



# Statistics Education Research Journal

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## STATISTICS EDUCATION RESEARCH JOURNAL

The *Statistics Education Research Journal (SERJ)* is a peer-reviewed electronic journal of the International Association for Statistical Education (IASE) and the International Statistical Institute (ISI). *SERJ* is published twice a year and is open access.

*SERJ* aims to advance research-based knowledge that can help to improve the teaching, learning, and understanding of statistics or probability at all educational levels and in both formal (classroom-based) and informal (out-of-classroom) contexts. Such research may examine, for example, cognitive, motivational, attitudinal, curricular, teaching-related, technology-related, organizational, or societal factors and processes that are related to the development and understanding of stochastic knowledge. In addition, research may focus on how people use or apply statistical and probabilistic information and ideas, broadly viewed.

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Susanne Schnell, University of Paderborn, Institute of Mathematics, Paderborn. Email: susanne.schnell@math.upb.de

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Douglas Whitaker, Department of Mathematics and Computer Science, Mount Saint Vincent University, Halifax, Nova Scotia, Canada. Email: douglas.whitaker@msvu.ca

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## EDITORIAL

Welcome to the third issue of *SERJ* for 2020. This is our first year with three issues of *SERJ*, allowing us to publish a Special Issue every year along with two distinct Regular Issues. Typically, the Special Issue will be published in June, with the Regular Issues coming out in February and October. For 2020, the Special Issue, Building Future Generations of Statisticians, was released in February, with Regular Issues in June and December. The change in publication dates underscores the growth of the statistics education community in general, and of the number of high-quality manuscripts submitted to *SERJ* in particular. It is a very exciting time for our research field! I would like to thank the Associate Editors, Daniel Frischmeier, Editor for the Special Issues, and Noleine Fitzallen, the Assistant Editor. Without their dedicated service to the mission of *SERJ*, the publication of this issue would not have been possible.

There are four articles in this issue of *SERJ*. Two of the articles investigate student outcomes related to the use of the Passion-Driven Curriculum in statistics courses. The first discusses the impact of the course on future course taking decisions of students in the U.S. and the second the impact of the course on affective outcomes of students in Ghana, West Africa and the portability of such a course outside the U.S. The other two papers address student understanding of probabilistic ideas that underscore inferential reasoning. In the third paper, tertiary students' ability to estimate sampling distributions of a proportion are reported based on the results of a mixed methods study. The final paper examines informal hypothesis testing of grade five students in the context of probability distributions of a categorical variable.

As the basis of the first article, Valerie Nazzaro, Jennifer Rose, and Lisa Dierker identified three courses at Wesleyan University in the U.S. to serve as comparison courses to the Passion-Driven Statistics course, taught at the same university. Passion-Driven Statistics aims to engage students by allowing them to experience statistics through the lens of a research question of their choosing, with the results of the student research presented at a poster session. The authors used a case-control matched analysis, calculating propensity scores using demographic variables, to account for the quasi-experimental design of their study. The authors report differences in the demographics of the students who chose to take each of the four types of statistics courses as well as differences in statistics course-taking in subsequent semesters. They conclude that students who take the Passion-Driven Statistics course are more likely than students who take a general introduction to statistics course to take a second course in statistics, but that students who start in a more targeted statistics course, requiring a mathematics pre-requisite, are more likely to take subsequent courses in statistics than those who took the Passion-Driven Statistics course.

In the next paper, Rebecca Awuah, Kristel Gallagher, and Lisa Dierker evaluate the impact of Passion-Driven Statistics on undergraduate students in Ghana, West Africa. This paper provides a more comprehensive description of Passion-Driven Statistics for the interested reader, including a link to the course materials accessed through Carnegie Mellon's Open Learning Initiative and the enactment of the research project. Based on student survey responses, the authors report that half the students claimed to learn more in the project-based course than in other courses they had taken, but nearly 60% found the course more challenging and said they put more effort into this course, compared to other courses they had taken. The authors also report an increase in student confidence in skills associated with statistics. The authors conclude these findings demonstrate the portability of the project-based approach outside of the United States and encourage future exploration of the global portability of this approach to teaching statistics. They report an additional benefit of the project-based statistics course: visitors to the poster presentation are now providing internship opportunities to students with whom they interacted at the poster session.

In the third paper, Carmen Batanero, Nuria Begué, Manfred Borovcnik, María Gea investigate the tertiary students understanding of sampling distribution of a proportion. The research used four tasks, two with equiprobable outcomes and two with probability of success greater than two-thirds. For each of the two probabilities of success, one task was written for a sample size of  $n = 10$  and the other for a sample size of  $n = 100$ . The results of the study indicate that students are able to estimate the mean of the sampling distribution for equiprobable events and the variability associated with the sampling distribution for small samples. The research also finds that students tend to underestimate the mean for

events with higher than equal probability and overestimate the variability of the sample distribution for large samples. The finding that students do not appear to use sample size when estimating sampling results, while not necessarily new, is particularly striking, especially as the subjects had already learned about sampling distributions in their coursework. It is a reminder about how difficult it is to disrupt the preconceived notions students have about sampling variability and help them create intuitions about the behaviors of large samples. Another aspect of this paper to which readers should attend is the method of analysis of the data as it is both unique and informative. Finally, the results from a qualitative analysis of student justifications identify other differences in approaches to the task. In particular, students were more likely to use classical probability and discuss randomness when justifying responses to the tasks with equiprobable outcomes and more likely to use frequentist probability when justifying responses to the task in which the outcomes were not equiprobable. This serves as a reminder for both researchers and instructors of the care that must be taken in designing tasks for research and teaching to ensure diversity in the examples we provide to capture or instill complete understanding of our subject.

In the final paper of this issue, Per Nilsson describes the results of a small-scale teaching experiment designed for grade five students to reason about uniform, categorical probability distributions in a data-rich learning environment. Over the three-lesson sequence students explored sampling distributions associated with uniformly distributed categorical variables in order to use sampling to identify a population not uniformly distributed. Analyses of transcripts and student written responses aim to illustrate how students develop and use informal inferential reasoning through the lessons and the role of data production in their investigations. The study is framed using *Inferentialism* and the unit of analysis are enacted episodes related to the Game of Giving and Asking for Reasons (GoGAR). The results of the study not only identify how students with no formal education in hypothesis testing express generalizations beyond the data at hand, use data as evidence, and add probabilistic language to their reasoning, they also provide a lesson sequence on which instructors and researchers can build to help students develop informal inferential reasoning. More research of this type is needed to provide the foundation for learning trajectories and research-based curricula and pedagogy designed to improve statistics education at all school levels.

JENNIFER J. KAPLAN