Also computers and the appropriate software are still not readily available to all students.

Computers have the advantage of using good graphics and are manipulable which aids learning by enabling students to explore, visualise and interact rather than merely calculate. Furthermore, they improve the ability of students to complete problems, reduce cognitive load and allow students to focus their attention on the concepts. He gave us the warning *"don't confuse the tool with the subject."*

One example of a *newer technology* is the *graphics calculator* with its sophisticated statistical capabilities. With these hand held devices most of a first statistics course at university level can be automated in a very accessible form at a modest cost. The graphics calculator has the advantage of being able to be shared with other subjects and it encourages active participation.

Some of its limitations were pointed out, in particular the limit on the complexity of data used and the screen size, especially for displaying graphics. Linking the graphics calculator to computers will help overcome some of these problems.

Another example of a newer technology is *multimedia*. In this system text, sound, still images, full-motion video, cartoon-style animation, dynamic computer graphics and computing for calculation are simultaneously available. The learner interacts with the software via the keyboard and mouse. Its advantages include the fact that it uses the strengths while avoiding the weaknesses of other medium. It can be highly interactive, it can generate frequent activity, makes use of video or graphics exercises and can include mastery learning. A big advantage is that the learner controls pace of the program. For example they can ask for review or enrichment whenever they need it. Further the program is customable by the instructor.

Some of the *weaknesses* of multimedia are that it is expensive to produce and there is only limited material available at the moment. Educators should be wary of the quality of the material available. Much is merely text based. David's word of advice *"If it is merely text-based, throw it out"*. A major weakness is seen in the fact that it reduces the social aspects of learning. He pointed out that there are still essential roles for human teachers when multimedia is used. These include motivational and facilitation roles, catering for special needs of some students and in assessment.

(Note: Several groups have/are about to release multi-media material statistics CDs. For example "ActivStats" from Addison-Wesley Interactive and the "Electronic Companion to Statistics" from Cogito.)

Some conclusions

David concluded by saying that content and pedagogy should drive instruction. He warned that technology should serve content and pedagogy rather than determine it. However, he noted that because of the interaction between developments in technology, content and pedagogy, there is a SYNERGY in statistical education between these elements.