Statistics Anxiety and Statistics Self-Efficacy in Doctoral Online Statistics: A Mixed Methods Study

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Abstract

Using concurrent mixed methodology, this study explored how doctoral students experience high statistics anxiety and low statistics self-efficacy as they worked through an accelerated, online introductory statistics course. Qualitative results indicate that high statistics anxiety and low self-efficacy are negative encounters for most in that they experience frustration, tension, and felt "incompetent" and "inadequate." Quantitative results showed a significant main effect of time on the combination of statistics anxiety & self-efficacy, as well as a significant interaction of prior experience and time on the combination of statistics anxiety and self-efficacy. Mixed integration results found no significant correlations between total STARS and CSSE scores with four salient qualitative themes: struggling to choose the correct test to answer a research question; wanting more practice to increase confidence; experiencing tension when engaging in statistics coursework, and struggling to use SPSS – using the program and interpreting the relevant output.

Introduction

When endeavoring required statistics coursework, many graduate students struggle with feelings of anxiety and low self-efficacy about their academic performance. This may be especially true for those enrolled in online, autonomous statistics courses. Since high statistics anxiety and low statistics self-efficacy can debilitate students' learning and affect retention in doctoral programs[1], understanding doctoral students' experiences with these constructs deems prudent.

Statistics anxiety is defined as a "state-anxiety reaction" when "encountering statistics in any form and at any level."[2] Symptoms include:
- Emotional: nervousness, worry, depression, apprehension, & frustration
- Physical: headaches, tension, bodily pain

Prior research identified six factors of statistics anxiety[3]:
- **Interpretation anxiety**: trouble interpreting statistical data
- **Test & class anxiety**: related to performance in class or on a test
- **Fear of asking for help**: seeking assistance from the professor or classmates when struggling to understand statistical concepts
- Worth of statistics: negative attitude and low value of a statistics course
- Computational self-concept: students' belief about their ability to attempt mathematics work
- Fear of statistics teachers: perceived rapport (or lack thereof) with their statistics instructor

* Bolded factors indicate current study focus

Antecedents of statistics anxiety:
- Dispositional: academic procrastination[4], perfectionism[5], **self-concept of ability**[6]
- Environmental: student age[7], gender[8], **prior statistics experience**[9]
- Situational: course materials[2], pace of course[10], length of course[11], **method of delivery (online vs on-ground)**[12]

Statistics self-efficacy is defined as one's confidence to engage in statistics curriculum.[13]
- Domain specific: occurs in context of statistics/research coursework[14]
- Contributing factors: systemic culture of anxiety & poor personal connections made to topic[15]

Study Aims

Distance education in U.S. universities has continued to grow faster than expected.[16] In 2015, graduate students were twice as likely to complete all their courses online than undergraduate students.[17] Since many social science graduate programs require statistics coursework, the regularity of these classes being conducted online will continue to increase. This study aimed to investigate doctoral students' experiences studying statistics in an online statistics course from a mixed-methods perspective. Doing so is important for two reasons. First, U.S. Doctoral attrition is estimated to be around 50%.[18] Thus, high statistics anxiety and low statistics self-efficacy can effect retention in these programs. Second, this research was (to the author's knowledge) the first study to investigate these constructs specifically within a doctoral population who study statistics in an accelerated, online format.

Research Questions:
- Qualitative: What does it mean to have high statistics anxiety and low statistics self-efficacy according to doctoral students enrolled in an online statistics course?
- Quantitative: Is there a difference in statistics anxiety and statistics self-efficacy between doctoral students enrolled in an online statistics course based on prior experience (little to none, moderate to extensive) and time (beginning of course , end of course)
- Mixed Methods: To what extent do the quantitative results about statistics anxiety and self-efficacy merge with the qualitative responses to describe doctoral students' experiences in an online statistics course?

Methods

Participants

Doctoral education students (N = 17) enrolled in an 8-week online introductory statistics course were recruited for this study. These students were mostly female (68%), white (63%), and between the ages of 30-59 years old. Students were in their last year of coursework and most had taken fewer than 3 previous statistics courses (82%).

Procedure

Participants were asked to report on their experiences learning statistics at the beginning and end of the course using quantitative and qualitative surveys.

- During weeks one and two (**Time 1**), participants completed a series of surveys: a demographic survey that included information about prior statistics coursework, select items of the Statistics Anxiety Rating Scale (STARS) and the Current Statistics Self-Efficacy (CSSE).

- Weeks six and seven of the course (**Time 2**) included repetition of the STARS and CSSE measures, as well as a qualitative survey (comprised of 10 open-ended items written specifically to align with the relevant items of the STARS and CSSE).

Data Analysis

These surveys were analyzed separately in concordance with each strand's research question, and then merged using a data transformation procedure. The qualitative strand used a phenomenological approach by coding relevant themes and deriving a narrative of the phenomena (high statistics anxiety and low statistics self-efficacy). The quantitative strand analyzed data using a 2 (prior experience) X 2 (time) split-plot MANOVA. The data transformation procedure integrated the previous strands together by binary coding on the presence or absence of four salient themes (choosing the correct statistics test, wanting more course practice, experience physical bodily tension, and having trouble using SPSS) and conducting point biserial correlations with STARS & CSSE Time 2 scores. By merging these two types of data together, this research seeks to gain understanding about doctoral students' experiences within their online statistics course in a more holistic way.

Results

Qualitative Results

Qualitative results indicate that the phenomena of *high statistics anxiety* and *low self-efficacy* was challenging for all and negative for most. Textual and structural descriptions described how the rapid course pace, lack of unified interaction, challenging topics, and lack of prior experience contributed to the phenomena.

Textural Description:
What Students Experienced

➤ Students had difficulty making deeper connections with the material

➤ They struggled most with identifying the proper statistical test to answer a research question & learning to use SPSS

➤ Experienced physical bodily tension, headaches, lack of concentration and felt frustrated, nervous, doubt, and angry

"Currently anxious because of the difficulty in grasping the how, what, and why of the subject"

"(Anxious about) if I am preforming the correct test"

"Experience doubt and racing thoughts"

"Most challenging is the terminology and its application"

Structural Description:
The Setting and Context of the Phenomena

➤ Course delivered online, asynchronously, and for a duration of 8 weeks

➤ Course content divided into four competencies, with roughly 2 weeks/competency

➤ Utilized a self-directed learning approach

"Personal instruction would be beneficial"

"I am most challenged by my limited background knowledge"

"Still concerned about my ability to utilize statistics appropriately for my dissertation"

"Real and practical application first to see the relative importance"

Quantitative Results

Mean Scores and Standard Deviations for Statistics Anxiety and Statistics Self-Efficacy as a Function of Prior Course Experience and Time (N = 17)

Prior experience	Time	Statistics anxiety			Statistics self-efficacy		
		M	SD	n	M	SD	n
Little to none	Time 1	42.08	14.85	12	30.67	15.10	12
	Time 2	44.50	14.36	12	41.25	17.58	12
Moderate to extensive	Time 1	45.20	17.81	5	37.40	19.83	5
	Time 2	36.80	16.48	5	45.20	13.22	5

Note. Statistics anxiety was measured using the STARS. Statistics self-efficacy was measured using the CSSE.

Results cont.

Total CSSE scores for levels of statistics experience over time.
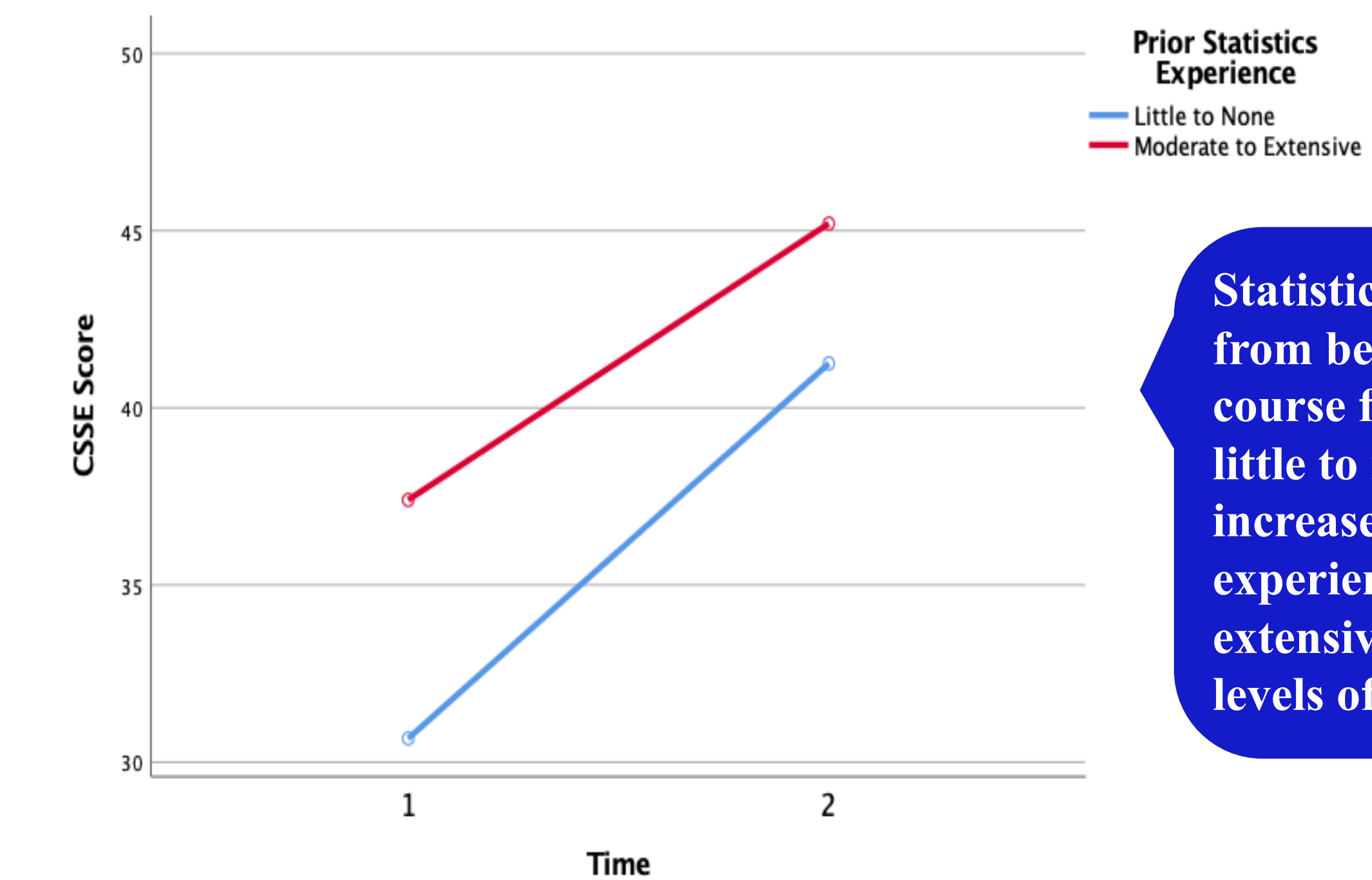
Statistics self-efficacy significantly increased from beginning of the course to the end of the course for all students, with those who had little to no prior experience showing a larger increase than those with moderate to extensive experience, and those with moderate to extensive experience having higher mean levels of self-efficacy overall.

Total STARS scores for levels of statistics experience over time.
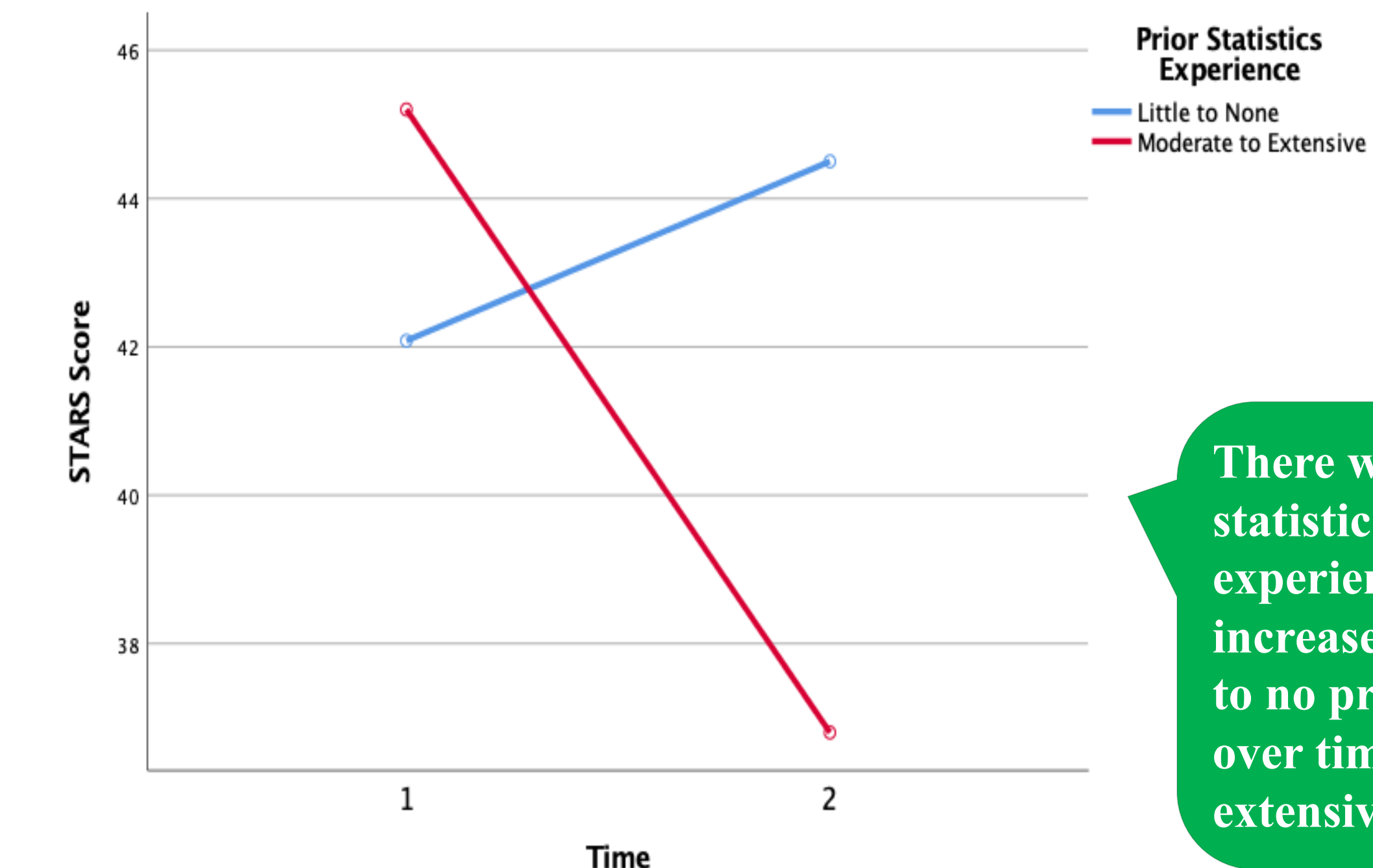
There was a significant interaction effect of statistics anxiety across levels of prior experience and time. Statistics anxiety increased over time for students with little to no prior experience, while decreasing over time for those with moderate to extensive experience.

Mixed Methods Results

Point-biserial correlations were conducted to see what (if any) relationship exists between these themes and total scores from the STARS and CSSE during Time 2 (end of course). There were no significant correlations between any of the four themes and STARS or CSSE scores. Further, content analysis comparing the amount of qualitative text with corresponding STARS & CSSE scores showed on average, those who provided less text (one short sentence for each item) tended to demonstrate lower statistics self-efficacy (low CSSE scores) and higher statistics anxiety (high STARS scores).

Discussion

This study used a concurrent mixed methodology to investigate the experiences of doctoral education students who worked through an 8-week, online introductory statistics course. Students' levels of statistics anxiety and statistics self-efficacy were investigated to discover both the qualitative essence of these two concepts and the quantitative effect of time and prior experience. Several trends emerged; in particular:
- Although they were pursuing advanced degrees, doctoral students with little to no prior statistics experience did not feel confident in their ability to learn statistics autonomously.
- As a result of completing the course, all students' self-efficacy increased to varying degrees.
- Less experienced students reported an increase in statistics anxiety by the end of the course whereas students with more statistics experience reported a decrease.

Although doctoral students are not naïve in their ability to be successful academically, statistical reasoning is challenging for all.[19]

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