Practical Issues in Conducting Statistics Education Research

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Abstract

Initiated by J. Garfield, this invited panel session focused on the logistics of conducting collegiate statistics education research. Topics included ethical and practical issues, when and how to get Internal Review Board (IRB) approval, using student assessment data as the basis of a research project, and making the transition from other disciplines to statistics education research. Compiled by L. Lesser, panelists' main ideas appear in order from the session.

Keywords: Internal Review Board, Statistics Education Research, Lesson Study.

1. Panelist Presentation from Andrew Zieffler

I focused on some of the challenges I faced in conducting classroom research and writing a dissertation (Zieffler 2006) in statistics education. The first challenges were framing research questions and proposing a study that will actually help answer those research questions. It was difficult to pose a question that was not too broad and yet not so narrow that it would not interest other statistics educators. Another challenge was writing a comprehensive review of the literature. Due to the diverse nature of the discipline, the literature review included sources from several different fields (e.g., psychology, statistics, business, economics, mathematics education and statistics education). Writing a literature review that included relevant studies from these diverse fields was challenging because the studies used different research questions, different operational definitions, different research methodologies, and had conflicting findings. A third challenge was applying the same treatment in two classes when the classes differed quite a bit in terms of student motivation and engagement. Different sections of a class can be made up of vastly different students, which can introduce many different confounding factors (e.g., attitude, attendance rates).

There were additional problems that arose due to constraints concerning measurement or assessment decisions. Finding instruments that produce valid and reliable measurements for the outcome measures, as well as for covariates that might account for some of the variability in differences was not easy, as few valid and reliable instruments existed for these purposes. In addition, there were tough decisions to be made about how best to get students to participate voluntarily, whether to give the assessments during class or outside of class, and concerns about memory effects by administering the same assessment multiple times. Another issue was getting Institutional Review Board (IRB) approval for the different study components.

In the end, all of the problems and headaches that seem to be inherent in classroom research can be worth it. This study found that students exhibited growth in their reasoning about bivariate data, and that most of that growth occurred in the first third of the course (before the unit on bivariate data was taught). It also found that changes in students' reasoning about univariate data were associated with changes in reasoning about bivariate data, after controlling for teacher differences. In addition to these results the study suggests that interesting research questions and methodologies can lead to interesting and worthwhile results. Planning and collaboration can help make classroom research an enjoyable experience. Above all, classroom research requires the researcher to be flexible and to stay optimistic!

2. Panelist Presentation from Robert delMas

I received a B.A. in Child Psychology with an emphasis in cognitive development. My work for a Ph.D. in Educational Psychology emphasized learning and cognition, but also included advanced coursework in theoretical and applied statistics, as well as coursework in human ecology and behavioral biology. Both the undergraduate and graduate level coursework introduced me to a variety of research designs and methods. While these educational experiences have influenced my research, collaborative research projects in statistics education have had the largest impact on

my academic career. I summarize below lessons I have learned from two of these collaborations:

One collaboration (e.g., Chance, delMas, & Garfield 2004; delMas, Garfield, & Chance 1999) involved conducting investigations of students' conceptual understanding of sampling distributions. One benefit of the collaboration has been an increased understanding of each other's areas of expertise (e.g., learning and cognition, mathematics education, assessment). The long-term collaboration has also developed the realization that a definitive answer to research questions is seldom achieved with a single study. Iterative research cycles are usually needed to refine assessment and measurement tools, and the results of each study often generate as many questions as they answer.

Another collaboration with Garfield and Chance explored the adaptation of Japanese Lesson Study to develop research-based lessons for college-level introductory statistics instruction. The project required the submission of two different proposals to a human subjects IRB: one addressing informed consent of the instructors to have meetings videotaped, and the other addressing informed consent of students to be videotaped in the classroom. This project furthered my understanding of mixed-method, non-experimental research. An observational study requires attending to many of the same issues that need to be addressed in comparative and experimental studies. A clear statement of goals and expected outcomes is required to identify student artifacts that can be linked to instructional goals in order to assess instructional impact. Artifacts can include completed worksheets, written responses, graphs and charts produced by students, videotaped discussions, and field notes taken by team members. All of these require careful planning, such as identifying needed materials, anticipating possible student responses, and developing protocols and prompts for taking field notes. Adequate time must be allotted to review artifacts, relate results to goals, and consider implications for instruction.

3. Panelist Presentation from Beth Chance

The Statistics Department at Cal Poly was asked to evaluate lower division course offerings in statistics as part of a General Education program review. Across three courses (six sections) and five professors, the department administered a pre and post test based on the CAOS test (https://app.gen.umn.edu/artist/) to assess understanding of basic statistical concepts, an open-ended written final exam question common across courses to assess students' ability to interpret and explain key statistical terms, and a follow-up survey six months after completion of the course to assess retention of concepts and student opinion of utility of the course. While this was a fairly informal, within-institution evaluation project, several lessons were learned that are broadly applicable to research in statistics education in general:

- Make sure you have institutional support (resources!) and backing for any assessment undertaking. Plan ahead (pilot test) and match scope of study to support available.
- Make sure you have departmental support. Tasks should be developed collaboratively, easy to integrate into existing courses, and yielding of results of interest to faculty.
- Make sure you have student cooperation. Offer incentives to increase participation rates, use sufficiently familiar and value-laden tasks embedded in the course to ensure authenticity of student performance.
- Take the time to develop/choose good questions but be prepared for less than impressive results with more conceptually enriched questions.
- Try to include as many good research practices as possible (e.g., combine qualitative and quantitative methods, uniform testing conditions and administration, independent evaluators of student results monitored for consistency, triangulation, representative sampling).
- Incorporate mechanisms for review and discussion of results and refinement of tasks.

4. Panelist Presentation from Sterling Hilton

After a PhD in biostatistics and seven years as a research statistician at Brigham Young, I began research in statistics education and switched to BYU's department of Educational Leadership where I have been doing mathematics education research for three years. The switch was a product of my personal and institutional commitment to teaching and the scholarship of teaching, and the impossibility of doing justice to distinct research agendas simultaneously.

Lessons learned include: (1) statistics education research is not a subfield of statistics; (2) being a teacher of statistics is not the same as being a researcher in statistics education; (3) statistics education researchers are not currently speaking in a language that statisticians understand; (4) asking the 'right' research question is a function of the developmental age of the discipline, and statistics education research is young (e.g., compared to the

medical research community); (5) different research methods answer distinct research questions and educational research community currently prefers qualitative research methods.

In conclusion, statistics education researchers need to educate statisticians, exploit wonderful connections to mathematics education research, allow the (still young) statistics education research discipline to develop, and persevere in doing quality research.

5. Panelist Presentation from Lawrence Lesser

My focus was the trajectory of issues faced when approaching statistics education research from or within the field of mathematics education (where I have my doctorate). While my work experience and masters degree in statistics were appreciated at university job interviews, there were sometimes mixed post-hire messages about the extent to which I was seen as a mathematics education researcher as opposed to a statistics education researcher or even a statistician. I found that being the only statistics education researcher (or only mathematics education researcher, for that matter) in a department can require doing some educating about the field's conferences, journals, methods, and infrastructure. Useful papers for this include Watson (2002) and NSF (1998).

Remaining active in both mathematics education and statistics education poses unique challenges in keeping up with the extra memberships, journals, service requests, and conferences. For the latter, I simply had to take turns attending conferences with big focus on mathematics education (e.g., NCTM, NCSM, PME, ICME, ICTM, MAA, AMTE, RCML, RUME, ICTCM, AMATYC, T^3, SSMA) and those focused on statistics education (e.g., ICOTS, JSM, USCOTS, CAUSE, ISI, SRTL, BTF). Just as I seek out statistics education talks at the JSM, I also seek out such talks and working groups at mathematics education conferences (e.g., PME) or even at broader conferences such as AERA.

Ultimately, challenges are exceeded by the benefits of having two pools from which to find mentors, collaborators, and opportunities for funding and disseminating. With the latter, it has felt important to help "bridge" the often too-separate literatures of mathematics education and statistics education. For example, I have used mathematics education venues to share my findings about the Birthday Problem, Simpson's Paradox, and line of fit (e.g., Lesser 1999, 2001). An example of the "other direction", is that I have published communications in *The American Statistician* and *Journal of Statistics Education* that share mathematics education research literature insights on multiple representations and counterintuitive examples. I have also published in joint (NCTM and ASA) publications such as *Statistics Teacher Network*.

It is usually clear for which statistics education journal a statistics education research paper is best suited (e.g., among *Statistics Education Research Journal, Journal of Statistics Education*, and *Teaching Statistics*). Though this is less the case now than it used to be, there may be times when it might be even more fruitful to aim a paper towards a mathematics education research journal, especially if key aspects of methodology or literature are more likely to be familiar to that journal's referees and readers. A statistics education researcher might find additional journals to target from www.rume.org/journals.html and many networking opportunities and resources at www.causeweb.org/research/.

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