Interview with Ann Watkins

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Beginnings

AR: Thanks very much, Ann, for agreeing to be interviewed for the Journal of Statistics Education. *Let's start not at the very beginning but when you were 18 years old. Where were you then, and what were your career plans and aspirations at that point?*

AW: At 18, I was living at home and working my way through the local state college. I knew only that I wanted to be a teacher, a job that I had observed to be compatible with raising children. (And which I now find compatible with helping with grandchildren.) This was 1967 and no one in my family had ever been to college. They all considered teaching to be the highest calling a woman could have.

At the orientation the previous year for freshmen who intended to teach, the professor had asked all history majors to raise their hands. She then informed us that few of us would be able to get a job. If we wanted to teach, she said dramatically, we should be a math major. The concept of

going to college to "pursue a passion" was still decades in the future, so without hesitation I switched my major from history, which I dearly loved, to mathematics.

AR: Very interesting. I almost started by asking which came first – your interest in statistics or your interest in education, but I think you've answered that clearly. Which college was that? Did you finish your degree in mathematics, and did you find that you enjoyed it as much as history?

AW: The local college was San Fernando Valley State College, now upgraded to California State University Northridge and branded as CSUN. In six years, I finished bachelor's and master's degrees in mathematics, minor in history, student teaching, and credentials in math and history, while working part time except for the sixth year when I taught math full time in a Los Angeles city middle school. It never occurred to me that it was acceptable to take longer.

In my last undergraduate semester, I wrote a term paper for an education class examining the widespread belief that learning math teaches you to think, then called "math as a mental discipline." When that justification for learning mathematics fell apart, I did a self-assessment and realized that much of what I had learned as an undergraduate in those New Math days of prove-everything-from-the-axioms-and-never-get-to-the-heart-of-the-subject wouldn't ever be of any use to me, even as a teacher. So the love of mathematics was still in the future.

AR: My sense is that the belief that learning math teaches you how to think is quite widespread still. Are you saying that the research does not support this notion?

AW: No, it doesn't, at least not in the sense that people usually mean it. People continue to look for a magic bullet—Greek, Latin, mathematics, listening to Mozart, and now chess—that will improve logical thinking skills. The research is clear that it is very difficult to teach so that students can transfer knowledge and skills to new situations.

Because statistics seems to us to be so immediately applicable, we don't pay any more attention to what our students take away from our course than do teachers in other fields. George Cobb reduced what is known about teaching statistics to three slogans: "teach statistical thinking," "more data and concepts; less theory and fewer recipes," and "foster active learning." But that is not enough. Joan Garfield and colleagues such as Robert delMas, Dani Ben-Zvi, Beth Chance, and many others have shown that we are not producing transfer of knowledge or conceptual change in students. By following the slogans and by teaching to our own tests, our students are reasonably successful and so we are able to ignore much of what these researchers are trying to tell us.

AR: Very interesting. Back to your biography, you finished your degrees while teaching middle school math full-time. Did you continue with middle school teaching at that point?

AW: I taught middle school for only one year. I didn't feel like I was able to do a good job. As a first-year teacher in a seniority-driven school district, I did not have my own classroom, had four different preparations, and taught the largest number of students who needed the most help. The administration was sympathetic and did what they could for me, but I knew it would be the same

story the next year and so I quit. Not having much of a plan, that fall I began a Ph.D. program in education at UCLA, where I finally was introduced to statistics.

AR: Ahh, the plot thickens! Please tell us about your introduction to statistics. Was your interest in the subject immediate, or did it take a while to blossom?

AW: Neither my math stat course nor the descriptive statistics that I learned for physics labs and educational measurement had given me any idea of what statistics is really about. The first glimpse I had of that came, I think, from reading Fred Mosteller's *Fifty Challenging Problems in Probability* (Mosteller 1965), where some of the problems had a statistical angle. What fun that was—I tried a problem a night. Perhaps Mosteller had the right idea, to use intriguing probability problems, devoid of real-life context, to hook mathematical types into the world of chance and sampling.

Meanwhile, at UCLA, I had to take four statistics courses. All were extremely easy because I had a master's degree in mathematics, while the other students came mostly from non-quantitative fields. The first was a fairly traditional and forgettable introductory course. The second two, taught by Jim Bruno, were much more interesting, centered around modeling of educational planning. I began to get the idea. The fourth course was taught by the high-powered Jim Popham, who was a president of AERA and author of a best-selling text on educational statistics. He called me in after the class ended to give me some serious advice. He said that I got 100% on the final exam, that very few people seemed able to understand statistics, but I did, and that statistics could make my fortune, as it had his. This was pretty good motivation.

AR: That's some strong encouragement indeed. Did you take more statistics courses at that point, or how did you proceed to follow Dr. Popham's advice?

AW: Because I had completed all required courses, I missed my big chance to learn statistics the easy way—while still in school. I was a minimalist as a student—every degree I got I completed with the smallest possible number of units.

The learning happened five years later, after two babies. I was teaching introductory statistics, thought I knew everything, and got a mediocre article accepted for an NCTM yearbook. That got me appointed in 1980 to the ASA-NTCM Joint Committee on the Curriculum in Statistics and Probability, where I met the likes of Jim Swift, Jim Landwehr, Jim Kepner, and Dick Scheaffer. Suddenly, I was in the grown-up world and desperately playing catch up. At meetings, I kept a second column of notes, a list of the things that I should learn more about. For example, "Who is John Tukey?" and "Why is a confidence interval better than a test?" Today, each of those would take a few hours on the Internet. Back then, it was more like a few days in the UCLA or CSUN library trying to find something readable.

Fortunately, I had the best help in the world from the other members of the committee. Jim Landwehr, then at Bell Labs, spent hours helping me understand confidence intervals and the role of graphics in serious statistical work. When Jim and I wrote some materials for high school students and their teachers, Tukey edited it. I was surprised by how willing the greatest of statisticians were to help educate me so that I could do a better job of educating other teachers. It

was very important to them that their subject be properly represented. In addition to those already mentioned, I've had long conversations with David Blackwell, Sally Morton, Jeff Witmer, Linda Young, Deb Nolan, Brad Efron, Ingram Olkin, Brian Joiner, and Don Rubin.

AR: Let me back up a moment. You finished your Ph.D. program in Education at UCLA, right? And then did you get a position in the Math Department at CSUN, and is that where you were teaching introductory statistics?

AW: Right. After UCLA, I taught part time at Pierce College, a Los Angeles community college, and then part-time at CSUN, and in 1979 began full-time at Pierce.

Quantitative Literacy Project

AR: The project that you mentioned about developing materials for high school – was that the ASA's Quantitative Literacy project? How did that come to be, and how did you get involved?

AW: The Quantitative Literacy Project came out of the ASA-NCTM Joint Committee. Jim Swift, a Canadian high school teacher, had the vision and Dick Scheaffer, then chair at the University of Florida, had the political skill and statistical expertise. By 1990, after several grants from NSF, we had written four booklets for grades 8 through 12, given numerous intensive workshops for high school teachers, and saw a complete change in how those high school teachers viewed statistics. Our emphasis was on statistics as a process rather than statistics as a correct answer; on data analysis first through graphics rather than by computation; on real data rather than pretend data easily summarized by whole numbers; on good uses of statistics rather than on how to lie with statistics; and on building intuition rather than presenting the probability paradoxes so beloved by mathematicians. Yet, the mathematics teachers immediately recognized all of this as the right thing for their students. The response was overwhelming.

The response from statisticians also was overwhelming. Each workshop had a statistician paired with a classroom teacher and the statistician's company or university often pitched in as well. Bell Labs, the Mayo Clinic, and Ford were especially supportive. One of the highlights of my life remains flying from Los Angeles to Chicago one morning in 1988, doing a workshop with teachers in the afternoon near the top of the John Hancock Center, and being home by bedtime. I wish I could remember which statistician's company sponsored this workshop, supplying a location that awed us all, with food to match.

AR: That was about the time that the NCTM Standards came out also, with some specific recommendations about teaching probability and statistics in high school mathematics. Was there any coordination between your team working on the QL project and those writing the NCTM Standards?

AW: Not formally, but we had been disappointed with the earlier *Agenda for Action* ("Problem solving should be the focus of school mathematics"), and many of us worked on the *Standards* in one way or another. John Dossey, NCTM president, was one of the all-time great friends of statistics and Dick Scheaffer was always behind the scenes being sure that the right people got appointed to the right positions.

AR: At this point, in the late 1980s, had you moved yet to CSUN for keeps?

AW: I moved to CSUN as an associate professor in 1990, leaving Pierce College with great reluctance. I thought it would be great for Bill and me to have the same vacation schedule. But as it turned out, I learned all of the reasons why it's not such a good idea for husband and wife to be in the same department, especially when one spouse (Bill) is heavily involved in department and university administration and politics. So I looked outside of CSUN for participation in professional activities.

AR: I'm tempted to ask for some juicy stories of departmental politics, but I'll resist that unworthy urge. Before we leave the Pierce years behind, what can you tell JSE *readers about your experience with teaching at a two-year college?*

AW: I loved it. The remedial-level students were so grateful for anything good that happened to them in a mathematics class. Those students found that, say, elementary algebra, which they had seen in multiple previous classes in high school, seemed so much easier than it ever had before. They were convinced that this was because no teacher had ever explained things so well before. Of course, I looked good because they had previously half-learned the material. At the other extreme, the students in calculus, statistics, and linear algebra were excellent. Many had chosen a community college for the first two years so that they could work and save money before transferring to UCLA. Today a huge percentage of California students have Pell Grants and Cal Grants and the community colleges have lost out. Even so, over 60% of recent CSUN graduates in mathematics transferred from a two-year college.

AR: Let's go back to 1990, when you moved to CSUN but went beyond for professional engagement. I know some of what came next, but I don't know the order, or perhaps several projects overlapped. You became more and more involved with MAA, eventually becoming co-editor of the College Mathematics Journal *and later President of the organization. You also played a large role in the early years of Advanced Placement Statistics, and you were also a key player in the* Activity-Based Statistics *project. Which of these came next, or perhaps you'll say none of the above?*

AW: During the 1980s, I was involved in parallel with the Quantitative Literacy Project and small jobs within the MAA, like running the twice-a-year Southern California book sale. The MAA has a remarkable member, Don Albers, who serves the MAA much like Dick Scheaffer serves the ASA. That is, both actively seek out exceptional new talent or, as in my case, competent hard workers, and somehow get them appointed to appropriate positions in the association.

In 1989, Don Albers asked Bill and me if we wanted to be co-editors of the *College Mathematics Journal*. He didn't take "you've got to be kidding" for an answer. That was certainly the hardest job I ever had, especially since the rejection rate was well over 90% —we just didn't have the pages for all of the good articles that came in. But I still get a glow every time I look at the shelf of five years of journals.

Is it time for me to talk about my husband?

AR: Sure, this seems like a fine segue. Please do tell us about Bill.

AW: I met him when I was working on my master's degree and he was an assistant professor. Although Bill was never my professor, we talked about math, worked puzzles, went to AMS/MAA meetings, and had many mathematical friends. I had never talked to anyone about math before, certainly never anyone whose understanding of it was so comprehensive and deep. A whole new world opened up, where math was beautiful, math was fun, and math was coherent. All of the isolated facts that I had learned turned out to be part of a greater whole. I started reading math books for fun. The downside was that it never occurred to me to go on for a Ph.D. in mathematics, as I knew I wasn't in Bill's league. But when I started learning statistics, I understood that a structure should fall into place. And it did.

Leadership in the Mathematical Association of America

AR: Please tell us more about your work with MAA. How did you proceed from editing the CMJ *in the early 90s to serving as MAA President in 2001-02?*

AW: My first MAA job was at the registration desk for a meeting at CSUN while I was a graduate student (the other female graduate student also was asked to do this). One thing led to another, in a somewhat chaotic fashion. I was second vice president, chair and then governor of the Southern California Section, on various editorial boards, and chair of lots of committees. The leadership over those years included Lynn Steen, Dick Anderson, Ivan Niven, Henry Alder, Henry Pollak, John Kennelly, Don Albers, Chris Stevens, Len Gillman, Lida Barrett, Ken Ross, Jerry Porter, Ron Graham, Jerry Alexanderson, Martha Siegel, Tom Banchoff, Tina Straley, David Bressoud, and Joe Gallian. These extraordinary people were committed team players. I watched them all with awe and tried to learn from them. I loved the MAA and its members and understood its culture through and through, and I think that showed. And I could meet a deadline. Next thing I knew, I was president-elect.

AR: I don't often think about organizations having a culture, but I probably should, and perhaps I do some of that sub-consciously. How would you describe the MAA's culture? And can you discuss, perhaps with an example, how knowing the culture helped you to succeed and enjoy your work with the organization?

AW: When I became active in the early 1980s, the MAA was very much a member-driven organization, with a small Washington staff. The members made the decisions and then did all of the work. The atmosphere was informal yet dignified with little humor. There were controls in place so that publications and meetings were first rate. The (Henry) Alder Rule said that no one should be invited to speak unless a member of the program committee had heard the speaker and was willing to vouch for the quality of exposition. As a corollary, there had never been a contributed (volunteer) paper at a national MAA meeting. The headquarters personified this culture, if a building can personify. Near Dupont Circle, it is an elegant and comfortable historical townhouse with a carriage house. In fact, it was the residence of Charles Evans Hughes when he was Secretary of State.

Time moves on and much of that earlier culture has changed. While the Alder Rule still stands for major speakers, MAA meetings now have dozens of first-rate contributed papers. That happened as the result of a dinner attended by several community college instructors including Don Albers, Ron Davis, and me. We proposed to the MAA leadership that contributed paper sessions be given a trial because it was important to community college instructors to have a chance to talk about teaching innovations. We presented contributed papers as something just for community college instructors and promised that we would insure quality through a referring process. The first MAA contributed paper sessions were given at the JMM in 1985. I was the leader for a session on "Teaching Introductory Statistics" and was quite nervous. I worked with the speakers a bit beforehand, but only turned down one proposal. The quality in this session and the others was excellent. The rooms were packed. Once the high standards had been set, we were able to ease off on the referring process and expand the number of sessions. The quality remains excellent to this day.

AR: Were you involved in the creation or development of the ASA-MAA Joint Committee on Undergraduate Statistics? Can you comment on how that group was formed and for what purpose?

AW: I was a member of the executive committee when the joint committee was formed in 1990 and remained a member of the joint committee until 2000. The first thing we did was write, jointly via e-mail, the report "Teaching Statistics," in *Heeding the Call for Change: Suggestions for Curricular Action*, published by the MAA in 1992 (Steen 1992). George Cobb was chair of the committee and edited the report. I was amazed and overwhelmed at how our primitive email could speed up the process. George grasped it immediately and had almost everyone responding almost every day to his questions, just like what you are doing now to me. Nowadays, everyone is used to immediate response, but it was revolutionary and exhausting then. This is the report in which George succinctly laid out the principles that I mentioned earlier, which eventually formed the basis of the GAISE report: "teach statistical thinking," "more data and concepts; less theory and fewer recipes," and "foster active learning" (Cobb 1992).

George then got an NSF grant to offer nine workshops to show mathematicians who were teaching statistics how to implement these principles. We had a lot of fun with those workshops because the mathematicians were so enthusiastic about the content. Allan, you had a follow-up grant that offered even more workshops, but by that time real statisticians had taken over and I wasn't involved.

AR: What's your sense of how friendly the MAA has been to statistics and statisticians? There always seems to be some awkwardness and perhaps tension for statisticians who are members of a Mathematics Department at their institution. Do you think the MAA has been helpful in this regard?

AW: As long as I have been around, the MAA has been very friendly to statistics and statisticians. Henry Alder, long a powerhouse of the Association, taught statistics and was the author with Edward B. Roessler of *Introduction to Probability and Statistics* (Alder and Roessler 1972), which went into six editions. While this was a mathematician's view of the subject, it was

a good book and Henry always felt that statistics should be represented within the Association. He certainly was not the only one.

The theme of the first contributed paper session in 1985 was teaching statistics. The second special interest group to be approved was on statistics education. The MAA currently has six books in print about statistics, with such familiar authors or editors as David Moore, Tom Moore, and Joan Garfield. Statistics invariably appears on any MAA list of recommended courses for math majors and for future teachers. For example, the 1991 *A Call for Change* listed five categories of standards for future middle school teachers (Leitzel 1991). One of these was probability and statistics. One of the five for future elementary school teachers was "collecting, representing, and interpreting data." Between 1998 and 2000, we rewrote the *Guidelines for Departments and Programs in the Mathematical Sciences* so that mathematics departments who hire statisticians can better understand how professional activity in statistics is different from that in mathematics (MAA 2003). Mary Parker currently is a member of the Committee on the Undergraduate Program in Mathematics (CUPM), the MAA's most powerful committee on education. Rick Cleary, former Associate Treasurer, has just been elected to the Nominating Committee.

But until the 1990s, when you and George Cobb and others got involved, the MAA just didn't have many statisticians who were active members. I think it was statisticians themselves who finally figured out that if they were going to teach in a mathematics department, they should pay some attention to the world of mathematicians and to undergraduate mathematics education.

Also, much of what mathematicians have learned about how to teach mathematics applies equally well to statistics. A recent example is the MAA study, *Characteristics of Successful Programs in College Calculus,* led by David Bressoud. I've found it very helpful in convincing administrators how we should restructure CSUN's introductory statistics course (Bressoud and Rasmussen 2015).

AR: One of the MAA's best programs is Project NExT (New Experiences in Teaching), which helps to prepare new faculty members for all that's involved with embarking on a teaching-oriented career in academia. Have you been involved with Project NExT, and do you recommend this program for statisticians?

AW: Absolutely, any statistician who is starting to teach in a mathematics department should apply to be a Project NExT Fellow. It's the best way to learn, not only what every beginning professor in the mathematical sciences should know, but how to get along with mathematicians. Seventy-three former Project NExT Fellows have listed "statistics" as their research interest. They include some people you know well, John Holcomb, Jackie Miller, Michael Posner, and Ginger Holmes Rowell, for example. I'm sure each of them would be happy to talk to any statistician interested in Project NExT. The American Statistical Association continues to sponsor two Fellows each year.

Chris Stevens and her Project NExT team managed to get almost all active MAA members, including me, as advisors or speakers. As president, I was a cheerleader for Project NExT with members, other organizations, and, especially, donors.

AR: What are the primary responsibilities of the MAA President? What aspect of the position did you enjoy the most, and would you mention one that you did not care for?

AW: If you read the by-laws, it looks like the president has fairly extensive control over the Association. But that's on paper. As is typical with organizations, it's the secretary who actually wields much of the power. The president is on the Executive Committee for four years and president for only two of those, but a secretary typically serves for ten years and feels like she is always training a new president. I was fortunate that the secretary was Martha Siegel during my term as president.

The president presides at meetings of the Board of Governors, Executive Committee, and many other committees; appoints most committee members (with the help of a committee); attends as many regional meetings of the MAA sections as possible; serves on umbrella organizations of the mathematical sciences; attends meetings of sister organizations; visits NSF and talks with Congressional staff; guides any ill-advised initiatives within the Association away from trouble; hosts receptions and dinners with donors and potential donors; and generally makes the call when there are difficult decisions to be made.

I enjoyed all of this, but the part of the job that I liked the most was attending national and local meetings. It's trite but true that the strength of the MAA lies in its members and so it was always at meetings that the magic happened.

I got comped suites at meetings, which sometimes were spectacular. For example, in San Diego one year the suite at the Marriott had a full kitchen, two bedrooms, a huge living room with a big balcony wrapped around it on three sides overlooking the harbor and the city. I figured I should share the luxury, so invited everyone I talked to up for a visit. Bill had to play host most of the time while I was in meetings, and the place was packed all day and into the night.

One job that I thought I wouldn't enjoy, but did, was handling complaints from members who wrote directly to the president because, for example, their issue of the *Monthly* was late. After I answered them and got their problem solved, they couldn't have been sweeter and more appreciative. Of course, I really loved the letters from members who were grateful for the work of the Association and, especially, from students thanking the Association for their experience with the American Mathematics Competitions or the Putnam exam.

Textbook Writing

AR: One of the ways that you've had a considerable impact on statistics education is through the book projects that you've been involved with, including Activity-Based Statistics (ABS), Statistics in Action, *and* Statistics: From Data to Decision. *Let's start with the first of these: How did the* ABS *project begin, and how did you come to be involved?*

AW: Dick Scheaffer had the vision for *Activity-Based Statistics* and put together a writing team of Jeff Witmer, Mrudulla Gnanadesikan, and me (Scheaffer et al. 1996). The world of statistics

education was much smaller in the 1990s and there was a lot of overlap in personnel from project to project.

In 1990, Dick got a planning grant from NSF, which became a major grant in 1991. The research of Joan Garfield and others was confirming the belief of many teachers that active learning is an effective way to teach statistics, so a collection of classroom-tested, easy-to-use activities was badly needed. But Dick also had a political motivation. Establishing statistics as a laboratory science that needs space, time, and materials for effective instruction would distinguish it from mathematics, define its unique place in the curriculum, and, last but not least, emphasize to NSF that grant support was necessary for innovation. *ABS* activities were written so that they could be used in almost any classroom situation by almost any instructor, and so were low-tech. But the hope was that the "laboratory science" idea would enable others to get grant support to create technologically-intensive laboratory experiences.

ABS was a lot of fun, especially meetings with the lively advisory group, which consisted of people like George Cobb, Joan Garfield, Jim Landwehr, Dennis Pearl, and Bob Stephenson.

Once most introductory statistics textbooks began to contain activities similar to those in ABS, there was no reason to revise the book again. The same thing happened after the second edition of *Exploring Data* from the Quantitative Literacy project (Landwehr and Watkins 1995). When almost every secondary school mathematics series contained scatterplots and box plots, *Exploring Data* wasn't needed anymore.

AR: Do you have a favorite activity (or two) from ABS *that you'd like to mention? And perhaps you could tell the story of how these activities evolved in development.*

AW: I like to use a series of three activities about size bias. The first is "Random Rectangles," where students are asked to estimate the mean area of a set of 100 rectangles by selecting a sample of size 5, using their best judgment. When comparing their estimates to random samples, students realize that their judgment samples gave them estimates that were much too large (and too variable). This activity never fails. My students are impressed with the results and say they have learned a valuable lesson.

I tried to argue with Dick Scheaffer that we shouldn't include this activity because it begins by having students use a biased method of sampling and thereby deliberately misleads students. One of our guidelines always had been to present only good statistics. Clearly, I was wrong. "Random Rectangles" is the most popular activity ever.

Later in class, we do the "Stringing Students Along" activity, using a bag of strings of various lengths. The objective is to estimate the average length of the strings in the bag by looking at only five of them. Students reach into the bag and take several strings "at random." Only when the distribution of the estimates goes on the board along with the population mean do students realize that there is a problem. Eventually a student makes the connection to random rectangles and explains to the others that they were more likely to select the longer strings. Okay, we finally get it now, students say, and we won't fall for size bias again.

A bit later comes George Cobb's "Time in the Hospital" activity from *Statistics in Action* (Watkins, Scheaffer, and Cobb 2008). The hospital has five beds and no bed is ever empty. First the students fill in a calendar, using non-face playing cards selected at random, that shows how long each patient in each of the five beds stays in the hospital. The task then is to use sampling to estimate the mean length of a stay. Students are happy to select several days at random and use the lengths of stays of the patients in the hospital on those days as their sample. They eventually realize that their estimates can't be right because the mean of the playing cards is 5.5, but their estimates are much higher. This is a little harder for them to see as size bias until I cut strings the same lengths as the hospital stays and place them over the chart.

The follow-up exercise is a real-life situation where researchers concluded that the elderly who get dementia live a median of about 7 years after diagnosis, which is about the same as those the same age without dementia. This was estimated by finding a sample of people who had been diagnosed with dementia and computing the time between the date they had been diagnosed and the date they eventually died. Students are asked whether the estimate of 7 years should be too high, about right, or too low. Few students recognize this as size bias even though it's exactly parallel to the hospital situation. Size bias is often hard to spot, especially when the sampling method involves random selection.

AR: I agree that "Random Rectangles" is quite possibly the most widely used statistics activity ever, so I'm glad that you did not succeed in stifling its appearance. What motivated you to work on the full-fledged textbook, Statistics in Action *(*SIA*), and how did you make* SIA *distinctive from other introductory texts?*

AW: The motivation was the chance to work again with Dick and George. We wanted to integrate the activities into the conceptual flow of a textbook. The first chapter, a case study of a lawsuit concerning age discrimination, sets the stage. Students analyze the same data that the court saw and simulate a sampling distribution to answer the question, "The average age of the laid-off workers is 58 years. Can such a high average age reasonably be attributed to chance alone or does the company have some explaining to do?" Many students get the idea of statistical inference by the end of the first week of class.

We also were on a mission to do a legitimate introduction to design and analysis of experiments. Experiments, where treatments are randomly assigned to the available subjects, should not be analyzed as if they involved random sampling from a larger population. Once the hypotheses and conclusions are stated correctly, students are able to understand how experiments can establish cause and effect.

AR: Am I correct that the title of that book changed in its second edition to Statistics: From Data to Decision (Watkins, Scheaffer, and Cobb 2011)*? Did the second edition involve a substantial revision, and what is the explanation behind the change of title?*

AW: The first and second editions of *Statistics in Action* were aimed mainly at the AP audience, so the idea was to write a version for use in the introductory statistics course taught in college. Unfortunately, the high school AP course and the introductory college course are now so different that the same book won't do for both. For example, the AP syllabus includes log

transformations, which is taught in few introductory college courses. We also cut some of the activities so the content fits better in a one-semester course. For the high school teachers who want to use the updated *Statistics: From Data to Decision*, supplementary sections are available that cover the missing topics.

Involvement with AP Statistics

AR: Thanks for providing me with a perfect transition to the next topic I wanted to raise. You've been involved with the Advanced Placement (AP) program in Statistics for many years. I'll go out on a limb and guess that Dick Scheaffer spurred your association with this project also. Am I right? Were you involved during the initial development process for the course or afterward?

AW: Dick Scheaffer had worked towards an AP Statistics course with the College Board and, remarkably, with the AP Calculus Committee for several years before a Task Force, which he chaired, was formed in 1992. Dick had been able to convince the College Board that statisticians finally had come to a near-consensus about the syllabus for an introductory course. It was the 1989 *Introduction to the Practice of Statistics (IPS)* by David Moore and George McCabe (Moore and McCabe 1989) that brought about this consensus, I'm pretty sure. The Task Force wrote a draft syllabus and the College Board approved the course. In 1994, Dick became Chief Reader and Rosemary Roberts became chair of the initial AP Statistics Development Committee.

I was appointed to this initial AP Statistics Development Committee, chaired it from 1997 to 1999, and was the editor and primary author of the first *Teacher's Guide*. (The first exam was offered in 1997.) In the early years, members brought copies of *IPS* to committee meetings, which served as the final authority when there was disagreement about statistical topics.

One of our first discussions was about who could teach AP Statistics. We thought that it should be high school science or maybe social science teachers. Unlike math teachers, many of them *had* taken statistics in college and used it in their teaching. But talented and dedicated high school math teachers like Dan Teague, Landy Godbold, Pam Coffield, Gretchen Davis, Josh Tabor, Laura Marshall, Chris Olsen, Dave Bock, Daren Starnes, and Gloria Barrett grabbed the course and ran with it. And so, at the turn of the century, the teaching of statistics in high schools came to be tied to mathematics just as it was in most colleges; statisticians were united about the introductory course; and mathematicians had learned that statistics is not mathematics and so began to gear up when they were assigned to teach it.

But, if a syllabus for AP Statistics had to be written from scratch today, there probably would not be consensus. Would it be randomization based? Would probability continue to be one of the four main themes? What technology would be used and how? Would the course be organized around modeling rather than the traditional sequence of topics? Where would data science come in? And a significant few, who will stay unnamed, might push for a Bayesian emphasis.

AR: Your response reminds me that I see a somewhat paradoxical relationship between AP Statistics and the introductory college course in some ways. Earlier you mentioned that in transitioning your textbook from an AP to college audience, you had to remove some topics such as log transformations that are often not taught in colleges. But on the other hand, you allude

here to some more innovative college instructors being disappointed that the AP course has not moved beyond the consensus of the 1990s to focus more on modeling and data science topics. Another paradox that I often point out to college professors is that the AP program is designed to reproduce college courses in a high school classroom, yet I also believe that the AP Statistics program has helped to lead many colleges to developing better introductory courses. Boy, I apologize for this long and rambling prelude to my next question, which is simply: Would you care to react or elaborate on any of these thoughts about the relationship between the AP Statistics course and introductory college courses?

AW: You've summarized things well. AP Statistics is stuck in a rut at the moment, epitomized by the "describe shape, center, and spread" and "write hypotheses, check conditions, do computations, and write conclusions tied to computations" mantras that students memorize. There is nothing wrong with any of that, but it's not consistent either with what's needed for general statistical literacy or with what practitioners do. Multivariate statistics, for example, is largely missing from AP courses.

AR: Do you think AP Statistics has had a net positive effect for the statistics profession?

AW: Are there any negative effects? My impression is that high school teachers have done a better job than we have in getting quantitatively proficient students interested in statistics. It's great to see STEM majors at CSUN who had a good experience with AP Statistics in high school.

AR: You alluded to the importance of teacher preparation when you mentioned that some of the leaders among AP Statistics teachers needed to retrain to teach statistics. Have you been very involved with teacher preparation either at CSUN or more broadly? Even if not, do you have some views to share on how best to prepare prospective teachers to teach statistics well?

AW: Most of what I've done in statistics has involved working with high school teachers. I'm completely in awe of successful secondary school teachers, being a failed one myself. Their energy level is beyond belief.

The Quantitative Literacy Project model for teacher training was the best I've ever seen. As I mentioned before, the leaders of every workshop were a classroom teacher paired with a statistician. The teachers appreciated hearing from the statistician, who convinced them that the statistics being shown to them was important and correct and that statisticians respected secondary school teachers and thought it important they teach statistics to their students. But of course, the teachers really sat up and paid attention when the classroom teacher demonstrated how to implement the ideas in the classroom.

Pop Quiz

AR: Now I'd like to ask a series of short questions that you can think of as a "pop quiz," and I'll ask that you confine your answers to a few sentences. First, you've told us about your husband Bill; please tell us about the rest of your family.

AW: Bill and I have two wonderful daughters and sons-in-law, and two grandchildren. Both daughters have MBAs—we're not sure where we went wrong there. Bill and I spend as much time as possible with all of them, but we are totally captivated by the little ones. I continue to be surprised at how having grandchildren changed my priorities.

AR: What are some of your hobbies outside of statistics and education?

AW: Hiking has always been my favorite thing to do. Most of my childhood was spent in a house adjacent to the misnamed Angeles National "Forest." As long as I took the dog, my parents let me wander to my heart's content. We now live around the corner from the Santa Monica Mountains National Recreation Area, but I feel most at home in the Sierra Nevada. John Muir's statement, "The mountains are calling and I must go," has always resonated with me.

AR: What are some books that you've read recently?

AW: Histories and biographies like *Benjamin Franklin: An American Life*, *Empire of the Summer Moon: Quanah Parker and the Rise and Fall of the Comanches, Undaunted Courage: Meriwether Lewis, Thomas Jefferson, and the Opening of the American West,* the novelized *Wolf Hall,* a few books with a statistical theme like *The Signal and the Noise*, an occasional mystery, and a gazillion children's books.

AR: What are some of your favorite destinations to which you have traveled? Let me ask for at least one place that you went related to work, and at least one place that was just for fun.

AW: One of the great advantages to academic life is the ability to go to conferences in places that you would like to see. The most memorable was a month-long trip to a university in Xian. When on non-tax deductible travel, it's a balance between hiking in the natural wonders of the world—Moorea, the Alps, Yosemite—and seeing the great buildings of the past—Chartres, the Acropolis of Athens, the Pantheon in Rome, the Great Wall of China. But, nothing beats our national parks, truly "America's best idea."

AR: Next I'll ask some questions that I have used to collect data from students. Let's start with some binary variables: Do you prefer window or aisle? Do you use a PC or Mac? Do you consider yourself an early bird or a night owl?

AW: Window, so I can see the world. After the first time I tried a Mac, I never looked back. Night owl, which makes traveling to the east coast a challenge.

AR: And now a non-binary categorical variable: On what day of the week were you born? (You can use www.timeanddate.com to produce a calendar for your birth year.)

AW: Monday, can't you tell? A memorable Monday as my father drove my mother to the hospital during the famous 1949 snowstorm in Los Angeles.

AR: Next a discrete quantitative variable: How many Harry Potter *books have you read?*

AW: Only the first one. I enjoyed it, but fantasy just isn't my thing.

AR: Here's a continuous quantitative variable: How many miles do you live today from where you were born? (You can use www.distancefromto.net to calculate this distance.)

AW: I live 42 crow miles from south-central Los Angeles.

AR: Now I'll ask a fanciful question that I have asked of students. Suppose that time travel were possible, and you could take one trip. You can only observe, not change anything, when you get there. Would you travel to a time in the past or in the future? Why?

AW: Being more of a pessimist than an optimist about this overpopulated planet, I wouldn't want to see the future. From the past, I would like to hear the Gettysburg Address, please, and if you can't arrange that, I would be happy attending the Second Continental Congress. Father Abraham was the great hero of my childhood and my grandmother taught me the Gettysburg Address by heart. The thought of seeing him in person gives me goose bumps.

AR: Here's another fanciful question: Suppose that you are offered dinner for four to discuss statistics and/or education anywhere in the world. Who would you invite for your three dining companions, and where would you dine?

AW: I've worked with or have talked to most of the obvious choices, so I would really like to get to know three of the many young'uns (to me, at least) whose work I admire. I'd randomly select from people like Danny Kaplan, Nick Horton, Kari Lock Morgan, Michelle Everson, Stephanie Casey, Jennifer Kaplan.

AR: Please describe something about yourself that is likely to come as a surprise to those reading this interview.

AW: I'm Scots-Irish, an ethnicity that I didn't know existed before I was in my thirties, but which describes me from top to bottom and explains much of how I behave and react to the world. As if they were still fighting the Revolutionary War, my family was intolerant of any form of privilege not based on merit and viewed government with suspicion because it invariably infringed on privacy and independence. Children were encouraged to be honest, trustworthy, unyielding, brave, argumentative, and competitive. Jim Webb's *Born Fighting: How the Scots-Irish Shaped America* is required reading for those who want to begin to understand the very real ethnic differences within "white" America.

AR: What has been your favorite course to teach?

AW: Introductory statistics, no doubt, because I feel great about what I'm doing. I know that the content eventually will be very important to the students, even if I can't convince them of that at the moment. My all-time favorite student evaluation came from an introductory statistics student: "You've changed the way I look at the world. Now, all around me I see chance and variation." Talk about getting the message!

AR: Indeed, that's a great student reaction! This ends the pop quiz, but your response about your favorite course brings to mind follow-up questions in two different directions. I'll start by asking whether you've taught many mathematics courses other than statistics courses. If so, which math courses have you taught often?

AW: Over the years, I taught a wide range of mathematics courses, from algebra and geometry for remedial students through algebra and geometry for senior math majors. More recently, I've taught only statistics because my department is always desperate to get the statistics courses covered. My favorite mathematics course is linear algebra, because it is the first proof-based course that math majors take nowadays and, like when teaching statistics, it's fun to watch students' minds working to understand something entirely new.

AR: My other follow-up about introductory statistics being your clear-cut favorite to teach is to ask you to describe how, if at all, your teaching of that course has changed over your career.

AW: I've become much more of a minimalist: teach less, but be sure the students understand what I do teach. I think that every topic in statistics (and probability) is important, so this has been hard for me. For the first time last year I didn't teach probability in introductory statistics.

Other statistics educators have just about convinced me that I should try a flipped classroom. If I get the nerve, that will be the biggest change of all.

Conclusions

AR: Thanks very much, Ann, for taking the time to answer my questions so thoughtfully. I have just three more questions to conclude this interview. My first is the kind of question that sometimes appears on an exam, where students are given the option of which question to answer. The themes for the past two USCOTS conferences have been "making change happen" and "making connections." Please select one of these, and then comment on how you've made this (change or connections) happen in your career.

AW: Thank you, Allan, for letting me talk about myself at such length. I've really enjoyed your other interviews and am honored to be an interviewee.

While statistics education has been finding its place within the mathematical sciences, we all have tried to make connections in order to make change happen. Here's an example. Ed Dubinsky and I come from different worlds, but in 1999 we found that we had the same agenda concerning the future of the MAA. He wanted a home in the Association for the RUME (Research in Undergraduate Mathematics Education) group and I wanted a home for the statistics education group, which had been growing rapidly. In the spring of 1999, we wrote a proposal to the Board of Governors to create special interest groups within the MAA, and we provided a structure to do so. We pointed out that RUME and statistics educators already were acting essentially as special interest groups and used the "sections" within the ASA as examples of how successful these could be. The Board approved the proposal in principle in August 1999. By then, I was president-elect and so was able to move things along very quickly. The SIGMAA on RUME and the SIGMAA on Statistics Education were approved in early 2000 as the first two

SIGMAAs. Allan, I think you were the first chair of the Stat Ed SIGMAA and immediately signed up 170 paid members, which astonished the MAA leadership.

AR: Oddly enough, I actually hold the distinction of starting out in the role of past-chair of the Stat Ed SIGMAA, without ever having served as chair, just because we wanted the officers to always include a past-chair as well as chair, chair-elect, secretary, and treasurer.

My penultimate question is: Of all of your accomplishments in statistics education, can you specify one that you're most proud of?

AW: It's hard to take any credit for projects like QL, ABS, SIGMAA Stat Ed, or even AP Statistics because they seemed to take off almost all by themselves. The time for statistics had come.

So, when I look back, what I'm most proud about is that so many first-rate people wanted to work with me and took the time to teach me what I needed to know. I'm still amazed that the statistics education community was so inclusive that they found work even for a greenhorn like me.

As far as projects and publications, one's first "baby" is often the most special and, for me, that would be the Quantitative Literacy Project. Yet, what is known about how to teach statistics education has evolved so rapidly that when I look at those booklets from the 1980s, I just see all of the ways that they should be different. For example, we were writing materials that could be used by teachers who were teaching the subject for the first time, so "how to do it" receives too much emphasis at the expense of "how to interpret it." Such semi-planned obsolescence exists to some extent with almost everything I've done. It's either outdated, superseded, or would have been done differently if we knew then what we know now.

But there are two publications that I look at without any desire to rewrite them. The first is a 2002 article in *The American Statistician* called "Is Human Height Bimodal?" (Schilling, Watkins, and Watkins 2002). The second is *Statistics: From Data to Decision.* I just hope my coauthors feel the same way.

AR: Thanks very much for your involvement in all of these projects, which have had considerable impact on the teaching and learning of statistics over the past few decades. My final question is: What concluding advice do you have for JSE *readers, especially those early in their professional lives, for enjoying a fulfilling and successful career in statistics education?*

AW: Students who are interested in statistics education frequently ask whether they should concentrate on statistics or on statistics education while still in school. I always advise them to concentrate on statistics. It is unlikely that you can find a position where all you will teach is statistics education, so you must be prepared to teach statistics and, likely, mathematics, too.

For example, Anna Bargagliotti recently went this route. She got a Ph.D. in 2007 in mathematical statistics, then quickly absorbed what is known in statistics education, and now is a leader in that field. She is able to teach a wide range of mathematics and statistics courses.

Another example is Jimmy Doi, a former student of mine and now a professor in your own (AR's) department. His heart has always been in teaching, but he wisely chose a traditional preparation in statistics.

The younger you are when learning the technical stuff and the more exclusively that you can concentrate on it, the better. Once you get the basic credentials in statistics, then you can branch out into statistics education. That is relatively easy because there is a small list of very helpful sources to consult: CAUSE, ICOTS, USCOTS, the ASA section on Statistical Education, the AP Statistics listserv, the Isolated Statisticians list, *Journal of Statistics Education*, *Statistics Education Research Journal*, and the Teacher's Corner of *The American Statistician*. All of these exist to train people in statistics education, from simply how to teach it best to how to conduct research on the learning and teaching of statistics. The statistics education community is incredibly inclusive and generous. It will welcome you and help you learn what you need to know. That certainly was true for me, and I am very grateful.

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