



# “Constantly Working on My Attitude Towards Statistics!” Education Doctoral Students’ Experiences with and Motivations for Learning Statistics

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## Abstract

Doctoral students in education-related fields are required to take graduate level statistics courses and often face anxiety and negative attitudes about taking these courses. Using a mixed methods survey research design ( $N=95$ ), this study explored students’ experiences with statistics anxiety and how course instructors can support them to mitigate statistics anxiety and improve attitudes. Analyses of quantitative survey data found that students who had never taken a statistics course before beginning their doctoral program, and students that had completed less doctoral coursework had higher negative attitudes towards learning statistics; and older students had higher statistics anxiety. Plans to use research in the future predicted more positive attitudes and lower statistics anxiety. Analysis of qualitative survey data found that students: (1) expressed that their attitude towards learning statistics was very important and played a big role in how they approached their coursework; (2) considered their plans to use research skills in the future as motivation to learn statistics; and (3) believed that their instructors’ attitudes and instructional practices supported learning and decreased statistics anxiety. This study has implications for how statistics and research methods courses are taught in higher education, and how the experiences of graduate students in education may have lasting implications for research use in Prek-12 education settings.

**Keywords** statistics anxiety · statistics attitudes · research methods · doctoral education · research use · higher education

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## Introduction

Doctoral students are often required to take at least one statistics course and face anxiety related to this coursework. Research has shown that students across disciplines face anxiety when taking statistics courses, with 80% of graduate students estimated to have statistics anxiety (Onwuegbuzie & Wilson, 2003). Statistics anxiety is defined as “a negative state of emotional arousal experienced by individuals as a result of encountering statistics in any form and at any level” (Chew & Dillon, 2014, p.199). Distinct from mathematical anxiety, statistics anxiety is argued to be “preceded by negative attitudes toward statistics” (Chew & Dillon, 2014, p.199). Many students have indicated that statistics courses are the most anxiety-inducing courses in their program’s curriculum (Zeidner, 1991). Social science fields such as education and psychology find that statistics anxiety is widespread among their students and students often have negative attitudes towards learning statistics in general, with implications for course achievement (e.g., Onwuegbuzie 2000; Onwuegbuzie & Seaman, 1995; Zeidner, 1991).

Beyond course achievement, the role of statistics anxiety and negative attitudes towards learning statistics in doctoral coursework may have implications for how students use research skills in subsequent employment. This may be particularly salient for students in education related fields. Each year students graduate with doctoral degrees (EdD., PhD, PsyD) in education-related fields and take on education leadership jobs in K-12 schools, early education programs, local and state education agencies, and other education organizations. While some doctoral students in education fields go on to research jobs in academic or non-profit research settings, many more work in applied education settings where research is not the main focus of their job (Kerrigan & Hayes, 2016). Increasingly, educators have been called upon to use “evidence-based” or “research-based” practices in their work (U.S. Department of Education, 2016). This focus has led to an increased need for education practitioners to be able to read, understand, and utilize research in their practice, including being savvy consumers of quantitative research in education, psychology, sociology, and other related fields. Indeed, statistics anxiety has been found to be related to a student’s ability to interpret research articles and analyze statistical data (Onwuegbuzie et al., 1997), key skills needed for education leaders to make evidence-based policy and practice decisions. Given the limited research on statistics anxiety and attitudes towards learning statistics in doctoral students in education-related fields, this mixed methods survey study sought to better understand the predictors of statistical anxiety and attitudes towards learning statistics, the interplay of statistics anxiety/attitudes with students’ plans to use research skills in future jobs, and ways course instructors could help mitigate statistics anxiety and improve attitudes.

## Theoretical Framework

Past research has examined predictors of statistics anxiety finding multiple predictors across different groups of students (Chew & Dillon, 2014). This study uses Onwuegbuzie and Wilson’s (2003) framework that argues that predictors of statistics

anxiety can be broken down into three categories: environmental, situational, and dispositional. Onwuegbuzie and Wilson drew upon research from multiple disciplines including psychology, education research, sociology, social work, and higher education when considering these categories (2003). Within this framework, environmental predictors include individual background or demographic characteristics; situational predictors refer to factors surrounding the situation where statistics anxiety occurs; and dispositional predictors refer to factors which an individual brings to the setting, such as personality characteristics, goals, and/or attitudes. Onwuegbuzie and Wilson's acknowledged at the time that most of the research had been done on undergraduate students and that more research was needed with graduate students (2003). In the literature review below we highlight subsequent studies that have been conducted on graduate student samples.

## Literature Review

### Predictors of Statistics Anxiety

Using Onwuegbuzie and Wilson's (2003) framework we consider research on environmental, situational, and dispositional factors related to statistics anxiety and attitudes. Research on demographic (environmental) factors, such as gender and age is limited and includes mixed results. For example, Onwuegbuzie & Wilson (2003), report that females tend to report higher levels of statistics anxiety than do males, however other researchers have found no gender differences (Baloğlu, 2003; Hsiao & Chiang, 2011). Similarly, some studies have found that older students had higher statistics anxiety (Baloğlu, 2003; Bell, 2003) and some found no age differences (Bui & Alfaro, 2011). This may depend upon the samples for each study. For education fields, where the majority of students are female and older, these are important factors to consider.

Situational factors such as prior statistics knowledge, statistics course grades, and setting of the statistics course (online vs. in-person) may be related to statistics anxiety (Onwuegbuzie & Wilson, 2003). Some research has found that online statistics learning may induce stronger anxiety and procrastination (DeVaney, 2016; Dunn, 2014). In addition to these factors, some research suggests that instructional situations such as the pace of the course could directly affect students' level of statistics anxiety (Bell, 2001). Other research has explored timed vs. untimed exams, finding that graduate students with high anxiety performed better on untimed vs. timed exams (Onwuegbuzie & Seaman, 1995). In addition, teaching style, such as unorganized teaching may negatively influence a students' ability to understand statistics material, resulting in a high levels of statistics anxiety (Lesser & Reyes, 2015).

Dispositional factors can include characteristics such as: personality, attitudes, reading skills. Regarding attitude, Kesici and colleagues (2011) found that negative attitude towards statistics result in a higher level of statistics anxiety. Cui and colleagues (2019) argued that students' attitudes towards statistics can be modified by their experiences. A lack of prior mathematics knowledge, low prior achievement, and/or an overall fear of mathematics can contribute to a student experience of statis-

tics anxiety (McGrath, 2014). Some research has also shown that attitudes and anxiety are two separate constructs that should be considered separately (e.g., Devaney, 2016) to better understand how they are related.

### **Challenges Associated with Statistics Anxiety and Negative Attitudes**

For many graduate students, statistics is one of the most anxiety-inducing courses in their programs of study (Zeidner, 1991). Research has found that statistics anxiety is most commonly experienced among students in social science subjects such as psychology and education (Onwuegbuzie & Wilson, 2003). Experiencing statistics anxiety can lead to many problems that can affect a graduate students' statistics education. Statistics anxiety is shown to be related to less time spent on learning and to less efficient learning and study strategies (Macher et al., 2013; Onwuegbuzie & Wilson, 2003) argue that statistics anxiety is often regarded as one of the most powerful negative influences on performance in statistics courses. However, some research has found that the relationship between performance and statistics anxiety depends on the students' prior academic background or the instructional context (Macher et al., 2015).

### **Education Practitioners**

Statistics anxiety affects both educators and students at all levels. Research on statistics anxiety in doctoral students' in education specifically has been limited; therefore, we draw upon other research on educators more broadly. Struggles with learning statistics are widespread, 70-80% of social science students and future educators reported moderate to high levels of anxiety about statistics courses and reported it as a barrier to obtaining their degree (Libman, 2010). Negative attitudes towards statistics may influence whether educators are comfortable reading research and using it to make evidence-based decisions in their classrooms, schools, and districts (Onwuegbuzie et al., 1997), an important part of their jobs. Despite these struggles, educators often express that learning statistics and research skills are important. Van Katwijk et al., (2019) found that pre-service teachers in their study believed that research skills were important or very important, although one-third indicated that they did not enjoy research, and experienced negative feelings such as frustration and stress. The research on this topic indicates that generally, people in education related fields value the use of research (Diery et al., 2020; Tack & Vanderlinde, 2014).

This research is helpful to consider how educators think about research use and anxiety, yet it mainly focuses on educator preparation at the undergraduate or masters' degree levels. For education doctoral students, their attitudes towards learning statistics and using research may be different than educators in higher education programs at the undergraduate or master's level. Kerrigan & Hayes (2016) explored research interests and self-efficacy of EdD students in an Education Leadership program. They found that research self-efficacy increased as the number of research courses students took increased, however, students' interest in research did not increase as course taking increased. In addition, research self-efficacy in this sample did not differ by students' past research experience. This work is limited, but important to consider as,

students pursuing doctoral degrees have professional goals that may include research or, at least an understanding that they must gain these skills to gain their advanced degrees. Yet, social science doctoral students, including education, are less likely to have had any research training at the undergraduate level or exposure to research methodologies such as statistics (Lin et al., 2011), and are less likely to have paid research assistantships and experiences during their doctoral programs compared to other fields (Levine et al., 2004). In addition, education doctoral students often are active education professionals, are sometimes engaged in highly structured and accelerated programs (Bernauer et al., 2013), and continue to hold professional jobs while completing their degrees making it stressful to balance their coursework and professional responsibilities (Gardner & Gopaul, 2012), particularly when coursework causes anxiety. At the doctoral level, research methods and statistics courses sometimes overlap making it important to consider them together at this level as they contribute to the overall research experience.

Overall, limited research has been conducted on this population to explore how negative attitudes towards statistics, statistics anxiety, and plans to use research in their future jobs are interrelated. Using a mixed methods approach, this study provides an innovative look at the ways education doctoral students consider their statistical anxiety, attitudes towards learning statistics, the interplay with their plans to use research in the future, and finally, ways that instructors can help support students. This study has implications for higher education instructors and program leaders who are training and mentoring education doctoral students, as well as the PK-12 districts, schools and classrooms that education doctoral students will lead after their degrees are completed.

## Present Study

In this convergent mixed methods survey data was analyzed using an integrated mixed methods approach, such that the information gleaned from the quantitative and qualitative questions provided a richer more robust understanding of the overarching questions than could have been understood separately (Creswell & Plano Clark, 2017). The mixed methods research questions below were addressed using both quantitative and qualitative data. Since this study is exploratory in nature with limited past research on the specific topic, we have not stated hypotheses.

- 1) What factors contribute to statistics anxiety and attitudes towards statistics for doctoral students in education related fields?
- 2) How is statistics anxiety, attitudes towards statistics, and plans for future research use connected for education doctoral students?

## Method

This study used a convergent mixed methods survey research approach (Creswell & Plano Clark, 2017) including both closed-ended and open-ended data survey data. In convergent mixed methods designs, quantitative and qualitative data are typically

collected at the same time from the same individuals and there is a focus on how results from both data sources converge. This is considered a type of triangulation of data sources to address the research goals (Creswell et al., 2003; Creswell & Plano Clark, 2017). By comparing results from the quantitative and qualitative data, we were able to gain a more complete understanding than we would have been able to using only one source of data alone.

## Participants

Participants were recruited virtually through email listservs, direct emails to student groups, through department chairs, program coordinators, and course professors with a focus on recruitment of doctoral students in education-related fields (e.g., school leadership, literacy, psychology). Since colleagues were asked to forward the recruitment message to their networks, the exact sampling frame is not known. One hundred and six participants responded to the survey and completed the online consent form embedded in the survey. Respondents who completed less than 10% of the survey were removed, for an analytic sample of 95 participants. Despite wider recruitment, the participants primarily attended two universities in the northeastern United States, with a small number from other universities. The majority of participants were enrolled in PhD programs (80%), with smaller percentages in EdD (10%), and PsyD (10%) programs. Program titles for participants varied and included the following as examples: Administration and Supervision, Counseling Psychology, Education Leadership, Education of Students with Exceptionalities, Educational Psychology, Higher Education, Instructional Leadership, Literacy, School Psychology, and Teaching of English as a Second Language. The majority of students were in programs located in schools or departments of education at their universities (86%). The sample was predominately female (81%). The age of participants when they started their doctoral programs ranged from 22 to over 60, with a mean of 36.11 years old ( $SD=9.37$ ). 66% of participants identified as white, 10% as Black, 7% Latinx, 8% as Asian or Asian Indian, and 8% as another race/ethnicity or multiple. The vast majority of participants had masters' degrees (90%).

The program delivery mode varied across participants with 42% enrolled in an in-person program, 47% in a fully online program, and 11% in a hybrid program. However, due to the COVID-19 pandemic, in the 2020–2021 academic year, survey respondents indicated that at the time of data collection, 81% were learning completely online, 15% were in a hybrid model, and only 2% were learning completely in person at that time. At the time of the survey 17% were in their first semester in their doctoral program. Students ranged from having already completed 0–11 semesters with a mean of 5 semesters or 2.5 years. Across their higher education experiences (undergraduate, master's, and doctoral), students had taken an average of 6 research methods or statistics courses ( $SD=4.63$ ).

The majority of the sample reported being currently employed during their doctoral program (83%). Of those currently employed, participants' employment varied: 31% worked in higher education in teaching or administration roles, 26% in prekindergarten through 12th grade teaching, 12% in prekindergarten through 12th grade administration roles, and 15% reporting an "other" position including librar-

**Table 1** Characteristics of the Sample

Variable Name	%/Mean(SD)	% Missing
Gender		0
Female	81	
Male	19	
Race		0
White	66	
Black	10	
Latinx	7	
Asian/Asian Indian	8	
Other/Multiple	8	
Master’s Degree	90	0
Age Began Program	36.11 (9.37)	2
Currently Employed	83	0
Last Time Took Stats/Research Methods		2
Never	13	
Less Than 5 Years	30	
5–10 Years	25	
10 or More Years	31	
Research Experience	35	0
Program Type		1
PhD	80	
EdD	10	
PsyD	10	
Program Modality		0
Face to Face	42	
Online	47	
Hybrid	11	
Semesters of Doc Coursework Completed	4.74 (3.12)	4
Total Courses Taken in Stats/Research Methods	6.14 (4.63)	0
Statistics Attitudes	0.00 (0.70)	5
Statistics Anxiety	0.00 (0.70)	1
Research Use Score	3.88 (0.63)	1

*Note.*  $N=95$ . Percentages rounded and may not add up to 100%

ians, psychologists, research staff, district level coaches, professional development, and consultants. Only 35% of the sample were engaged in research outside of their coursework, including holding a doctoral research assistantship or fellowship. Full descriptive statistics for the sample are included in Table 1.

**Survey Instrument**

An online survey was used to collect demographic information as well as information related to the research questions. The study and survey instrument were approved by the institutional review board at the authors’ university and all participants provided their consent prior to beginning the survey. All data was collected anonymously. The

survey was designed to take approximately 20 min and included three sections: (1) demographic characteristics and prior experiences, (2) plans for research use in the future, and (3) statistics anxiety. In addition, it included three open-ended questions at the end asking participants about these topics (see [measures](#) section). Prior to data collection the survey was piloted by four doctoral students across PhD, EdD, and PsyD programs. Small edits to the survey were made after the pilot to improve question clarity. The survey was administered between October 2020 and May 2021.

## Measures

### Demographic Characteristics and Prior Experiences (Environmental Factors)

In Onwuegbuzie and Wilson's (2003) framework, demographic characteristics and prior experiences are considered environmental factors associated with statistics anxiety. For demographic characteristics, participants reported on their gender identity, race/ethnicity, prior educational experience and degree attainment, age at which they began their doctoral program and current employment. For prior experiences, participants reported on the number of statistics courses and the number of research methods courses they had taken at the time of data collection at the undergraduate and graduate levels separately. Based on the pilot and responses to open-ended questions at the end of the survey, it was clear that participants found it challenging to distinguish between courses that were purely statistics compared to broader research methods courses. Therefore, the two types of courses were combined and summed for a total score measuring the number of courses taken to date that were either statistics or research methods focused. To gain an understanding of past experiences with research methods and statistics courses, participants reported on the last time they took a statistics/research methods course prior to their doctoral programs. These responses were categorized as "never," "less than five years ago," "five to ten years ago," or "10 or more years ago."

### Current Doctoral Experiences (Situational Factors)

Considering factors surrounding their statistics and research methods course taking experiences in their doctoral program, situational factors were considered (Onwuegbuzie & Wilson, 2003). Participants reported on whether they held a research assistantship or fellowship during their doctoral program and whether they worked with a faculty member on research outside of coursework. An indicator variable for research experience during their doctoral program was created to show whether a participant responded yes to either of these two questions. They also reported on whether their program was face to face, online, or hybrid, and whether their degree program was for a PhD, EdD, or PsyD. A continuous measure of the number of semesters of doctoral coursework students had completed was also collected.



**Table 2** Plans for Future Research Use

Variable Name	Mean	SD
1. I plan to use research in my future job in order to make research-based decisions.	4.20	0.89
2. I plan to conduct research as a regular part of my future job.	3.52	1.17
3. I plan to teach research or statistics courses in a future job.	2.38	1.20
4. I believe I will be prepared to conduct my own research when I complete this program.	4.06	0.87
5. I believe I will be prepared to read and evaluate research in my field when I complete this program.	4.40	0.68
6. I believe I will be prepared to read research in my field and apply the findings to practice and/or policy decisions when I complete this program.	4.50	0.68
7. I believe I will be prepared to partner with external researchers to conduct research studies that will inform policy and practice in the organization I work for.	4.06	0.88
Future Research Use Mean Score ( $\alpha=0.82$ )	3.88	0.63

*Note.*  $N=94$ . Likert scale from 1–5 with 1=*strong disagree*, 2=*disagree*, 3=*neither*, 4=*agree*, 5=*strongly agree*

### Plans for Future Research Use (Dispositional Factor)

Participants responded to a set of seven closed-ended questions created by the authors about their plans to engage in and with research in future jobs. These items were developed based on prior research related to ways education professionals may engage with research in their professional roles (Diery et al., 2020; Kerrigan & Hayes, 2016; van Katwijk et al., 2019). The seven items are included in Table 2 with descriptive statistics for each item. For example, participants were presented with items such as: “I plan to use research in my future job in order to make research-based decisions,” “I plan to conduct research as a regular part of my future job,” and “I plan to teach research or statistics courses in a future job.” Participants responded from strongly disagree to strongly agree on a five-point scale to a total of seven statements. Factor analysis found that a one factor solution was appropriate, with all items loading highly onto one factor. The mean of the seven items was calculated to create a total score for each participant after reliability analysis also showed high internal consistency ( $\alpha=0.82$ ). This variable was considered a dispositional factor (Onwuegbuzie & Wilson, 2003) when considering its potential association with statistics anxiety and attitudes towards learning statistics.

### Statistics Anxiety and Attitudes Toward Statistics

To measure statistics anxiety, a slightly adapted version of the Cruise et al., (1985) Statistics Anxiety Rating Scale (STARS) was used (Hanna et al., 2008). STARS is the most commonly used measure of statistics anxiety, with multiple studies indicating reliability and validity of the measure (Chew & Dillon, 2014). Studies have been conducted on both graduate students and undergraduate student samples (e.g., Baloglu, 2002; Cruise et al., 1985; Nesbit & Bourne, 2018; Teman, 2013), and it has been validated for use with students taking online statistics courses as well as face to

face courses (DeVaney, 2016). Studies have shown moderate to high levels of internal consistency ( $\alpha=0.62-0.94$ ) depending on the subscales created in different studies (e.g., Baloglu 2002; Teman, 2013).

Our slightly adapted version of the STARS contained 47 items arranged in two sections. Some of the minimal changes we made were based on the version adapted by Hanna and colleagues (2008) and some small additional revisions were made to fit the times and population for our study. For example, questions that referenced outdated practices such as printing output in a computer lab were revised or removed. The first Sect. (20 items) assessed test and class anxiety, interpretation anxiety and fear of asking for help. For this section, participants were asked to rate the extent to which a given situation made them feel anxious on a 5-point Likert scale, from not anxious to extremely anxious. The second adapted section of the STARS (27 items) measured attitudes towards statistics including worth of statistics, fear of statistics instructors and computational self-concept. Participants were asked to respond using a 5-point Likert scale ranging from *strongly disagree* to *strongly agree* for each item. Higher scores indicate more negative attitudes towards learning statistics.

While early research using the STARS broke the anxiety and attitudes items into multiple sub constructs within the different scales, more recent research has suggested that a two factor solution, with one scale focused on the *anxiety* questions and one scale focused on the *attitudes* questions was appropriate (Devaney, 2016; Hanna et al., 2008; Hsiao & Chiang, 2011; Papousek et al., 2012). Factor analysis and reliability statistics confirmed that this two factor solution was also appropriate in the current study. Consistent with past research, the anxiety scale had a high level of internal consistency of ( $\alpha=0.95$ ), as did the attitudes scale ( $\alpha=0.96$ ) in this sample. Each item was standardized, and a mean anxiety score, and a separate mean attitudes score were calculated. Since there was item level missing data on the STARS (85 participants completed all items), mean scores were calculated based on non-missing items if a participant completed at least two thirds of the STARS items ( $n=90$ ).

## Qualitative Data

The survey included three open-ended questions: (1) “How do you believe your attitudes towards learning statistics are related to your future engagement in research through your dissertation, job or other experiences?” (2) “Are there specific examples of successful statistics or research methods courses you have taken? What practices did the instructor use to make the course successful for you?” (3) “Is there anything else on this topic you would like to share?” Out of 95 survey participants, 56 completed at least one open-ended question.

## Analytic Plan

This study took a convergent mixed methods approach where the quantitative and qualitative data were analyzed separately first, using quantitative and qualitative analytic techniques independent of one another. In the second step the results of the separate analyses were integrated to gain greater meaning to address the research

questions (Creswell & Plano Clark, 2017). The multiple analysis techniques and steps are described below.

### Quantitative Analyses

Descriptive analyses were conducted for all quantitative data collected through the surveys. Across the quantitative analyses missing data was addressed with listwise deletion. Missing data on individual variables in the study ranged from 0 to 5%. To address research question one, multiple linear regression analysis was conducted in SPSS 24 to examine whether background characteristics and experiences were predictors of anxiety scores and attitudes towards learning statistics. Using Onwuegbuzie and Wilson's (2003) framework we considered participant characteristics and past experiences (environmental factors) including: gender identity, race/ethnicity, whether participant had a master's degree, age when participant began their doctoral program, whether they were currently employed, and the last time they had taken a research methods or statistics courses prior to starting their doctoral program. To consider situational factors (Onwuegbuzie & Wilson, 2003), we included information about the participants' experiences during their doctoral program, including: whether they had hands-on research experience outside of coursework; the type of program they were enrolled in (PhD, EdD, PsyD), whether their program was face-to-face, online, or hybrid, the number of semesters of doctoral coursework they had completed to date, and the total number of research methods/statistics courses they had taken to date.

To address research question two, Pearson correlations were assessed between the mean STARS anxiety scores and attitudes scores and the total future research use mean score. See Table 3 for a full correlation matrix for all variables used in this study. Second, plans for future research use scores were added to the regression models described above to consider whether they are a dispositional factor (Onwuegbuzie & Wilson, 2003) that influences statistics anxiety and attitudes towards statistics.

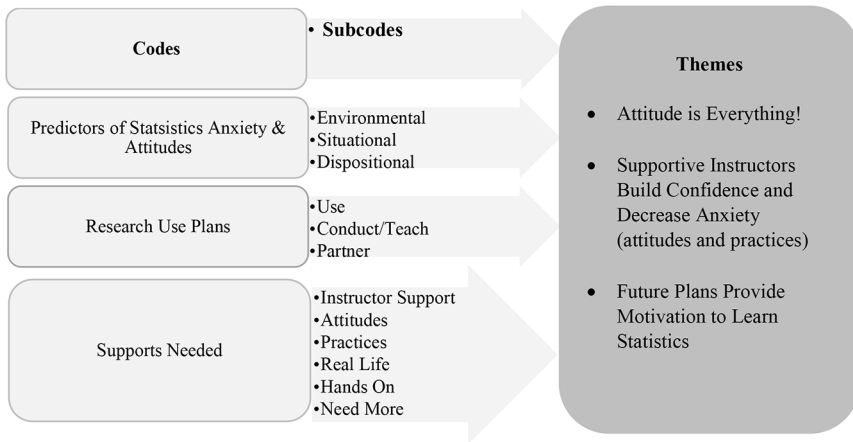
### Qualitative Analyses

The open-ended qualitative data was analyzed using a thematic analysis (Clarke & Braun, 2013) to address aspects of both research questions. We took the following steps: (1) data familiarization; (2) complete coding across the entire dataset using a combination of data-derived and a priori research derived codes based on the research questions; (3) analysis for themes from the codes mapped to the research questions; (4) analysis for relationships between themes and writing to finalize the analysis (Braun & Clarke, 2006; Clarke & Braun, 2013). Specifically, we started with the following a priori codes based on the research questions: predictors of statistics anxiety, research use plans, and supports needed. For the predictors of statistics anxiety we also had prior subcodes (environmental, situational, dispositional) based on the study's theoretical framework (Onwuegbuzie & Wilson, 2003). During the first step of coding these codes were applied and additional subcodes were developed based on the data. Additional subcodes under research plan use included: use, conduct/teach, partner. Additional codes under supports were originally: instructor support, real life/

**Table 3** Correlations

Variable Name	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Gender	1.00	0.18	-0.08	-0.08	-0.08	-0.07	-0.25*	0.07	0.09	-0.14	-0.05	0.03	0.23*	0.25*
2. Race	0.18	1.00	-0.05	-0.09	-0.09	-0.11	0.12	0.12	-0.01	0.09	0.07	-0.12	0.12	0.09
3. Master's Degree	-0.08	-0.05	1.00	0.33*	0.30*	0.30*	0.08	-0.40*	-0.39*	0.15	0.17	0.46*	0.07	-0.13
4. Age Began Program	-0.08	-0.09	0.33*	1.00	0.32*	0.39*	0.39*	-0.56*	-0.34*	0.13	-0.16	0.00	0.21*	0.23*
5. Currently Employed	-0.07	-0.09	0.30*	0.32*	1.00	0.14	0.14	-0.38*	-0.08	0.11	0.03	0.05	0.14	-0.02
6. Last Time Took Stats/ Research Methods	-0.25*	-0.11	0.08	0.39*	0.14	1.00	-0.24*	-0.11	0.05	0.05	-0.31*	-0.07	-0.10	-0.11
7. Research Experience	0.07	0.12	-0.40*	-0.38*	-0.56*	-0.38*	-0.24*	1.00	0.10	-0.25*	0.13	-0.09	-0.16	-0.03
8. Program Type	0.09	-0.01	-0.39*	-0.34*	-0.08	-0.11	0.10	0.10	1.00	-0.10	-0.09	-0.28*	0.10	0.16
9. Program Modality	-0.14	0.09	0.15	0.13	0.11	0.05	-0.25*	-0.10	-0.10	1.00	0.05	-0.02	0.17	-0.05
10. Semesters of Doc Coursework	-0.05	0.07	0.17	-0.16	0.03	-0.31*	0.13	-0.09	0.05	0.05	1.00	0.35*	-0.21*	-0.15
11. Stats/Research Methods Courses	0.03	-0.12	0.46*	0.00	0.05	-0.07	-0.09	-0.28*	-0.02	0.35*	1.00	-0.13	-0.15	0.10
12. Statistics Attitudes	0.23*	0.12	0.07	0.21*	0.14	-0.10	-0.10	0.10	0.17	-0.21*	-0.13	1.00	0.65*	-0.36*
13. Statistics Anxiety	0.25*	0.09	-0.13	0.23*	-0.02	-0.11	-0.03	0.16	-0.05	-0.15	-0.15	-0.15	0.65*	1.00
14. Research Use	-0.15	-0.06	-0.02	-0.01	-0.16	0.02	0.12	-0.32*	0.01	-0.06	0.10	-0.36*	-0.30*	1.00

Note. N=95. \*p<0.05. Pearson correlations



**Fig. 1** Codes and Themes from Thematic Analysis on Statistics Anxiety, Attitudes, and Future Research Use

hands on experiences, and more. Next, three initial themes were developed: attitude is everything, future research plans are motivating, and supportive instructors build confidence and decreases anxiety. These initial themes were then applied back to the coded text for further refinement. During this process additional subcodes were developed for the supports needed code splitting real life experiences and hands-on experiences into two separate codes, adding instructor attitudes, practices, and what students would like to see more of as separate subcodes. This process helped categorize the different examples participants provided with more nuance and then regroup them within the overall theme that supportive instructors build confidence and decrease anxiety. This led to refine the final version of theme three to have two subthemes (instructor attitudes and practices). Figure 1 shows the final main codes, subcodes and final themes developed from this thematic analysis.

### Integrated Mixed Methods Analyses

In the final step of a convergent mixed methods analysis the results from the separate quantitative and qualitative analyses are merged to compare how they converge (or diverge), relate to one another, and/or together provide a combined fuller understanding of the research questions (Creswell & Plano Clark, 2018). We organized the quantitative and qualitative findings by research question to examine if and how the findings complement one another, whether the qualitative findings serve as explanatory for the quantitative findings or if there is divergence between them. The results are presented by research question with additional insights from the integrated analyses in the [discussion](#) section to highlight key mixed methods findings. Integrated key findings are also presented in a joint display. Joint displays are used in mixed methods research to help merge and connect both the qualitative and quantitative data (Creswell & Plano Clark, 2017).

## Personal Contexts Note

In qualitative and mixed methods research it is common for researchers to provide statements about their positionality to better understand the positions from which they conduct research and analyze data. This can be conceptualized as “personal contexts” that frame the viewpoints of the researchers (Plano Clark & Ivankova, 2016). For this study it is important to note that the authors are a research methods/statistics course instructor and a current doctoral student in an education-related field. These personal contexts were an asset for studying this topic as they provided lived experiences that helped shape the research questions, study design, survey development, analysis, and interpretation. However, it is important to note our personal contexts to better understand the lenses we had when interpreting the findings.

## Results

### Contributors to Statistics Anxiety (Research Question 1)

To address the first research question about factors contributing to statistical anxiety and negative attitudes towards learning statistics for doctoral students, we first conducted regression analyses to examine whether demographic characteristics and prior experiences (environmental factors) were predictive of statistics attitudes scores and statistics anxiety scores in our sample. Second, we examined the open-ended qualitative data to understand how participants’ viewed factors contributing to their statistics anxiety.

### Predictors of Statistics Anxiety

Regression analysis (Table 4) revealed that some factors included in the models were statistically significant predictors of attitudes towards statistics (panel 1) and statistics anxiety (panel 2). For attitudes towards statistics, prior experiences with statistics and research methods courses (environmental factor) before their doctoral program predicted attitudes. Specifically, participants who had never taken a statistics course or research methods course had significantly higher negative attitudes than those who had taken a course recently (less than 5 years ago), or ten or more years ago. For participants who had taken a course less than five years before their doctoral program, their negative attitudes were 0.39 *SD* lower than those who had never taken a course, and for those who had taken a course more than 10 years ago, their negative attitudes were 0.43 *SD* lower than those who had never taken a course. In addition, the more semesters of doctoral coursework that students had completed at the time of data collection was significantly related to less negative attitudes towards statistics, such that for each additional semester a student had completed, their negative attitudes decreased (-0.29 *SD*).

When considering the statistics anxiety scale as the outcome, age (environmental factor) and program type (situational factor) were significant predictors of statistics anxiety. Students who were older when they began their doctoral programs had

**Table 4** Regression Results with Characteristics/Experiences Predicting Statistics Anxiety and Attitudes

Variable Name	Statistics Attitudes		Statistics Anxiety	
	Unstandard-ized (SE)	Standardized	Unstandard-ized (SE)	Standardized
Female	0.25 (0.19)	0.14	0.23 (0.19)	0.13
Race/Ethnicity (white omitted)				
Black	0.29 (0.28)	0.12	0.29 (0.27)	0.11
Latinx	0.38 (0.35)	0.13	0.40 (0.31)	0.14
Asian/Asian Indian	0.03 (0.28)	0.01	-0.17 (0.27)	-0.07
Other/Multiple	-0.04 (0.28)	-0.02	0.06 (0.27)	0.02
Master’s Degree	0.27 (0.34)	0.11	0.07 (0.32)	0.03
Age Began Program	0.01 (0.01)	0.18	<b>0.04 (0.01)</b>	<b>0.45**</b>
Currently Employed	0.15 (0.24)	0.07	-0.06 (0.22)	-0.03
Last Time Stats/Research Course (never omitted)				
Less Than 5 Years	<b>-0.59 (0.27)</b>	<b>-0.39*</b>	-0.13 (0.25)	-0.09
5–10 Years	-0.38 (0.26)	-0.23	-0.16 (0.25)	-0.10
10 or More Years	<b>-0.64 (0.28)</b>	<b>-0.43*</b>	-0.43 (0.26)	-0.28
Research Experience	0.10 (0.28)	0.07	0.34 (0.26)	0.23
Program Type (PhD omitted)				
EdD	-0.13 (0.33)	-0.05	-0.11 (0.31)	-0.05
PsyD	0.56 (0.34)	0.22	<b>0.86 (0.31)</b>	<b>0.36**</b>
Program Modality (face-to-face omitted)				
Online	0.15 (0.25)	0.11	0.26 (0.24)	0.18
Hybrid	0.47 (0.29)	0.20	-0.02 (0.25)	-0.01
Semesters of Doc	<b>-0.06 (0.03)*</b>	<b>-0.29*</b>	-0.04 (0.03)	-0.17
Total Stats/Research Courses	-0.01 (0.02)	-0.06	-0.01 (0.02)	-0.06
Intercept	-0.48 (0.66)		-1.36* (0.65)	
R <sup>2</sup>	0.32		0.37	
N	86		89	

Note. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; higher attitude scores indicate higher levels of negative attitudes towards learning statistics

higher statistics anxiety, such that as age increased, anxiety increased by 0.45 *SD*. Students who were in PsyD programs had statistically significantly higher statistics anxiety scores in this sample (0.36 *SD*) compared to students in PhD programs.

### Factors Students’ Believe Contribute to Their Statistics Anxiety

Analyses of participant’s responses to the open-ended survey questions showed that they believed that there were environmental, dispositional, and situational factors that contributed to their statistics anxiety. This information was important as it went beyond what we were able to measure in closed-ended quantitative questions. Two major themes captured the responses that fit with this research question. Situational factors were captured in the theme “Supportive Instructors Build Confidence and Decrease Anxiety,” and dispositional factors were captured in the theme “Attitude is Everything!” Environmental factors discussed by participants are embedded within

these findings. The findings also highlight the integrated nature of attitudes towards statistics and statistics anxiety.

**Supportive Instructors Build Confidence and Decrease Statistics Anxiety.** Specific experiences are considered situational factors in terms of Onwuegbuzie and Wilson's (2003) framework. Participants mentioned specific situational factors that they believed had an influence on their statistics anxiety and attitudes towards statistics, including past positive or negative experiences, specific instructors, practices, and features of the courses they had taken. There were over fifty responses related to the role of instructors and specific examples of positive instructional and relational practices that students found supportive. First, it became clear that participants believed that the instructor was key to their success in their courses, and in some cases even directly described the instructors' role in reducing their anxiety. Although conflating math with statistics, participants stated, "My success in any mathematics course has always been highly dependent upon the approach of the instructor," and "If you have a good professor, statistics can be learned despite the level of mathematical academic preparation one has." Given the large number of responses related to this theme, we grouped findings into subthemes: (1) *instructor attitudes* and compassion are linked to statistics anxiety; (2) *instructor practices* that include clear, scaffolded, hands-on activities with feedback support learning and less anxiety.

**Instructor Attitudes.** Across the responses attitudes and approaches of instructors played a key role in how participants viewed their statistics experiences, often citing specific instructors or courses by name in their responses, describing the instructors they felt were most successful using phrases such as: "approachable," "kind," "accessible," "positive attitude," "encouragement," "passionate," "considerate of student anxiety," "available," "patient," "positive affirmations," "energy," "enthusiasm," "understanding," and "empathize."

Participants cited key attributes of successful teachers such as positive attitudes, accessibility for questions and feedback, and passion and energy for teaching. Specific to teaching statistics, an attitude that stood out was some participants' description of the importance of the instructor acknowledging statistics anxiety as a way to help address it. For example, "Having a professor who is passionate about statistics yet understanding the anxiety of many of his/her students will help in their presentation of material." Another echoed this by describing a specific instructor they had, stating they "always acknowledged our apprehensions and followed up with positive affirmations, and always instilled in us that we can do it."

**Instructor Practices.** Beyond instructor attitudes, the majority of responses about instructors focused on specific practices they engaged in to support student learning and reduce their anxiety. Across the responses, participants described instructional practices that were scaffolded, had step by step instructions broken down into multiple smaller steps, and opportunities for instructor feedback. Six responses specifically used the phrase "step by step," noting its importance. For example, "My professors were terrific in taking us step by step as to what to do with statistics. I remember being very nervous about the formulas and mathematical elements but with the step by step process, it was clear and I got through it well."

Participants mentioned materials and learning aids that helped including, detailed presentations and slides, sample write ups, problem sets, and examples. Many partic-



icipants noted the importance of videos for this “step by step” instruction as a key tool. Videos were mentioned specifically in eight responses. One participant explained why the videos were so important to them, stating:

Because statistical concepts can be so abstract...just reading texts has not often been enough for me to fully understand the ideas in depth. The most helpful professor I’ve had created videos modeling not only how to utilize statistical technology but also illustrating all of the concepts from our readings.

Participants expressed the importance of labs and problem sets to try out using software, and the need for using real-world education research questions to practice these skills and apply the work to applied scenarios. Some noted that support from their instructors including teaching assistants in lab settings helped enhance these experiences. One participant stated, “It was most helpful to watch videos using SPSS and then do the analyses myself. It was also helpful doing/using the stats and software with real world data and problems.”

The responses highlighted that the hands-on experiences that were tied to real-world examples and presented in clear language were beneficial for deeper learning. One participant stated, “It was useful when the professor explained the practical applications of statistics in plain language.” Further illustrating this point, one participant explained:

If I learn about concepts in statistics and do not understand how to actually use that knowledge when conducting my own research or when evaluating other research, it feels futile to learn. Courses that culminate in designing my own studies, developing models, and making decisions with real data have been the most helpful.

Other responses about how instructional practices included some participants preferring low-stakes assessments with multiple opportunities for instructor feedback, and a dislike for timed exams.

While the examples were primarily positive describing times when participants had successful experiences based on instructors’ practices, it is important to note that some of the responses were not positive. These responses detailed experiences that were the opposite of the positive examples. One participant stated, “Stats is scary, and the required level to which it is taught at my university was not appropriate for my learning needs... In truth, I neither use nor can recall anything from my stats courses that has been relevant to my work since.” Others captured that negative experiences influenced whether they wanted to stay in their programs, anxiety about comprehensive exams and dissertations, and overall stress of success. One participant noted a particularly negative experience among more positive experiences stating,

Of the 3 stats courses required for my program, the 2nd one was the worst...I felt that there was no teaching or learning occurring. Had that been my first course...I would have definitely dropped the program and maybe even decided not to earn a doctoral degree.

Two other participants described overall negative experiences within their programs. One stating, “My stat professors assume that we know or understand more about the work than we do. They speed through the explanations...I fear I won’t do well with stats on the comprehensive and that causes great anxiety for me.” Another student expressed strong concerns about the lack of support they received personally as well as a concern about equity.

All the statistics classes I have ever taken have been very very difficult. I believe that departments should have better options for students in terms of grading and possibly introducing pre- statistics courses to students. I have always been a very good student but was demoralized, even depressed when I received no support from my stats professor or TAs. On the other hand, I was made to think and feel that I was not good enough for the program just because stats was so difficult for me. I tried private tutoring, spent over ten hours a week on stats and I still had to take classes over. I feel stats are important but it felt that departments use it as a money maker since many students fail. There is little or NO support. It’s sad that many of the students that do poorly in stats are also minority students. It almost felt as a weed out program to get rid of us. Although I excelled in all other areas [institution] did a horrible job at helping students succeed in stats.

While these negative experiences represented a very small number of the responses in this subsample, it is possible that these experiences are more prevalent in the population and it is important for them to be discussed. It is also possible that many students did not feel comfortable sharing these negative experiences and they are under-reported within this sample.

**Connection to Past or Level of Experience.** It is also important to note that some of the experiences participants’ described as contributing to their statistics anxiety were prior to their doctoral programs. These past experiences or lack of experience in some cases, influenced their attitudes and feelings of anxiety as they approached statistics in their doctoral program. Past experiences would also be considered situational factors. For example, some participants expressed “I have had very little experience with statistics, and math was never my strong subject so I am a bit intimidated at the prospect of learning them.”

Sometimes their past experiences were positive and that also had an influence. For example, “What we are doing so far related to research methods and statistics is difficult, but I am not at all anxious, probably because I was successful with difficult math and statistics courses in the past. Another participant stated “I think coming from a science background, I’m more familiar and therefore more comfortable with statistics.”

In some cases participants discussed that having more experience was positive, expressing how their views changed over time. “I would have reported hating statistics before I came into this PhD program. The professors turned my mind completely and made me feel empowered.”

**Attitude is Everything!** Participants’ specifically referenced their attitudes around learning statistics in their responses making it very clear that they believed

attitude played a very large role. This would be considered a dispositional factor within Onwuegbuzie and Wilson's (2003) framework. Participants expressed positive attitudes towards learning statistics and learning in general, with some sharing their personal positive attitudes about statistics and others stating more general growth mindset dispositions that they hold. For example, some participants provided statements such as "a negative attitude transpires to a negative outlook on statistics," "every learning opportunity must be approached with a positive attitude," and "I believe that I have to have a growth mindset, do the best I can, and persevere." While noting their positive attitudes, some acknowledged their statistics anxiety in the same statements "I have to admit that taking statistics classes does intimidate me, and is probably one of the reasons I put off a PhD program until now...I do worry that I may experience a high degree of anxiety if I have to do a lot of statistics, but I'm up for the challenge." Participants' attitudes were discussed in the qualitative data as playing a role in their statistics anxiety as well as connected to their plans for future research use. These findings are intertwined and are discussed with further integration in the [discussion](#) section.

### **Role of Statistics Anxiety in Plans for Future Research (Research Question 2)**

Research question two examined the role that students' plans had to conduct research or use research skills in the future had in their statistics anxiety and attitudes towards statistics. Seven items assessed participants' plans and beliefs about research use in their future jobs (Table 2). On average, participants agreed the most with the statements related to being prepared to read, evaluate, and apply findings from research in their field to practice and/or policy decisions when they complete their program. The statements related to conducting their own research as a regular part of their future job or teaching research/statistics courses had the lowest levels of agreement. Open-ended survey questions provided qualitative data on how students viewed the interplay between their plans for research use and statistics anxiety.

### **Relationship Between Statistics Anxiety and Future Research Plans**

To address this question with the quantitative data we replicated the analyses in Table 4, this time adding in plans for research use scores as an additional independent variable to capture a dispositional factor of interest. Plans for future research use was a statistically significant predictor of attitudes towards statistics and statistics anxiety. As plans to use research in the future increased, negative attitudes towards statistics decreased ( $-0.29$  *SD*) and statistics anxiety also decreased ( $-0.22$  *SD*), when accounting for other variables in the models. The other findings in these models were consistent to the models without plans for research use included, with timing of last statistics course, and number of doctoral semesters completed significant predictors of statistics attitudes; and age and program type significant predictors of statistics anxiety.

## Student Views of Plans for Future Research Use

About half of the respondents to the open-ended questions noted ways that their plans for the future motivated them to learn statistics. This motivation could be considered a dispositional factor according to Onwuegbuzie and Wilson's (2003) framework. We named this theme "Future Plans Provide Motivation to Learn Statistics." As examples, some of the future plans motivating them to learn statistics included: "to read the literature in my field," "conduct and write my own research," "my future work in policy and advocacy," "perform duties of my profession effectively well," "gather a variety of statistical data," and "look at data." They focused on a mix of using research and data in their future jobs and plans to conduct their own research either as part of their dissertations or in future jobs. One participant clearly described the tension between anxiety and the need to learn statistics for the future, stating "I have had very little experience with statistics, and math was never my strong subject so I am a bit intimidated at the prospect of learning them... But I also know it is important for me to know, so I will have to step out of my comfort zone and ask for help!"

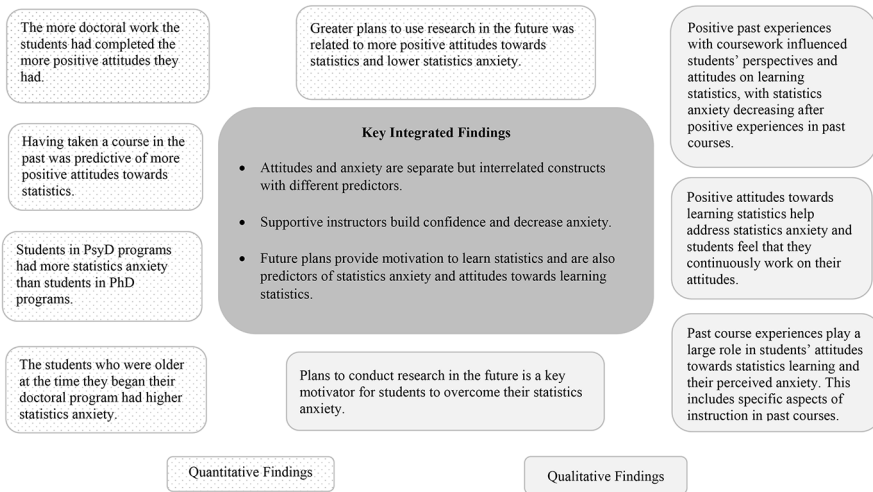
Overall, participants described how their future plans helped them to approach their coursework with positive attitudes. For example, one participant wrote, "Most educational programs today utilize data-driven instruction and interventions. Statistics is necessary, not only to perform my research for my dissertation, but to perform the duties of my profession effectively as well." Another participant explained that learning statistics was key to her plans to transition her career path in the future, "I would love to be able to move from my K-12 role into academia or an NGO. I know research will be a part of that path, so success with statistics is necessary."

Since all of our participants were in the education field or were studying for jobs in the education field this positive attitude and growth mindset focus, may not be surprising. However, given the focus of the study on statistics anxiety, it was surprising that the responses were overwhelming positive. It is also possible that participants with more positive dispositions may have been more interested in filling out these specific questions than others. Given this, we included a discussion of the small number of responses that did not fit with the generally positive findings from this theme.

Two participants shared that their statistics anxiety made them feel limited or concerned about future jobs. One participant mentioned, "Since statistics was very difficult for me I tend to shy away from looking for jobs that require research since it has to do a statistical analysis. This is sad because overall I would like to do research but the statistics behind it make it impossible for me." Another participant expressed concern about the ability to perform her job in the future.

I know I need to not only learn statistics and be comfortable with it. I also need to be proficient in it as it is going to be an important part of my education and future career plans... I am constantly working on my attitude towards statistics as a part of my learning.

It is important to note these perspectives given that they may be more prevalent in the population than they were in this particular small sample. These findings show that



**Fig. 2** Joint Display Depicting Key Findings with Evidence from Qualitative and Quantitative Analyses

dispositional factors such as students’ attitudes and motivations may play a role in their statistics anxiety as well as their plans for future research use.

## Discussion

This exploratory study sought to examine statistics anxiety and attitudes towards learning statistics in doctoral students in education related fields and the role of students’ plans to use research skills in the future. Using closed-ended quantitative and open-ended qualitative survey data we first analyzed the data separately. Then we conducted an integrated analysis to identify key findings using evidence from both data sources. Figure 2 provides a joint display with key findings from both data sources separately with the integrated findings in the middle of the visual.

### Attitudes and Anxiety Are Separate but Interrelated Constructs

Drawing upon the quantitative data and statistical analysis, we found that some environmental and situational factors (Onwuegbuzie & Wilson, 2003) for students were related to more negative attitudes towards statistics and higher statistics anxiety. Across all factors considered in the models (Table 4), we found that as the number of semesters of course work completed for the doctoral program increased, students’ attitudes towards statistics learning became more positive. We also found that students that had some experience taking past coursework in statistics or research methods had less negative attitudes compared to students who had never taken a course before starting their program. These findings suggest that more exposure to coursework (either in the past or during their doctoral program) actually increase positive attitudes. This finding was echoed in the qualitative data where participants

expressed that past experiences with coursework influenced their perspectives and attitudes on learning statistics. This is important since social science and education students often lack experience with research methodologies prior to their doctoral programs (Lin et al., 2011).

However, students also expressed that prior coursework and positive experiences decreased their statistics anxiety which was not replicated in the quantitative analyses with statistics anxiety as the outcome. Based on participant responses, it is possible that many participants believed that their attitude towards learning statistics was more important than their anxiety. Some students even expressed that they were “constantly working on their attitudes towards statistics” in order to help combat the potential negative effects of their anxiety. They described that they could both have high levels of statistics anxiety and yet have a positive attitude that helped them push forward and succeed in their coursework. While connected, statistics attitudes and anxiety were described in different ways by students.

From the quantitative analyses with statistics anxiety as the outcome, we found students who were older when they started their doctoral programs had higher levels of statistics anxiety, and students in PsyD programs had higher levels of statistics anxiety compared to PhD students. When considering age, it is interesting that age had the opposite effect on statistics anxiety than past experiences had on attitudes. This finding is consistent with some other research that also found that older students had more statistics anxiety (Baloğlu, 2003; Bell, 2003). It is possible that students who are older when they begin their program may have other characteristics or experiences that lead to increased anxiety. One participant provided some insight on this topic when they discussed that “I have to admit that taking statistics classes does intimidate me, and is probably one of the reasons I put off a PhD program until now,” alluding to starting a program at a later age. This also may imply that statistics anxiety is a predictor of the age a student starts their program rather than the other way around. This is something that should be explored more in the future.

Taken together, these findings support that attitudes towards learning statistics and statistics anxiety are interrelated, but separate constructs. Our qualitative findings suggest that you cannot really understand one without the other, while our quantitative findings provide support that the correlates of attitudes and anxiety may be slightly different. These findings support previous research that has sought to separate attitudes towards statistics and statistics anxiety into two separate scales (e.g., Devaney, 2016).

### **Supportive Instructors Build Confidence and Decrease Anxiety**

As described above, participants expressed that their experiences in their courses played a big role in decreasing anxiety and supporting positive attitudes. Although the quantitative analyses supported this finding for attitudes, but not anxiety, the qualitative findings provided rich information on the ways in which specific courses, instructors and instructional practices were instrumental in how students’ viewed learning statistics and the supports that were needed. Participants provided multiple examples of how positive attitudes of instructors provide supports that enabled students to be successful in coursework that was anxiety-ridden for them. This included

emphasizing a growth mindset, and positive affirmations. In addition, participants noted the types of instructional practices that increased their learning and decreased their anxiety. These practices included: step by step instructions, tutorials, and videos, scaffolded assignments with multiple opportunities for instructor feedback, and low-stakes assessments that could be redone if needed. Participants also emphasized the importance of hands-on experiences using statistical software and using real-world problems of practice as examples, assignments, and ways to connect the coursework to their professional goals. These findings have direct implications for how doctoral programs and individual course instructors can support students in statistics and research methods coursework.

### **Future Plans Provide Motivation to Learning Statistics**

Understanding that many doctoral students in education would eventually be entering jobs where they would be required to use their research skills to make evidence-based decisions, this study sought to connect statistics attitudes and anxiety to student plans to use research in the future. From the qualitative data, we found that participants described their future goals and career plans as motivation for learning statistics and a way to mitigate their anxiety. This suggests that plans for future research skills use may actually be a predictor of statistics anxiety. These qualitative findings led us to include the future research plans scale as an additional dispositional factor (Onwuegbuzie & Wilson, 2003) in the final statistical models (Table 5). We found that students who greater more plans to use their research skills in their future jobs, had less negative attitudes towards statistics and lower statistics anxiety. These findings were consistent across the quantitative and qualitative analyses. It should be noted that including the research use plans variable in these models did not change the other results. In other words, the same environmental and situational predictors of attitudes and anxiety continued to be significant predictors even after accounting for plans for future research use. This is an area where more research is needed. Future research could take a longitudinal approach and study whether and how attitudes and anxiety during doctoral programs relate to actual research use in their jobs after graduation.

### **Limitations and Areas for Future Research**

It is important to elaborate upon some limitations of this study. First, statistics attitudes, anxiety, and plans for future research use were measured through the survey simultaneously. Although the research skills use questions asked about plans for the future, they were measured at the same time as statistics anxiety in the doctoral program. Therefore, it is possible that the findings would be different if we were measuring the actual use of research skills a few years after the participants completed their degrees. In addition, we were not able to link statistical anxiety to actual performance in coursework given that we did not have course or program grades or completion rate data for students in this study. Future research could include other student achievement outcomes as well. Related, while we found a statistically significant correlation between statistics attitudes, anxiety and predictor variables, temporal precedence is not clear. For example, does age predict statistics anxiety or does statistics anxiety

**Table 5** Regression Results with Characteristics/Experiences and Research Use Plans Predicting Statistics Anxiety and Attitudes

Variable Name	Statistics Attitudes		Statistics Anxiety	
	Unstandardized (SE)	Standardized	Unstandardized (SE)	Standardized
Female	0.18(0.19)	0.10	0.170.18	0.10
Race/Ethnicity (white omitted)				
Black	0.31(0.27)	0.12	0.300.26	0.11
Latinx	0.17(0.35)	0.06	0.270.31	0.09
Asian/Asian Indian	0.12(0.27)	0.05	-0.080.27	-0.03
Other/Multiple	0.00(0.27)	0.00	0.090.26	0.03
Master's Degree	0.17(0.33)	0.07	-0.030.31	-0.01
Age Began Program	0.02(0.01)	0.20	<b>0.040.01</b>	<b>0.47**</b>
Currently Employed	0.11(0.23)	0.05	-0.100.21	-0.05
Last Time Stats/Research Course (never omitted)				
Less Than 5 Years	<b>-0.51(0.26)</b>	<b>-0.34*</b>	-0.080.25	-0.05
5–10 Years	-0.333(0.26)	-0.21	-0.120.25	-0.07
10 or More Years	<b>-0.62(0.27)</b>	<b>-0.42*</b>	-0.430.26	-0.28
Research Experience	0.072(0.27)	0.05	0.320.25	0.21
Program Type (PhD omitted)				
EdD	-0.25(0.32)	-0.11	-0.200.31	-0.08
PsyD	0.24(0.36)	0.10	<b>0.680.32</b>	<b>0.29*</b>
Program Modality (face-to-face omitted)				
Online	0.10(0.24)	0.07	0.220.24	0.15
Hybrid	0.44(0.28)	0.19	-0.020.25	-0.01
Semesters of Doc	<b>-0.07(0.03)</b>	<b>-0.31*</b>	-0.040.03	-0.18
Total Stats/Research Courses	-0.01(0.02)	-0.05	-0.010.02	-0.04
<b>Research Use</b>	<b>-0.32(0.13)</b>	<b>-0.29*</b>	<b>-0.250.12</b>	<b>-0.22*</b>
Intercept	0.93(0.86)		-0.260.83	
$R^2$	0.38		0.41	
$N$	86		89	

Note. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; higher attitude scores indicate higher levels of negative attitudes towards learning statistics

predict the age that students actually begin their doctoral program? More research, data collection, and analysis is needed to examine the ways in which these constructs are related to one another in order to inform practice.

Second, it is important to note some other limitations of this small, exploratory study. This is a small sample and is not representative of the experience of all education doctoral students' experiences in the United States. Given the recruitment strategy, it was also not possible to calculate an overall response rate based on how many people the survey was sent out to. In this particular sample, a very small percentage of students had hands-on research experiences in their program and most were employed full time in professional education roles. It is also possible that students who were motivated to participate in this voluntary study may have had more or less anxiety than the average doctoral student; this may be particularly true for the



open-ended qualitative questions. This was also primarily made up of PhD students (80%) with a smaller percentage of EdD (10%) and PsyD (10%). This means that comparisons between these three degree programs should be made with caution. For example, the finding that PsyD students have higher statistics anxiety than PhD students may not hold in samples with more balanced representation across these program types. Future research could include samples that are more representative of different doctoral program types. We also may have been missing key background characteristics for doctoral students in the sample such as income, potentially leading to omitted variable bias.

### Implications for Policy and Practice

Despite these limitations, this research adds to the limited literature on doctoral students in education-related fields and how to better address statistics anxiety. Universities, schools, departments, and programs can use this information to consider some of the challenges doctoral students face when taking statistics courses and to help mitigate this anxiety and the negative consequences of the anxiety. The findings in this study on demographic or environmental factors that may predict statistics anxiety are consistent with past research (Chew & Dillon, 2014; Onwuegbuzie & Wilson, 2003). We find that students who began their doctoral program when they were older had higher statistics anxiety. This finding is important since many doctoral students in education begin their doctoral programs after many years as professionals in the field as teachers and education leaders. These findings point to the need for universal supports for doctoral students to help address statistics anxiety at the program and course level. Our findings suggest that many of the best practices such as hands-on learning experiences, connections to real world experiences, and supportive instructors are key for statistics and research methods courses. However, our study adds more nuance to this conversation by considering that supporting student attitudes towards statistics may be one of the more important roles instructors can play in order to support student success. Our qualitative findings point to the need for statistics instructors to directly acknowledge students' statistics anxieties, while helping to support their positive attitudes. It is possible that statistics anxiety may remain high, but that improving attitudes may be more important. This was clear from students who were able to express holding both of these realities at the same time, high anxiety, yet positive attitudes. In addition, this study also suggests that tapping into students' motivations for learning statistics in the first place may help support their positive attitudes. Many participants expressed that their need to use research skills in their future jobs was very motivating for them to engage in statistics coursework that they found anxiety producing. This finding is consistent with participants' reports that real-world examples and hands-on activities in their statistics and research methods courses were very important to them. In order to better support doctoral students who will be going into education fields where they will have to use research as part of their jobs, doctoral programs can provide statistics learning experiences that mirror real-world experiences. This may not only improve students' practical skills, but also provide motivation to learn, improve attitudes, and decrease anxiety.

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## Declarations

**Conflict of Interest** The authors have no relevant financial or non-financial interests to disclose.

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