Concepts and Methods in One Intro Stats Course?
Jerry Moreno moreno@jcu.edu
John Carroll University

JSM Contributed Panel Session 154: Conveying the Core Concepts
www.jcu.edu/math/faculty/MORENO/moreno.htm Scroll down and click on: *Conveying the Core Concepts*

This paper reflects a brief overview of my two ten-minute presentations given as part of contributed panel session 154 organized by Robert Carver and John McKenzie. I thank the organizers for asking me to be on the panel. The first part of the paper discusses what prompted me to critique what I have been doing in over 30 years of teaching the introductory statistics course for liberal arts students when basically the course has been going well in most professors and students eyes; the second part looks at challenges in trying to decide what a new version of our current reformed course should be.

This is very much a project in continuous discussion. I have no conclusions; I have no solutions; I do have a deep desire to produce liberal arts students who are statistically aware, who are able to use basic statistics concepts throughout their lives to read a newspaper more intelligently, and to help them make decisions in their political, economic, and personal lives.

Outline

A: Why the need?
- **Memphis Kiddy Park**
- **JCU Liberal Arts Core Requirements**

B: Challenges
- **Statistical Literacy vs Statistical Methods Both in one course -- is it possible?**
- **What are the basic core concepts?**

C: Examples
- **Understanding the concept of a measure Center; Variation; Relationship**
- **Understanding graphs**
- **Understanding risk**
- **Making decisions**

Expanded comments for parts A and B including the examples for part C may be found at:
www.jcu.edu/math/faculty/MORENO/moreno.htm
Scroll down and click on:
Conveying the Core Concepts

A: Why the need?
Joel Best speech at Augsburg College, 11/2002

"I'm talking about simple stuff. I'm talking about percentages, proportions, ratios, and rates. It's the sort of thing that gets handled, if handled at all, in the first week of the introductory statistics course and then it's assumed that "Hey, we all know this stuff. We can move on" Yet those of us who spend our time talking with students know full well that, in fact, this isn't something they all understand. Their confusion affects the way they read the newspaper, it affects the way that they vote, and it affects the way that they understand the world around them."

AMEN, Joel!

- **Memphis Kiddy Park**
A couple summers ago, I had taken my two young grandchildren to a "kiddy park." While watching them enjoy one of the rides, I felt a tap on my shoulder. "Are you Professor Moreno? I had you for statistics 25 years ago." Flattered that even through gray, thinning hair, I must not have changed that much over the decades, she proceeded to tell me over the length of two or three long rides how much she had enjoyed the class, how every time she bought M&M's for her children she thought of our stats class, and how much she thoroughly enjoyed all the formulas!

Probably taking her comments far too literally, I couldn't sleep that night embarrassed by and thinking about what does my former student and hundreds over my career who have taken the intro course from me really know about statistics? How do they view statistics in their daily lives? Is statistics to them the fun activities we did with M&M's? Is statistics the formulas whose computation when finally done correctly after much blood, sweat and tears brought smiles to their faces? Of what practical use were these in helping them become intelligent readers of the newspaper, better informed decision makers?

Fortunately, in the last 15 years or so in the "reform era" of teaching intro stats, I and my

mathematics colleagues have changed the course significantly to incorporate more data collection activities, far fewer formulas, more technology, much more conceptual thinking. But I wonder still what a graduate of a "reformed" class would say about his/her personal/practical use of statistics after having tapped me on the shoulder. Would I be able to sleep that night?

- **JCU Liberal Arts Core Requirements**

Besides my "tap on my shoulder" episode, what else has prompted a review of the intro course? John Carroll University is a small liberal arts Jesuit university with a very extensive core curriculum. Core courses must satisfy a list of 18 criteria. The University Core Committee reviews a course for it to be approved as core; our introductory statistics course is a core course undergoing review currently to maintain its core status. As a member of the writing team, I have been forced to think about what we are doing in the course to satisfy the 18 core principles. Here are a few of them; all are on the web site.

1. Core courses are designed to open the mind, broaden awareness, and widen horizons.
2. Core courses stress critical thinking, problem-solving, and oral/written expression.
3. Core courses encourage active learning.
4. Core courses introduce students to how an individual discipline employs various methodologies to generate knowledge.
5. Core courses contain interdisciplinary aspects to build bridges to other disciplines.
6. Core courses are pedagogically rigorous.
7. Core courses help students to become aware of their own values and to develop a reflective view of life.
8. Core courses introduce the ethics of a discipline.
9. Core courses address the state-of-the-art technology in a discipline.
10. Core courses encourage the collaborative process of learning.
11. Core courses create an awareness among students of the current issues in a discipline.
12. Core courses broaden students' perspectives through attention to global concerns and to such issues as diversity and gender, environmental responsibility, and social justice.

And so what direction does reviewing the intro stats course with the university's core principles in mind suggest? Well, briefly, choosing key phrases: a direction that opens the mind, stresses critical thinking, problem-solving, and

oral/written expression, encourages active learning, employs methodologies, builds bridges to other disciplines, introduces the ethics of a discipline, addresses state-of-the-art technology, encourages the collaborative process of learning, broadens attention to global concerns and to issues such as diversity and gender, environmental responsibility, and social justice.

Wow! The course of over two decades ago certainly did not come close to satisfying many of those principles. But what about the current "reformed" course that we are teaching? I suggest that our current course no doubt does so during the span of a fourteen week offering but to what extent has the so-prepared student retained and mastered the material for life-long use? That's the bottom line core goal. Isn't it?

B: Challenges
- **Statistical Literacy vs Statistical Methods Both in one course -- is it possible?**

Keep in mind that our students in the course are liberal arts majors typically whose quantitative skills could be a lot better. So it would seem natural to create a statistical literacy course for them (perhaps of the type for which possible texts would be Jessica Utts' *Seeing Through Statistics*, or David Moore's *Concepts and Controversies*, or maybe *Statistics* by Freedman, Pisani, and Purves, or Iversen and Gergen's *Statistics: The Conceptual Approach* or a *Chance*-type course as developed by Laurie Snell, or a course based on ideas that Milo Schield emphasizes on statistical literacy, e.g., www.augsburg.edu/ppages/~schield/ or www.statlit.org).

But the difficulty is that there are also students in the course, for example, psychology students, who need to have covered certain statistical methods in the first course so to be prepared for a second course. So we have a tug-rope contest between a concepts-based course to satisfy university core and let me call it the traditional methods-focused course that most of us no doubt teach whose texts allow us to teach the course in many different ways and which satisfy the prerequisite material required for students who need to take more statistics courses.

We cannot afford to offer two intro courses. So, is it possible to satisfy both in one course? If so, how? If you have suggestions, please let us know. We are in the discussion phase currently.

- **What are the basic core concepts?**

Some suggest that one course cannot satisfy both the statistical literacy course and the statistics methods course. But what are we to do who can only afford to have one course? Is there not a possible compromise in which the number of topics in the current methods course can be reduced to core basic ones that then can be conceptualized for life-long statistical literacy?

To those who argue that the second course would have to change dramatically because of students lacking prerequisite material, I ask how much of the current second course is spent "reviewing" topics, now for true understanding, that were covered but only superficially learned in the first course? Might it be that if students who leave the intro offering having truly understood core concepts to mastery that then the second course would not be affected to a great degree? Assuming, for the moment, that such a course to satisfy two masters is possible, what would be its core topics?

For a concepts/methods course, there are simply too many topics in what we are now teaching. But what are we to eliminate? Even to begin to answer that, there should be some agreement on what are basic core statistics concepts that we want every educated citizen to have mastered.

One of ASA's strategic initiatives is the GAISE project for grades k-13: *Guidelines for Assessment and Instruction in Statistics Education* (co-chaired by Chris Franklin and Joan Garfield). A draft of the guidelines may be found at http://it.stlawu.edu/~rlock/gaise.
GAISE suggests statistical thinking involves realizing:

The need for data to base personal decisions;
The importance of data production of quality;
The omnipresence of variability;
The quantification and explanation of variability taking into consideration randomness and distributions; patterns and deviations (fit and residual); mathematical models for patterns; model-data dialogue (diagnostics).

In session 75 of JSM Toronto on *Planning a Statistics Literacy Program*, Bob Hayden defined *statistical literacy* as "those skills that a person needs in order to deal with issues of probability and statistics that arise in everyday life." His topics include:

- Categorical data – census, polls

interpretation of empirical probabilities (connection between rates and conditional probabilities)
- Reading tables; understanding graphs
- Non-computational issues – bias, inadequate samples, faulty design
- Measurement – defining what is to be measured, finding a way to measure it
- Ability to ask questions about studies – was it observational or experimental, what variables were included, what variables were controlled/adjusted, what important variables were not controlled/adjusted, what kinds of bias may have been present
- Practical significance (leave statistical significance for the methods course)

Jessica Utts (*The American Statistician*, 57:74-79, May 2003) suggests seven topics in "What educated citizens should know about statistics and probability."
- Cause and effect – observational studies and randomized experiments
- Statistical significance versus practical importance
- Finding no effect versus finding no statistically significant effect
- Bias – poor survey wording, volunteer response, socially desirable answers
- Very improbable events are not uncommon
- Conditional probabilities
- Variability is natural – "normal" is not the same as "average"

Agreeing on say four fundamental core concepts that frame the concepts/methods course is clearly not an easy task.

Closing Remark

To be comfortable with the current course as the one for lifelong learning, as "reformed" as it is but filled with too many methods, is simply not acceptable. Our task is to define a few basic core statistics concepts that are fundamental to being able to function statistically in one's everyday life and then build one course around those core concepts, incorporating just enough methods to demonstrate how they apply and are meaningful in real life settings. Retention for life-long learning and application is the key.

The challenge is great. Meeting it is essential if we are ever to create a statistically literate citizenry.