GRADUATE TEACHING ASSISTANTS' BELIEFS, PRACTICES AND PREPARATION FOR TEACHING INTRODUCTORY STATISTICS

Nicola Parker, Elizabeth Fry, Joan Garfield, and Andrew Zieffler
University of Minnesota, Minneapolis, MN, USA
parke675@umn.edu

Graduate teaching assistants (GTAs) are responsible for the instruction of approximately 15% of introductory courses in U.S. statistics departments (Blair, Kirkman & Maxwell, 2013). Little is known about graduate teaching assistants' beliefs and practices regarding the teaching of introductory statistics. As part of an NSF-funded project (eATLAS, DUE 1044812 & 1043141), an online survey was developed to explore the beliefs and practices of statistics GTAs, including course content priorities, teaching methods, use of technology and assessment strategies. The data collected from the survey were based on responses from 213 GTAs across over 35 Ph.D. granting institutions in the United States. The results can inform future programs for GTA development.

OVERVIEW

Institutions rely on graduate teaching assistants (GTAs) to teach a substantial share of statistics course offerings. According to Blair, Kirkman and Maxwell (2013), GTAs teach approximately 15% of introductory statistics courses taught in statistics departments, and nearly 30% of introductory statistics courses offered in mathematics departments.

Despite the large role GTAs play in undergraduate statistics education, research particular to GTAs of statistics is relatively sparse; two main studies have been published in the literature. Noll (2011) investigated the statistical knowledge necessary for GTAs to teach the introductory course; and Green (2010) explored the experiences and perceptions of GTAs of statistics. Still, little is known about national trends in GTAs' development as teachers, teaching practices, or beliefs about teaching introductory statistics. In particular, little is known about whether GTAs' teaching beliefs and practices align with recommendations outlined in the *Guidelines for Assessment and Instruction in Statistics Education* (GAISE; ASA, 2005).

In response, we developed and administered an online survey to investigate the beliefs, practices, and teaching development experiences of GTAs in statistics departments across the United States. The data were analyzed in response to four questions: 1) What professional development experiences have GTAs had? 2) To what extent are statistics GTAs' pedagogical practices aligned with the GAISE recommendations? 3) What are GTAs' beliefs about the teaching of introductory statistics? 4) To what extent are GTAs' pedagogical beliefs and practices aligned?

THE GRADUATE STUDENT STATISTICS TEACHING INVENTORY

The *Graduate Student Statistics Teaching Inventory* (GSSTI) was developed to explore GTAs' beliefs, practices and development experiences in teaching statistics. The instrument was developed as part of a NSF-funded project (eATLAS, DUE 1044812 & 1043141). Many items on the GSSTI were adopted or modified from the latest version of the *Statistics Teaching Inventory*, an instrument originally developed by Zieffler, Park, Garfield, delMas, and Bjornsdottir (2012). Questions underwent several rounds of revision in order to properly apply to graduate students and to fit within the web-based program, *Survey Monkey*. The online survey was then piloted with three GTAs who were teaching introductory statistics. Based on data from this piloting, the instrument was again revised. In its final form, the GSSTI consisted of eight items related to GTAs' teaching responsibilities, seven items related their teaching practices, 12 items related to their beliefs about the introductory course (i.e. content, pedagogies, and assessment strategies), and 17 items related to GTAs' development experiences in teaching. Two additional open-ended items appeared in the survey; responses to these are addressed in this analysis.

The survey was sent to faculty contacts in statistics departments ranked in the *2013 US News and World Report*. These contacts were asked to forward the survey to their GTAs and solicit participation. Additional participants were contacted via a blog posting on *Statistical Modeling, Causal Inference, and Social Science* (Gelman, 2013). Prior to analysis, respondents from

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institutions outside the target population were removed from the data set whenever discernable. The final usable data included *N* = 213 GTAs from 38 U.S. institutions in the United States.

RESULTS

GTA Development Experiences

Analysis of the data revealed that GTAs' development as teachers appears quite limited. Of the GTAs surveyed:

- just over half have been observed teaching and received subsequent feedback;
- just under half have attended a workshop on teaching; however, only about one-tenth have attended a workshop that lasted more than two days;
- just under half have taken a course on teaching;
- 40% have had a faculty teaching mentor;
- 25% have attended a conference on teaching; and
- 14% have had no experience with any of the five types of development listed above, whereas 3% have experienced all five types.

GTA Pedagogical Practices and the GAISE Recommendations

In order to gather information about their pedagogical practices, GTAs were asked to rate the extent to which a (hypothetical) fully engaged student would agree or disagree with each of seven statements. Responses to these items are presented in Figure 1.

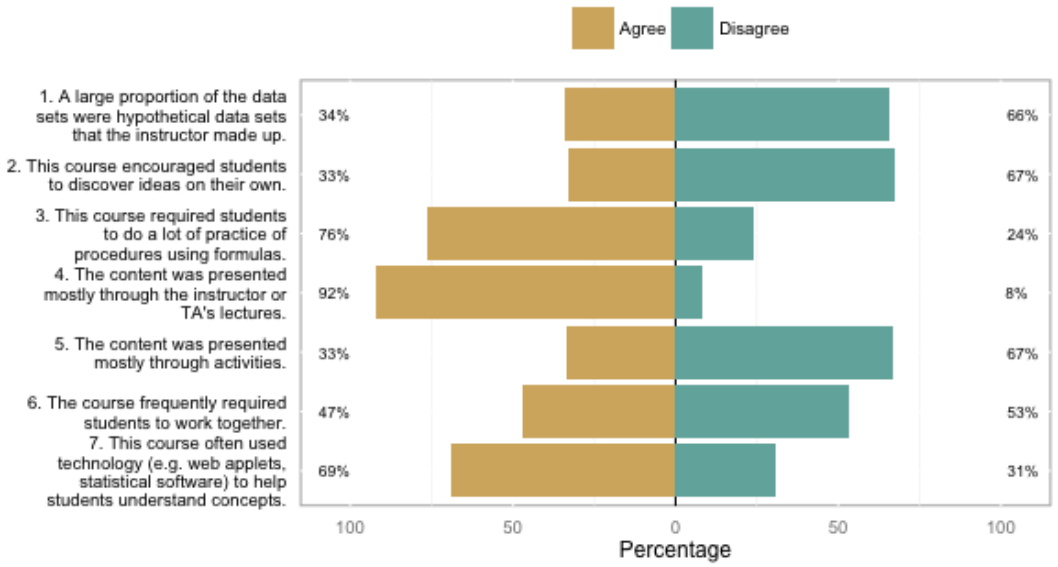

Figure 1. GTAs' perceptions of the extent to which a (hypothetical) fully engaged student would agree or disagree with each of seven statements about pedagogical practices.

These GTAs' pedagogical practices were aligned with two of the GAISE recommendations: using real data and using technology. However, their practices did not appear to align with the GAISE recommendations with regards to fostering active learning nor with that of stressing conceptual understanding. Over 90% of GTAs indicated their courses use lecture (primarily) to present content. About three-fourths of GTAs agreed that their courses require students to do a lot of practice of procedures using formulas. About two-thirds of GTAs reported that their courses did not encourage students to discover ideas on their own. Less than half of GTAs reported that their courses frequently require students to work together in small groups. Only one-third of the GTAs indicated that their courses present content primarily through activities.

GTA Beliefs about Teaching Introductory Statistics

Analysis of the data on GTAs' beliefs about the content of the introductory statistics course indicate that the overwhelming majority of those surveyed believe students should learn connections between the characteristics of the data and the inferences that are made. Most GTAs (90%) also believe that the rules of probability should be included in an introductory course, and the majority (73%) believe theoretical probability distributions (e.g. the binomial distribution) should also be included. GTAs are, however, divided on whether mathematical formulas (e.g. the formula for standard deviation and standard error) should play a primary role in the content.

Regarding their pedagogical beliefs for the introductory course, the data revealed that most GTAs surveyed believe students should frequently be required to work together in small groups. The majority also believe technology should be used to both illustrate abstract statistical concepts and to analyze data. The GTAs are divided on their beliefs about the primary method in which statistics content should be taught. About half believe lecture should be the primary way for students to learn statistical content. The other half believes that course content should be delivered primarily through activities. There are also roughly 10% of these GTAs that are undecided.

The majority of GTAs surveyed (81%) believe that students should be assessed on their ability to complete open-ended problems. Also, most believe that assessments should be used to provide formative feedback to students. GTAs are divided over whether quizzes and exams should be the primary way of assessing student learning.

GTAs' Pedagogical Beliefs and Practices: Are They Aligned?

GTAs' beliefs and practices are not necessarily aligned. For example, the overwhelming majority of GTAs who disagreed or were undecided about whether, "Lectures should be the primary way for students to learn statistical content" appear to primarily use lectures in their teaching. In fact, the data suggest there is little association between beliefs and practices regarding the use of lecture. Figure 2 displays GTAs' pedagogical use of lectures, conditioned on their belief in the use of lectures as the primary method for content delivery (undecided students omitted).

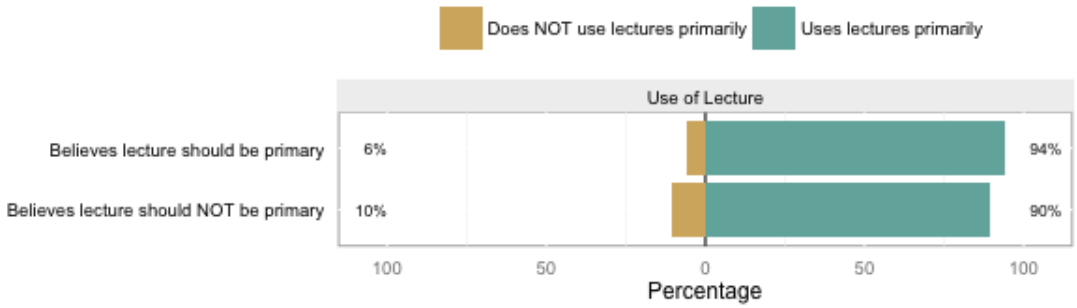

Figure 2. GTAs' use of lecture, conditioned on their belief in the use of lectures (*N*=187). GTAs who were undecided about the role of lecture are omitted.

Similarly, the use of technology to illustrate the most abstract statistical concepts is fairly independent of GTA's beliefs in using technology for that purpose. Regardless of these beliefs, about two-thirds of GTAs use technology to illustrate abstract concepts.

When it comes to the use of cooperative group work, however, there is a relationship between beliefs and practices. Two-thirds of GTAs who believe students should be required to frequently work in groups actually do require frequent group work, whereas only about one-fourth of GTAs who do not believe in group work require it in the classroom. The percent of GTAs who use group work is much higher for those who believe in group work.

DISCUSSION

The data reported in this paper suggest that GTAs' practices and beliefs are not aligned. Most notably, the majority of students who do not believe in the use of lecture still primarily use lecture in the classroom. The data also suggest that GTAs are not prepared to teach using their

preferred pedagogies. It is possible that time constraints, class sizes, or those supervising the GTAs restrict their use of instructional methods. These potential explanations call for further exploration.

There is also evidence to suggest that GTAs' teaching practices are typically not aligned with the GAISE recommendations. The majority of GTAs do not seem to believe their courses let students discover ideas on their own or engage in active learning methods. Delivery of content is primarily using lecture, not activities, and without frequent cooperative group work. GTA courses also appear to place emphasis on procedures using formulas. On the bright side, the majority of GTAs do appear to be using real data and using technology to illustrate concepts, both of which are recommended by GAISE.

It is possible that some of the observed disconnect between beliefs, practices, and GAISE recommendations is a result of ambiguity in the survey questions. The survey may have had some ambiguity about the type of introductory course being referenced. For example, responses may have differed if participants had more clarification as to whether the introductory course would be directed toward statistics majors, students in science related fields, or liberal arts students seeking to fulfill a quantitative requirement.

These findings suggest a need for more opportunities to help graduate students become aware of recommendations for teaching statistics and to develop their teaching expertise and flexibility. One way to fulfill this need is to develop resources for GTAs that provide them with experiences in innovative teaching methods. Researchers could then explore whether these experiences shape GTAs' beliefs and practices. Further studies could also investigate whether such experiences help beliefs and practices ultimately become more aligned with each other and with the GAISE recommendations.

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