EXCHANGING PEDAGOGY BETWEEN POST-SECONDARY AND SECONDARY SCHOOL STATISTICS COURSES: FACILITATING MEANINGFUL PROFESSIONAL DEVELOPMENT

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With the implementation of the Common Core State Standards in the United States, all teachers of mathematics in grades 6–12 will also be teachers of statistics. College faculty should play an important role in developing the statistical content knowledge of these teachers, as well as teachers of AP Statistics. Successful examples of professional development for K–12 teachers will be highlighted and future opportunities will be discussed.

INTRODUCTION

This paper is divided into two parts. The first part describes my growth as a statistics teacher by highlighting several meaningful professional development opportunities and interactions with post-secondary faculty. The second part includes suggestions for future professional development and the role of post-secondary faculty in these opportunities.

PART 1: DEVELOPMENT OF A SECONDARY STATISTICS TEACHER

To no one's surprise, my first interaction with a post-secondary statistics teacher occurred in college. As a math major, I took a two-semester sequence of 300-level probability and statistics. Although the courses were well-taught and covered the advertised content, these upper-level courses weren't a useful preparation for teaching statistics at the secondary level. I have yet to need a moment generating function in any of my courses. Still, the idea that statistics could be used to solve real-world problems is what inspired me to begin an AP Statistics course at my high school in 1996.

Once I began teaching the AP Statistics course, I read the "listserv" religiously. The listserv was an electronic discussion group made up of AP Statistics teachers and other interested people, including many post-secondary teachers. Like many other AP Statistics teachers, I was the only one teaching statistics at my school and had no one else to collaborate with. Members of the listserv asked and answered each other's questions, shared resources, and had many productive discussions. Many of these discussions were enhanced by post-secondary faculty who had much more experience and knowledge than the rest of us. For the most part, these faculty also understood where the secondary teachers were coming from and were careful to provide answers (and corrections) at an appropriate level and with a helpful spirit. As with any internet discussion group, there were instances where the tone was condescending or ignorant of the audience, but these were thankfully quite rare. Having been a member of this group (now called the AP Teacher Community) for more than 18 years, I can trace many of my "aha moments" to these discussions.

In the summer of 1999, after my third year of teaching AP Statistics, I was selected to attend the NCSSM Statistics Leadership Institute. The institute was an three-week crash course in post-AP content, organized by Dan Teague and taught by many prominent post-secondary faculty including Dick Sheaffer, Jeff Witmer, Linda Young, Bob Stephenson, Jon Cryer, and several others. Fifty secondary teachers attended the institute at the North Carolina School of Science and Mathematics, staying in the dorms and immersing themselves in statistics day and night. During the three weeks, we learned about topics ranging from mathematical statistics to multiple regression and advanced experimental design. Although these topics aren't part of the secondary curriculum, understanding what comes next made me a better teacher. Just as an Algebra 1 teacher can benefit by understanding what happens in an Algebra 2 course, knowing how to use ANOVA to analyze the results of experiment with blocking helps me explain to my students in simple terms how blocking can account for a source of variability.

Several years later, I attended an MAA-sponsored week-long workshop about regression. Led by Dick Sheaffer and Jeff Witmer, we started with material at the intro-level and quickly

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moved beyond to multiple regression and other topics. Again, although multiple regression isn't a topic usually taught at the secondary level, understanding how adding additional variables affect r^2 makes it much easier to explain what this quantity is trying to measure.

Other than the listserv, my most regular contact with post-secondary faculty happens at the annual AP Statistics reading each June. At the reading, over 600 secondary and post-secondary teachers gather together to score the free-response portion of the AP Statistics exam. In 2013, there were over 170,000 exams, each consisting of 6 free-response items, for a total of over 1 million questions to be graded. Each grader works with a partner, and by design the pairs usually include one secondary teacher and one post-secondary teacher. Working with a partner encourages collaboration and consistency of scoring, but also provides meaningful professional development for both members. Having many more hours to teach the course to smaller groups of students, secondary teachers have more opportunities to incorporate activities, address misconceptions based on interactions with students, and try out different teaching methods. Based on their interactions with students, the secondary teacher is often able to offer insight about why a student made a particular mistake and how the teacher is able to help his students avoid the same mistake. Likewise, because of their extensive content knowledge, post-secondary teachers are able to share insights into the deeper concepts being addressed by certain items. This occurs informally in the reading rooms or over a meal, and formally in optional evening "beyond AP" sessions.

PART 2: RECOMMENDATIONS FOR MEANINGFUL PROFESSIONAL DEVELOPMENT

In Part 1, four major professional development opportunities for secondary teachers were highlighted: college course work, the AP Teacher Community (formerly known as the listserv), workshops addressing material beyond the intro-course, and the AP Statistics reading. In the remainder of the paper, I will make specific suggestions that illustrate how post-secondary faculty can facilitate meaningful professional development for secondary teachers.

Because the majority of secondary statistics teachers take college course work in mathematics, reconsidering the statistical content required for future teachers is perhaps the best way to develop competent teachers of statistics. An intro-level course, similar to the AP Statistics course, should be required for all prospective mathematics teachers. No college requires students to take differential equations without several semesters of calculus—and no college should encourage taking advanced courses in probability or statistics without an introductory course in statistics. Furthermore, the intro class aimed at future teachers should put a special emphasis on the topics required by the Common Core State Standards, such as simulation-based inference the differences between sample surveys, observational studies, and experiments. Post-secondary faculty in statistics need to collaborate with their colleagues in the mathematics and education departments to initiate discussions and facilitate change.

Although not all secondary statistics teachers are teachers of AP Statistics, the AP Teacher Community is an established forum where ideas about statistics education can be exchanged. As the number of statistics teachers grows in the future, a more inclusive forum should be developed. In the meantime, post-secondary faculty are encouraged to join the AP Teacher Community and participate in discussions, understanding that many of the secondary members have very little confidence in their ability to teach statistics. A real-world example, a teaching suggestion, or a simple word of encouragement can make a big difference. Furthermore, the professional development can work both ways, as secondary teachers often share activities they have developed and examples of statistics in the media.

In addition to the NCSSM Statistics Leadership Institutes and MAA courses, the American Statistical Association has sponsored several BAPS (Beyond AP Statistics) workshops. These are usually offered in conjunction with the Joint Statistical Meetings or other conferences and cover topics such as multiple regression, randomization tests, logistic regression, and ANOVA. Unfortunately, because of travel costs and other logistical difficulties, it is very difficult for most secondary teachers to attend valuable workshops like these. To enable more secondary teachers to attend, these workshops could be offered by post-secondary faculty at their colleges or universities. A common curriculum could be developed by a committee of experienced secondary and post-secondary teachers, making it easy to replicate these workshops all over the world. A less desirable

alternative would be to offer such a workshop online, where accessibility wouldn't be a problem, but interaction between teachers would be minimal.

Finally, both secondary and post-secondary statistics teachers are encouraged to attend the AP Statistics Reading. Secondary teachers must have taught the AP course for at least three years. Post-secondary teachers must have taught an intro course at least once in the last three years. A link with information about becoming an AP reader is included in the references below.

CONCLUSION

With the implementation of the Common Core State Standards in the United States, the number of teachers of statistics is increasing quickly, as is the need for professional development in statistics education. Both secondary and post-secondary teachers have an important role to play. Working together we can develop a generation of students who are statistically literate and understand the power of data to solve problems.

WEBSITES

- The AP Teacher Community: https://apcommunity.collegeboard.org
- The NCSSM Statistics Leadership Institute: http://courses.ncssm.edu/math/Stat_Inst/links_to_all_stats_institutes.htm
- MAA Regression workshop: http://www.maa.org/prep-regression-analysis
- Becoming an AP Reader: http://apcentral.collegeboard.com/apc/public/homepage/4137.html