

# Collaborative Projects in Statistics Education

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## Abstract

The field of statistics education is growing, but needs more quality studies to address unanswered questions. To meet this need, the Research Advisory Board (RAB) of CAUSE initiated a mentoring program under the NSF-funded CAUSEmos grant. The program's purpose is to support the development of researchers new to statistics education. Three teams were formed from eleven faculty participants based on common research interests. During the first year, each team conducted a literature review, refined research questions, and designed a preliminary research project. In this paper, an RAB member presents an overview of the mentoring program. Representatives from each group discuss their respective studies. In conclusion, the participants discuss their participation in these clusters.

**Key Words:** CAUSE, statistics education, collaborative research

## 1. Overview of CAUSE-sponsored Research Clusters

The Consortium for the Advancement of Undergraduate Statistics Education (CAUSE) is an organization that has been promoting undergraduate statistics education since 2002. The Research Advisory Board (RAB) of CAUSE is comprised of 9 members from 7 institutions of higher education and has adopted as part of its mission statement the “promotion of statistics education research”. More specifically, the RAB intends to foster high quality research, to promote research that is cumulative, and to support apprentice researchers in statistics education. In an effort to accomplish these three goals, RAB created and is currently mentoring three collaborative research clusters consisting of 3-4 apprentice researchers per cluster. The next paragraphs provide a brief history of this creation and mentoring process.

In late 2006, the RAB outlined a process by which participants would be selected for the research teams. In outlining this process, discussions were held about the nature of successful collaborative teams. It was understood that a tension existed between structure and flexibility. Having established goals for the program and identifying general expectations, RAB solicited applications. Several applications were received and reviewed by all members of RAB. Twelve individuals were invited to participate; these 12 individuals attended USCOTS II in May 2007. The day prior to the conference, all the participants met with RAB members in order to get to know one another, discuss the purposes of the collaborative endeavor, and explore statistics education research. Participants and RAB members were encouraged to attend research sessions together at the conference, to talk with one another, and to learn of current research interests.

After the two-day conference, RAB created three collaborative research clusters based on participants' input, interests, and dispositions. At least two RAB members were assigned as mentors to each cluster. Specific research tasks were outlined and general deadlines were established. Collaboration within the research cluster was nurtured through regular (monthly) phone conferences. During these phone conferences, participants identified and explored research

topics and ideas by sharing what they had thought and learned as they read relevant research literature and reflected on what had been done in the field of statistics education. General topics were narrowed and viable, interesting research questions emerged. Preliminary plans were also made for designing and carrying out research plans.

This attempt to foster collaboration among young statistics education researchers appears to be useful and productive. It is a dynamic process that requires ongoing reflection and flexibility to ensure that it meets its intended goals and purposes.

## 2. Lexical Ambiguities in Statistics

**Cluster Members:** Diane G. Fisher (University of Louisiana – Lafayette), Jennifer J. Kaplan (Michigan State University), Neal T. Rogness (Grand Valley State University). **RAB Advisors:** Sterling Hilton (Brigham Young University), John Holcomb (Cleveland State University), Marsha Lovett (Carnegie Mellon University)

The use of domain-specific words that are similar to commonly used English words may encourage students to make incorrect associations between words they know and words that sound similar but have specific meanings in statistics that are different from the common usage definitions. The words or phrases that are the same or similar but can be used to express two or more different meanings are said to have lexical ambiguity (Barwell, 2005). In order to create instructional materials that aid teachers in confronting lexical ambiguities in the statistics classroom, more must be known about the nature of lexical ambiguities in statistics and their effects on student understanding.

The study reported here is first stage of a research program designed to uncover the extent to which lexical ambiguity exists in statistics and its effect on student learning. In order to “exploit” the lexical ambiguity of words and help students form strong mental connections between their existing word meanings and the statistical meanings, we must first ascertain the meanings of the words that are most commonly used by students. This study involves five words chosen by the research team: association, average, confidence, random, and spread. The research question for the study presented here was: What are the meanings of the five target words most commonly used by students entering an undergraduate statistics course?

A pilot study was conducted in the spring semester of 2008 at the University of Louisiana at Lafayette using 65 students from a variety of majors enrolled in sections of Elementary Statistics. During the first week of class, before any of the five words were discussed, the students were given a questionnaire asking five sets of questions. For instance, they were asked to a) Define or give a synonym for the word “association.”, as well as b) Use the word “association” in a sentence. The same questions were repeated for each of the other four words. Student responses were coded and a list of definitions used by students was generated for each of the five words. This coding scheme will be used in a larger across institutions and across instructors within institutions. A more detailed discussion of the rationale for choosing these words and discussion of the results is available in Kaplan, Fisher, and Rogness (submitted, 2008).

## 3. Pre-requisites for Understanding Sampling Distributions

**“Abnormally Distributed” Cluster Members:** Dale Berger (Claremont Graduate University), Tisha Hooks (Winona State University), Michael Posner (Villanova University), Michelle Sisto (International University of Monaco). **RAB Advisors:** Bob delMas and Andy Zieffler (University of Minnesota).

Students in introductory statistics courses often encounter difficulties when introduced to hypothesis testing. Our cluster was initially interested in this problem, so we started a literature review on student understanding of hypothesis testing. Soon, we discovered that there were several issues that come before hypothesis testing that deserve the attention of researchers. This led us to our current research question: How does understanding the theoretical prerequisites of sampling distributions relate to students’ understanding of sampling distributions?

Chance, delMas, and Garfield (2004) identified these prerequisites to learning about sampling distributions: (1) sampling, (2) variability, and (3) distributional thinking. These authors noted that students were not able to reason about sampling distributions until they had a sound understanding of these related concepts. They have also identified several misconceptions students have concerning the theoretical prerequisites; however, our intent is to focus on how these concepts and misconceptions are connected to one another.

Currently, we are in the process of creating an assessment tool to measure student understanding of both these prerequisites and sampling distributions in general. The assessment items can be accessed online at <http://wise.cgu.edu/> (click on Statistics Concepts Quiz). We have piloted this tool with students from Winona State University, the International University of Monaco, and respondents to the online version of the test; moreover, we are continuing to pilot the questions in the interest of gathering data to support item development. Our initial objective is to establish that our instrument provides a valid and reliable measure of student understanding in each concept area. Then we hope to use this instrument to measure students' understanding of distribution, variability, sampling, and sampling distributions, as well as to look at relationships between students' understanding of the former three to their understanding of sampling distributions.

#### 4. Teacher Efficacy for Teaching Statistics

**“Stats Trek” research cluster members:** Leigh M. Harrell (Virginia Tech), Teri J. Murphy (University of Oklahoma), Rebecca L. Pierce (Ball State University), and M. Alejandra Sorto (Texas State University). **RAB Advisors:** Felicity B. Enders (Mayo Clinic), Randall E. Groth (Salisbury University), Lawrence M. Lesser (University of Texas – El Paso).

Preservice teachers have been the focus of much research, including studies that focus on teacher preparation and/or teacher beliefs and attitudes. An idea central to teacher beliefs and attitudes is teacher efficacy. Teacher efficacy has been defined as a teacher's “belief that they have the skills to bring about student learning” (Ashton, 1985 (p.142); Smith, 1996; Gresham, 2008). Teacher efficacy is important as it affects teacher motivation, willingness to use more innovative techniques, student achievement, and time spent teaching certain concepts (Czerniak, 1990; Riggs & Enochs, 1990; Wenta, 2000).

Research about teacher efficacy in science and mathematics education has shown that levels of teacher efficacy are related to teacher content knowledge, teacher pedagogical content knowledge, and teacher beliefs and attitudes regarding the content (Cakiroglu, 2000; Gresham, 2008; Huinker & Madison, 1997; Swars, 2005; Wenta, 2000). Teacher efficacy to teach statistics is a potentially more complex concept than in mathematics or science education as teachers of mathematics and statistics in grades K-8 tend to be graduates of mathematics education programs rather than statistics undergraduate majors or graduate students. However, as state-mandated standards incorporate statistics and probability into K-8 mathematics curriculums, the teacher efficacy to teach statistics increases in importance.

The purpose of this phase of our study is to examine pre-service middle school teacher efficacy about teaching statistics. We are developing an instrument to measure levels of this construct based on the GAISE guidelines for K-8 curriculum (Franklin et al., 2007), as well as the state standards for teacher knowledge and student learning outcomes that have specific statistics requirements.

The initial items for the instrument on teacher efficacy about teaching statistics will be piloted this fall at Virginia Tech and Texas State. The pilot study will include the recently developed items along with questions aimed at determining the amount and type of course work completed in statistics, attitude towards statistics, and experiences that influenced the development of both attitude towards statistics and efficacy for teaching statistics. Based on the results of the pilot study, the items will be revised and a larger study at multiple institutions will then be conducted.

## 5. Participation in the Collaborative Experience

The 11 participating members of the research clusters come from different colleges and universities in nine different states in the United States and from the Principality of Monaco. Some are relatively new to their field, while others have many years of experience in both teaching and research. What they all have in common is a passion for teaching statistics and providing a quality experience for their students.

There are three research clusters. Each cluster, along with their Research Advisory Board members, work on a particular research project. What they learn from their individual projects is shared with other statistics educators through presentations and publications.

The cluster members and their advisors meet once a month by telephone and approximately once a year in person at national conferences. The communication is sometimes challenging due to the different time zones and work schedules. However, between conference calls the clusters take advantage of electronic communication technologies, such as Learning Management Systems, Google Docs, and ReadyTalk.

Despite the difficulties of working across distance, the members have found it to be a valuable and rewarding endeavor. They no longer feel like isolated statisticians. The members enjoy working with others who, although they may be thousands of miles away, have similar interests. They have found that working with others and reporting monthly their individual progress has made them set deadlines and get the work done. Perhaps the greatest benefit the cluster members have received is that, through their reading, research, and discussion with other members, they have become better statistics teachers.

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