Learning Communities and the Undergraduate Statistics Curriculum: A Response to "Mere Renovation Is Too Little Too Late"

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George Cobb urges the Statistics discipline to "rethink" the entire undergraduate curriculum. As I was reading his excellent, thought provoking article, I was asking myself, "Why do students continue learning Statistics on college campuses at all?" After all, Cobb points out many excellent books, which treat Statistics and Probability from broad points of view. Students can also fall in love with Statistics through data driven projects, many of which can be explored on the Internet, during internships, or in research opportunities related to data analysis. So what distinguishes the undergraduate academic experience in Statistics on a college campus from what a well-motivated student could learn on her/his own, from the excellent books, journal articles, and online resources, including those that Cobb cites in his paper? Answer: A sense of community. Learning communities are sometimes called "communities of practice" (see Lave and Wenger, 1991, p. 49). They provide an excellent environment for students to practice what they are learning (e.g., to apply statistical methods) at a much earlier point in their studies, much as Cobb urges. Although Cobb also points out that "all curriculum is local" (p. 34), nonetheless, I believe that some of the initiatives we recently began at Purdue could be implemented much more broadly, in Statistics departments nationwide. The Purdue Statistics Living-Learning Community blends the academic, research, residential, and professional development experiences of 20 sophomore students per year. We briefly discuss Purdue's new initiative here, but we also refer interested readers to visit *http://llc.stat.purdue.edu* and to contact me directly.

Students in a learning community have a sense of comfort and confidence that is often missing from the undergraduate STEM experience. This comfort promotes retention. Cobb does not explicitly mention retention in his article, but if we are completely revamping the undergraduate program, we are obligated to keep retention in mind. If learning communities were implemented more broadly in Statistics undergraduate programs, our discipline could potentially increase the numbers of women, minorities, and persons with disabilities, who are pursuing (and completing) undergraduate degrees in Statistics. This would yield a broader and more diverse pipeline of students into graduate programs in Statistics. Project INGenIOuS (Zorn et al., 2014) has a great vision for broadening the pipeline in the mathematical and statistical sciences. Our discipline could also benefit from best practices learned in Computer Science about attrition and students' comfort levels; Margolis and Fisher (2002) give a helping starting point to this literature.

Cobb states, "statistics suffers from the difficulty of its challenge to integrate abstract deductive thinking with interpretation in context." To address this, faculty can offer pairs of Statistics courses in block-scheduled patterns, such as theoretical probability paired with data analysis. When students take multiple courses together as a cohort, they have more opportunities to discuss complementary ideas, outside the classroom. Residential life staff members can work with faculty on ways to supplement the academic learning experience. Professional development helps too, and it can consist of simply a series of weekly seminars. Also, faculty who take the time to dine with students in the residence hall cafeterias are richly rewarded with good discussions and increased insight into the student experience in Statistics. These are just a few extracurricular ideas; many others are possible.

Cobb celebrates diverse means of presenting the material to students. Such innovations, such as "flipped" classroom experiences in Statistics, can help us to better engage with students. At Purdue, I use video content and online modules in both my probability and my data analysis courses. Instead of lectures, the students spend class periods working on problems in probability or projects in data analysis. So that our questions are appealing to students, Ellen Gundlach and I asked undergraduate students to design the majority of the examples that we included in our recent textbook, Ward and Gundlach (2015).

Cobb calls for students to get involved in research at an earlier stage in their studies. For large data analysis projects, students can benefit from having immersion into a yearlong project with a research mentor from another discipline. Students learn not only about the data set to be studied, but more broadly, they learn about the terminology, customs, literature, and traditions in the applied discipline. Such an interdisciplinary view gives the students a renewed appreciation of the concepts that they learn in their Statistics classes. I believe that these research projects exemplify what Cobb is mentioning, when he discusses the crucial role of "context as a source of understanding" (p. 21).

Immersive research experiences will require improved computational facilities dedicated for student use. Cobb alludes to this need. Some departments will require a strong push—for internal or external funding—to secure sufficient computational resources.

Academic advisors should be invited to the discussion about the kind of curricular overhaul that Cobb is advocating in Statistics departments. Academic advisors are often uniquely positioned to guide students who are pursuing double (or triple) major programs of study, or minor programs that complement their main areas of interest. Students in Statistics can naturally be encouraged to pursue double majors, since Statistics complements many applied areas of study. Cobb discusses the need to minimize prerequisites. This goal is accomplished more easily

Online discussion of "Mere Renovation is Too Little Too Late: We Need to Rethink Our Undergraduate Curriculum From the Ground Up," by George Cobb, *The American Statistician*, 69. Mark Daniel Ward, Department of Statistics, Purdue University (Email: mdw@purdue.edu). This material is based upon work supported by the National Science Foundation under Grant No. 1246818.

when academic advisors are able to give direct input to the curriculum design. They understand a student's view of the overall curricular structure at the university or college.

The ASA DataFest is emerging as a way that the American Statistical Association is working with faculty on several campuses, to give students a very exciting annual data analysis experience. Among the many activities in Statistics at Purdue this year, the students cited the ASA DataFest as one of the most rewarding and enjoyable events. I encourage the ASA to continue recruiting more departments to host ASA DataFest events for undergraduate students.

I applaud George Cobb for his vision about the entire undergraduate curriculum in Statistics. His paper is full of insights and innovative ideas! I also thank Cobb for pointing out several very recent innovations in the undergraduate Statistics curriculum, including Kuiper and Sklar (2013) and Wagaman (2013). Finally, I heartily thank Nolan and Temple Lang for their workshops on "Integrating Computing into the Statistics Curricula"; see Nolan and Temple Lang (2010) for an overview of their efforts to implement changes. My participation in their workshops inspired me to start Purdue's Statistics Living-Learning Community, with large research projects for sophomores as a unifying element. Cobb is urging all of us to do more, to try new things, and to continue the dialogue about how innovations can support our students.

List of references that are not found in George Cobb's paper:

References

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