"Guidelines for Teaching and Learning Statistics within the PreK-12 Mathematics Curriculum"

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Introduction

In this breakout session ideas and activities from the document, *A Curriculum Framework for Pre K-12 Statistics Education,* will be presented. *The Framework* was developed though ASA funding of a Strategic Initiative Grant (GAISE) proposed by the Advisory Committee on Teacher Enhancement in March 2003. The main objectives of this document are to provide a conceptual framework for Pre K-12 statistics education and to provide guidelines toward developing statistically literate citizens. *The Framework* was endorsed by ASA in early May 2005.

The foundation for the *Framework* rests on the National Council of Teachers of Mathematics' (NCTM) *Principles and Standards for School Mathematics* (2000). The NCTM *Standards* are the basis for most of the state curriculum guidelines in place for Pre K-12 education. The newly written *Framework* is intended to support and complement the objectives of the NCTM *Principles and Standards,* most notably the *Data Analysis and Probability Strand.*

The Framework provides a conceptual and developmental structure for statistics education that presents a coherent model for the overall statistics curriculum at the Pre K-12 level. *The Framework* is designed to provide stakeholders such as writers of state standards, writers of assessment items, educators at teacher preparation programs, curriculum directors, and Pre K-12 teachers with guidance in developing standards in statistics and data analysis as part of the Pre K-12 mathematics curriculum.

This breakout session will provide a general overview of the *Framework* with illustrations of several activities.

The Framework

The Framework presents statistical problem solving as an investigative process that involves four components:

(1) Question formulation, (2) Data collection, (3) Data analysis, (2) Interpretation.

An *understanding of variability* is crucial for the practice of this process. Understanding the role of variability in the statistical problem solving process requires maturation in statistical thinking. The beginning student cannot be expected to make all of these linkages. Statistical education should be viewed as a developmental process, and this *Framework* provides guidelines for statistical education over the three developmental levels, A, B, and C. These three levels roughly parallel the Pre K-5, 6-8, and 9-12 grade bands of the NCTM *Standards*. Although we hope that the school curriculum is such that these three levels are somewhat equivalent to elementary, middle, and secondary, *The Framework* levels are based on experience not age. Thus, a middle school student who has had no prior experience (or no rich experiences) with statistics will need to begin with Level A concepts before moving to Level B. This holds true for a secondary student as well - if a student hasn't had Level A and B experiences prior to high school, then it is not appropriate to jump into Level C expectations. At Level A the learning is more teacher

driven, but transitions toward student-centered work at Level B and becomes highly student driven at Level C. Hands-on, active learning is a predominant feature throughout.

The Framework presents a conceptual structure for statistics education in a two-dimensional model. One dimension is defined by the components of the statistical problem-solving process along with the nature of and the focus on variability. The second dimension is comprised of the three developmental levels.

Two Examples from *The Framework*

Example 1 – What type of music do students like?
Suppose students are interested in knowing what type of music (rock, country, or rap) is most popular among their peers in school? Level A students could collect data in their classroom and analyze the data by summarizing frequencies for the different categories in a table or bar graph. They could draw conclusions about the most popular type of music and the least popular in their classroom. At Level B, students could transition to summarizing categorical data by reporting relative frequencies – making the leap to proportional reasoning for comparing categories or groups. Additionally, data on different types of music "liked" or "not liked" might be summarized in a two-way frequency and possible associations explored through conditional relative frequencies. Regarding the musical preference question, level C students will transition to understanding the notion of estimating the population proportion who prefer a particular type of music with the sample proportion, exploring the sampling distribution (through simulation) of the sample proportion, and developing the idea of the "margin of error" associated with the sample proportion.

Example 2 – Developing the Concept of a Mean
At the inaugural *TEAMS* conference, sponsored by the ASA, in October 2003, then President of NCTM, Johnny Lott, gave one of the keynote addresses. In his address, he asked statisticians to help him see how the understanding of the mean advances from elementary grades to middle grades to high school grades within the framework of the NCTM Standards. Clearly defining the expected development of a concept at each level, as illustrated in the previous example, is a major goal of this document and one that nicely complements the NCTM standards. Another example of clarity of concepts at each level relates to the notion of the mean for a collection of numerical data. In *The Framework,* we attempt to clarify this distinction as follows:

Level A: The notion that the mean is the "fair share value"
Level B: The notion that the mean is the "balancing point" of a distribution
Level C: The notion that the sample mean is an estimate of the population mean, as well as understanding the concepts of the sampling distribution of the sample mean (through simulation) and the margin of error associated with the sample mean.

Summary

A good deal of progress has been made in statistics education in recent years, but there is still plenty of room for improvement. State standards and assessments are all over the map and the data analysis portions are often poorly structured. Textbooks and other teaching materials tend to be unfocused with many errors (unless these materials have statistics educators as part of the

writing team). The Pre K-12 guidelines in *The Framework* have already made a positive impact in the state of Georgia with the current revisions of the Georgia state mathematical standards. It is the hope that *The Framework* will provide a conceptual foundation in data analysis for the interested stakeholders.

The Framework also serves as an essential background for moving more students toward a major or minor in statistics at the undergraduate college level. Most importantly, it is the goal of this *Framework* to help educators work toward the important goal of developing statistically literate citizens who can use statistics to make reasoned judgments, evaluate quantitative information, and value the role of statistics in everyday life. The complete report can be viewed at http://it.stlawu.edu/~rlock/gaise/