Towards Remediating Undergraduate Students' Statisticophobia

Michael Firmin, Cedarville University
Elizabeth Proemmel, University of Utah

ABSTRACT

In this conceptual paper, based on teaching and TA experience, seven suggestions are made for improving the statistics experience of students in social science courses. These include hiring non-mathematicians to teach the course; emphasize conceptual statistics rather than computational approaches; recognize that many, or ever most, social science students think intuitively—rather than scientifically—so teaching statistics as a means of answering questions is needed; loosen-up the mundane nature that statistics courses often follow; relate statistics to students' day-to-day lives; and utilize an undergraduate student assistant in all sections of statistics classes.

Keywords: Statistics, Undergraduate Teaching

Researchers have shown statistics to create varying levels of anxiety in students (Bell, 2003; Benson, 1989). Some researchers have focused on psychological attributions such as self-concepts, perceived self-efficacy, and failure attributions (Thorndike-Christ & Yates, 1995) and others have examined anxiety related to statistical phobia (Onwuegbuzie, 2000) and mathematical anxiety in general (Bessant, 1995). Bell (2001) created the Statistical Anxiety Rating Scale (STARS) and Piotrowski (2002) has developed a similar instrument for assessing statistics anxiety among graduate students.

With all this anxiety generated through statistics courses, what factors, if understood by statistics professors, might help to reduce the anxiety experiences by students enrolled in education and social science courses and enhance their learning and educational experience? Moreover, what practical steps could be taken in order to reduce the stress experienced by students and enhance their learning and educational experience?

Seven outlined factors are presented that may lead to students' anxiety and make suggestions for consideration by educational measurement faculty for their statistics classes. These are drawn from the research literature, experience, and some action research data collected in statistics classes in providing these ideas. Specifically, a survey was administered to a class of statistics students both at the start of the semester and at the conclusion of the semester, and also a separate survey to two statistics classes of twenty-four students each.

First, professors teaching undergraduate statistics tend to be mathematicians, but department chairs may want to consider hiring faculty who are practitioners instead. When an instructor is exceptionally gifted in mathematics, there may be tendencies to teach over the heads of average-to-below-average students. Often the best art or music teachers, for average students, are those who once could not draw or play an instrument. They understand the necessary steps needed for proficiency whereas the exceptionally gifted artist or musician may find it difficult to grasp why a learner cannot perform what seems to be such simple tasks. The same principle may to be true for statistics. In the surveys, several students specifically mentioned that the material would be easier to grasp if more problems were worked through, step by step, instead of assuming that the students understand the process and rushing through it. If practitioners teach the courses, they may have a more natural tendency to explain what may seem obvious to the mathematician but not to the average undergraduate student.

Second, statistics courses often emphasize computing data in multiple formulas, when a more conceptual approach could be more beneficial. Prior to the advent of computer software packages, it was necessary to hand calculate formulas. Some statistics professors (particularly those middle aged or older) may have learned elementary statistics "by hand," meaning with the aid of a calculator—not a computer, and feel a need to pass this learning protocol to their students. Mulhern and Wylie (2004) suggest that students come to statistics classes less mathamatically prepared today than they did a decade ago. Obviously this is not the fault of the statistics professor, but it is a factor not to be overlooked—and a variable about which an instructor must take account when designing a statistics course.

This article advocates that instructors should shift towards conceptually based instruction, rather than maintaining formula-based pedagogy. When will a teacher or social scientist actually sum squares or take the square root from a mean of numbers? In the action research conducted, students recognized the need to understand the concepts better. Several students said that they could not understand how to apply the formulas to actual problems because they did not grasp the underlying concepts and how they fit together. One student stated: "I felt like I couldn't see the forest for the trees."

Class time is finite, and focusing on becoming intelligent consumers of statistics and the principles behind the calculations can reduce anxiety and produce students who actually use the material from their statistical courses in the future. It is understandable, of course, that some students grasp the principles better by doing the hand calculations. In fact, some instructors argue that students will not learn the concepts of statistics unless they first do the computations without computer aid. While the debate will not be solved this present paper, the present sentiment is that what students miss by not doing the hand calculations is offset by the reduction of statisticophobia. Everything in life, and teaching, is a trade-off. The proposed exchange is worth the cost in this context.

Third, education and the social sciences tend to draw more "artists" than "scientists," and the difference should be recognized. Whether viewed from the perspective of brain lateralization, personality, gender socialization, or other similar paradigms, education and social science students, as a group, will probably never fully-appreciate statistics or have high measures of ability in this domain of the curriculum as scientists do. They often seem to trust their instincts to answer questions about teaching strategies, clinical skills, and the like. Consequently, they often do not turn to the scientific method in order to answer questions that arise in their professional preparation. Statistics professors need to affirm intuition as one means of epistemology, but also emphasize that there are other equally—and sometimes better—means of knowing and answering questions.

Empiricism is the cornerstone for statistics, and professors may need to spend some class time helping students to see the connection between learning statistics and answering the relevant questions students possess and will have regarding their professional futures. Sometimes instincts are wrong and lead to ill-fated solutions. Statistics instructors can use illustrations to show students that intuition-plus-research generally leads to better conclusions than instincts alone. This way, the statistic-student-artists can think like scientists when needed, and utilize the scientists' world of knowledge when beneficial. In so doing, statistics professors may end up salting the horses' oats, rather than trying to make them drink water that they do not see a need to drink.

Fourth, students find statistics boring! Yet, professors can find ways to make it more interesting. Over half of the surveyed students in the class sample said the subject matter was boring, and others expressed an indifference or even annoyance about being required to take the course. As in any class, greater participation will improve the students' outlook on the class. One way to increase participation is to divide into small groups in order work on problems (Perkins, 2001). Students from the survey seemed to recognize the benefit of learning the concepts with other students. Along with increasing individual participation, dividing into groups could allow the professor more explanation time for those who are struggling while allowing the students who felt confident about the material to advance further or deeper into the unit being covered.

Faculty also can utilize technology and pedogical creativity to enhance student experiences (Meletiou-Mavrotheris, 2003). Video clips (also, DVD clips), for example, are available from major test publishers that illustrate a number of statistical concepts. Some can be purchased and others are available free with adoption of

particular texts. The clips do not generally teach new concepts, but rather illustrate various points and elaborate with real-to-life illustrations or examples. Videocasettes also are available for classroom use through most major film distributors. However, the video clips have the advantage of being brief and allowing the instructor to quickly pick back up on the main point being illustrated. If the instructor uses PowerPoint, then the clips can be embedded into the lecture material with a click of the mouse for ease of use and minimal distraction.

Classroom exercises and demonstrations enhance instructional pedagogy for all classes, and can be used quite creatively in statistical classes (Connor, 2003). Ranging from simple and short exercises such as coin flipping to more elaborate ones such as generating fabricated lotteries or slot machines with modest prizes can keep students' anticipation high from one class period to the next. Having students physically and actively involved with the process, however, is what we recommend—rather than merely painting word pictures or explaining how a theory might operationalize itself. The university where the authors teach has a commercial kit which provides some prefab exercises for instructional use, but ingenuity and creativity do not need to be purchased from a college supplier.

Even for the more concrete-thinkers who teach statistics, resources for generating creative ideas are available (e.g., Gelman, 2002). Professional development at conferences, collaborating with colleagues, and reading periodicals are beginning points for statistics instructors to fan innovative flames for teaching statistics. The internet has opened an extremely rich resource for idea sharing and creative content relative to statistics instruction (Varnhagen, Drake, & Finley, 1997). However, the most important element is for the statistics instructor to commit himself/herself to enginuity in the classroom. When this heart-set aptly is in place, resource utlization likely will follow—but the converse is not neccessarily the case. That is, purchasing resources without the internal commitment to creativity.

Fifth, undergraduate students tend not to see the day-to-day relevance of statistics to life, but it is relevant. Regarding statistics courses, students feel they must undergo the tortures that curriculum committees have placed upon them in order to enjoy full the privileges of their degree. Again, over half of the students surveyed in the study's sample said the subject matter just did not seem applicable. Case studies and other exercises can help to bring statistical courses out of the abstract and into the here-and-now, helping students to mentally buy-into the semester course. Increasing the number of examples advances student interest, providing them more opportunities to participate. After their attention and interest are cultivated, then instructors can turn students toward future research interests.

Sixth, holding out of class study sessions and tutorials helps to reduce student statisitcophobia. The authors' university provides an undergraduate teaching assistant to help the statistics instructor each semester. Students refer to this person as a Teaching Assistant (TA) although the student does not provide formal instruction as a graduate TA would do. Having a person who is knowledgeable in statistics, yet a peer, helps students to feel less intimidated about asking for assistance, according to our survey responses.

This does not imply, however, the statistics professor is intimidating. Rather, students bring to the class with them various fears and anxieties about math in general, and statistics in particular. Being able to approach a senior student for special assistance often does not seems as humiliating, compared to the alternative of making an appointment with the course professor to receive extra instruction. Students are encouraged to approach the course professor and for instructors to spend extra time with struggling students. The TA is not a replacement for this dynamic. However, as a supplement and added student service, the authors have found a TA to be a significant aid for reducing statisticophobia.

At the author's university, the undergraduate TA completes this experience as an independent study course. The student attends all the lectures, assists the professor with grading, attendance, and other course needs, tutors students with needs, proctors exams when the instructor is out of town, and assists with generating tests and grading. In short, the TA is a boon not only to the students, but also to the instructor. Since the course professor is freed from some of the housekeeping chores of the academic experience, he/she has more time and energy to provide individual assistance to students struggling with course material (Firmin, 2004).

Seventh, journaling has shown effectiveness in reducing student anxiety about learning statistics. Sgoutas-Emch and Johnson (1998) report that in their sample of 44 undergraduate statistics students, for example, journaling throughout the semester, including their concerns, fears, and anxieties, showed improvement in their grades, lower anxiety before exams, and lower physiological reactions when compared to cohorts who did not journal. In short, statisticophobia may be reduced when students are self-aware of their issues and have a meaningful outlet for expressing these concerns.

In an open ended manner, statistics students were asked at the start of the semester to describe their affect. The most common response (11 of 48) of students in our sample regarding their feelings towards the statistics course was that they were *nervous.* They also felt *scared* (9), *overwhelmed* (6), *apprehensive* (6), *worried* (4), *frightened* (4), *anxious* (3), *intimidated* (3), and *afraid* (2). Yet students also felt challenged (6) and excited (9) about the problems before them.

By the end of the term, many students realized that *"it wasn't as bad as everyone made it out to be"* (16), felt like they had *accomplished something* (5), and were *confident* (13) in their *new knowledge* (9). Applying some of the principles mentioned in this paper are believed to have helped to produce positive and proactive modifications in student behavior regarding their statistics experience. There are no silver bullets for effective statistics teaching, but adaptation to student needs, including some of the suggestions outline here, may assist toward remediating the problem of academic statisticophobia in social science courses.

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