# What do the Papers say to Educators and Researchers?

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## 1. Introduction

One question facing a discussant is what to focus on. I have taken the view that you have read the papers and what I should do is focus on some key general issues that arise from the papers. What follows is the perspective taken by this discussant as an educator-researcher.

I will focus on one question: What do the papers say to educators and researchers? As educators we read many papers, some of which have no impact while others can impact our thinking in a fundamental way. Having read the papers in this session, I will raise some questions for you, the audience or reader, to consider. Some are explicit in at least one paper, others are implicit, and yet others come from the discussant's "extension, interpretation and filtering" of the ideas mentioned in the various papers. There is no attempt to attribute any question to a specific paper or papers; they are a product of all of the papers. It is not claimed that this is a definitive list of all the questions that could be raised; however, it is a list that I feel contains important issues that need to be addressed by professional statistics educators. A final note. In the following the word statistics incorporates probability.

## 2. Real World Examples – To use or not to use, that is the question!

There is an implicit belief in some of the papers, as well as in the literature in general, that using real world examples is *inherently good*. The result of this is that many educators go to considerable effort to ensure that they use real data and real situations. However, there has not been, in my opinion, attention given to the question of when real situations or artificial situations might be effective. Is the use of marbles in bags to teach probability necessarily poor pedagogy? Are students necessarily interested in real data – there are people who do not care about soccer or baseball? Just because it is not real does not mean it does not motivate and visa versa.

Also, artificial situations can be designed to reflect specific issues that may not be inherent in real data. Using loaded dice (hopefully not a real situation) enables educators to explore specific siutations. So, educators and researchers need to address the issue of the boundaries for the useful role of real data in statistics education, not just "assume" that real means useful and valid.

## 3. Simulations – What combinations really help conceptual development?

The power of desktop computers has made computer simulation activities easily accessible to students at all levels. Some of the papers discuss the usefulness of simulations and the literature is full of activities involving simulations. Furthermore, the marketplace has many commercial simulation programmes. In terms of probability the question arises as to the usefulness of a computer simulation (with its ability to simulate a very large number of replications) versus a small scale activity involving real objects. This is in addition to the question as to whether a simulation is useful at all in a given situation. For example, a probability simulation of coin tossing, dice tossing (using loaded dice, say) is easy. However, what is the difference in conceptual understanding when studuents use a real simulation (e.g. toss a coin), a computer simulation (of coin tossing), or a combination of both? Does conceptual understanding develop better with or without simulations? If simulation is valuable, what combination(s) of simulations is(are)

effective? If I give students some manufactured loaded dice, while others have fair dice, will the conceptual development associated with activity be better drawn from a small experiment involving a game rather than from a computer simulation. Would we be better to do the small scale experiment first, discuss, then do the computer simulation? Again, there is a lack of research into maximising effective pedagogy of involving simulations. As educators we have been using small scale simulations for a long time, but do we really now how to effectively integrate these with the power of technology?

## 4. Misconceptions – How to use them in teaching and learning?

The literature on misconceptions is extensive. Over the last couple of decades or so we have learned a great deal about misconceptions in probability. The literature also shows that misconceptions are hard to change. As educators we would like to stop them developing, but this is not realistic. We can teach in a way to try to minimise the possiblity of students developing misconception, but as teachers we have to deal with the situation where students have developed misconceptions.

How can we, as eductors, use what we know about misconceptions to better inform instruction? How can we use misconceptions as an effective pedagogical tool? Correcting them is one goal, but utilising them as instructional tools is another.

## 5. Conclusion

As indicated at the beginning of this discussion, this is not a definitive list. The reader may well have focused on other points of interest that are just a valid as the ones identified by this discussant.

The issues of using real world examples, employing simulations and the pedagogical implications of misconceptions are not independant. As educators and researchers we need to carefully consider the basis for our decision making. Many countries are moving to, what is termed, "evidence-based policy decision making". As educators much of what we do is based on experience, discussions with colleagues, etc. In most cases we cannot wait for the evidence; we have to make decisions. Tomorrow I am introducing randomness to my secondary school students and it is not acceptable to say: Come back in 20 years when we have the research base to teach it more effectively.

So, what do we do? My title included the words educators and researchers. If we are to be more effective in educating students we need to see ourselves as educator-researchers. We need to address the issues raised in our own classrooms. While such research may lack the rigour that statisticians like, over time it should provide a body of evidence to support practice, and we can say that professional statistics educators have "evidence-based teaching decision making". We cannot rely on a small band of statistical reseachers to provide the evidence.


## RÉSUMÉ

Cet exposé invite l'auditoire à examiner certaines questions posées par d'autres études. Trois questions ont été choisies, à savoir: l'utilisation d'exemples du monde reel, l'emploi de simulations et l'usage de faux concepts en pédagogie. Ce faisant, il convient de noter que certains de nos procédés semblent être fondés sur des croyances qui ne sont pas supportées par la recherche, celle-ci étant absente ou fort limitée. Les participants sont invités à se considérer comme éducateur-chercheurs aspirant a developper le savoir necessaire à l'amélioration des procédés pédagogiques, étant donné que le petit nombre de chercheurs impliqués dans la recherche statistique éducationnelle ne peut pas produire toute la recherche.