RESEARCH ON ATTITUDES TOWARDS STATISTICS

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1. INTRODUCTION

Have you ever met new people who ask you what you teach? If you reply that you teach statistics, and perhaps even mention other courses, your new acquaintances then regale you with descriptions of their experiences in their statistics courses, sometimes taken decades ago. These stories most often aren't positive (with the exceptions of other statisticians and Candace's tax accountant who says that she uses statistics in her life more than anything else she learned in her advanced education). The negative stories are rarely about what they did or didn't learn but rather about their attitudes toward statistics, their statistics courses, and often their statistics instructors, who may hold a special bad place in their memories. Either these people do not use statistics in their lives or they don't realize that they do; we suspect the former is more common. We do not want this outcome from our courses. To avoid leaving our students with negative attitudes toward statistics, we must first understand their attitudes towards our discipline. And although we all have experiences and stories along the lines of the ones above, we would like to base our knowledge of students' attitudes on firm empirical research and theoretical bases.

In that vein, we are pleased to introduce this *SERJ* special edition on attitudes toward statistics. We had a great response to our call for papers in the May 2011 issue of *SERJ*. Out of the many papers that were submitted, this special edition presents eight. Of the other papers submitted, several are still being improved and could not be readied in time for our deadlines. We hope that their authors will resubmit them to *SERJ* soon.

The impetus for this special issue came from members of the Attitudes Research Cluster that began at USCOTS 2009 (United States Conference On Teaching Statistics) and has been supported partially by the Consortium for the Advancement of Undergraduate Statistics Education (CAUSE). About one-quarter of the authors of the papers in this special issue are members of the Cluster. This Cluster has promoted interest in attitudes research and has brought new researchers into this area; we introduce some of them in this issue.

2. ATTITUDES IN THE CONTEXT OF STATISTICS EDUCATION

As statistics instructors, we often concentrate on what to teach and how to teach it. In focusing on these aspects of instruction, we may overlook the fact that some of our students do not like statistics, feel that they cannot understand statistics, think that statistics is worthless, believe that statistics is too difficult to learn, are not interested in statistics, or aren't willing to put in the effort needed to learn statistics. That is, some of our students have negative attitudes toward statistics. In statistics education, it is becoming increasingly apparent that attitudes exert a primary impact on students' academic behaviors and are important outcomes in their own right. See, for example, Ramirez, Schau

and Emmioğlu in this issue. However, this recognition isn't yet universal in our discipline, and it needs to be.

In the early 1990s, Candace realized that she needed to try and better understand her statistics students' attitudes. With help from her graduate students, she created the original version of the *Survey of Attitudes Toward Statistics* (SATS-28) which she then revised as the SATS-36. At that time, she had no idea what she was getting into. She copyrighted both versions of the SATS so that she could keep track of its use and has been following research and evaluations using the SATS since its inception. Both versions of the SATS are used across the United States and the world, having been translated into many different languages (e.g., Turkish, Spanish, Afrikaans, Chinese, and Dutch). In addition to her own and others' SATS-based research, Candace and her colleague Marjorie Bond collected web-based SATS-36 data from students, as well as information from their instructors, from the fall term of 2006 through the spring term of 2008. The SATS Project has yielded information from hundreds of sections of statistics courses. The Schau and Emmioğlu article in this issue uses data from this project.

3. THE ARTICLES

This issue's editors, authors, and papers represent several layers of diversity. The editors are from three different countries with different backgrounds: Candace, an educational psychologist, consultant, and retired professor, is from the United States; Michèle, an applied statistician and statistics educator working with quantitative methods, is from Canada; and Peter, an applied statistician and statistics educator often using qualitative research methods, is from Australia. The papers are written by authors from Australia, Canada, Portugal, Turkey, and the United States; the authors come from a variety of disciplines, including statistics, education, psychology, and veterinary medicine. We have included work from new statistics education researchers as well as from 'old hands.' For some of the newer researchers, their papers in this issue are the first ones they have published in a research journal. Some of the papers reporting original research use mixed methods whereas others use quantitative approaches. The papers include original research studies as well as reviews, syntheses of research, and theory applied to attitudes, as well as practical concerns. One paper examines teachers' attitudes while the remaining papers examine students' attitudes.

As editors, we do not necessarily agree with everything said in these articles or how the research and analyses were conducted. However, we believe that each of these papers advances our field by providing important information about attitudes toward statistics and how attitudes fit into statistics education.

Our first three papers use mixed methods. "Students' Perceptions of Statistics: An Exploration of Attitudes, Conceptualizations, and Content Knowledge of Statistics" is by Marjorie Bond and her colleagues Susan Perkins and Caroline Ramirez. This study qualitatively explores undergraduate students' perceptions of statistics as measured by their understanding and conceptualization of statistics. Students' perceptions are assessed at the beginning and the end of their elementary statistics course, thus allowing an examination of changes in perceptions across the course. The authors then quantitatively examine the relationships between these two aspects of perceptions and students' attitudes as assessed by the SATS-36. They work with a relatively small sample (under 50) of students from a small liberal arts college in the United States.

In our second paper we move to Portugal and look at teachers' attitudes rather than those of students. "Looking Back Over Their Shoulders: A Qualitative Analysis of Portuguese Teachers' Attitudes Towards Statistics" is by José Alexandre Martins and his colleagues Maria Manuel Nascimento and Assumpta Estrada. They qualitatively analyze teachers' open-ended explanations for their Likert-scale responses to nine items from an attitude survey. The survey includes items which reflect the teachers' attitudes to statistics (e.g., *Statistics help me understand the world of today*) and their attitudes to teaching statistics (e.g., *I have fun in the classes in which I teach statistics*). They report results for almost 200 in-service elementary school teachers. This paper is our only one on teachers' attitudes.

The third paper, "Students' Attitudes Toward Statistics Across the Disciplines: A Mixed-Methods Approach," by James Griffith and four colleagues (Lea Adams, Lucy Gu, Christina Hart and Penney Nichols-Whitehead) examines differences in United States students' attitudes toward statistics across

majors. Their study involves almost 700 undergraduates enrolled in required statistics courses who were majoring in business, criminal justice, or psychology. After separating the students into two groups, those with generally positive attitudes and those with negative, a qualitative data analysis based on students' explanation for their attitudes yielded five categories of responses. The authors then quantitatively explore the differences and similarities across majors.

This is followed by a theoretical paper: "The Importance of Attitudes in Statistics Education." Beginning with a brief description of 15 different surveys designed to measure students' attitudes, this paper focuses on the SATS-36, and presents a conceptual model (the SATS-M) to help instructors and researchers consider the impact of attitudes on statistics course outcomes. The authors, Caroline Ramirez, Candace Schau, and Esma Emmioğlu, describe Eccles and colleagues' Expectancy-Value Theory (Eccles' EVT), and demonstrate the congruence among the SATS-M, the SATS-36, and EVT, as well as other theories. They then relate evidence from research using the SATS-36 to the SATS-M.

The next paper also concerns EVT theory, but from an applied perspective. "Using the Expectancy Value Model of Motivation to Understand the Relationship Between Student Attitudes and Achievement in Statistics," by Michelle Hood, Peter Creed and David Neumann, looks at about 150 second-year Australian university students in a compulsory psychology statistics and research methods course. The authors hypothesize a model relating past performance, student attitudes, and statistics achievement based on Eccles' theory. Path analysis reveals that their initial model is not a good fit to their data, so they refine their model in keeping with the data and other research using EVT to explain 40% of the variance in achievement. They finish with a detailed discussion of this final model.

We now return to North America. "Do Introductory Statistics Courses in the United States Improve Students' Attitudes?" by Candace Schau and Esma Emmioğlu describes students' attitudes from 101 different introductory statistics service courses. Data from the SATS project are used to examine these attitudes at the beginning and end of the courses, as well as changes in attitudes across the courses. This article enhances our understanding of the current impact of statistics instruction in the United States.

Our seventh paper is a meta-analysis: "Attitudes and Achievement in Statistics: A Meta-Analysis Study." The authors, Esma Emmioğlu and Yesim Capa-Aydin, are from Turkey. Studies included in the analysis provided examined post-secondary students' statistics attitudes, used the SATS to assess attitudes, and reported the Pearson correlation coefficient between at least one SATS attitude component assessed at the end of the course and student achievement. The meta-analysis found positive relationships between attitudes and achievement, and differences in the strength of these relationships depending on the attitude component. The results revealed an interesting distinction in the strengths of these relationships, depending on the geographical regions in which the studies were conducted.

The final paper is a systematic review of surveys designed to measure student attitudes. "Surveys Assessing Students' Attitudes Toward Statistics: A Systematic Review of Validity and Reliability" is by Meaghan Nolan, Tanya Beran, and Kent Hecker, all from Canada. Surveys were included provided they were written in English, published in a peer-reviewed journal, and presented extractable validity and/or reliability data for the instrument. Fifteen surveys are presented. The authors discuss four types of validity evidence (content, substantive, structural, and external), and include Cronbach's alpha as an indication of internal consistency whenever it is available. They conclude that only four surveys have a substantial amount of validity and reliability evidence available.

4. DISCUSSION

We hope that you will look at each paper. In addition to describing the articles, we want to point out some themes and findings we notice that emerge across them and that suggest future directions for research into attitudes to statistics. You may well notice other themes and research needs.

First, and most clearly, all of these authors believe that the constructs of attitudes toward statistics and perceptions of statistics are important on their own, as well as in their impact on course and life outcomes. The papers stress these beliefs and present evidence and arguments to support them. We hope that this special issue helps to highlight attitudes and perceptions firmly within the field of statistics education.

Second, some consistent findings about the components of attitude emerge from these articles. These include students' like or dislike of statistics; the value they attribute to statistics in education, in their careers, and in their lives; their confidence in themselves to learn and understand statistics; and the difficulty of statistics as a subject. The categories of students' interest in statistics and the effort required to learn statistics appear less often but they appear multiple times.

Third, our research should continue to build on theory and knowledge about attitudes found in other disciplines, such as education and psychology (see Hood et al.; Ramirez et al.).

Fourth, most of the research in attitudes toward statistics has relied on the use of Likert surveys. Like any assessment approach, these surveys have strengths and weaknesses. Some of the articles in this issue, especially the mixed methods ones, suggest other qualitatively-based measurement approaches. Regardless of the approach, though, these authors are clear that researchers and instructors must assess the validity of the measurement approach used with their subjects. If they do not, their interpretations are suspect. For example, as Nolan et al. indicate, scores from only four of the many Likert scales that have been used to assess students' attitudes toward statistics have a reasonable amount of peer-reviewed evidence of their score validity with a variety of student groups; even then, this evidence is not complete.

Fifth, the subject groups included in our research need to be extended: to instructors, to other student groups, and across countries. We are very pleased that one of our papers examined the attitudes of instructors who teach statistics (José Alexandre Martins et al.). The importance of instructors' attitudes is highlighted in some of the other articles whose subject pools consisted of students; they also report evidence of the effect of instructors on students' attitudes (e.g., Griffith et al.). Clearly, a great deal more research is needed that examines instructors' attitudes and their links with students' attitudes toward statistics.

Further, all of the papers that examined students' attitudes looked only at post-secondary students, usually at four-year and advanced degree granting institutions. We are missing information on preschool, primary, and secondary students, as well as students enrolled in United States two-year institutions and their equivalents in other countries, and adults who have completed their educations. Emmioğlu and Capa-Aydin found unexplained heterogeneity in attitude-achievement relationships using the SATS-28 components as the measure of students' attitudes. In the one article that examined student majors (Griffith et al.), differences in attitudes by major were found. Additional student, instructor, instruction, and research characteristics need to be examined, as well as attitude-achievement relationships using other attitude surveys.

With the exception of the article by Hood and colleagues, our special edition does not present research on attitudes using more complex quantitative modeling methods. We need more research such as that carried out by Dirk Tempelaar, Stijn Vanhoof, and their colleagues (there are references to their research in several of the papers that are included in this issue, and some of them have appeared in previous editions of *SERJ*).

To truly understand attitudes toward statistics, we need a coordinated, systematic, cross-country, interdisciplinary research approach. Such an approach, of course, requires funding and a great deal of cooperation. We hope that this special edition can be used as a first step in encouraging this work.