

## Understanding Undergraduate Statistical Anxiety

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### *Abstract*

*The purpose of this study was to understand undergraduate students' views of statistics. Results reveal that students with less anxiety have a higher interest in statistics and also believe in their ability to perform well in the course. Also students who have a more positive attitude about the class tend to have a higher belief in their abilities. These findings can help statistics instructors plan course lessons helping ease student anxiety. Results also help researchers understand the impact of students' attitudes on learning outcomes.*

With many fields requiring students to complete some form of statistics prior to graduation the number of students enrolled in these courses is increasing (Loftsgaarden & Watkins, 1998; Onwuegbuzie & Wilson, 2003). With this increase in enrollment comes the need to better understand student learning and how attitudes and anxiety impact learning outcomes (Schau, Stevens, Dauphinee, & Del Vecchio, 1995). Researchers have found that students' attitudes toward statistics affect enrollment, achievement, and class climate (Gal, Ginsburg, & Schau, 1997).

Statistics courses produce the highest anxiety for students (Schacht & Stewart, 1991; Zeidner, 1991). Onwuegbuzie and Wilson (2003) estimated that among all the students who take statistics more than 65% experience anxiety that is uncontrollable. Statistical anxiety is defined by a worry or fear that occurs when a student is exposed to various statistical concepts (Onwuegbuzie, Da Ros, & Ryan, 1997). High levels of anxiety have also been linked to poor performance (Onwuegbuzie, Da Ros, & Ryan, 1997). Ahmed and colleagues (2012) found a negative relationship between anxiety and achievement. As students' anxiety level increases their academic achievement decreased. Betz (1978) found a similar trend decades earlier in the field of math. The study examined the relationship between math anxiety and success and found a negative relationship. These finding shows the importance of considering anxiety when teaching a course.

Anxiety can also impact the ability to gain statistical skills and knowledge (Hsu, Wang, & Chiu, 2009). More importantly high anxiety impacts students' ability to plan, design, and execute research studies (Onwuegbuzie, Da Ros, & Ryan, 1997). The causes of anxiety typically revolve around the student's disposition, the situation, and the environment (Baloglu, 2004). The present study focuses student dispositions, including attitude about statistics (Harvey, Plake, & Wise, 1985; Zanakis & Valenzi, 1997) and perceptions of the personal usefulness of statistics (Zeidner, 1991).

Students often enroll in a statistics course with a preconceived idea that the course will be difficult, boring, and not relevant to their daily life (Awan & Ullah, 2011). These perceptions, attitudes, and beliefs counteract the supportive environment the instructor is trying to foster (Onwuegbuzie, 2000). There is also a connection between students' attitude and their achievement. Attitudes toward statistics also have a long-term effect. Zanakis and Valenzi (1997) stated that "attitudes and perceptions about statistics influence...the extent to which students use statistics in their careers" (p. 10).

The need for the current study lies in the notion that few studies exist to support the belief that attitudes towards statistics impact student-learning outcomes (Hilton, Schau, & Olsen, 2004). Few studies have examined these constructs with undergraduates (Onwuegbuzie & Wilson, 2003). The purpose of this study was to better understand undergraduate students' views of statistics including factors contributing to anxiety level.

### *Methods*

This study used a concurrent mixed methods design model where the researchers collected and analyzed the quantitative data separately from the qualitative on the same phenomenon. The quantitative and qualitative data collection happened at the same time but data analysis was conducted separately. Data collection included a quantitative and qualitative component.

#### *Quantitative Component*

*Survey instrument development.* One of the instruments administered to students enrolled in an undergraduate statistics course was the *Statistics Anxiety Measure (SAM)* developed by Earp (2007). This instrument was used to measure students' attitudes toward the class and attitudes toward mathematics as they relate to statistics anxiety. The *Statistics Anxiety Measure (SAM)* is composed of 23 items with four subscales: anxiety, class, math, and performance.

Another instrument, *Survey of Attitudes Toward Statistics (SATS)* developed by Schau and colleagues (1995), was also used to measure students' feelings toward statistics, their attitudes toward the usefulness, relevance, and worth of statistics, their attitudes about the difficulty of statistics in the college classroom, their attitudes about their knowledge, their interest, and their effort. The SATS assessed six components of students' attitudes: (a) affect, (b) cognitive competence, (c) value, (d) difficulty, (e) interest, and (f) effort and is comprised of 36 items on a 7-point Likert-type response scale.

*Reliability.* Subscale reliabilities were determined for the six subscales of the Survey of Attitudes Toward Statistics (SATS) scale. Reliabilities ranged from 0.554 for the Effort subscale to 0.871 for the Interest subscale. These reliabilities are comparable to reliabilities reported by Schau and colleagues (1995) except the effort subscale, which is lower than previously reported reliabilities. Scale reliabilities for the four subscales of the Statistics Anxiety Measure (SAM) instrument ranged from 0.733 for the Class subscale to 0.939 for the Math subscale. These reliabilities are comparable to the reliabilities reported by Earp (2007).

*Participants.* The instrument was administered to undergraduates at a large Midwestern university. Participants included 173 undergraduate students enrolled in an introductory statistics course in the College of Education. Students in seven sections of an undergraduate introductory statistics classes volunteered to participate. The instrument was administered during class time and required approximately 15 minutes to complete. Participants were also asked to provide demographic information such as gender, age, grade level, major, ethnicity, and grade-point average (GPA).

### *Qualitative Component*

*Qualitative methods.* This study was framed within an exploratory design to understand participants experience with statistics. The qualitative design involved semi-structured interviews that explored the experiences and perceptions of undergraduates experience in an introductory statistics course.

*Interview protocol development.* The open-ended questions were developed based on the two instruments used in the quantitative component (the SATS by Schau, Stevens, Dauphinee, & Del Vecchio and the SAM by Earp). The interview protocol mirrored the subscales of the quantitative instrument. The interview questions were phrased as open-ended questions to elicit more information from participants, while measuring the same concepts. Participants were asked ten questions on eight main topics. The questions dealt with students' perceptions of statistics, how they felt in regard to the usefulness of statistics, and their anxiety with the course.

*Participant identification and access.* Participants were enrolled in an introductory statistics course at a large Midwestern university. The researcher interviewed 13 students. The researcher reached saturation after roughly seven participants, but conducted a few more interviews to ensure saturation and because more than seven participants volunteered. The interviews were administered outside of class time and each interview required approximately 20 minutes. Participants had a mean age of 19.56 ( $SD = 1.12$ ). The majority of participants were white (88%), females (61%), and studying nutrition (22%).

### *Mixed Methods Component*

*Analysis.* The quantitative and qualitative data were compared using the method described by Creswell and Plano Clark (2007) to determine whether or not the two data collection methods revealed similar results. Quantitative and qualitative analysis was done separately and then together using a matrix. The analysis focused on the inferences made in the quantitative and qualitative components of the study with regard to students' levels of statistics anxiety, cognitive competence, statistics difficulty, value of course, interest, effort, and performance.

## *Results*

### *Quantitative Results*

*Descriptive statistics.* The majority of the participants were white (90%), female (70%), and majoring in nursing (16%). A majority of the participants were sophomore (56%) with an average age of 20.32 ( $SD = 2.07$ ).

*Pearson correlations.* There was a significant relationship between anxiety and performance,  $r(171) = -0.43, p < 0.05$ . There was a significant relationship between students' view of the class and their performance,  $r(172) = 0.47, p < 0.05$ . There was also a relationship between students' interest in statistics and their anxiety,  $r(172) = -0.28, p < 0.05$ . There was a significant relationship between cognitive competence and perceived difficulty,  $r(173) = 0.55, p < 0.05$ .

### *Qualitative Findings*

*Difficulty.* When talking about the difficulty of the course participants mentioned how hard certain homework and exam problems were. They also discussed struggling with the math component of the course and mentioned having hard times in past math courses. Participants who thought statistics was difficult reported less confidence in their abilities. One participant stated "I think that my skills are definitely lacking ... my knowledge about statistics is limited."

*Anxiety.* When students were talking about statistics they mentioned having higher levels of anxiety compared to other courses. Many students mentioned that their anxiety comes from the use of numbers and calculations throughout the course. One student stated, "sometimes I get anxious, because I know I'm not doing well and I really don't want to have to retake this course." Some students stated their anxiety impacted their ability to do as well as they would like to in the course.

*Value.* While students struggled with various components of the course, students did see the usefulness of the course. Students stated that while they were taking the course because it was required they could see how it could be used in their future career. One student mentioned they believed "every student should take a statistics course because it is not difficult and it is very relevant to everyday life." Another student said, "I think I will use statistics in almost any profession I might employ because statistics is very relevant to the work life."

*Effort.* In addition to seeing the value of the course some students reported putting a great deal of work into the course. When asked to compare the amount of time they spent on their statistics class to other courses most students reported spending more time on statistics. One student said, "I would say that my skills are good/above average because I went to the class often and worked hard to achieve good grades." However, students who reported spending more time also reported doing better in the course compared to students who reported spending less time. One student said, "as I worked harder throughout the semester I began to understand the concepts and I received better grades."

### *Mixed Methods Results*

The survey and interview results were merged together to further understand how other statistics students described relationship among certain variables found in the qualitative component of the study.

There was a negative relationship between anxiety and performance. Participants who reported lower levels of anxiety reported higher performance. One participant who reported little anxiety

stated, "I have learned a lot in this statistics class ... I definitely have more knowledge about statistics because of this course." There was a positive relationship between students' views of the class and their performance. Also participants who had a more positive attitude about the course tended to do better in the course. One student said, "I would say that my skills are good/above average because I went to the class often and worked hard to achieve good grades." There was also a significant negative relationship between students' interest in statistics and their anxiety. Participants with less anxiety reported more interest in the course. There was also a negative relationship between cognitive competence and perceived difficulty. One participant stated "I think that my skills are definitely lacking ... my knowledge about statistics is limited."

### *Discussion*

Overall, results reveal students with lower anxiety and a better attitude believed in their ability to perform in the class. Also students with lower levels of anxiety tended to be more interested in the course. These findings confirm what others have found while expanding on the various components that also contribute to anxiety and attitude. Students also reported above average effort when asked about the energy they put into their statistics course. Effort was a new component of the study and seemed to have no relationship to anxiety; however, students who believed they put in more effort seemed to show higher levels of interest. Difficulty was another concept that was measured in this study. Overall, students reported the difficulty of statistics was about average. Students who perceived the class as more difficult perceived the class as more valuable. This was a finding that was not revealed in the literature review. This could be attributed to the fact that students who value the class want to make sure they understand everything and therefore struggle and perceived the class as challenging.

Over the years the number of studies that have studied teaching statistics have increased and the findings from those studies have found a strong link between anxiety and performance in statistics courses (Benson, 1989; Gal & Ginsburg, 1994; Perney & Ravid, 1990; Zeidner, 1991). This study found similar results; anxiety was negatively correlated with all other factors except effort, which was not significant. One study found students who experience statistical anxiety perceived statistics as useless and hard (Hsu, Wang, & Chiu, 2009). However, in this study, while students with high anxiety did perceive the class as useless, they did not perceive the class as difficult.

Future research is needed to further clarify the relationship between statistical anxiety and perceived usefulness. Researchers should also examine what math preparation could be done in high school to prepare students for college level statistics and lower anxiety. The results of this study should be of great value for statistics instructors. Statistics instructors should be aware that students who have limited previous mathematics experiences might experience more difficulties in statistics courses. These difficulties might be present in the form of perceiving statistics as less important, more stressful, and requiring more effort. As a statistics instructor, it is important to realize some students might need more individual attention and support.

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