THE IMPACT ON TEACHER ATTITUDES AND STATISTICAL PEDAGOGICAL KNOWLEDGE OF A REGIONAL HUB AND MENTORSHIP PROGRAM FOR TWO-YEAR COLLEGES IN THE U.S.

Michael A. Posner and Monica Dabos
Department of Mathematics and Statistics
Villanova University, 800 Lancaster Ave, Villanova, PA 19085
michael.posner@villanova.edu

Training a New Generation of Statistics Educators (TANGO Stat Ed) is a National Science Foundation funded program that took place over the past two years in two year colleges in the United States. It provided training workshops, paired instructors with experienced statistics education mentors, created professional learning communities in four regional hubs, and brought instructors to the US Conference on Teaching Statistics. This paper reveals preliminary results of changes in attitudes, beliefs, and pedagogical practices of these instructors. These include increased alignment with the Guidelines for Assessment and Instruction in Statistics Education (GAISE), identifying impediments to this process, and determining increase in utilization of existing resources from the statistics education community. Testimonials will be included and lessons learned will be discussed.

BACKGROUND

The demand for statistics is clear and the big data revolution has been here for a while. In order to be successful in the 21st century workforce, data-driven skills are crucial. Statistics educators have increasingly agreed upon appropriate content and pedagogy as evidenced by documents like the GAISE guidelines (American Statistical Association, 2012) and the Statistics Education of Teachers (SET) report (Franklin et al., 2015). However, we have yet to solve the problem of a sufficiently large workforce of qualified teachers of statistics across the US and the world in order to meet the growing demand. This paper presents one example of an endeavor to address such needs.

In the US, two year colleges (also known as community colleges) bear the burden of training the majority of students who take introductory statistics. According to the 2015 CBMS Report (Conference Board of the Mathematical Sciences, 2015), two thirds of all introductory statistics students are taught at two year colleges. The rate of growth in these courses over the past five years is a staggering four times larger than at four year colleges and universities (+102% vs. +23%). The passion and devotion that is present in many two year college instructors is not enough to overcome the lowest rates of advanced degrees in statistics among all types of institution. That often leaves them at a loss of how to effectively teach statistics and without a sufficient support network to provide professional learning communities. And those instructors that have become enlightened to modern statistics pedagogy often face an uphill battle to create change among entrenched senior faculty.

This paper is part of the Training a New Generation of Statistics Educators (TANGO Stat Ed) project, funded by the National Science Foundation (DUE 1432251) in the U.S.. The goal of the project was to create regional hubs of professional learning communities to train community college teachers about modern statistical pedagogy. This was accomplished through three primary activities. First, instructors (whom we are calling next generation instructors or NGIs) were paired with mentors from the statistics education community who met up to two hours per month to share ideas and resources. Second, training workshops brought together the regional TANGO Stat Ed communities and were held at either the US Conference on Teaching Statistics or at regional venues. These workshops brought in national leaders in statistics education, including authors of textbooks that these instructors were using (or wanted to use, but couldn't convince their colleagues), to train NGIs in modern statistical methods. Third, professional learning community meetings occurred during the year to bring together NGIs and mentors in regional hubs.

NGIs were recruited from four regional hubs and participated for either one or two years, depending on when they joined the program. A total of 62 NGI were recruited and matched with 19 mentors.

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METHODS

The main instrument used in our quantitative analysis was a modified Statistics Teaching Inventory (Zieffler, Park, Garfield, DelMas, & Bjornsdottir, 2012). We augmented it with additional questions that were of particular interest for us. Most questions were either dichotomous (yes/no) or on a five point likert-type scale and are listed in the tables below. This paper presents preliminary results with only a subset answering the post-survey questions. Additional responses were collected after that point but have yet to be analyzed.

Analysis of the likert-type scales were done using a two-sample paired t-test and also a Wilcoxon Signed Rank test. We also explored a weighted kappa (Cohen, 1968) for concordance of measures and McNemar's test for analysis of the dichotomous data.

Our external evaluator monitored the progress on the grant and also conducted structured interviews at the end of the program.

RESULTS

Preliminary results are included below. These include only the first subset of respondents after USCOTS 2017. Additional data has been collected since then and will be included in subsequent publications.

Table 1 presents select characteristics about the instructors in TANGO Stat Ed. Table 2 presents changes from pre to post on the survey questions that were asked on both surveys. This table is sorted in ascending order based on the p-value of the Wilcoxon Signed Rank test. Note that differences were calculated as post – pre, so positive numbers indicate more time spent or a higher priority for the given question. In some cases, however, lower numbers would be desired. For example, teachers' ratings for using teacher presentations, like lectures, went down, meaning the NGIs felt that less reliable on lectures would be appropriate. This is consistent with the GAISE guidelines.

Table 1. Select characteristics of instructors in TANGO Stat Ed

Question	Result
Class Size	Average =31, Range = 10–50
Math Prerequisite	Mostly high school or intermediate algebra
Have Teaching Assistant	13% yes
Constraints to Improve	58% personal time 55% department 47% technology 8% value placed on teaching 33% student characteristics
Department	86% mathematics
Position	21% part-time, adjunct 27% tenure-track 40% tenured
Years Teaching	Average = 7
Graduate Coursework	Theory – 19% none, 18% 5+ Applied – 45% none, 17% 5+
Conference Attendance	26% education-related, 6% statistics, 13% stat ed
Data Analysis Experience (Outside of Class)	20% none, 8% a lot

Table 2. Results of likert-type survey questions on modified STI

Question	Mean Diff	p-value (t)	p-value (WSR)
Teacher presentation (e.g., lectures, demonstrations, etc.) are used to help students learn statistics.	-0.733	0.006	0.019
Students use technology tools to help them understand statistical concepts.	0.600	0.045	0.051
Alternative assessments (e.g., projects, presentations, minute papers) should be used to evaluate student learning.	0.357	0.055	0.073
Difficulties involved in getting good quality data.	0.467	0.089	0.097
Students perform step-by-step calculations to compute answers to problems.	-0.467	0.089	0.097
Technology tools should be used to illustrate most abstract statistical concepts.	0.231	0.082	0.149
Students use technology tools to analyze data.	0.400	0.164	0.158
Students learn statistics more effectively by learning fewer topics in greater depth than learning more topics in less depth.	0.357	0.136	0.174
Homework-type problems are worked out for students to show how the answer is obtained.	-0.533	0.178	0.187
Rules of probability should be included in an introductory statistics course.	-0.357	0.174	0.187
Traditional assessments (e.g., exams, quizzes) should be used to evaluate student learning.	0.214	0.189	0.233
Activities are used to help students learn statistics.	0.267	0.262	0.279
Small group class discussions are used to help students learn statistics.	0.267	0.301	0.305
The topic of theoretical probability distributions (e.g., the binomial distribution) should be included in an introductory statistics course.	-0.500	0.251	0.328
Indicate the type of data that you believe helps students learn statistics best	-0.231	0.273	0.345
The study of variability is at the core of statistics.	0.267	0.334	0.358
Students learn statistics more effectively from a good lecture than from a good activity.	-0.357	0.418	0.433
Students should learn how to read statistical tables of theoretical distributions (e.g., t-table, F-table).	-0.214	0.459	0.454
Students should learn methods for collecting data (e.g., taking samples, taking surveys).	0.143	0.435	0.484
Indicate the method of computing numerical solutions to problems that you believe helps students learn statistics best.	-0.154	0.502	0.572
All assessments should be regularly reviewed to see that they are aligned with important student learning goals.	0.143	0.435	0.586
It is important to assess students on their ability to successfully complete a statistical investigation (e.g., an open-ended student project).	-0.167	0.586	0.589
Real data sets are used during instruction.	0.071	0.671	0.766
The need to base decisions on evidence (data).	0.067	0.792	0.824
Students should learn methods for producing data (e.g., designing an experiment).	0.000	1.000	1.000

In the structured interviews, the external reviewer found that the TANGO Stat Ed project was having a positive impact on participants. The project had created something for them that they could not create on their own. It helped them identify and use valuable statistics education resources as well as tap into the existing statistics education community. They identified the face-to-face sessions as particularly crucial in their growth. The NGIs presented at USCOTS and a number of them, including two new presenters, will be presenting at the American Mathematical Association of Two Year Colleges (AMATYC) annual meeting in November 2018. We are excited to see how they continue to grow and impact their communities.

CONCLUSION

Preliminary results show that the TANGO Stat Ed program has had positive effects on the two year college teachers that participated. Many instructors have called the program transformative and some have shown an interest in continued engagement with the professional learning communities and with the larger statistics education community – clearly a positive outcome. Models to create such support on a larger scale, including sustainability, should be explored. Additional data has been gathered and additional analyses on what was and was not successful about the TANGO Stat Ed program are being conducted.

REFERENCES

American Statistical Association. (2012). *Guidelines for Assessment and Instruction in Statistics Education: College Report*. *Report*. https://doi.org/10.3928/01484834-20140325-01

Cohen, J. (1968). Weighted kappa: Nominal scale agreement provision for scaled disagreement or partial credit. *Psychological Bulletin*, *70*(4), 213–220. https://doi.org/10.1037/h0026256

Conference Board of the Mathematical Sciences. (2015). 2015 CBMS Survey Final Full Report. Retrieved December 11, 2017, from http://www.ams.org/profession/data/cbms-survey/cbms2015-work

Franklin, C. A., Bargagliotti, A. E., Case, C. A., Kader, G. D., Scheaffer, R. L., & Spangler, D. A. (2015). *Statistical Education of Teachers*. Retrieved from https://www.amstat.org/asa/files/pdfs/EDU-SET.pdf

Jones, I., Swan, M., & Pollitt, A. (2015). Assessing Mathematical Problem Solving Using Comparative Judgement. *International Journal of Science and Mathematics Education*, (November 2013), 1–27. https://doi.org/10.1007/s10763-013-9497-6

Lane-Getaz, S. J. (2013). Development of a reliable measure of students' inferential reasoning ability. *Statistics Education Research Journal*, *12*(1), 20–47.

Schau, C. (1992). Survey of Attitudes Toward Statistics (SATS-36). Retrieved from http://evaluationandstatistics.com/

Zieffler, A., Park, J., Garfield, J., DelMas, R., & Bjornsdottir, A. (2012). The Statistics Teaching Inventory: A Survey on Statistics Teachers' Classroom Practices and Beliefs. *Journal of Statistics Education*, *20*(1), 1–29. https://doi.org/10.1080/10691898.2012.11889632