

## TEACHING STATISTICS USING SHORT STORIES: REDUCING ANXIETY AND CHANGING ATTITUDES

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*This paper presents the results of a pilot study investigating the use of short stories in teaching introductory statistics to positively affect statistical anxiety and attitudes toward statistics. The Statistics Anxiety Rating Scale (STARS) and the Attitude Toward Statistics (ATS) scale were given to 17 graduate students at the beginning and end of the semester course. Results suggest a significant decline in statistical anxiety and a positive change in attitudes toward statistics courses, but no significant change in negative attitudes toward the field of statistics.*

### INTRODUCTION

According to Conners, Mccown and Roskos-Ewoldsen (1998), the statistics instructor faces four major challenges: to motivate students to value a topic they think is irrelevant to their life, to deal with the anxiety that is often associated with learning statistics, to effectively teach both high and low achievers, and to make the learning memorable. Trying to meet these challenges, instructors have experimented with a variety of teaching approaches. Just to mention a few: cooperative learning (Borresen, 1990) real data sets (Fillebrown, 1994), humor (Berk & Nanda, 1998), and journal writing (Sgoutas-Emch & Johnson, 1998).

The purpose of this study was to use short stories that involved some “sleuthing” by on-going characters (a statistics professor and her friends) to teach introductory statistics to graduate students. The expectation was that this somewhat light-hearted approach to applying statistics would reduce statistical anxiety and improve attitudes toward statistics--as well as have a learning benefit.

### METHOD

#### *Sample*

Participants in the present study were graduate students enrolled in a graduate-level, introductory statistics course in the College of Education. There were 32 volunteers who completed the pre-course questionnaire, of whom only 17 completed the post-course questionnaire. The average age for the final sample of 17, 16 of whom were female, was 37 years.

#### *Instruments*

*Statistical Anxiety Rating Scale* (STARS) is a self-administered questionnaire consisting of 51 statements (Cruise, Cash & Bolton, 1985; Cruise & Wilkens, 1980). Using a Likert-type scale, the student responds to each statement by circling a number from 1 to 5, where 1 indicates “No Anxiety” or “Strongly Disagree” and 5 indicates “Very Much Anxiety” or “Strongly Agree.” Six subscales are derived from the 51 statements. Subscale scores are measures of statistical anxiety, which is defined as “the feelings of anxiety encountered when taking a statistics course or doing statistical analyses (Cruise, Cash, & Bolton, 1985, p. 92). The subscales are:

- *Worth of Statistics* (16 items). A high score suggests a lack of relevant application for statistics in the student's life.
- *Interpretation Anxiety* (11 items). A high score suggests experiences of high anxiety when faced with interpreting statistical data.
- *Test and Class Anxiety* (8 items). A high score suggests experiences of high anxiety when attending a class or taking a test in a statistics course.
- *Computation Self-Concept* (7 items). A high score suggests experiences of high anxiety while doing mathematical problems, and doubting of abilities to understand and accurately calculate statistics.
- *Fear of Asking for Help* (4 items). A high score suggests experiences of high anxiety when asking for help from a fellow student or the professor.

- *Fear of Statistics Teachers* (5 items). A high score suggests experiences of high anxiety because the student questions the humanness of statistics teachers.

*Attitudes Toward Statistics* (ATS) is a self-administered questionnaire consisting of 29 statements (Wise, 1985). Using a Likert-type scale, the student responds to each statement by circling a number from 1 to 5, where 1 indicates "Strongly Agree" and 5 indicates "Strongly Disagree." Two subscales measuring attitudes toward statistics are available. The subscales are:

- *Field* (20 items). A high score suggests a negative attitude toward the usefulness of statistics in general or in the student's field.
- *Course* (9 items). A high score suggests a negative attitude toward the statistics course the student is currently enrolled in.

*Short-stories*. The authors wrote a series "sleuthing" stories that revolved around a statistics professor and her friends (a restaurateur, a blackjack player, a hair dresser, and a police officer). The first story in the series, as an example, required the student to construct a graph involving actual and extrapolated measures of blood alcohol concentration to determine if a hit-and-run driver was legally intoxicated at the time of the accident. The last story, as another example, required the student to do an ANOVA to see if the solving times of crossword puzzles found in a daily newspaper were significantly different for different days of the week.

There were nine short stories in all. Following a class lecture on the relevant statistic, a story was given to the class (one per week) with instructions to "solve the case." Each story included a summary of "facts" related to the case and step-by-step instructions, which included symbolic formulas and the formulas "in words," for solving the case. For each case, the student had to answer a question based on their statistical calculation, for example, "Could the bones found belong to a population of Chinese rail workers?"

#### *Procedure*

On the first day of class, students were asked to volunteer to fill out two questionnaires. They were told that their participation would not affect their grade in the class, and to further assure them, they were told to use a fictitious name on the questionnaire and send it to the administrative assistant. On the second to last day of class, they were given the same questionnaires and similar instructions (including to use the same fictitious name they used on the first questionnaire).

## RESULTS

*Statistical Anxiety Rating Scale* (STARS). For the pre-questionnaire and the ending-of-the-course questionnaire (Post-Questionnaire), Table 1 shows mean scores and standard deviations for the six STARS subscales and the mean-difference (Post - Pre) and standard deviation for each subscale, along with the paired-sample *t* and level of significance (2-tailed) for each subscale mean-difference. In addition, the percentile ranks (Pre and Post) are shown for subscale means. The percentile rank represents the standing within a normative sample ( $N=229$ ) of mostly Education graduate students "attending a small, private, religiously oriented midwestern university" (Cruise et al., 1985, p. 92).

As can be seen in Table 1, there was a significant ( $p < .05$ ) decrease in pre- to post-questionnaire mean-scores for each of the six subscales. Since the number of items for each subscale varies, comparing *percent* of pre-post change, rather than amount, allows for a more relevant comparison of decreases in anxiety. From largest to smallest decrease in anxiety, the subscales ranked as follows: 1. *Interpretation Anxiety* (31.2%), 2. *Fear of Statistics Teachers* (24.4%), 3. *Computation Self-Concept* (20.1%), 4. *Fear of Asking for Help* (20.0%), 5. *Worth of Statistics* (12.7%), and 6. *Test and Class Anxiety* (10.2%).

Percentile rank provides a third way of looking at the data. Though the normative sample is less than ideal, it does provide a yardstick by which to interpret the current sample's levels of anxiety, as measured by the STARS subscales.

Table 1

*Statistical Anxiety Rating Scale (STARS): Pre- and Post-Questionnaire Scale Scores, and Related Statistics, for Graduate Students Taking an Introductory Statistics Course (N = 17)*

Scales	Pre-Questionnaire Scale Scores			Post-Questionnaire Scale Scores			Post - Pre Differences Scale Scores			
	<i>M</i>	<i>SD</i>	% Rank*	<i>M</i>	<i>SD</i>	% Rank*	<i>M</i>	<i>SD</i>	<i>t</i>	sig. (2-tailed)
Worth of Statistics	27.4	9.30	51	23.9	8.42	45	3.47	5.66	2.53	.022
Interpretation Anxiety	33.2	9.21	82	22.8	6.54	44	10.35	7.78	5.49	.000
Test and Class Anxiety	27.2	6.00	66	24.5	6.55	56	2.76	4.93	2.31	.034
Computation Self-Concept	14.3	7.05	50	11.4	5.61	30	2.88	4.79	2.48	.025
Fear of Asking for Help	10.9	5.53	88	8.8	4.52	75	2.18	4.22	2.13	.049
Fear of Statistics Teachers	10.4	3.35	45	7.7	3.18	28	2.65	2.64	4.13	.001

\* Percentile Ranks for STARS mean-scores from a normative sample of 229 graduate students in Education (Cruise et al., 1985).

Looking at the Pre-Questionnaire data in Table 1, for example, percentile ranks for *Worth of Statistics* (51) and *Computation Self-Concept* (50) placed the current sample at the average level of anxiety for graduate students in Education, while percentile ranks for the *Fear of Asking for Help* (88) and *Interpretation Anxiety* (82) placed them at a comparatively high level of anxiety.

Looking at the change in percentile rank from pre- to post-questionnaire, notable is the substantial decrease in *Interpretation Anxiety* (82nd to 44th percentile rank) and *Fear of Statistics Teachers* (45th to 28th percentile rank), and the relatively minimal decrease for *Fear of Asking for Help* (88th to 75th percentile rank) and *Worth of Statistics* (51st to 45th percentile rank).

*Attitudes Toward Statistics* (ATS). For the beginning-of-the-course questionnaire (Pre-Questionnaire) and the ending-of-the-course questionnaire (Post-Questionnaire), Table 2 shows mean scores and standard deviations for the two ATS subscales and the mean-difference (Post - Pre) and standard deviation for each subscale, along with the paired-sample *t* and level of significance (2-tailed) for each subscale mean-difference.

As can be seen from Table 2, there was a significant ( $p = .001$ ) decrease in pre- to post-questionnaire mean-scores for the *Course* subscale, but the mean-difference for the *Field* subscale was not significant ( $p = .348$ ). The *percent* pre-post change for the *Course* subscale was 24.6% (perhaps coincidentally, the same as for the STARS subscale *Fear of Statistics Teachers*, 24.4%).

Table 2

*Attitudes Toward Statistics (ATS): Pre- and Post-Questionnaire Scale Scores, and Related Statistics, for Graduate Students Taking an Introductory Statistics Course (N = 17)*

Scales	Pre-Questionnaire Scale Scores		Post-Questionnaire Scale Scores		Pre-Post Differences Scale Scores			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	sig. (2-tailed)
Field	35.1	9.20	33.4	6.77	1.71	7.28	0.9	.348
Course	24.9	8.98	18.8	5.67	6.12	6.29	4.0	.001

## DISCUSSION

The results of this study were consistent with the expectation that the use of fictional short stories to provide the context for the statistical problem-to-be-solved would reduce the student's statistical anxiety. However, the expectation that there would also be a change in the attitudes toward the field of statistics was not supported by the data. What the results suggested was that, while the student attitudes toward the statistics teacher and the course were positively affected, their attitudes toward the field of statistics were not substantially changed: they still questioned the relevance of statistics in their lives. Because of anonymity, actual grades for the students in this study could not be associated with the questionnaire data, but a comparison of the semester grades with previous semester grades revealed no significant difference in the mean grade for the total class. The question, Is anxiety reduction and positive change in attitude significantly correlated with student grades? will have to be answered by another study.

Perhaps the most troubling result of this study was the finding that there was such high anxiety associated with asking other students or the professor for help in understanding the material covered in the course. This suggests a need to develop and promote a structure for obtaining help starting on day one--if not sooner--of the course.

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