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Online Discussion Forums: Quality Interactions for Reducing Statistics Anxiety in Graduate Education Students

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Abstract: Fully online graduate education courses/programs incorporate faculty-student online discussion interactions as a mainstay component for instruction. Virtually all graduate education students are required to enroll in at least one graduate statistics course. Historically, students perceive statistics as anxiety producing, and impossible for successful completion. Previous literature on statistics anxiety in graduate education students has primarily focused on traditional face-to-face learning environments. This study emphasized the continuing need for educational researchers to examine statistics anxiety, especially within online learning environments. The current study explored the use of online discussion forums with graduate education students enrolled in a required fully online graduate statistics course. An integrated conceptual framework focused on online discussion quality constructs relative to statistics anxiety constructs generated the major research question: "What are the interrelationships among students' online discussion quality ratings and students' statistics anxiety levels within an online graduate education statistics course?" The study empirically examined faculty-students' quality of discussion content, interactions, and participation within online discussions relative to students' statistics anxiety levels using a non-experimental pre-post one group research design. Data analyses involved research assistants matching 68 graduate education students' online discussion assessment ratings of discussion content, interactions, and participation with students' corresponding statistics anxiety subscale scores. Pearson correlation coefficients were used to empirically analyze interrelationships among online discussion quality ratings and statistics anxiety subscale scores with results identifying specific types of discussion qualities positively encouraging students' attitudes toward learning statistics. Pre- and post-statistics anxiety assessments completed by study participants were analyzed using the dependent t-test procedure with results indicating significant reduced average statistics anxiety levels after completing the online graduate education statistics course. Implications of the findings are pertinent for online graduate statistics educators, researchers, and assessment professionals.

Keywords: online faculty/student discussion interactions; statistics anxiety in graduate education programs; Interrelationships among online discussions and statistics anxiety.

Résumé : Les interactions en ligne entre professeurs et étudiants constituent un élément essentiel de l'éducation dans les cours/programmes d'enseignement supérieur entièrement en ligne. Les étudiants de cycle supérieur doivent s'inscrire à au moins un cours de statistiques, ce qu'ils perçoivent souvent comme une source d'anxiété, de craintes, de difficultés voire d'impossibilité à réussir. Cette recherche étudie empiriquement les relations entre les professeurs et les étudiants à l'intérieur d'un forum de discussion en ligne, en s'intéressant à la qualité du contenu de la discussion, à la qualité des interactions dans la discussion, à la qualité de la participation dans la discussion et aux niveaux d'anxiété des étudiants relativement aux statistiques, dans le cadre d'un cours de statistique en ligne dans un programme d'enseignement supérieur. Le cadre conceptuel sur lequel repose cette étude se centre sur les concepts de qualité à l'intérieur d'un forum de discussion et ceux d'anxiété relativement aux statistiques, dans le cadre d'un cours de statistique en ligne dans un programme d'enseignement supérieur. La principale question de recherche est la suivante : « quelles sont les interrelations entre les discussions postées par les étudiants et, plus particulièrement, les éléments constitutifs de la qualité des discussions, et les niveaux d'anxiété des étudiants relativement aux statistiques, dans le cadre d'un cours de statistique en ligne dans un programme d'enseignement supérieur ? Une recherche fondée sur l'analyse ex post facto pre-post d'un groupe a été mise en œuvre. L'analyse de données a impliqué des assistants de recherche mettant en correspondance les scores de 68 étudiants concernant la qualité du contenu des discussions, les interactions et la participation aux discussions sur le forum avec leurs scores relatifs à l'anxiété causée par les statistiques, en regardant cela selon plusieurs sous-échelles. Les coefficients de corrélation de Pearson ont été utilisés pour analyser empiriquement les interrelations. En outre, une évaluation statistique pre-post de l'anxiété a été réalisée par les étudiants de cycles supérieurs, faisant ressortir des résultats significatifs du test t indiquant une réduction des niveaux statistiques moyens d'anxiété pour le groupe après avoir suivi le cours de statistiques d'enseignement supérieur. Ces résultats peuvent avoir des implications pour les enseignants, les chercheurs et les professionnels de l'évaluation de cours de statistiques dans l'enseignement supérieur.

Mots clés : cours de statistiques d'enseignement supérieur en ligne, discussion en ligne, anxiété liée aux statistiques

Introduction

Recent reports indicate radical increases in online graduate and undergraduate education programs in colleges and universities, with the rise of graduate degrees rapidly moving away from traditional face-to-face programs toward fully online instructional venues (Betts, 2018; Friedman, 2018). Substantial growth in online graduate education programs across the United States has prompted researchers to examine instructional concerns prevalent within traditional graduate education programs of study and the potential transitioning of these specific concerns within fully online

instructional programs (Bollinger & Halupa, 2012; Kebritchi, Lipschuetz & Santiague, 2017; Kirtman, 2009; Rovai & Jordan, 2004).

The current study focused on the specific concern of preparing students within graduate education programs, i.e., the successful completion of graduate education students in required graduate educational statistics courses. Virtually all university graduate educational programs require a minimum of one graduate statistics course and some programs require a series of two or three graduate statistics courses. A fully online graduate education degree may potentially consist of multiple statistics courses required for graduate education students to complete.

Literature focused on statistics anxiety in students pursuing graduate degrees in education have provided prevalent research findings substantiating statistics anxiety as a prohibitive factor in students' success rates in graduate programs since the early 1980s (Baloglu, 2003; Onwuegbuzie, 2004; Zeidner, 1991), however, research efforts to explore the influence of students' statistics anxiety levels and students' learning of statistics topics, especially within online environments, has seemingly dropped off the radar with current researchers. Yet, the problem of students' statistics anxiety in online teaching and learning may possibly be as prominent and as prevalent as the problem of statistics anxiety in students within face-to-face instructional environments, as discussed by Macher, Papousek, Ruggeri & Paechter (2015) when describing statistics anxiety as "an enduring, habitual type of anxiety" (p. 1) and highlighted within Onwuegbuzie & Wilson (2003); Macher, Paechter, Papousek, & Ruggeri (2011); and Macher, Prachter, Papousek, Ruggeri, Freudenthaler & Arendasy (2013). The current study emerged from the need for researchers to revive the research emphasis on examining students' statistics anxiety levels in graduate education programs, especially within online instructional environments.

Just as math anxiety pervades many educational settings, statistics anxiety may create a prohibitive environment for graduate students to successfully complete degrees, especially for students new to online instruction or unaccustomed to working within online learning environments (DeVaney, 2010; Kirtman, 2009; Mathieson, 2010; Summers, Waigandt, & Whittaker, 2005). Students often postpone or avoid taking required statistics courses until late in their degree programs (Bollinger & Halupa, 2012). The overwhelming prevalence of graduate education students' statistics anxiety/fear levels and low self-confidence levels surrounding their perceptions of successfully completing advanced educational statistics courses is evidenced in the literature (Baloglu, 2003; Chau, 2018; DeVaney, 2016; Koh & Zawi, 2014; Onwuegbuzie, 2010, Perepiczka, Chandler, & Becerra, 2011; Onwuegbuzie & Wilson, 2003; Williams, 2013). The current study focused on examining an online instructional process of using discussion forums/boards for assisting graduate education students in successfully completing their graduate educational statistics requirement.

Faculty members in graduate education courses use online discussion forums for multiple purposes, such as, presenting new content, responding to questions, modeling writing skills, providing praise, and supporting student responses. The influence of online forum discussions as instrumental vehicles for improving learning such as critical thinking, collaborative learning, student communities, and other types of learning outcomes has been examined by multiple researchers (Chau, 2018; Dawson, 2006; Nandi, Chang, & Balbo, 2009; Perepiczka, Chandler, & Becerra, 2011; Richardson, 2010; So, 2010; Williams, 2010). The current study focused on these considerations by empirically examining relationships and influences among specific faculty and student online discussion forum interactions relative to students' statistics anxiety within an advanced online graduate educational statistics course. The major research question driving the study was: "What are the interrelationships among students' online discussion quality ratings and students' statistics anxiety levels within an online graduate education statistics course?" This study addressed the following specific considerations: graduate education students' statistics anxiety; online teaching and learning of statistics; instructor feedback; and student-teacher/teacher-student interactions within online discussion threads. This study examined empirical relationships and influences among specific faculty and student online discussion forum interactions relative to students' statistics anxiety within an advanced online graduate educational statistics course.

Literature Review and Conceptual Framework

A summary of the literature review consisted of determining substantive resources relevant to the following areas of focus: (a) history and evolvement of online instruction; (b) literature reflecting differences and similarities in traditional and online instructional environments; (c) literature depicting the prevalence and severity of the issue of statistics anxiety within graduate education programs; (d) current literature specific to online instructional considerations and options for working with graduate education programs, with special attention to the use of discussion forums/boards/threads as a mainstay instructional modality within online teaching and learning environments; (e) sound conceptual framework literature for exploring the topic for investigation; (f) potential instrumentation literature for measuring online discussion forums within an instructional venue and appropriate instrumentation for measuring statistics anxiety to align with the major research question posited for the study; and (g) exploratory literature for advancing the potential for assisting graduate education students in attaining success in graduate education statistics courses within online teaching and learning environments. Each of these literature review areas is summarized pertinent to the current study with an emphasis on the pervasive need for online educational environments to adhere to college students' apprehension of statistics and fear of statistical concepts within graduate online educational programs of study.

History and Evolvement of Online Graduate Education Programs

A brief history of the evolvement of online instruction literature highlights the explosion of universities across the United States and globally moving toward online instruction as the mainstay for teaching and learning for both undergraduate and graduate education programs (Bollinger & Halupa, 2012; Friedman, 2018; Kirtman, 2009; Summers et al., 2005). Graduate online education programs are identified as easily accessible, convenient, and affordable for working educators (teachers, administrators, and other educational personnel) and provide appropriate pathways for professional educators to pursue graduate degrees while continuing to be active in their respective careers. *BestColleges.com* (2018) acknowledges online doctorate degrees as increasing from one percent to almost two percent of the population over age 25 from 1995 to 2015 with the benefits of online degree programs providing flexibility for students in accessing coursework while working full time. One note for students interested in applying for an online doctoral program located on the *BestColleges.com* (2018) website under prerequisite courses for admission is "at least a C in a statistics course." This note reemphasizes the rapid influx of graduate students into online programs as an instrumental consideration relative to the topic of statistics anxiety and the need for students to experience success in graduate programs.

Differences/Similarities in Traditional and Online Instruction

Literature reflecting differences and similarities in online versus traditional instruction reflect both satisfaction and anxiousness from students moving from one venue to another with stronger positive satisfaction from students in fully online programs rather than hybrid programs (Betts, 2017; Bollinger & Halupa, 2012). Literature concerning specific graduate education or social sciences statistics courses taught online versus within traditional classroom environments provided mixed reports, i.e., some results indicated student preferences and performances were positive within traditional classrooms while some results indicated student preferences and/or performances were positive within online environments, however, these results seem to align with the length of time and experience students have had within the two respective instructional environments (Chau, 2018; DeVaney, 2016; Koh & Zawi, 2014; Mathieson, 2010; Perepicka et al., 2011). Prior research specific to online learning of educational statistics versus face-to-face learning of educational statistics provides a strong message regarding the need for graduate programs to fully examine pedagogical approaches that emphasize learning communities (Kebritchi et al., 2017; Rock, Coventry, Morgan & Loi, 2016). Successful learning communities within an online environment are focused on a "presence pedagogy" (Rock et al, 2016, p. 341) consisting of the following three principles: "(1) benefiting from the presence of others; (2) encouraging interaction and facilitating community; and (3) sharing resources." (Rock et al, 2016, p. 341) and substantiated by Sanders and Melton (2010). Song and McNary (2011) and Kebritchi

et al. (2017) emphasized the need for discussion boards as critical mechanisms for enhancing student participation and learning within online learning environments.

The current study focused on using online discussion forums as the basis for promoting a community of learners, including a strong emphasis on the pedagogical presence of the teacher as a positive influence for encouraging students. Literature providing information pertinent to the use of online discussion forums/boards as an instructional vehicle within online education environments have reported consistent positive influences concerning student participation, acceptance as a viable means for communication and feedback, and as an effective best practices instructional tool (Dawson, 2006; Kebritchi et al., 2017; Le, Jassen, & Wubbels, 2018; Richardson, 2010; Rizopoulos & McCarthy, 2009; So, 2010; Song & McNary, 2011).

Literature Depicting the Severity of the Issue of Statistics Anxiety

Research depicting the specific depth and breadth and the severity of the issue of statistics anxiety within graduate education programs was a dominant research focus in the decades prior to online learning environments and became a mainstay premise within graduate education programs, however, literature emphasizing graduate education students' statistics anxiety issues within face-to-face and online instructional environments has seemingly fallen off researchers' interests or agenda items for action research efforts in the last decade. The current study focuses on renewing research focus points regarding the severity and debilitating effects of statistics anxiety on graduate students' success rates in graduate education programs. Najmi, Raza and Qazi (2018); Macher et. al. (2017); Song and Kong (2017); and Zimmerman (2017) emphasized the specific need for researchers to reexamine the influence of statistics anxiety and student performance in higher education specifically related to online learning environments. Najmi et al. (2018) provided sound empirical support of student group projects, interactive lectures, and instructors relating humor and practicality relative to statistics content as successful approaches for minimizing students' statistics anxiety levels. The current study revives the critical need for examining statistics anxiety, especially pertinent to online graduate education programs. The current study employed a concentrated emphasis for researchers to examine instructional approaches within online educational learning environments by providing a focused approach to dealing with statistics anxiety in graduate education programs using a common instructional tool indicative of online learning environments, i.e., online class discussion forums.

Literature Specific to the Conceptual Framework

The current study focused on the use of online discussion forums/boards with the specific types, content and characteristics of the discussions as the independent constructs, and variables examined in the study and students' statistics anxiety constructs and variables as the dependent considerations in the study exemplified in the discussion of the conceptual framework section description and

schematic (Nandi, Chang, and Balbo, 2009; Onwuegbuzie and Wilson, 2003). Multiple researchers have examined the effectiveness and use of discussion boards within online teaching and learning environments (Biriyai & Thomas, 2014; Orlando, 2017; Song & McNary, 2011). Biriyai and Thomas (2014) referred to the "moderator" (instructor) as the manager of the discussion forum emphasizing the effectiveness of the moderator as the key individual who "directly impacts the quality and usefulness of the forum in general, its appeal, and its usefulness as a community of interrelated users" (p. 113). Zhou (2015) outlined several key factors highlighting instructor interactions with students within online discussion boards: (a) instructor feedback was highly valued by students; (b) instructor feedback over time positively influenced students' participation; and (c) instructor supportive feedback positively influenced students' interaction quality and quantity over time. Zhou (2015) also suggested two key areas of need for further research focused on using online discussion boards: (a) virtually all of the meta-analysis studies reviewed by Zhou (2015) were qualitative suggesting a critical need for quantitative research and (b) the meta-review by Zhou (2015) indicated the "need for more empirical studies investigating students' perceptions and performances" (p. 197). The need for connecting discussion boards or students' online posted discussions as the independent variable within a quantitative study to students' reactions or performance levels has been reflected in prior literature by the following exemplars: (a) Song and McNary (2011) examined discussion board posts for student interaction variants, such as students' changes in posting types, length, and number over time, and relationship to students' grades in the course; (b) Hong and Kao (2017) determined three patterns of statistics students interacting online, i.e., (1) students interacted for the purpose of completing tasks within a specified timeframe; (2) students interacted online for the purpose of exchanging answers; and (3) students interacted online for the purpose of gaining knowledge; and (c) Gilbert (2015) emphasized the advantage of students interacting within online learning environments as the following: "Online learning has the ability to disassemble barriers that have been constructed by poverty, location, disability, as well as other factors." (p. 28). These focused literature sources exposing the strong influence of discussion boards in student learning online substantiate the use of online discussion boards as a key influence in student learning within online learning environments. The current study utilized discussion boards as an empirically based independent variable for conducting quantitative research focused on the examination of relationships among discussion board assessments scores and students' statistics anxiety levels within a graduate education statistics course.

Literature Reflecting Appropriate Instrumentation Pertinent to the Current Study

Literature reflecting the appropriate instrumentation for use in the data collection and methodology for the current study provided the pertinent alignment to the constructs and variables within the conceptual framework for guiding the research (Baloglu, 2003; Hanna, Shevin, & Dempster, 2008; Nandi, Chang, & Balbo, 2009). Research focused on the use of online discussion forums as potential

measurable arenas with appropriate measurement tools for serving as the independent variable in the current study has been emphasized within the literature (Balaji & Chakrabrti, 2010; Ryan, 2013; Seethamraju, 2014). Balaji and Chakrabi (2010) empirically examined students' interactions within online discussion forums relative to student participation levels and students' perceived learning levels. Ryan (2013) measured students' perceptions of satisfaction, collaborative learning, and social presence within discussion forums. Seethamraju (2014) analyzed the quantity and quality of online discussion forums relative to accounting for variability in students' performance levels. These prior research sources provide substantial support for the need and utility for using discussion forums or discussion boards as a measurable tool for examining student online participation and online performance or perceived learning. The current study empirically assessed student-instructor types of participation and contributions within discussion forums as a quantifiable independent variable for investigation.

Previous research focused on examining statistics anxiety levels within adults in educational settings have utilized multiple types of approaches to assess and/or reduce statistics anxiety in students. Lin and Tang (2017) used a mixed methods research model to examine the influence of students' perceptions of open educational resources (OER) on students' statistics anxiety levels, specifically focused on reducing students' "test and class anxiety, interpretation anxiety, and computational self-concept" (p. 122).

Literature Addressing Content Perceived by Students as Anxiety Producing

Literature focused on areas of instructional content traditionally perceived as difficult, fearful, or anxiety producing by students within graduate programs indicates the need for online instructional design to include the consideration of teaching and learning methodologies appropriate for all types of content, learning styles, and instructional delivery modes (Le, Janssen & Wubbels. 2018; Nash, 2015; So, 2010). Williams (2013) investigated worry, intolerance of uncertainty and statistics anxiety in graduate students and specifically identified these three areas as measurable traits of graduate students for researchers to consider. Chew and Dillon (2014) found no differences among college students' statistics anxiety levels with three types of groups (students who had not taken statistics, students who were currently taking statistics, and students who had completed a statistics course) with students' fears of statistics prevailing within all three groupings, indicating students' fears and anxious feelings concerning statistics and the need for researchers to continue to focus on statistics anxiety as a valid concern within colleges and university degree programs. Specific implications from the related literature regarding appropriate measures or instrumentation for aligning online students' discussions and interactions with students' statistics anxiety levels have not been clearly delineated within the existing literature (Lin & Tang, 2017; Perepiczka et. al., 2011), however, prior research on

statistics anxiety includes variables of self-efficacy and students' perceived social support as measures potentially pertinent to assessing graduate students' levels of statistics anxiety. DeVaney (2010) compared online statistics students with face-to-face statistics students relative to statistics anxiety levels from pre- to post-assessments with on-campus students demonstrating more favorable attitudes toward statistics than online students and other outcomes indicating a need for future research to examine online learning environment strategies for reducing online students' statistics anxiety levels. A common instrument used by previous researchers for examining graduate education students' statistics anxiety levels in both face-to-face and online learning environments is the *Statistics Anxiety Rating Scale (STARS)* (Baloglu, 2003; DeVaney, 2016; Onwuegbuzie &Wilson, 2003). These findings and prior literature assisted researchers in the development of the conceptual framework and the aligned instrumentation for the current study.

The conceptual framework for the current study integrated the work of Nandi, Chang, and Balbo (2009), focused on the constructs associated with criteria for assessing interaction quality in online environments and Onwuegbuzie and Wilson (2003) focused on the constructs associated with statistics anxiety. The integrated conceptual framework is depicted in Figure 1.

The study examined the constructs (Content, Interaction Quality, and Participation) operationalized by the descriptive criteria aligned with the "Quality in Online Discussion Forums" (Nandi, Chang, & Balbo, 2009) relative to the constructs (Instrument Anxiety, Content Anxiety, Interpersonal Anxiety, and Failure Anxiety) operationalized by the descriptive criteria aligned with "Statistics Anxiety" (Onwuegbuzie & Wilson, 2003). The framework depicts the potential interrelationships among the criteria and posits multiple research questions for guiding the study. The constructs depicted within the conceptual framework pinpoint the interaction of the variables pertinent to the study and highlight the substantive information surrounding the conceptual framework. The framework depicted in Figure 1 provides the descriptors for each of the three focus areas of the potential assessment of the "Quality in Online Discussion Forums: Content, Interaction Quality; and Participation" (Nandi, Chang, & Balbo, 2009, p. 670). Each of these three focus areas are described pertinent to the criteria for assessing the online discussion forums.

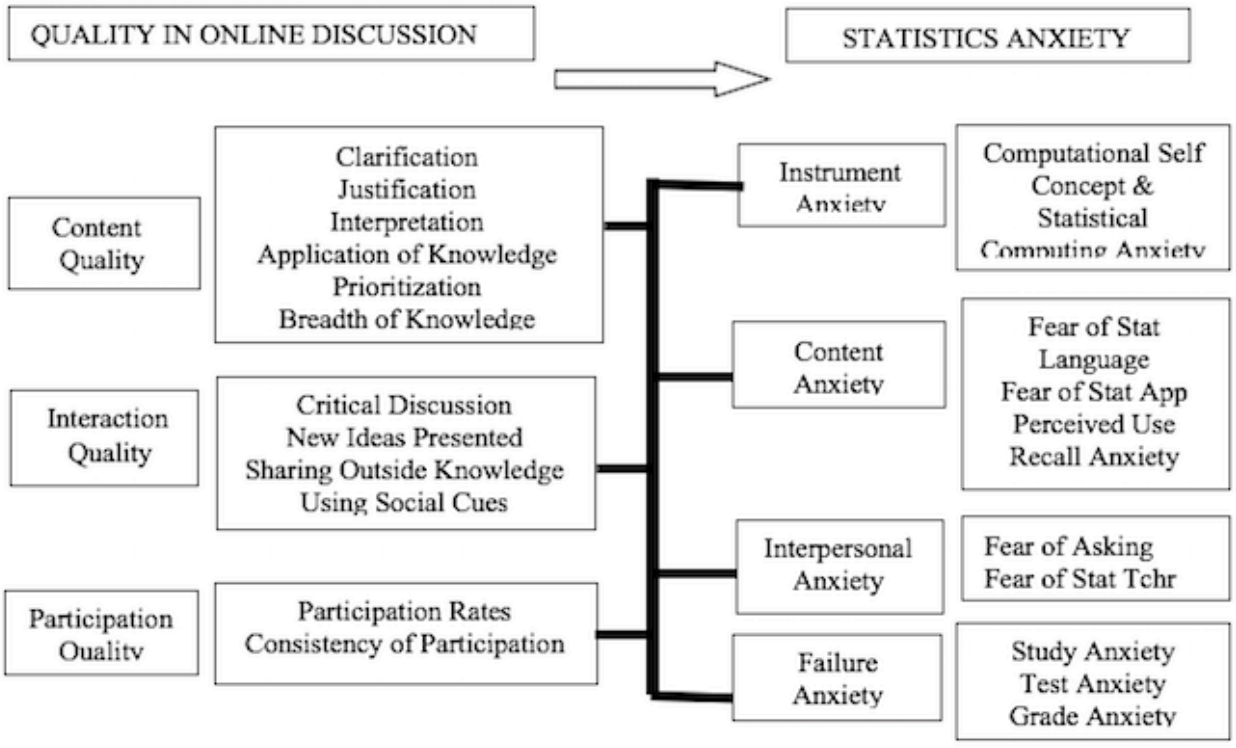

Figure 1. Integrated Conceptual Framework

Content Assessment of quality in online discussion forums as presented by the conceptual model of Nandi, Chang, and Balbo (2009) is characterized by six descriptors focused on students' discussions delivered within the online discussion forum: (1) Clarification: Clarification of information by the student within the discussion; (2) Justification: Student justifies a discussion statement with an appropriate argument, supportive information, and/or referenced sources; (3) Interpretation: Interpreting a statement as intended by the deliverer of the information in the discussion thread (either faculty member to student or student to faculty member); (4) Application of Knowledge: Student expresses an example or question demonstrating application of knowledge within the discussion and the faculty member acknowledges, confirms knowledge, apprises errors or changes needed in the student's application discussion, and/or praises the student's remarks; (5) Prioritization: Student accentuates key points and/or orders remarks within a priority context; (6) Breadth of Knowledge: Student widens or expands the discussion by bringing in new sources and/or information to the forum.

Interaction Quality Assessment in online discussion forums as presented by the conceptual model of Nandi, Chang, and Balbo (2009) in Figure 1 is characterized by four descriptors indicative of student-

student interactions and/or student-faculty interactions within the online discussion forum: (1) Critical Discussion: Student uses analytic skills to constructively and critically assess their own work and efforts of others within the discussion forum; (2) New Ideas Presented: Student suggests new ideas and proposes solutions to new problems; (3) Sharing Outside Knowledge: Student relates personal experiences to textbook knowledge; and (4) Using Social Cues: Student/faculty member uses encouragement or social messages to support others within the forum.

Participation Assessment of quality in online discussion forums is the third area of quality assessment of discussion forums presented by the conceptual model of Nandi, Chang, and Balbo (2009) in Figure 1. Participation includes two focus areas of assessment: (1) Participation Rates or the total number of times a student posts to the discussion forum; and (2) Consistency of participation or the frequency of posts of each student.

The framework depicted in Figure 1 provides the descriptors for each of the four focus areas of the potential assessment of Statistics Anxiety: "Instrument Anxiety; Content Anxiety, Interpersonal Anxiety, and Failure Anxiety" (Onwuegbuzie & Wilson, 2003, p. 13). Each of these four focus areas are described pertinent to the constructs and criteria for assessing statistics anxiety.

Instrument Anxiety as presented by the conceptual model of Onwuegbuzie and Wilson (2003) in Figure 1 is characterized by two descriptors indicative of students' anxious perceptions: (1) Computational Self-Concept refers to a student's anxiety associated with the student's perceived ability/skill to perform mathematical computations; and (2) Statistics Computing Self-Concept focuses on a student's anxiety associated with the student's perceived ability/skill to perform statistical procedures.

Content Anxiety as presented by the conceptual model of Onwuegbuzie and Wilson (2003) in Figure 1 is characterized by four descriptors indicative of students' anxious perceptions: (1) Fear of Statistics Language refers to a student's anxiety toward unfamiliar/new terms and concepts within the field of statistics; (2) Fear of Applications of Statistical Knowledge emphasizes a student's anxiety stemming from the student being required to make a decision regarding the interpretation of data and data analyses results; (3) Perceived Usefulness of Statistics focuses on a student's anxiety relative to the student's perception of relevance of statistics within the individual student's life; and (4) Recall Anxiety refers to a student's perceived ability to recall statistical terms and concepts.

Interpersonal Anxiety as presented by the conceptual model of Onwuegbuzie and Wilson (2003) in Figure 1 is characterized by two descriptors indicative of students' anxious perceptions: (1) Fear of Asking for Help refers to a student's anxiety associated with asking an instructor or peer for assistance in interpreting a statistical symbol, term, concept, or data results; and (2) Fear of Statistics Instructors pertains to a student's anxiety directly aimed at the mannerisms and/or personality of the professor

perceived by the student as unapproachable, whereby the student may feel embarrassed or ill-prepared to ask questions or discuss statistical concepts with the instructor.

Failure Anxiety as presented by the conceptual model of Onwuegbuzie and Wilson (2003) in Figure 1 is characterized by three descriptors indicative of students' anxious perceptions: (1) Study Anxiety focuses on the student's efforts to gain knowledge using study habits comfortably associated with the student's prior college coursework but not necessarily aligned with learning the new statistical terms, concepts, and strategies perceived by the student as unattainable through conventional study habits; (2) Test Anxiety emphasizes the need for the student to focus on a strong support network for accomplishing testing within statistics courses to avoid feelings of failure and perhaps grappling with self-esteem issues; and (3) Grade Anxiety refers to the student's continual desire in graduate education courses to maintain high grades when confronting topics in the degree plan with statistics being perceived by many students as the most difficult course for maintaining high grade point averages.

The conceptual framework depicted in Figure 1 provides an integrated foundation for the current study focused on the interdependence of the constructs inherent within the work of Quality in Online Discussion Forums (Nandi, Chang, & Balbo, 2009) and Statistics Anxiety constructs posited by Onwuegbuzie and Wilson (2003). The integrated framework (Figure 1) provided the left to right focus of the current study, i.e., the Quality in Online Discussion Forums framework (Nandi, Chang, & Balbo, 2009) provided the independent constructs/variables and the Statistics Anxiety framework (Onwuegbuzie and Wilson, 2003) provided the dependent constructs/variables for the current study focus. The integration of the two framed areas of constructs and variables presented in Figure 1 allowed researchers to posit specific research questions utilizing the independent and dependent frameworks as sound foundational components for the study. In addition, the integrated conceptual framework offered researchers a solid foundational perspective of the need for online teaching and learning environments to examine student reactions and student anxiety within the context of a specific graduate discipline, graduate educational statistics.

Research Design and Methods

The three-fold purpose of the research project included the following: (1) explore the interrelationships among constructs exemplified within the Integrated Conceptual Framework posited for the study, including the constructs comprising the Quality in Online Discussion Forums (Nandi, Chang & Balbo, 2009) representing the independent variables within the study and the constructs comprising Statistics Anxiety (Onwuegbuzie & Wilson, 2003) representing the dependent variables for the study; (2) examine specific relationships and influences among faculty/student online discussion forum interactions on graduate students' statistics anxiety within an online graduate educational

statistics course; and (3) identify specific types/characteristics of online discussion forum interactions using empirical evidence aligned with reducing students' anxiety levels.

The *Major Research Question* guiding the study generated by the literature review and the guiding conceptual framework is the following: "What are the relationships among specific faculty-student online discussion forum interactions and students' statistics anxiety levels within an online graduate education statistics course?"

Specific hypotheses examined in the study include the following:

> *Research Hypothesis One (H_1):* There is an indirect or negative relationship among specific faculty and student online discussion forum interaction scores and students' statistics anxiety scores within an online graduate education statistics course.
>
> *Null Hypothesis One ($H0_1$)*: There is no relationship among specific faculty and student online discussion forum interaction scores and students' statistics anxiety scores within an online graduate education statistics course.
>
> *Research Hypothesis Two (H_2):* There is an indirect or negative relationship among specific faculty and student online discussion forum interaction scores and specific subscales reflected in students' statistics anxiety scores within an online graduate education statistics course.
>
> *Null Hypothesis Two ($H0_2$):* There is no relationship among specific faculty and student online discussion forum interaction scores and specific subscales reflected in students' statistics anxiety scores within an online graduate education statistics course.

The research design, methodology, and procedural overview for the study are presented within the context of the study purpose and major research question.

The research design utilized for the study was a pre-post one group ex post facto relational research design. The study targeted a convenience sample of N = 68 graduate education students enrolled in an advanced online educational statistics course during the summer/spring/fall of 2015-2016. All students were provided extra credit incentives for their participation in the study. Those students who chose not to participate in the study were provided alternative extra credit options. Participant data were matched for pre-assessments and post-assessments by unique number codes and were not identifiable to the researcher. Pre-post student assessment data represented the constructs of the dependent variable, Statistics Anxiety (Onwuegbuzie and Wilson, 2003) outlined in the study and served to determine changes in pre-post statistics anxiety levels of the students prior to taking the online advanced graduate educational statistics course and after completing the online advanced educational statistics course. Constructs represented by the independent variable (Quality in Online Discussion Forums, Nandi, Chang, & Balbo, 2009) were assessed by two research assistants who

monitored the online advanced graduate educational statistics course daily using rubrics aligned with the *Rubric for assessing quality in online discussion forums* (Nandi, Chang, & Balbo, 2009). Specific study procedures and detailed descriptions of the statistics course procedural requirements are interfaced within the research procedural requirements and aligned with the instrumentation and data collection activities.

Course Procedural Requirements: Discussion forums were posted weekly for fifteen weeks by the instructor with specific types of discussion questions relative to weekly statistics topics. Students were required to post a minimum of 300 words as their initial posting each week, supported by at least two references other than the course textbook and using the appropriate guidelines for referencing. In addition, students were required to post at least two replies to peers each week comprised of at least 150 words and with at least one reference other than the course textbook. The instructor responded to each student's original first posts within the discussion thread for the fifteen-week course and responded to selected subsequent reply posts.

Research Procedural Requirements: Two research assistants matched the students' discussion posts to their names using identification codes for collecting the data associated with the Quality in Online Discussion Forums (independent variable). The two research assistants were trained in the rubric associated with the assessment of the students' discussion posts (aligned with the constructs depicted in Figure 1: Quality of Online Discussion Forums) and described in the instrumentation and data collection section. Interrater reliability was performed for determining the reliability of the two research assistants' use of the rubric assessment of Quality of the Discussion and is reported in the instrumentation and data collection section. The procedure for assessing the independent variable of quality of the discussion consisted of the research assistants assessing every discussion post and matching the posts to the students using the rubric for quality of instruction.

The procedure for assessing the dependent variable (statistics anxiety) included assessing all students prior to the beginning (pre-anxiety assessment) of an advanced educational statistics course and assessing students after completing the course (post-anxiety assessment) to examine changes in mean scores from pre-course anxiety scores to post-course anxiety scores. The instrumentation used for the assessment of the pre- and post-statistics anxiety levels of the students is described within the instrumentation, data collection, and data analyses procedures used in the study relative to the focal point of the conceptual framework as delineated in Figure 1 and within the context of the major research question and research hypotheses. Each of these topics (instrumentation, data collection, and data analyses procedures) is discussed relative to the independent and dependent variables comprising the major research question and research hypotheses.

Instrumentation: The instrumentation utilized in the study consisted of two assessment measures aligned with the independent and dependent variables focus within the major research question, i.e., "What are the interrelationships among students' online discussion quality ratings and students' statistics anxiety levels within an online graduate education statistics course?"

The independent variable, Quality of Instruction in Online Discussion Forums, was measured using the *Rubric for assessing quality in online discussion forums* (Nandi, Chang, & Balbo, 2009) and aligned with the constructs presented in the Conceptual Framework depicted in Figure 1. This instrument enlists a Likert-like observational assessment tool comprised of each of the three major areas of observational assessment, Content, Interaction Quality, and Participation with specific criteria associated with each of the major areas as delineated in Figure 1. The Likert-like scale used in this instrument includes the following observational ratings: Poor = 1, Satisfactory = 2, Good = 3, and Excellent = 4. The interaction quality scale instrument utilized for this study based on the scales by Nandi, Chang, and Balbo (2009) is depicted in Figure 2.

The summation of the associated values for each of the subscales for Content, Interaction Quality, and Participation included the following specific areas of observational assessment depicted in Figure 2 is delineated as follows:

> (a) Content Scale: clarification justification, interpretation, relevance, prioritization, and breadth of knowledge; (b) Interaction Quality Scale: critical discussion of contributions, new ideas from interactions, sharing outside knowledge, and using cues to engage other participants; and (c) Participation: participation rates and consistency of participation." (Nandi, Chang, & Balbo, 2009, p. 670).

The dependent variable, Statistics Anxiety, was measured by the *Statistics Anxiety Rating Scale or STARS* (Baloglu, 2003). The *STARS* (Baloglu, 2003) is comprised of six subscales (Worth of Statistics, Interpretation Anxiety, Test and Class Anxiety, Computational Self-Concept, Fear of Asking for Help, and Fear of Statistics Teachers) and includes a Total *STARS* score. The items on the *STARS* are comprised of a Likert-like scale for participants to respond to on the basis of their perceived levels of anxiety from "not at all anxious" to "very anxious".

Data Collection: Two research assistants trained to use the instrument depicted in Figure 2 assessed the online discussion forum interactions relative to the three areas of focus of Content Quality, Interaction Quality, Participation and Overall Quality. Research assistants collected data weekly for all posts keeping track of the students who contributed to each post using identification numbers for matching. Research assistants matched the students' Quality of Online Discussion (Nandi, Chang, and Balbo (2009, p. 670) scores with students' *STARS* (Baloglu, 2003) scores. In addition, the pre- and post-students' *STARS* (Baloglu, 2003) scores were matched for additional analysis procedures.

	CRITERIA	Poor 1	Satisfactory 2	Good 3	Excellent 4
Content	Clarification	Little or no Explanation	Clear Explanation	Explanation/ Examples	Expanded Explanation
	Justification	No Justification	Justification is Opinion	Justification by Theories	Justification Implications
	Interpretation	Misrepresentation of Information	Paraphrased Information	Clear Interpretation	Additional Discussion
	Application	No relevance to Application	Application Knowledge	Application Examples	Critical Applications
	Prioritization	No Prioritization of Knowledge	Basic Comparisons	Prioritization Examples	Prioritization Criteria
	Breadth of Knowledge	Narrow / Limited Knowledge	Somewhat Wider View	Wider View Knowledge	Multiple Perspectives
Interaction	Critical Contributions	No Engagement with Others	Basic Responses	Consistent Engagement	Advances Discussions
	New Ideas & Interactions	No New Ideas or Thoughts	Some New Ideas/Thoughts	Interactions Drive Ideas	Collaborative Ideas
	Sharing Knowledge	No Sharing of Information	Sharing Available Ideas	Sharing Real Examples	Sharing New Insights
	Using Social Cues	No Engagement in Discussions	Some Social Interactions	Engaging with Others	Encouraging Discussions
Participation	Frequency of Participation	0 to 1 posts	2 to 3 posts	4 to 5 posts	> 5 posts
	Consistency of Participation	Rarely posts or Participates in Activity	Occasional Activity	Fairly Consistent Activity	Consistent and Productive Activity

Figure 2. Instrument Used for Collecting Data Reflective of Online Discussion Quality Adapted from the *Rubric for assessing quality in online discussion forums* (Nandi, Chang, and Balbo (2009, p. 670).

Data Analyses Procedures: Several types of data analyses procedures were employed within the study: (1) Interrater reliability analyses (Warner, 2013) were performed on N = 30 students' pilot data cases using the *Rubric for assessing quality in online discussion forums* (Nandi, Chang, & Balbo, 2009) by two research assistants prior to the initiation of the study; (2) Pre- and post-statistics anxiety levels were analyzed for the N = 68 student participants in the study using the Dependent t test procedure after

attending to and satisfying appropriate preliminary data screening procedures (Warner, 2013); and (3) Pearson r correlation analyses with appropriate preliminary data screening analyses (Warner, 2013) were performed among the multiple variables from the N = 68 students' scores on the various subscales of the *Rubric for assessing quality in online discussion forums* (Nandi, Chang, & Balbo, 2009) and the students' matched subscale scores from the statistics anxiety measure, the *STARS* (Baloglu, 2003).

Results and Conclusions

Results and conclusions are reported within three sections of discussion: (1) Preliminary Analyses from the Pilot Study; (2) Pertinent Descriptive Statistics; and (3) Results Pertinent to the Research Question and Hypotheses. Each of these topics is reported within the context of the conceptual framework, associated instrumentation, and aligned data analyses performed to obtain specific results.

Preliminary Analyses of Data and Results: Preliminary data analysis focused on determining the inter-rater reliability assessment for the pilot data analyses involving the two research assistants who served as observers for the duration of the online discussion threads for the statistics course during the pilot study using the *Rubric for assessing quality in online discussion forums* (Nandi, Chang, & Balbo, 2009). Preliminary data analyses consisted of conducting an inter-rater reliability coefficient using N = 30 randomly accessed unidentifiable participants' discussion threads from previous online statistics courses not utilized in the present study. Both research assistants used the rubric to assess and score 30 unidentifiable discussion threads from previous online statistics courses to generate a data file for computing inter-rater reliability analyses. The resulting inter-rater reliability coefficient of .82 using Cohen's Kappa statistical procedure indicated a "substantial level of reliability" (Warner, 2013, p. 909) conducted between the two research assistants regarding the use of the rubric for assessing students' quality of discussions in the online discussion forum for the graduate statistics course.

Additional preliminary data analyses performed prior to the initiation of the current study included calculating the Cronbach Alpha reliability measure of internal consistency for the *STARS* (Baloglu, 2003) using pre-assessments of the students who participated in the current study. The resulting Cronbach Alpha from study participants' responses to the pre-assessment use of the *STARS* (Baloglu, 2003) indicated an internal consistency (Cronbach Alpha) reliability coefficient of .84 (Warner, 2013, p. 931) with N = 68 participants. A confirmatory factor analysis was not performed on study data. Results of a prior confirmatory factor analysis performed by Hanna, Shevin, and Dempster (2008) provided the appropriate validation information pertinent to the current study. Additional Information regarding the reliability and validation efforts reported for the *STARS* is also reported by

Onwuegbuzie (2000); Papousek, Ruggeri, Macher, Paechter, Heene, Weiss, Schulter, & Freudenthaler (2012).

Findings and Results Pertinent to the Research Question and Hypotheses

Three areas of discussion focus on the presentation of the results pertinent to the major research question and research hypotheses posited for the current study: (1) Frequency distributions related to the demographic representation of study participants are presented in Table 1; (2) Pre and post assessment means and standard deviations associated with students' *STARS* scores with resulting dependent t-test values are reported in Table 2; and (3) Correlations among the pertinent variables from the rubric data categories delineated in Figure 2 (Content of Student Discussion Postings, Interaction Quality, and Participation) with the subscales pertinent to the *STARS* (Baloglu, 2003) are presented in Table 3. Discussions of findings are presented following each table.

Discussion: Frequencies depicted in Table 1 provide a composite of the characteristics of the study participants. Almost two-thirds of the study participants were female and one-third male from the distribution of the N = 68 participants. The ages of the participants were found to distribute as follows: a majority (63%) of the participants were between the ages of 30 and 50, with just under 18% of the participants below age 30 and approximately 18% of the participants above the age of 50. The ethnic distribution of the participants included almost 70% Caucasian and 30% from minority populations. A large majority (62%) of the participants had not had a course in statistics in more than three years, with more than three-fourths (78%) of the study participants indicating no statistics courses completed in more than two years. Less than one-fifth (18%) of the study participants had recently (less than one year) completed a statistics course. An examination of previous studies reported in the literature depicting demographic descriptions of research participants in graduate educational statistics courses (face-to-face or online) revealed comparable distributions by gender, age, and ethnicity in multiple studies by DeVaney (2010), Koh and Zawi (2014) and Lin and Tang (2017). The lack of a required statistics course or a statistics focus in education and social science graduate programs is reflected in the literature and apparent within the resulting demographic distribution captured from the current study participants.

Table 1: Frequencies of demographic information pertinent to N = 68 study participants.

	f	%
Demographic Characteristics		
Gender:		
Male	21	31
Female	47	69
Total	68	100
Ethnicity:		
African American	10	15
Asian American	2	3
Caucasian	47	69
Hispanic	5	7
Multi-Ethnic	4	6
Total	68	100
Age:		
< 30 years	12	18
30-50 years	43	63
> 50 years	13	19
Total	68	100
How long ago was your last statistics course?		
Less than one year ago	12	18
Between one and two years ago	3	4
Between two and three years ago	11	16
More than three years ago	42	62
Total	68	100

Resulting changes in statistics anxiety levels of the study participants from the pre-assessment to the post-assessment statistics anxiety levels scores determined by the participants in the current study are presented in Table 2.

Table 2: Means and standard deviations of pre- and post-STARS (Baloglu, 2003) scores with subscales and associated dependent t-values and p-values.

***STARS* Subscales**	**Paired Samples t-test**		
	Pre M (s.d.)	Post M (s.d.)	t (p-value)
Worth of Statistics	36.5 (11.3)	33.2 (11.1)	2.4 (.02)
Interpretation Anxiety	27.8 (9.7)	26.6 (5.7)	1.6 (NS)
Test and Class Anxiety	18.7 (6.7)	18.1 (6.3)	0.0 (NS)
Computation Self-Concept	17.5 (6.3)	16.1 (5.9)	0.0 (NS)
Fear of Asking for Help	9.7 (7.5)	7.2 (5.4)	2.4 (.03)
Fear of Statistics Teachers	12.4 (3.4)	10.1 (2.4)	2.7 (.01)
STARS Total Score	123.9 (15.4)	102.8 (14.2)	2.5 (.04)

Discussion. Results presented in Table 2 indicate significant differences (decreases) in the resulting paired samples t-tests of students' pre- and post-assessment scores on the *STARS* prior to taking the advanced statistics course and after completing the advanced statistics course. As indicated in Table 2, the mean *STARS* scores decreased significantly ($p < .05$) across the following subscales: Worth of Statistics, Fear of Asking for Help, Fear of Statistics Teachers, and the overall *STARS* Total Score. Three of the six subscales and the overall total score of the *STARS* results indicated significant ($p < .05$) decreases in students' anxiety levels associated with perceptions concerning statistics. These results align with the existing prevalence of statistics anxiety of entering graduate education students as substantiated within the literature (Chew & Dillon, 2014; Onwuegbuzie, 2004; Onwuegbuzie, 2010; Onwuegbuzie & Wilson, 2003; Rock et al., 2016). The results corroborate evidence of the potential intervention of teacher immediacy within online discussion forums as an effective practice for assisting in decreasing statistics anxiety as evidenced by Tonsing (2018) and Williams (2010). These results also reflect the potential for collaboration through student discussion forums with faculty members and/or student colleagues as an influential learning practice for decreasing statistics anxiety in education students enrolled in an educational statistics course (Le et al., 2018). Current study results also substantiate the work of Williams (2013), documenting her findings of significant reductions in "uncertainty, worry, and statistics anxiety from pre to post testing after using an intervention focused on removing the intolerance of uncertainty" (p. 52). The decreases in average statistics anxiety levels revealed in the Table 2 results may also reflect decreases in feelings of uncertainty often prevalent in

statistics anxiety graduate education students and possibly prevalent in students new to online instruction. The resulting significant decreases in students' fear of statistics, decreased fear of asking for help in statistics courses, and decreased fear of statistics teachers as well as study participants' overall decrease in fear of statistics content is positively aligned with studies from Onwuegbuzie (2010); Onwuegbuzie & Wilson (2003); Zhou (2018); and Zimmerman (2018), advocating interventions for students within statistics courses that include positive dispositions, situations, and environments. The current study finding provides some evidence for advocating that online discussions include positive dispositions, situations, and environments for influencing positive attitudes in students regarding successfully completing online educational statistics courses.

Results of the correlational analyses are presented in Table 3.

Discussion. Results presented in Table 3 reflect the relationships (Pearson r Correlation Coefficients) determined empirically among the variables of the three subscales of the Quality of Online Discussion Forums students' quality rating scores as assessed by the two research assistants and the seven subscales of the *STARS* (Baloglu, 2003) scores of the post assessments completed by the students. Students' quality of online discussion subscale scores were aligned with students' respective post *STARS* subscale and total scores to perform the correlations for determining empirical relationships.

An examination of the correlations depicted in Table 3 reveals the following findings:

a) Significant inverse relationships were indicated between the Content Quality of the discussion forums and students' statistics interpretation anxiety ($p < .01$), between Content Quality of the discussion forums and students test and class anxiety levels ($p < .05$), Content Quality of the discussion forums and students' fear of statistics teachers ($p < .05$), and Content Quality of the discussion forums and students' total statistics anxiety scores ($p < .01$) with all findings indicating negative relationships.

b) Significant inverse relationships were indicated between the Interaction Quality of the discussion forums and students' test and class anxiety levels ($p < .05$), Interaction Quality of the discussion forums and students' fears of asking for help ($p < .05$), Interaction Quality of the discussion forums and students' fears of statistics teachers ($p < .01$), and Interaction Quality of discussion forums and students' total statistics anxiety score ($p < .05$).

c) Significant inverse relationships were found between the Participation Quality of the discussion forums and students' test and class anxiety levels ($p < .05$), Participation Quality of the discussion forums and students' fears of asking for help ($p < .05$), Participation Quality of the discussion forums and students' fears of statistics teachers, and Participation Quality of the discussion forums and students' total statistics anxiety scores ($p < .01$).

Table 3: Results of the correlations among subscales of the quality of discussion forums and the STARS subscales.

Correlation Coefficients

	STARS Subscales and Total Score						
	Worth of Statistics	Interpretation Anxiety	Test and Class Anxiety	Computation Self-Concept	Fear of Asking for Help	Fear of Statistics Teachers	Total
Quality of Discussion Posts							
Content Quality of Discussion Posts	-.19	-.78**	-.82*	-.32	-.07	-.89*	-.71*
Interaction Quality of Discussion Posts	.21	.33	-.79*	.14	-.82*	-.88*	-.75*
Participation Quality of Discussion Posts	.11	-.42	-.83*	-.62	-.78*	-.81*	-.87**

*p < .05
**p < .01

A summary of the results of the correlation findings provide empirical evidence for multiple collaborations focused on using online discussions as a positive instructional tool posited in the literature. Dawson (2006) promotes "online forum discussion interactions as an indicator of student community" (p. 495). Dawson (2006) also delineates student communities as defined by online discussion posts as indicators of community development with strong communities potentially strongly supportive for instructional interventions and weak communities (non-responsive students within discussion forums) as potentially fearful or anxious students. Song & McNary (2010) emphasize the use of discussion boards as a viable mechanism for students to take their time to reflect on course content, other students' comments, and concepts prior to posting their thoughts and information. The use of discussion boards on student performance and student satisfaction levels has also been the focus of technology influences within online learning environments (AlJeraisy, Mohammad, Fayyoumi, & Alrashideh, 2015). Onwuebuzie (2004, 2010) and Williams (2013) found

strong positive relationships between statistics anxiety and student procrastination. The implications for using discussion threads among student-student and/or teacher-student for encouraging as a community of learners to avoid procrastination is substantiated within the findings of the current study. The results related to the two current study hypotheses are as follows:

Research Hypothesis One (H_1): There is an indirect or negative relationship among specific faculty and student online discussion forum interaction scores and students' statistics anxiety scores within an online graduate education statistics course. Hypothesis one was supported by the results of the data presented in Table 3.

Research Hypothesis Two (H_2): There is an indirect or negative relationship among specific faculty and student online discussion forum interaction scores and specific subscales reflected in students' statistics anxiety scores within an online graduate education statistics course. Hypothesis two was supported by the results of the data presented in Table 3.

Discussion Summary of Results. Results presented in Tables 1, 2 and 3 and associated discussions provide pertinent conclusive information for educators and researchers. The results indicate some empirical evidence regarding the interrelationships among observed discussion forum posts by students and the instructor within an advanced educational statistics course for graduate education students relative to decreases in students' statistics anxiety levels after completing an advanced educational statistics course.

Demographic information retrieved from study participants provided a snapshot of the students enrolled in the advanced educational statistics course. A snapshot of the 68 students who participated in the study included, primarily, female Caucasian students between the ages of 30 and 50 who had not had a statistics course in more than three years (see Table 1).

Results depicted in Table 2 provide insight into statistics anxiety levels of students prior to taking an advanced educational statistics course in the graduate education degree program and after completing the advanced educational statistics course. Significant positive changes ($p < .05$ and $p < .01$) from the pre-assessments to post-assessments for statistics anxiety levels using the *STARS* (Baglolu, 2003) were found for the following subscales: (a) Worth of Statistics; (b) Fear of Asking for Help; (c) Fear of Statistics Teachers; and (d) Total *STARS scale.* These results provide some empirical evidence of the influence of the discussion boards in changing (decreasing) statistics anxiety levels in the students who participated in the study.

Results depicted in Table 3 offer educators and researchers specific areas of focus for discerning the kinds of online discussion forums conducive to supporting positive environments for the teaching and learning of educational statistics within graduate educational statistics courses. Significant ($p < .05$ and $p < .01$) relationships were found between students' quality of discussion forum posts and

students' statistics anxiety levels relative to multiple subscales. Quality of students' content depicted within discussion posts was found to be inversely related to students' interpretation anxiety levels relative to interpreting statistical analyses results; inversely related to students' test and class anxiety levels; inversely related to students' fears of statistics teachers; and inversely related to students' overall statistics anxiety (total scores on the *STARS*). Quality of students' interactions with others depicted within discussion posts was found to be significantly ($p < .05$ and $p < .01$) inversely related to the following statistics anxiety scales from the *STARS*: (a) students' statistics tests and statistics class anxiety levels; (b) students' fears of asking for help with statistics; (c) students' fears of statistics teachers; and (d) students' total scores on the *STARS* reflecting overall statistics anxiety levels. Quality of students' participation in the advanced educational statistics course was found to be significantly ($p < .05$ and $p < .01$) inversely related to multiple statistics anxiety scales depicted by the *STARS* subscales as follows: (a) students' anxiety levels concerning statistics tests and statistics classes; (b) students' anxiety levels associated with students' fears of asking for help in a statistics course; (c) students anxiety levels associated with students' fears of statistics teachers; and (d) students total anxiety scores on the *STARS*. This sound empirical connection of the assessments of quality of discussion forums respective of individual students' scores on specific subscales of the *STARS* provides strong evidence regarding the interrelationships of online discussions and graduate education students statistics anxiety levels. In addition, these results propel an in-depth purpose for future studies to examine the implications of the study findings for graduate statistics education.

Discussion, Implications and Limitations

Study findings have implications for multiple areas of consideration: (1) insightful perspectives for instructors concerned with reducing statistics anxiety in online graduate educational statistics course are posited by the resulting statistics anxiety reductions determined in this study related to the quality of interactions of students with others (other students and the instructor) in online discussion forums; (2) potential professional development provided for education statistics instructors for using discussion forums as a teaching tool and an assessment means for determining statistics anxiety reduction potential; (3) using online discussion forums as statistics anxiety desensitization vehicles; (4) potential use of online discussion forum data in annual faculty evaluations as pertinent to evidenced based best practices. Four major areas of implications are presented relative to specific findings of the current study:

(1) *Emerging Online Graduate Education Environments*: Emerging online teaching and learning environments for delivering graduate educational statistics courses provides added concerns for faculty teaching these courses commonly labeled by graduate education students as fearful and anxiety producing. Face-to-face computer laboratories are disappearing from university

campuses and online campus enrollments are surging to capacity, especially within graduate education programs. Graduate education students are able to continue their teaching and educational administration careers in educational environments while completing advanced degrees in education involving completing quantitative research and statistics courses pertinent to advanced graduate level programs of study. Discussion forums within online graduate education programs are the primary teaching and learning mechanisms for students to communicate ideas, pose questions, initiate discussions, post responses to others, interact with the instructor and others in the course, and provide feedback for considerations and concerns of interest related to the course. The emergence and utility of online graduate education teaching and learning environments is a prime arena for educational researchers and faculty curriculum planners focused on teaching graduate online educational statistics courses. Examining online discussion forums as strong mechanisms for delivering sound instructional content, high quality interactions among students and instructors, and consistent and frequent discussion participation levels of students include framing high-quality teaching and learning environments with avenues for decreasing or not increasing statistics anxiety in graduate educational students.

(2) *Professional Development for Graduate Education Statistics Faculty Concerning Quality Online Discussion Forums:* The use of a rubric for determining quality of online discussion forums involves not only the discussion posts of students but the discussion posts of students' peers as well as the instructor's responses to students' discussion posts. The rubric used in the current study: *Rubric for assessing quality in online discussion forums* (Nandi, Chang, & Balbo, 2009) assessed the quality of the content within the discussion posts, the interaction quality of the discussion posts (interaction discussion posts between a specific student and the student's peers' discussion posts directed at the student, and the interaction discussion posts of the instructor with the individual student), and the participation (frequency and consistency of participation) of the student. These three elements (content quality, interaction quality, and participation quality) comprising the assessment of the quality of the discussion forums for an individual student is an additional method for assessment consideration for faculty members teaching graduate level education statistics. Although instructors may provide class points for students' discussion posts and/or grades for students participating in discussion forums within online courses, these current methods of attaching points for discussion forum activity using the number of words posted or the number of postings per student may not provide information pertinent to assessing the level of understanding of the content or the level of discomfort the student may be experiencing with the content or the interactions within the discussion forums. Findings from the current study support the use of a detailed rubric clearly

defined with specific criteria for assessment and associated with individual student assessment data as a strong method for determining the quality of the student's understanding of content, the quality of the student's scholarly skills for interacting with peers and the instructor, and the quality of the student's participation in terms of frequency and consistency within online discussion forums. This study rubric approach for using a specified measure for including discussion forum assessment data as a key element in student assessment data for course grades in graduate education statistics courses is a recommendation of the findings of the current study. Implications of this recommendation include the need for graduate faculty to be provided with professional development experiences with developing and/or using rubrics directly tied to the assessment of online discussion forums within online graduate statistics courses.

(3) *Use of Online Discussion Forum Data in Faculty Evaluations*: Empirical findings of the current study connecting online discussion forum content quality, interaction quality, and participation quality for assessing students provide implications for connecting faculty discussions of content within online discussion forums, faculty interactions within online discussion forums, and faculty participation levels within online discussion forums for assessing/evaluating faculty. Implications of the findings of the current study for utilizing online discussion forum assessment data for evidence in graduate faculty annual evaluations and/or tenure and promotion materials is recommended as a potential additional assessment source for consideration in faculty evaluations. Data retrieved from faculty input into online discussion forums relative to specific courses taught each term may serve as viable evaluative measure for faculty to include in their annual evaluation reporting as well as in their tenure and promotion materials. These types of discussion forum data provide a sound connection to instruction, curriculum considerations, and faculty activity not captured in course evaluations completed by students. In addition, the almost daily discussions occurring within online discussion forums provide faculty members with a rich storyline for determining both individual student and overall class progress within a formative assessment level prior to summative assessments accrued at the end of a course.

(4) *Study Limitations*: Three limitations pertinent to the study are described for researchers desiring to replicate or further examine the current study outcomes: (a) student participants were provided extra credit incentives for their participation in the study with all students allowed extra credit points for other various activities if the student preferred not to participate in the study; (b) although the use of cross-validation was employed in the data analyses for the use of large numbers of correlations and dependent t test procedures as advocated by Warner (2013) to defer the potential risk for inflated Type I errors, the potential

for this limitation may influence the findings; and (c) the current study was conducted within a regional comprehensive university online graduate program and may not reflect outcomes from the types of students representing a research-focused university or a four-year college institution.

Conclusions

Findings of this study have pertinent implications for future educational researchers interested in pursuing additional studies focused on statistics anxiety in graduate education programs and findings of the study have imminent applications for graduate education faculty members facing fully online graduate programs. Future research focused on statistics anxiety in graduate education programs is an important consideration for researchers to renew an intensive research focus because of the proactive need for statistics education within online graduate education programs as a key content emphasis within masters and doctoral programs of study within the field of education. Research emphasizing pedagogy, materials, and educational options for reducing statistics anxiety within online learning environments is a major need for future investigations (DeVaney, 2010; Koh & Zawi, 2014; Macher et al., 2015; Onwuegbuzie, 2010; Perepiczka, 2011; Tonsing, 2018). Reviving and renewing focused studies on statistics anxiety within graduate educational degree programs is a prominent message emerging from the current study and corroborated by current literature.

The use of online discussion forums as a primary vehicle for delivering instruction mandates that faculty examine the potential for these forums to serve as a rich environment for quality content delivery, quality interactions among students, peers, and faculty members, and quality class participation arenas for instructors and students. "Discussion boards are considered to be a powerful tool for inclusion and development of pedagogical competencies, such as acute thinking, collaboration, and reflection." (AlJeraisy et al., 2015, p. 257). The parallel of the face-to-face classroom environment and the online classroom environment is inherent in the use of quality online discussion forums for both faculty and students (Ni, 2013; Song & McNary, 2011). Implications of the findings for graduate education programs focus on strong quantitative research and statistics courses strategically addressing the online delivery of these courses historically identified as anxiety producing among students. These key courses within graduate degree programs must consist of quality content, quality interactions, and quality participation elements within the context of online instruction. Providing high quality instruction within graduate education statistics classrooms (whether face-to-face or online) is the mainstay for maintaining high quality graduate programs of study. The future of online education must avoid anxiety producing courses within graduate programs by providing the highest quality of discussions and intellectual interchanges.

References

AlJeraisy, M. N., Mohammad, H., Fayyoumi, A., & Alrashideh, W. (2015). Web 2.0 in education: The impact of discussion board on student performance and satisfaction. *TOJET: The Turkish Online Journal of Educational Technology, 14*(2), 247-258. https://files.eric.ed.gov/fulltext/EJ1057329.pdf

Balaji, M. S., & Chakrabarti, D. (2010). Student interactions in online discussion forum: Empirical research. 'Media Richness Theory' perspective. *Journal of Interactive Online Learning, 9*(1), 1-22. ISSN: 1541-4914. www.ncolr.org/jiol

Baloglu, M. (2003). Individual differences in statistics anxiety among college students. *Personality and Individual Differences, 34*(2003), 855 – 865. http://www.elsevier.com/locate/paid

BestColleges.com (2018). *Online vs traditional college degrees: What to expect from an online doctorate program.* https://www.bestcolleges.com/features/online-doctorate-degree

Betts, K. (2017). The growth of online learning: How universities must adjust to the new norm. *Education Dive,* June 24, 2018. https://www.educationdive.com/news/the-growth-of-online-learning-how-universities-must-adjust-to-the-new-norm

Biriyai, A. H., & Thomas, E. V. (2014). Online discussion forum: A tool for effective student-teacher interaction. *International Journal of Applied Science Research and Review, 1*(3), 111-116. ISSN: 2394-9988. www.ijas.org.uk

Bollinger, D. U., & Halupa, C. (2012). Student perceptions of satisfaction and anxiety in an online doctoral program. *Distance Education, 33*(1), 81-88. htttp://dx.doi.org/10.1080/01587919.2012.667961.

Chau, Q. (2018). Exploration of statistics anxiety among doctoral students in health sciences related disciplines. *Seton Hall University Dissertations and Theses (ETDs)* .2525. http://scholarship.shu.edu/dissertations/2525

Chew, P. K. H., & Dillon, D. B. (2014). Statistics anxiety update: Refining the construct and recommendations for a new research agenda. *Perspectives on Psychological Science, 9* (2), 196-208. DOI: 10.1177/1745691613518077. https://www.researchgate.net/publication/264864713.

Dawson, S. (2006). Online forum discussion interactions as an indicator of student community. *Australian Journal of Educational Technology, 22*(4), 495-510. http://www. ascilite.org.au/ajet22/dawson.html.

DeVaney, T. A. (2010). Anxiety and attitude of graduate students in on-campus vs. online statistics courses. *Journal of Statistics Education, 18*(1), (2010). DOI:10.1080/10691898.2010.11889472. www.amstat.org/publications/jse/v18n1/devandy.pdf

DeVaney, T. A. (2016). Confirmatory factor analysis of the Statistical Anxiety Rating Scale with online graduate students. *Psychological Reports, 118* (2), 565-86. DOI: 10.1177/0033294116644093.

Friedman, J. (2018). Study: More students are enrolling in online courses. *US News and World Report,* January 11, 2018. https://www.usnews.com/higher-education/online-education/articles/2018-01-11/study-more-students-are-enrolling-in-online-courses

Gilbert, B. (2015). Online learning revealing the benefits and challenges. *Education Masters, Paper 303.* http://fisherpub.sjfc.edu/education_ETD_masters/303

Hanna, D., Shevin, M., & Dempster, M. (2008). The structure of the statistics anxiety rating scale: A confirmatory factor analysis using UK psychology students. *Personality and Individual Differences, 45*(1), 65-74. DOI:10.1016/j.paid.2008.02.021

Hong, Y. C., & Kao, M. H. (2018). Exploration of students' online discussion engagement in statistics collaborative learning, In Persichitte, K., Suparman, A., Spector, M. (Eds.), *Educational technology to improve quality and access on a global scale.* Educational Communications and Technology: Issues and Innovations, Springer, Cham. DOI: https://doi.org/10.1007/978-3-319-66227-5_11

Kebritchi, M., Lipschuetz, A., & Santiague, L. (2017). Issues and challenges for teaching successful online courses in higher education: A literature review. *Journal of Educational Technology Systems, 46*(1), 4-29. https://doi.org/10.1177/0047239516661713.

Kirtman, L. (2009). Online versus in-class courses: An examination of differences in learning outcomes. *Issues in Teacher Education, 18*(2), 103-116. https://files.eric.ed.gov/fulltext/EJ858508.pdf

Koh, D., & Zawi, M. K. (2014). Statistics anxiety among postgraduate students. *International Education Studies, 7*(13), 166- 174. ISSN: 1913-9020 E-ISSN 1913-9039.

Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: Teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education, 48*(1), 103-122. DOI: 10.10080/0305764X.2016.1259389.

Lin, Y., & Tang, H. (2017). Exploring student perceptions of the use of open educational resources to reduce statistics anxiety. *J Form Des Learn*, *1*(2017), 110-125. Association for Educational Communications and Technology. DOI: 10.10007/s41686-017-0007-z. https://link.springer.com/content/pdf/10.1007%2Fs41686-017-0007-z.pdf

Macher, D., Paechter, M., Papousek, I., & Ruggeri, K., (2011). Statistics anxiety, trait anxiety, learning behavior, and performance. *European Journal of Psychology in Education*, *27,* 483-498. DOI: 10: 1007/s10212-011-0090-5.

Macher, D., Paechter, M., Papousek, I., Ruggeri, K., Freudenthaler, H. H., & Arendasy, M. (2013). Statistics anxiety, state anxiety during an examination, and academic achievement. *British Journal of Educational Psychology, 83,* 535-549. DOI: 10.1111/j.2044-8279. 2012.0208.

Macher, D., Paechter, M., Papousek, I., & Ruggeri, K. (2015). Statistics anxiety and performance: Blessings in disguise. *Frontiers in Psychology*, *6,* 1116. DOI: 10.3389/fpsyg.2015.01116.

Mathieson, K. (2010). Comparing outcomes between online and face-to-face statistics courses: A systematic review. *International Association of Statistical Education (IASE).* www.stat.auckland.ac.nz/~iase/

Najmi, A., Raza, S. A., & Qazi, W. (2018). Does statistics anxiety affect students' performance in higher education? The role of students' commitment, self-concept and adaptability. *International Journal of Management in Education, 12*(2). https://www.inderscienceonline.com/doi/pdf/10.1504/IJMIE.2018.090705.

Nandi, D., Chang, S., & Balbo, S. (2009). A conceptual framework for assessing interaction quality in online discussion forums, In *Same places, different spaces. Proceedings Ascilite* Auckland 2009. http://www.ascilite.org.au/conferences/auckland09/procs/nandi.pdf

Nash, J. A. (2015). Future of online education in crisis: A call to action. *TOJET: The Turkish Online Journal of Educational Technology*, *14*(2), 80-88. ISSN: 2146-7242.

Ni, A. Y. (2013). Comparing the effectiveness of classroom and online learning: Teaching research methods. *Journal of Public Affairs Education, 19*(2), 199-215. www.naspaa.org/jpaemessenger/Article/Vol19-2/03_Ni.pdf.

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. *Assessment and Evaluation in Higher Education, 29* (1), 3-19. DOI: 10.1080/0260293042000160384

Onwuegbuzie, A. J. (2010). Statistics anxiety and the role of self-perceptions. *The Journal of Educational Research, 93*(5), 323-330. https://doi.org/10.1080/00220670009598734.

Onwuegbuzie, A. J. & Wilson, V. A. (2003). Statistics anxiety: Nature, etiology, antecedents, effects, and treatments—A comprehensive review of the literature. *Teaching in Higher Education, 8*(2), 195- 209. https://doi.org/10.1080/1356251032000052447

Orlando, J. (2017). *What research tells us about online discussion.* Faculty Focus: Higher Ed Teaching Strategies from Magna Publications. https://www.facultyfocus.com/articles/online-education/research-tells-us-onlin-discussion/

Paechter, M. Macher, D., Martskvishviti, K., Wimmer, S., & Papousek, I. (2017). Mathematics and statistics anxiety: Shared but also unshared components and antagonistic contributions to performance in statistics. *Frontiers in Psychology(8)*, 1196. DOI: 10.3389/fpsyg.2017.01196. https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01196/full

Papousek, I., Ruggeri, K., Macher, D., Paechter, M., Heen, M., Weiss, E.M., Schulter, G., & Freudenthaler, H.H. (2012). Psychometric evaluation and experimental validation of the statistics anxiety rating scale. *Journal of Personality Assessment, 94*(1) 82-91. https://doi: 10.1080/00223891.2011.627959

Perepiczka, M, Chandler, N., & Becerra, M. (2011). Relationship between graduate students' statistics self-efficacy, statistics anxiety, attitude toward statistics, and social support. *The Professional Counselor*, *1*(2), 99-108. DOI:10.15241/mpa.1.2.99.tpcjournal.nbcc.org/?s=statistics +anxiety.

Richardson, J. (2010). Investigating students' level of critical thinking across instructional strategies in online discussions, *The Internet and Higher Education, 13*(1-2), 52-69. https://doi.org/10.1016/j.iheduc.2009.10.009

Rizopoulos, L. A., & McCarthy, P. (2009). Using online threaded discussions: Best practices for the digital learner. *Journal of Educational Technology Systems, 37*(4), 373-383. DOI: 10.2190/ET.39.4.c. http://baywood.com

Rock, A. J., Coventry, W. L., Morgan, M. I., & Loi, N. M. (2016). Teaching, research methods and statistics in eLearning environments: Pedagogy, practical examples, and possible futures. *Frontiers in Psychology, 2016* (7), 339-357. DOI: 10.3389/fpsyg.2016.00339. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4785677

Rovai, A. P., & Jordan, H. M. (2004). Blended learning and sense of community: A comparative analysis with traditional and fully online graduate courses. *International Review of Research in Open and Distributed Learning, 5*(2), http://dx.doi.org/10.19173/irrodl.v5.i2.192

Ryan, R. S. (2013). The effect of online discussion forums on student learning and student perception of learning in a science course at the community college level. *Dissertations.* 207. https://aquila.usm.edu/dissertations/207

Sanders, R. L., & Melton, S. J. (2010). The AETZone experience: A qualitative analysis of the use of presence pedagogy in a 3D immersive learning environment. *Journal of Online Learning and Teaching, 6*(1), 62-70. ISSN: 1558-9528. www.jolt.merlot.org/vol6no1/sanders_0310.htm

Seethamraju, R. (2014). Effectiveness of using online discussion forums for case study analysis. *Education Research International, 2014* (Article ID 589860). https://doi.org/10.1155/2014/589860

So, H-J. (2010). Towards rigor of online instruction research: Implication for future distance learning research. *TOJET: The Turkish Online Journal of Educational Technology, 9*(2). 256 – 263. www.tojet.net/articles/v9i2/9226.pdf

Song, L., & McNary, S. W. (2011). Understanding students' online interaction: Analysis of discussion board postings. *Journal of Interactive Online Learning, 10*(1), 1-14. www.ncolr.org/jiol ISSN: 1541-4914.

Summers, J. J., Waigandt, A., & Whittaker, T. A. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. *Innovative Higher Education, 29*(3), 233-250. https://doi.org/10.1007/s10755-005-1938-x

Tonsing, K. N. (2018). Instructor immediacy and statistics anxiety in social work undergraduate statistics. *Social Work Education, 37*(2), 223-233. DOI:10.1080/02615479.2017.1395009

Warner, R. M. (2013). *Applied statistics: From bivariate through multivariate techniques*. (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc. ISBN-13: 978-1412991346.

Williams, A. S. (2010). Statistics anxiety and instructor immediacy. *Journal of Statistics Education, 18* (2), 1-18. www.amstat.org/publications/jse/v18n2/williams.pdf

Williams, A. S. (2013). Worry, intolerance of uncertainty, and statistics anxiety. *Statistics Education Research Journal, 12*(1), 48-59. http://iase-web.org/Publications.php?p=SERJ © International Association for Statistical Education (IASE/ISI).

Zeidner, M. (1991). Statistics and mathematics anxiety in social science students: some interesting parallels. *British Journal of Educational Psychology, 61*(3), 319-328. DOI:10.1111/j.2044-8279.1991.tb00989.

Zimmerman, W. A. (2017). Predicting success in an online course using expectancies, values, and typical mode of instruction. *International Journal of E-Learning & Distance Education, 32*(1), 1-20. ISSN: 2292-8588.

Zhou, H. (2015). A systematic review of empirical studies on participants' interactions in internet-mediated discussion boards as a course component in formal higher education settings, *Online Learning*, *19*(3), 181-200. https://olj.onlinelearningconsortium.org/index.php/olj/article/download/495/151

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