



Anxiety and Attitude of Graduate Students in On-Campus vs. Online Statistics Courses

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Abstract

This study compared levels of statistics anxiety and attitude toward statistics for graduate students in on-campus and online statistics courses. The Survey of Attitudes Toward Statistics and three subscales of the Statistics Anxiety Rating Scale were administered at the beginning and end of graduate level educational statistic courses. Significant effects were observed for two anxiety scales (Interpretation and Test and Class Anxiety) and two attitude scales (Affect and Difficulty). Observed decreases in anxiety and increases in attitudes by online students offer encouragement to faculty that materials and techniques can be used to reduce anxiety and hopefully enhance learning within online statistics courses.

1. Introduction

In 1991, Zeidner noted that increasing numbers of students were completing a basic statistics course as part of their required curriculum. Zeidner also suggested that statistics may be one of the most demanding and rigorous courses taken, consequently evoking cognitive and emotional reactions that may inhibit level of performance. In 1985, [Cruise, Cash, and Bolton](#) defined statistics anxiety as “the feelings of anxiety encountered when taking a statistics course or doing statistics” (p. 92). The nature of this definition is consistent with Zeidner’s comments and later echoed in a literature review by [Onwuegbuzie and Wilson \(2003\)](#). It has also been reported that the percentage of graduate students experiencing uncomfortable levels of statistics anxiety is

between 66% and 80% ([Onwuegbuzie and Wilson, 2003](#)). It has been shown too that students' views of statistics have become negative, and consequently, these courses are often delayed until the end of programs ([Onwuegbuzie, 2004](#)).

The suggestion that statistics anxiety may influence performance has been supported through research in multiple disciplines including business ([Zanakis and Valenzi, 1997](#)), psychology ([Lalonde and Garner, 1993](#)), and education ([Fitzgerald, Jurs, and Hudson, 1996](#); [Onwuegbuzie, Slate, Paterson, Watson, and Schwartz, 2000](#)). In addition to examining its effect on achievement, previous research (e.g., [Bradley and Wygant, 1998](#); [Rodarte-Luna and Sherry, 2008](#)) has compared anxiety levels of different types of students. Of particular interest to the current research was a series of studies conducted by [Bell \(2001, 2003, 2008\)](#). These studies used the Statistics Anxiety Rating Scale (STARS) ([Cruise, Cash, and Bolton, 1985](#)) and found differences based on course length and type of student.

In addition to statistics anxiety, previous research has examined student attitudes toward statistics. [Mills \(2004\)](#) noted that research suggested that student attitudes toward statistics tend to be negative. Of particular interest to the current research is the suggestion by [Onwuegbuzie \(2000\)](#) that levels of anxiety may be a determinate of student attitude. The relationship between anxiety and attitude was evidenced by [Finney and Schraw \(2003\)](#) who reported statistically significant negative relationships. Because of the suggested relationship between statistics anxiety and attitude towards statistics, it seems logical to examine both issues.

Although a variety of research related to statistics anxiety and attitude toward statistics has been conducted, one issue that it seems has not been examined is the delivery format of the course, on-campus or online. [Hsu, Wang, and Chiu \(2009\)](#) used online MBA students to examine statistics anxiety; however, the results were not compared to students who completed a traditional, on-campus course. Additionally, [Alajaaski \(2006\)](#) examined the effect of web-technology on student attitudes, but the students were able to meet in a traditional classroom setting once a week. Because it is believed that enrollment in online courses is expected to continue increasing ([Allen and Seaman, 2008](#)), the purpose of the present study was to compare the levels of statistics anxiety and attitudes toward statistics of students in on-campus and online sections of a graduate educational statistics course.

2. Methods

2.1 Participants

Graduate students enrolled in on-campus and online sections of an educational statistics course offered from a regional university in the southeast completed a web-based attitude and anxiety survey at the beginning and end of the course. As an incentive to complete the survey, students were given extra credit for completing both administrations. One-hundred thirty-four students completed the first administration of the survey. This included 100 students enrolled in online sections and 34 students enrolled in on-campus sections. A total of 120 students completed both administrations of the survey for an overall completion rate of 89.6% with online and on-campus completion rates of 93% and 79.4%, respectively. Because the survey was anonymous, it is not

possible to determine if the completion of fewer post-surveys was due to students dropping or withdrawing from courses or simply choosing to not complete the survey for the second time.

[Table 1](#) contains the demographic characteristics of the 120 students who completed both administrations of the survey. Examination of the demographic information showed no statistically significant differences in the gender distribution or mean and median age for the on-campus and online sections. For both groups, the age distribution was positively skewed with students ranging in age from 22-23 to 63. However, differences did exist between the sections with respect to ethnicity and degree program. Students in the on-campus sections were predominantly Black (66.7%) while the online sections were predominantly White (74.2%). Students in the online sections were mainly enrolled in counseling programs (69.9%) with only 16.2% in elementary, early childhood, or secondary education programs. Unlike the online students, the percentages of on-campus students enrolled in counseling programs and elementary, early childhood, and secondary education programs were the same (40.7%).

Table 1. Demographic Information

| Demographic | Course Type | |
|---------------------------|------------------------|------------------------|
| | On-campus (n = 27) | Online (n = 93) |
| Male | 5 (18.5%) | 18 (19.4%) |
| Female | 22 (81.5%) | 75 (80.6%) |
| White | 9 (33.3%) | 69 (74.2%) |
| Black | 18 (66.7%) | 21 (22.6%) |
| Asian | -- | 1 (1.1%) |
| Other | -- | 2 (2.2%) |
| Elementary Education | 4 (14.8%) | 6 (6.5%) |
| Early Childhood Education | -- | 2 (2.2%) |
| Secondary Education | 7 (25.9%) | 7 (7.5%) |
| Educational Leadership | -- | 3 (3.2%) |
| School Counseling | 1 (3.7%) | 45 (48.4%) |
| Counseling/Psychology | 10 (37.0%) | 20 (21.5%) |
| Library Media | 3 (11.1%) | 4 (4.3%) |
| Other | 2 (7.4%) | 5 (5.4%) ^a |
| Age | M = 30.81 SD = 9.90 | M = 33.03 SD = 8.68 |

^a One subject did not identify a program, n = 92

2.2 Course Description

The summer term was chosen because the lengths of the on-campus summer semester and online term were 10 weeks, thereby controlling for course length. In addition to matching the length of the course, all sections used the same materials, assignments, and grading scale. The content of the course was typical of an introductory statistics course at the graduate level and included topics such as descriptive statistics, inferential statistics (e.g., t-tests, anova, etc.), correlations, and selected non-parametric analyses. The requirements for the course included a set of practice problems designed to guide students through the topic and a graded assignment for each topic. The culminating assignments included a set of problems requiring the students to identify and conduct the proper analyses and a final exam. In both course formats, the focus was on using SPSS statistical analysis software to conduct the analyses rather than learning formulas and performing hand calculations.

2.3 Instrumentation

Two existing surveys were used in the current research. Statistics anxiety was measured using subscales from the Statistics Anxiety Rating Scale (STARS) ([Cruise, Cash, & Bolton, 1985](#)). Attitude toward statistics was measured using the Survey of Attitudes Toward Statistics (SATS-28) ([Schau, Stevens, Dauphinee, and Vecchio; 1995](#)).

STARS uses a 5-point response scale and consists of 51 items representing 6 subscales. The first 23 items represent situations associated with statistical anxiety and require a response ranging from No Anxiety to Very Much Anxiety. The remaining 28 items are statements related to statistics and require a response ranging from Strongly Disagree to Strongly Agree. For the current research only three subscales were used: (a) Test and Class Anxiety, (b) Fear of Asking for Help, and (c) Interpretation Anxiety. These subscales represent the 23 anxiety related statements; therefore the anchor labels for all items in the anxiety subscales were No Anxiety (1) and Very Much Anxiety (5). [Table 2](#) provides a description of the STARS subscales used in the current research and example statements.

Table 2. Description of STARS Subscales with Sample Statements

| Subscale (number of items) (Score range) | Description Sample Statements |
|---|--|
| Interpretation Anxiety (11) (11 – 55) | <p>“This factor is concerned with the anxiety experienced when a student is faced with making a decision from or interpreting statistical data” (Cruise, Cash, & Bolton, 1985, p. 93).</p> <p>Asking one of your professors for help in understanding a printout.</p> <p>Asking a fellow student for help in understanding a printout.</p> |
| Fear of Asking for Help (4) (4 – 20) | <p>“This factor measures the anxiety experienced when asking for help” (Cruise, Cash, & Bolton, 1985, p. 93).</p> <p>Trying to decide which analysis is appropriate for your research project.</p> <p>Figuring out whether to reject or retain the null hypothesis.</p> |
| Test and Class Anxiety (8) (8 – 40) | <p>“This factor deals with the anxiety involved when taking a statistics class or test” (Cruise, Cash, & Bolton, 1985, p. 93).</p> <p>Studying for an examination in a statistics course</p> <p>Doing homework for a statistics course</p> |

Based on the scoring procedure provided by [Cruise et al. \(1985\)](#), subscale scores were calculated as the sum of the responses to items in the subscale, and a low score represented low anxiety while a high score represented a high level of anxiety. Pretest alpha reliabilities for the STARS subscales ranged from .88 to .92 for the total sample. Subgroup reliabilities ranged from .89 to .93 for the on-campus sample and .88 to .91 for the online sample. These were consistent with previous estimates reported by Cruise, Cash, and Bolton that ranged from .85 to .91. In addition to the forced-response items from the STARS, students were given the opportunity to list additional issues related to the course that may cause anxiety.

The SATS-28 contains 28 statements related to statistics, uses a 7 point scale ranging from Strongly Disagree (1) to Strongly Agree (7) for all items, and contains four subscales: (a) Affect, (b) Cognitive, (c) Value, and (d) Difficulty ([Schau et al., 1995](#)). Additionally, some statements are negatively worded and require reverse coding before the data can be analyzed. A description of the subscales and sample positive and negative statements are contained in [Table 3](#).

Table 3. Description of SATS-28 Subscales and Sample Statements

| Subscale (number of items) | Description Sample Statement |
|----------------------------|---|
| Affect (6) | Concerns positive and negative feelings toward statistics I will like statistics. I will be under stress during statistics classes. ^a |
| Cognitive (6) | Concerns attitudes about intellectual knowledge and skills applied to statistics I can learn statistics. I will find it difficult to understand statistics concepts. ^a |
| Value (9) | Concerns the usefulness, relevance, and worth of statistics Statistical skills will make me more employable. Statistics is irrelevant in my life. ^a |
| Difficulty (7) | Concerns attitudes about the difficulty of statistics as a subject Statistics is a subject quickly learned by most people. Statistics is a complicated subject. ^a |

Note: ^a illustrates a negatively worded statement that requires the responses to be reverse coded

Subscale scores for the SATS-28 were obtained by calculating the mean response of the items composing the subscale. Therefore, all subscale scores on the SATS-28 range from 1 to 7. After the negatively worded statements are reversed, higher subscale scores corresponded to more positive attitudes. Previously reported alpha reliabilities for the SATS-28 subscales ranged from .64 to .85 (Schau et al., 1995). The alpha reliability estimates based on the current sample ranged from .75 to .85 for the total sample. Subgroup reliabilities ranged from .69 to .85 for the on-campus sample and .74 to .85 for the online sample.

3. Analysis of Data

3.1 Anxiety and Attitude Differences

A series of 2 (course type) x 2 (administration) repeated measures analyses of variance were conducted to determine if statistically significant differences existed between course types and examine changes in anxiety and attitude. Administration (pretest and posttest) was specified as a within-subjects factor and course type (online and on-campus) was specified as a between-subjects factor. An alpha level of .05 was used to determine statistical significance. Effect size estimates were determined by calculating an r statistic using the formula provided by Field (2009).

The results contained in [Table 4](#) identified a statistically significant main effect for the type of course with respect to Interpretation Anxiety, $F(1, 118) = 4.753$, $p = .031$. The results indicate that the average level of Interpretation Anxiety was higher among the online students ($M_{ol} = 28.80$, $M_{oc} = 25.54$). The results also showed no statistically significant effects on the Fear of Asking for Help subscale. Finally, the results for the Test and Class Anxiety subscale identified a statistically significant interaction between administration time and course type, $F(1, 118) =$

4.103, $p = .045$. Simple effects analyses revealed a statistically significant decrease in anxiety among online students, $F(1, 118) = 4.32$, $p = .040$, but no significant change in anxiety among on-campus students. Simple effects analyses also showed that the pretest anxiety level for online students was statistically significantly higher than the on-campus students, $F(1, 118) = 18.19$, $p < .001$; however, there was no significant difference between the types of courses with respect to the posttest measure of anxiety. Effect size estimates indicate that most effects were small ($<.10$). The smallest effects were consistently associated with Administration Time, and larger effects were associated with Course Type. The largest effect was a medium effect for the Course Type with respect to Test and Class Anxiety ($r = .30$).

Table 4. Repeated Measures ANOVA Results for STARS Subscales by Course Type and Administration Time

| Subscale | Course Type | | ANOVA statistics | | | |
|--------------------|---------------------|------------------|------------------|--------|------|-----|
| | On-campus M (SD) | Online M (SD) | Factor | F | p | r |
| Administration | | | | | | |
| Interpretation | | | | | | |
| Anxiety | | | Admin | 0.125 | .724 | .03 |
| Pre | 25.04 (10.40) | 29.82 (8.54) | Type | 4.753 | .031 | .20 |
| Post | 26.04 (10.31) | 27.78 (10.06) | Admin x Type | 1.078 | .301 | .10 |
| Fear of Asking for | | | | | | |
| Help | | | Admin | 0.018 | .893 | .01 |
| Pre | 7.15 (4.25) | 8.46 (3.82) | Type | 1.751 | .188 | .12 |
| Post | 7.70 (3.96) | 8.06 (3.95) | Admin x Type | 0.670 | .415 | .08 |
| Test and Class | | | | | | |
| Anxiety | | | Admin | 0.003 | .957 | .01 |
| Pre | 19.04 (8.09) | 25.46 (6.51) | Type | 11.469 | .001 | .30 |
| Post | 21.56 (7.98) | 23.08 (8.58) | Admin x Type | 4.103 | .045 | .18 |

Results for the attitudinal subscales are shown in [Table 5](#). The results of the analyses showed no statistically significant differences based on the course format or administration time for the Cognitive and Value subscales. However, the results for the Difficulty subscale indicated a statistically significant main effect for the type of course, $F(1, 118) = 4.206$, $p = .043$. The results indicated that the on-campus students ($M = 3.49$) had a more positive attitude concerning the difficulty of statistics compared to online students ($M = 3.21$).

Table 5. Repeated Measures ANOVA Results for SATS-28 Subscales by Course Type and Administration Time

| Subscale | Course Type | | ANOVA statistics | | | |
|------------|---------------------|------------------|------------------|-------|------|-----|
| | On-campus M (SD) | Online M (SD) | Factor | F | p | r |
| Affect | | | Admin | 1.222 | .271 | .10 |
| Pre | 4.46 (1.28) | 3.36 (1.30) | Type | 9.636 | .002 | .27 |
| Post | 4.26 (1.36) | 4.03 (1.48) | Admin x Type | 4.150 | .044 | .18 |
| Cognitive | | | Admin | 1.800 | .182 | .12 |
| Pre | 4.88 (1.19) | 4.49 (1.14) | Type | 2.281 | .134 | .14 |
| Post | 5.01 (1.23) | 4.85 (1.20) | Admin x Type | 0.400 | .528 | .06 |
| Value | | | Admin | 0.522 | .471 | .07 |
| Pre | 4.58 (0.74) | 4.96 (0.97) | Type | 0.474 | .493 | .06 |
| Post | 4.97 (1.17) | 4.81 (1.13) | Admin x Type | 2.652 | .106 | .15 |
| Difficulty | | | Admin | 0.051 | .821 | .02 |
| Pre | 3.60 (0.93) | 3.07 (0.94) | Type | 4.206 | .043 | .19 |
| Post | 3.38 (1.03) | 3.35 (0.90) | Admin x Type | 2.752 | .100 | .15 |

The results also showed statistically significant effects with respect to the Affect subscale. A statistically significant difference was identified for the type of course, $F(1, 118) = 9.636$, $p = .002$, and the interaction between the type of course and administration time, $F(1, 118) = 4.150$, $p = .044$. The simple effects analyses revealed a statistically significant increase in attitude scores among the online students, $F(1, 118) = 1318.61$, $p < .001$, and a statistically significant difference between on-campus and online students with respect to the pretest measure, $F(1, 118) = 14.98$, $p < .001$.

Like the results from the anxiety subscales, the effect of Administration Time was consistently associated with small effects. The estimates show that none of the factors produced a medium size effect. The largest observed effect was related to Course Type with respect to the Affect subscale ($r = .27$).

3.2 Qualitative Responses to Additional Anxiety Issues

Sixty students responded to the open-ended question regarding anxiety inducing issues on the pretest administration. Of these, the majority (55) of responses were provided by online students. The responses were generally related to technology, course format, or personal issues. The most common responses concerned personal issues such as competency, often due to the amount of time since the previous math or statistics class, and grades. The following are examples of statements regarding these issues (Note: * denotes an on-campus comment):

“My largest concern, which may cause anxiety is returning to a statistical class after 10 years with no experience.”*

“I graduated with my undergrad degree in 1987. I have not had any type of math related course since 1985”

“Because I feel that I am not a strong mathematical person, I don't think that I will do well in statistics.”

“The Final Grade when you are under pressure to maintain a certain GPA”

“I am anxious about graduating this August but I am nervous because if I do not do well in statistics I will not graduate.”

Comments related to course format centered on concerns regarding contact with the instructor, amount of work, and expectations. The following are typical comments illustrating these issues:

“I am worried that I cannot physically see my professor and see him instruct”

“I'm nervous that I'm not allowed to have personal contact in a classroom setting. I'm very anxious about having questions that I need answered right away.”

“All the course requirements, objectives”

“Not sure what to expect.”

Although technology is intuitively tied to the course format, some responses were related directly to technological issues. Along with the use of technology in general, most of the technology based responses focused on the ability to use the SPSS software. The following provide examples of the technology related comments:

“My computer knowledge (or lack of it)”

“Computers in general”*

“I have no idea what SPSS is or what to expect; this is somewhat nervewracking.”

“Having to deal primarily with computers (computer as an instrument, software, and emails as primary means for relaying assignments etc), I'm not a fan of technology”

3.4 Summary

The purpose of this study was to compare the levels of statistics anxiety and attitude toward statistics for students in on-campus and online statistics courses. The Statistics Anxiety Rating Scale (STARS) and Survey of Attitudes Toward Statistics (SATS-28) were used to measure anxiety and attitude at the beginning and end of a 10-week course. The results indicate that students in the online classes generally had higher levels of anxiety and less favorable attitudes towards statistics. Of the three scales contained on the STARS, significant differences based on course type were observed for Test and Class Anxiety and Interpretation Anxiety. Further, the results indicated an interaction between the course format and administration time for the Test and Class Anxiety scale.

The results also indicate that significant differences in attitude existed for the Affect and Difficulty scales. For both scales, on-campus students had more favorable attitudes toward statistics. However, the results on the Affect scale also indicated that the Affect scores for online students increased significantly from the beginning to end of the course. The fact that significant differences were identified for these two attitudinal scales was not surprising because they had moderate to strong negative correlations with the Test and Class Anxiety and Interpretation scales. These correlations suggest that an inverse relationship may exist between statistics

anxiety and attitudes toward statistics. Specifically, for the students in this study, lower levels of anxiety were associated with more positive attitudes.

4. Limitations

4.1 Regression to the Mean

Although the results from the repeated measures analyses identified statistically significant effects for several subscales, the profile plots that accompanied the analyses consistently suggested that there were differences on the pretest. A series of independent sample t-tests revealed statistically significant differences between the on-campus and online students for 2 STARS subscales (Interpretation Anxiety, Test and Class Anxiety) and 2 SATS-28 subscales (Affect and Difficulty). This is of particular importance because [Kelly and Price \(2005\)](#) noted that if groups differ on the initial measurement, then the expected change from pretest to posttest will differ among the groups, which could increase the likelihood of significant interaction effects that are incorrectly attributed to the factors (e.g., Course Type).

[Kelly and Price \(2005\)](#) made this statement within the context of a discussion concerning regression to the mean. Regression to the mean refers to the tendency of individuals with high pretest scores to score lower on the posttest, individuals with low pretest scores to score higher on the posttest, and individuals who score around the average on the pretest to score around the average on the posttest ([Rocconi and Ethington, 2009](#); [Rogosa, 1995](#)). In 1963, Campbell and Stanley identified this issue as a threat to internal validity and referred to it as statistical regression.

Much of the discussion concerning regression to the mean, including [Campbell and Stanley \(1963\)](#), associates its presence with the use of a selection criteria on which students with extreme high or low scores are placed in different groups. The current research did not utilize selection and placement criteria that would have artificially introduced regression to the mean. Further, although local students had the opportunity to enroll in the on-campus or online sections, the majority of online students were completing an online degree and, due to distance, did not have the opportunity to select an on-campus section. Therefore, potential differences due to section selection should have been minimal.

Although selection and placement criteria were not used in this study, [Rogosa \(1995\)](#) noted that regression to the mean may be present when the correlation between initial and change scores is negative. An examination of this correlation revealed negative correlations between initial and change values for all subscales ($r = -.656$ to $-.750$). To examine the possible influence of regression to the mean, an adjustment proposed by Roberts (as cited in [Rocconi and Ethington, 2009](#)) was applied to the initial scores and the analyses were repeated. This adjustment required the test-retest reliability estimates for each subscale. Because test-retest estimates were not available for the SATS-28, an adjustment to the internal consistency estimate ([Roberts, 1980](#)) was used.

The results of the subsequent analyses revealed no statistically significant main or interaction effects for the SATS-28 subscales. For the STARS subscales, no statistically significant effects were identified for the Fear of Asking for Help subscale. Additionally, there were no statistically significant interaction effects for the Interpretation or Test and Class Anxiety subscales. However, significant differences were identified for these two subscales with respect to the main effect of Course Type. For both subscales, students in the online sections had higher levels of anxiety. The lack of significant interaction effects suggests that the previously identified interactions may have resulted from a regression to the mean effect.

4.2 Sample Related Issues

The on-campus sample was small relative to the online group which may have influenced the statistical analyses and resulting conclusions. As seen in the description of the sample, the ratio of online to on-campus students exceeded 3:1. Based on an assumption that the responses from the on-campus students were representative of the larger population of students who complete the course on-campus, the observed data for the on-campus students was duplicated and the analyses repeated. The results identified multiple statistically significant main effects on the SATS-28 and STARS subscales. The most consistently identified effect was for Course Type and suggested that online students had higher anxiety and less positive attitudes.

In addition to the difference in sample size, there were demographic differences with regard to ethnicity and program enrollment. The majority of the online group (71.1%) was enrolled in counseling programs while the on-campus group contained a large percentage of education majors (40.7). Additionally, a higher percentage of on-campus students reported Black (66.7% compared to 22.6% online) as their ethnicity. The differences in ethnicity and program enrollment suggests that the on-campus and online students in this study may represent different populations.

4.3 Additional Limitations

In addition to sample related issues, the on-campus and online courses were taught by different faculty. Although all classes used the same materials and contained the same requirements, differences among faculty could have influenced students' perceptions, particularly on the post-surveys. Finally, the levels of anxiety and attitude were based on self-report instruments that were developed and validated with on-campus classes. Consequently, some of the items within a subscale may not have been as appropriate for online students.

5. Discussion and Recommendations

[Allen and Seaman \(2007\)](#) reported that the rate of online enrollments between 2002 and 2006 exceeded the rate of overall higher education enrollment. In Fall 2006, approximately 3.5 million students enrolled in at least one online course, and nearly 20% of all U.S. higher education students enrolled in at least one online course. Enrollment increased to over 3.9 million during the Fall 2007 term, and 83% of institutions who offered online courses expected enrollments to

increase in coming years ([Allen and Seaman, 2008](#)). As the demand for online courses continues to grow, courses that many faculty and students believe may be more effectively delivered in an on-campus setting, such as statistics, will be available through online delivery.

Although [Cruise, Cash, and Bolton's \(1985\)](#) definition of statistics anxiety was provided more than 20 years ago, time and technology have not likely caused this form of anxiety to disappear. Despite the limited amount of current research on statistics anxiety, particularly related to online students, it appears that individuals within the field of statistics education remain aware of its existence. This can be seen through a review of available books including "Statistics for People Who (Think They) Hate Statistics" ([Salkind, 2007](#)), "Statistics Without Tears: A Primer for Non-Mathematicians" ([Rowntree, 2003](#)), and "Statistics for the Utterly Confused" ([Jaisingh, 2005](#)). Further, [Hsu, Wang, and Chiu's \(2009\)](#) use of online students to examine levels of statistics anxiety may signal the start of a new line of statistics anxiety research that focuses on virtual environments. Finally, because of [Finney and Schraw's \(2003\)](#) evidence that anxiety and attitude are related and [Onwuegbuzie's \(2000\)](#) suggestion that anxiety may be a determinant of attitude, it is logical that as anxiety research begins to focus on virtual environments, attitudinal research will follow.

As evidenced through the results of this study, the online delivery of a statistics course is likely to lead to higher levels of statistics anxiety and less positive attitudes toward statistics at the beginning of the course. However, the current results also show that anxiety and attitudinal levels of online students at the end of the course were similar to those in traditional, on-campus settings. Because the purpose of this study was not to implement a strategy to reduce anxiety or improve attitudes, the observed reduction in anxiety levels among online students provides promise that faculty and others who design statistics courses for online delivery can incorporate materials and techniques that will lessen the anxiety of students and hopefully lead to better performance.

Although the initially identified interactions may have been influenced by a regression to the mean effect, it is clear that differences in initial attitude and anxiety levels existed. Therefore, future research that examines anxiety and attitude among online students should explore the cause for these higher levels. Additionally, future research should address some of the limitations present in the current research including the use of similar samples. Finally, existing instruments that have been used to measure statistics anxiety and attitude toward statistics should be validated or adapted for online environments.

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