

FUNDAMENTAL IDEAS IN STATISTICS AND HOW THEY AFFECT THE TRAINING OF TEACHERS

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The central idea of evidence-based education – that education policy and practice ought to be based on what is known from rigorous research – offers a compelling way of approaching reform efforts. How to make a decision with statistics is a topic that exposes the students to the major ideas and themes of statistics that they will use throughout life. How to best present this to teachers as well as an early coverage of sampling and experimental design will be discussed at this presentation, where it will be argued that teaching statistical decision making early on and using the topic throughout the year will reinforce the learning so the subject becomes natural to the teachers and their students. This discussion is based on a previous analysis of teaching statistics and training teachers in the United States and several educational initiatives fostered by the American Statistical Association (ASA).

TEACHING STATISTICS AND EDUCATING THE TEACHERS

In 2000 the National Council of Teachers of Mathematics (NCTM) released a new set of standards for the K-12 mathematics curriculum (NCTM, 2000). These standards include a data analysis and probability component at all levels of instruction. Achieve, Inc (<http://www.achieve.org/>) has also included a component on Data Interpretation, Statistics, and Probability as part of its Mathematics Benchmarks. Both of these are important steps toward making sure statistics and probability are included in the K-12 mathematics curriculum in the United States.

More recently, a number of statistics educators have been involved in a project, Guidelines for Assessment and Instruction in Statistics Education (GAISE). The participants in this project have written two reports (Franklin et al., 2007; Aliaga et al., 2007) that address PreK-12 and college education in statistics. And the College Board has released its *College Board Standards for College Success – Mathematics and Statistics* that provides additional information about what students should learn in grades 6-12 in order to be successful in college (College Board, 2006). These, too, include statistics and probability as necessary ingredients of the pre-college mathematics curriculum.

While these documents provide an overview of what students should be taught, they do not address the issue of what knowledge is needed by the teachers of these students. In 2001, the Conference Board of the Mathematical Sciences published *The Mathematical Education of Teachers*, which provides a suggested set of courses for teachers at three levels, elementary school, middle school, and high school. A National Summit brought together about 300 educators to discuss and publicize the ideas in the book. The book and the summit both include statistics as an important part of the mathematics education of teachers. The book emphasizes that this is an area in which very few teachers have received any training. But changes in curriculum move very slowly. Classes in statistics are not required for a degree in mathematics education at many (if not most) institutions. So, there is a sizeable number of teachers who are expected to teach statistics in the K-12 grades but who do not have a good understanding of the subject.

ASA EDUCATIONAL INITIATIVES

The ASA has been working for many years to remedy this problem, beginning its own Quantitative Literacy (QL) program in the 1980s (Scheaffer, 1986) with funding from the National Science Foundation (NSF). As part of this program, curriculum materials in modern data analysis, statistical inference, and probability were developed, and many K-12 teachers had the opportunity to attend summer workshops. This project had the support of NCTM, and the result of the project influenced its *Standards for School Mathematics* (NCTM, 2000). A consequence of these workshops was an increase in the knowledge of and enthusiasm for teaching quantitative methods in the K-12 classrooms.

With an NSF grant in the 1990's, ASA supported the development of a series of supplemental materials to be used in high school mathematics classes. The series titled Data Driven Mathematics (Burrill et al., 1998) included topics in statistics as well as mathematics. Building on the success of the QL program, ASA launched SEAQL (Science Education and Quantitative Literacy) in the 1990's. This extended training to science teachers and encouraged the use of experiments in teaching (rather than just the verification of constants, such as the boiling point of water). Supported by another NSF grant, ASA ran a series of workshops for teachers and published supporting material under the title, SEAQL: Science Education and Quantitative Literacy.

Another outgrowth of the ASA QL program was its Adopt-a-School program. This program is designed to promote K-12 statistics education by bringing practicing statisticians together with local K-12 teachers. Through its Adopt-a-School program, ASA is attempting to provide K-12 teachers with a local source of information and knowledge that they can use to enhance their classroom activities.

In 2007 in Salt Lake City, the American Statistical Association (ASA) launched the first workshops for Middle School teachers grades 6-9, called Meeting Within the Meeting (MWM). It is expected to be the first of a series of annual meetings for K-12 teachers. The second meeting will be held in Denver in August 2008 (with the Joint Statistical Meetings). At the Denver meeting, the MWM program will include activities related to STatistics Education Web (STEW), featuring lesson plans that cover various statistical topics at levels that range from kindergarten through high school. The information will be organized in a database, so that teachers can easily identify activities that can be used to teach specific statistical topics at their students' age levels. The lesson plans will identify which standards (state, NCTM, Achieve, etc.) were addressed by the activity and will enhance understanding and teaching of statistics within the mathematics/science curriculum based on conceptual understanding, active learning, real-world data, and appropriate technology. Teachers will explore problems that require them to collect, organize, analyze, and draw conclusions from data and apply basic concepts of probability. The MWM program will include examining what students can be expected to do at the most basic level of understanding and what can be expected of them as their skill levels develop and their experience broadens.

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