A Mixed Method Investigation of Social Science Graduate Students' Statistics Anxiety Conditions before and after the Introductory Statistics Course

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Abstract

Research frequently uses the quantitative approach to explore undergraduate students' anxiety regarding statistics. However, few studies of adults' statistics anxiety use the qualitative method, or a sole focus on graduate students. Moreover, even fewer studies focus on a comparison of adults' anxiety levels before and after an introductory statistics course. This line of study is important to pursue, since the introductory statistics course should play very important roles of both preparing students' foundation knowledge and inspiring their interests for a higher-level course. In addition, graduate students tend to have different backgrounds, learning motivations, and learning habits, compared to their undergraduate counterparts. Overall, limited mixed research method is available on social sciences graduate students' (1) statistics anxiety before and after the introductory statistics course, and (2) actions taken to decrease the anxiety. This study seeks to fill this gap by incorporating a mixed research method in order to explore social sciences graduate students' statistics learning processes. Findings suggest that the social sciences graduate students' anxiety levels tend to diminish after the introductory statistics course, even though these also experience severe statistics anxiety at the very beginning. These findings become essential for institutions, higher education instructors, and social sciences statistics learners to consider.

Keywords: statistics background, adult learners' characteristics, learning motivation, learning desire, decrease statistics anxiety

1. Introduction

1.1 Statistics Anxiety Before and After the Introductory Statistics Course

Statistics is a difficult subject for many students, particularly those whose majors are not related to statistics or mathematics. "Statistics anxiety" is experienced by as many as 80% of graduate students (Onwuegbuzie, 2004). Some studies reported that undergraduate students are likely to experience severe anxieties in their encounters with concepts, questions, or tests related to statistics (Zeidner, 1991; Onwuegbuzie, 1998; Onwuegbuzie & Leech, 2003). Researchers opined that anxiety in statistics is regarded as the major obstacle in acquiring a degree (Onwuegbuzie, 1998; Onwuegbuzie & Leech, 2003). Moreover, students with high levels of anxiety usually delay enrollment in statistics courses as long as possible, which often leads to a failure to complete degree programs (Onwuegbuzie, 1997). Furthermore, most undergraduate or graduate students in social sciences are required to take one or more statistics courses as part of their program of study. However, this group of students displays a minimal background in statistics or mathematics. As a result, statistics anxiety levels among students with non-statistics or mathematics background may be higher than among those students from statistics or mathematics-natured areas (Zeidner, 1991). Pan and Tang (2005) also indicated that students with limited prior statistical or mathematical training may show noticeably higher levels of statistics anxiety. Thus, statistics anxiety may be considered a top issue in the statistics education of social sciences students, and therefore must be addressed. In addition, Gal and Ginsburg (1994) stated that an introductory statistics course should encourage guidance toward a goal that prepares students to take higher level statistics courses, even though most students experience severe statistics anxiety at the beginning of the course. Therefore, students' attitudes after the introductory statistics course become pivotally important.

Studies revealed that undergraduate students' statistics anxiety levels become more serious from the pre-test to post-test (Ramirez & Bond, 2014; Swanson, VanderStoep, & Tintle, 2014). As a result, researchers focused on actions that could reduce statistics anxiety. Dillon (1982) demonstrated that students' statistics anxiety could be

alleviated by talking about their fears. Schacht and Stewart (1990) suggested that collecting real data from students and having students perform simple calculations (obtaining the mean, etc.) aids in not only in a reduction of anxiety levels, but also in an increased motivation in the class. Teachers may contribute to the reduction of statistics or mathematics anxiety, and thus enhance learning by integrating more efficient instructional strategies into their teaching (Smith, 2000; Pan & Tang, 2005). Chiou, Wang, and Lee (2014) found that a one-minute paper strategy could reduce students' statistics anxiety significantly and thereby improve students' statistics achievement.

Literature signifies that it is important to have students talk, share, and discuss their experiences in the statistics learning process, including their concerns regarding statistics anxiety, as well as actions to reduce that anxiety. Most studies focus on students' statistics anxiety and actions to reduce anxiety levels, conducted with a quantitative approach. Yet too little qualitative research (or mixed method research) exists in this area. Moreover, the differences between undergraduate and graduate students in statistics learning are even less discussed, which may lead to an extensive bias in statistics education, since undergraduate and graduate students are very different in regard to their backgrounds, learning motivations, learning habits, etc. As a result, very limited mixed research method is available on social sciences adult learners' statistics anxiety conditions before and after the introductory statistics course, and possible actions that could be taken to release statistics anxiety.

1.2 Purpose of the Study

The target population for this study focuses on graduate students in the social sciences. These individuals require statistics skills in order to read academic reports and papers, design experiments, and analyze quantitative data collected from surveys or test results. In analyzing data, these students usually encounter significant problems, due to the lack of familiarity with statistical techniques such as the analysis of variance (ANOVA), the analysis of covariance (ANCOVA), regression analysis, exploratory data analysis, multivariate analysis techniques, etc. (Gould, 2010). In addition, this study focuses on adult learners, defined as graduate students ranging in age from 25 to 64 years.

This target population, by combining social sciences and adult learners, provides a basis for statistics education to be viewed as unique and worthy of emphasis. Most students from the social sciences tend to display a limited background in statistics or mathematics; such a lack of background knowledge makes statistics comprehension difficult. Further, statistics itself is not an easy subject. The inherent mathematical difficulties of statistical language, as well as abstract statistical concepts, lend to make statistics learning even more of a challenge. Moreover, graduate students tend to have both different limitations and strong points in learning, when compared to undergraduate students. For example, adult learners usually have part- or full-time jobs or are teaching assistants, and often need to deal with the issues of a family. In fact, the primary limitation in statistics learning for the adult students could be a shortage of time, which is rarely a problem for undergraduate students. However, graduate students usually display a high expectation, a strong self-motivation, a strong willingness to learn statistics, and more confidence in dealing with statistical challenges.

1.3 Research Questions

As discussed earlier, few researchers have specifically examined students' statistics anxiety from the learner's perspective, with both quantitative and qualitative approaches. In addition, students' statistics anxiety levels at the very beginning and after the introductory statistics course are rarely discussed and compared. Moreover, the statistics anxiety among social sciences adult learners with limited statistics or mathematics backgrounds are discussed even less. Thus, this study will focus on a deeper analysis of the statistics learning experience of social sciences adult learners in a doctoral level statistics course. These students from 25 to 64 years of age are from various area backgrounds, but these areas are within the social sciences domain.

This study is conducted to discuss the following questions:

1. Do students' anxiety levels diminish after the introductory statistics course?
2. If yes, what actions could be taken to release the statistics anxiety?

2. Method

2.1 Methodology

The mixed method research with both quantitative and qualitative methods are utilized in this study, while the qualitative portion plays a major role. The quantitative research focuses on comparing the difference between students' anxiety levels before and after the introductory statistics course. The qualitative portion plays the role of further exploring students' statistics learning experience.

For the quantitative part, the quantitative data from two survey items are collected. The Mann-Whitney U test is used to analyze the quantitative data. The Mann-Whitney U test is the nonparametric counterpart for the independent two-sample t-test. First, this is appropriate since the total number of participants for this study is thirteen, and the sample size for each group is even smaller. In addition, the Likert items from the surveys are collected for this study. The response values are ordinal with 5-point scales from "strongly disagree" through to "strongly agree." Therefore, the dependent variables are ordinal, and thus are inappropriate for the parametric test of the independent two-sample t-test. Moreover, the assumptions of normality and equality of variance required for the parametric tests are not met. Considering these various conditions, the nonparametric Mann-Whitney U test is a good fit for this study. In addition, since two hypotheses (two items) are being performed simultaneously on a single factor, the Bonferroni adjustment is made to the P value to keep the desired alpha value to .05 for the whole family of hypotheses tests. The family-wise error rate is .05/number of hypotheses tests. In contrast to the parametric test, the mean rank instead of the mean value is compared between the two groups.

For the qualitative part, ten cases are included. Like Crotty's (1998) model, this study model is composed of four parts: (1) epistemology, (2) theoretical perspective, (3) methodology, and (4) methods. This model is guided by constructivism, defined as the belief that people efficiently construct the meaning of the reality surrounding them by means of their interactions with one another, and with objects in the environment (Malik, 2015). The theoretical perspective in this study is *interpretivism*, a means of understanding and explaining human and social reality, which in turn explores students' beliefs about actions reducing statistics anxiety (Crotty, 1998). The methodology of phenomenology, the best fit for the emphasis of this study, rests on the statistics learning experience of social sciences graduate students. Phenomenology refers to the study of people's subjective and everyday experiences (Crotty, 1998). In a phenomenological study, the researcher seeks to explore the useful information and structure patterns of a phenomenon by analyzing data drawn from the participants' first-hand experience of the phenomenon (Yeh & Lehman, 2007). Lastly, the primary method of this study is the qualitative approach with open-ended, one-on-one, task-based, semi-structured interviews (Merriam, 2009). The aim of this study is to understand students' experiences and perceptions of statistics learning. The semi-structured interview is also a good fit for this research in order to retain details from talking directly with participants and allowing them to tell their stories. Thus, this data collection surpasses what the researcher expects to find from previous experience and what is previously read in historical literature.

2.2 Ethical Issues

Before conducting the study, the researcher obtained university approval from the institutional review board for this study. In the dissemination of the volunteer information to students, the purpose of the study was disclosed to the participants. After selecting the volunteers and before the interview, all participants voluntarily signed a consent form approved by the university institutional review board. This form included the purpose of the study, subject, study procedures, benefits, risks (no risks), right to refuse (Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled), and privacy (results of the study may be published, but no names or identifying information will be included in the publication). Subject identity will remain confidential unless disclosure is required by law. The participants are identified by the use of acronyms in the final paper.

2.3 Data Collection

Thirteen volunteers are involved in the quantitative part, which constitutes male and female students with ages ranging from 30 to 55 years. Students report the following for race/ethnicity: Asian, Brazilian, and white. Each participant holds a masters degree and pursues a doctoral degree. Their majors are within social sciences. The various time demands of their jobs include part-time and full-time jobs. Some have no background in statistics, and others have a minimal statistics knowledge from a basic-level statistics course. The quantitative data from the two survey items are collected from the thirteen students. The two items are (1) I am scared of statistics, and (2) I get nervous going to statistics class. The Mann-Whitney U test is conducted with students from before-course and after-course groups. The Bonferroni adjustment is made to the P value to keep the desired alpha value to .05. The family-wise error rate is .05/2=.025 for this study.

The qualitative data from a series of interviews are collected from the ten students, with five students interviewed from each of the two groups. Before the interview, the researcher conducted a pilot interview with an acquaintance, who relates to this study as well. The purpose of the pilot interview is to ascertain whether these questions make sense and whether the participant will respond in expected ways. After this pilot interview, small changes are applied to the questions.

The researcher, who is also a teacher assistant for a doctoral level introductory statistics course, conducted all the interviews for this study. The researcher, a teaching assistant in an introductory statistics course for several years, carries the primary responsibility for teaching students how to conduct statistical analysis with the software package, "Statistical Package for the Social Sciences" (SPSS). The researcher has similar experiences to those of the students, and thus represents a good fit for conducting the clinical interview for this study. After collecting the interview data, the thematical analysis is then used to analyze the data.

All ten interviews were conducted in the researcher's office, since some participants had requested statistics help during the past semester. The concept of using a familiar location deemed it viable that the participants would find such surroundings more comfortable, since the possibility existed that the participants would feel relaxed and more inclined to speak. The audiotape was used via iPhone during the interview. When the interview began, the researcher placed the iPhone on the desk between them. With the participants' prior permission, the researcher started the audiotape positioned in front of them, with the explanation that the audiotape would aid in recording their views correctly, and with an added assurance that the participants could stop the interview or recording at any time if they felt uncomfortable. This process went very smoothly, and all the participants seemed quite comfortable with the audiotape.

When conducting the interview, the researcher combined both semi-structured and in-depth interviews. With the semi-structured interview, the interviews were conducted on the basis of a loose structure, one which is guided by different topics and open-ended questions. The guiding topics include demographic information, previous statistics background, attitudes toward statistics, experiences in statistics classroom, group study versus study alone, and online versus in-class courses. With the in-depth interviews, the researcher sought to explore participants' perceptions and experiences in greater detail.

After recording the ten interviews, the researcher uploaded the recordings to his/her computer and deleted them from iPhone to make certain that no transcripts were lying around, and that no one else could access those materials. The researcher transcribed the recordings via the website www.swiftscribe.com. With the general transcripts from the website, a literal sentence-by-sentence correction was gained, based on the audio.

3. Results

3.1 Social Sciences Adult Learners' Statistics Anxiety Before and After the Introductory Statistics Course

The Mann-Whitney U test results from Table 1 indicated that one hypothesis was significantly different between students from the two groups, with Asymp. 2-tailed Sig. value of .004 less than the family-wise error rate of .025. More details from Table 2 demonstrated that students from the after-course group had comparatively lower levels of statistics anxiety for both items. Concerning Item 1, the mean value for students from the after-course group was 2.40, indicating that students held a disagreeing-to-neutral attitude toward the statement that they were scared of statistics, while the mean value for students from the before-course group was 4, indicating that the students agreed with this statement. Concerning Item 2, the mean value for students from the after-course group was 1.2, showing that students tended to disagree with the statement that they become nervous at the thought of going to statistics class. The mean value for students from the before-course group was 3.75, indicating that the students held a neutral-to-agreeing attitude toward this statement.

To conclude, students' attitudes differed between the two groups. At the beginning of the course, students had comparatively higher levels of statistics anxiety, with mean values of 4 and 3.75 out of 5 regarding the statement of (1) I am scared of statistics, and (2) I get nervous going to statistics class. However, students' attitudes diminished after the introductory statistics course, being against the statements, showing mean values of 2.4 and 1.2, respectively.

Table 1. Mann-Whitney U Test Statistics[a] for Students' Anxiety Related Attitudes Toward Statistics

	Item 1	Item 2
Mann-Whitney U	7.5	1.0
Wilcoxon W	22.5	16.0
Z	-1.888	-2.857
Asymp. Sig. (2-tailed)	.059	.004
Exact Sig. [2*(1-tailed Sig.)]	.065[b]	.003[b]

a. Grouping Variable: Group

b. Not corrected for ties.

Table 2. Students' Anxiety Related Attitudes Before and After the Statistics Course (Mean Values)

	Group	N	Mean	Std. Deviation
1. I am scared of statistics.	Before Course	8	4.00	1.195
	After Course	5	2.40	1.342
2. I get nervous going to statistics class.	Before Course	8	3.75	1.282
	After Course	5	1.20	.447

Follow-up interviews were conducted with five students from each of the two groups to explore more deeply about their statistics learning experience. The interview responses indicated that all students, interviewed at the course beginning, displayed high levels of statistics anxiety. Most of them took the statistics course due to its being required, while almost all of them had no plans to take any higher-level statistics courses at that moment if not required. However, all five students from the after-course group also had serious statistics anxiety at the beginning of their statistics course, yet after they had completed the course, they were not so anxious about statistics; all planned to take some higher-level statistics courses. The interview findings are consistent with the quantitative survey results: before taking the statistics course, the social sciences adult learners had much higher levels of statistics anxiety, while students' statistics anxiety levels were relinquished after these completed the introductory statistics course; in fact, the students became somewhat interested in statistics.

3.2 Actions to Release Statistics Anxiety of Social Sciences Adult Learners

Students interviewed at the end of the statistics course indicated a release occurred of their statistics anxiety levels, even though they were anxious about statistics at the very beginning of the course. Most of them planned to further take higher-level statistics courses. The experiences of these students were generalized into four actions to help release their statistics anxiety: (1) emphasize the basic concepts to ensure mastery, (2) make more time for statistics learning, (3) focus on fewer materials at a time to increase learning, and (4) relate statistics to students' research areas.

The first action was to emphasize the fundamental concepts to ensure mastery. Comments from the students indicated that understanding the basics would a) lay sound foundations for statistics learning, b) make the instruction more enjoyable, and c) further develop their interests in statistics.

The second action was to make more time for statistics learning. The primary challenge for adult learners was the shortage of time. Comments from the students indicated that with more time for statistics, they would expect to find more success and enjoyment. On the other hand, limited time might increase anxiety while decreasing interest, success, and satisfaction. The comments reported that much of the anxiety experienced was not related to statistics subject matter, but rather to insufficient time to prepare before classes and exams. The interviewees expressed that with more time to study and practice statistical concepts, they would enjoy the subject more.

The third action, suggested by all students, was to focus on fewer materials at a time to increase learning. Alfred North Whitehead (1916) suggested that teachers should focus on teaching a few very important ideas as "thoroughly" as possible. Attempting to "cover" too many ideas leads to one becoming an expert in none of them, and everyone should "possess…expert knowledge in some special direction…" (Whitehead, 1916). In applying this idea to statistics education for graduate students, instructors might consider breaking down the statistics subject matter into smaller, more manageable lessons so that students have time to learn the material more deeply. This avenue of instruction may tend to expand the same statistics material to two courses instead of one.

The fourth action was to relate statistics to students' research areas. Comments from the students indicated that applied topics from students' research areas might inspire their interests and thereby connect their statistics learning to practical studies. These comments were also in accordance with the learning assumption of Knowles (1984), who asserted that adult learners were problem-centered and had a perspective for immediate application of knowledge.

4. Discussion

As previously mentioned, limited qualitative research is available when comparing students' statistics anxiety levels before and after the introductory statistics course, as well as actions that could reduce their anxiety levels. Moreover, studies focusing on students from social sciences often either focus on the undergraduate students, or regard undergraduate and graduate students as a whole. However, many contemporary social science students range in age from 25 to 64 years and thus present different characteristics when compared to their undergraduate counterparts.

This study was conducted to fill the gap in this area by applying a mixed research method to explore the statistics learning experiences of social science graduate students.

This analysis produced some impressive results. Contrary to the previous studies that undergraduate students' statistics anxiety became more serious from pre-test to the post-test (Ramirez & Bond, 2014; Swanson, VanderStoep, & Tintle, 2014), the social sciences graduate students' anxiety levels diminished after the introductory statistics course, with most of them planning to take some higher-level statistics courses. Four activities were generalized as to how the introductory statistics course might reduce students' statistics anxiety. These four activities are (1) emphasizing the basic concepts to ensure mastery, (2) leaving more time for statistics learning, (3) focusing on fewer materials each time to increase learning, and (4) relating statistics learning to students' research areas. Emphasizing the basics to ensure mastery thus would lay a good foundation that might make the statistics learning process more enjoyable, while further developing students' interests. With the proper foundation and enough time for statistics learning, students might experience more enjoyment during the learning process. Focusing on fewer materials each time to increase learning also might decrease anxiety and increase enjoyment. With this approach, students could address each statistics topic in depth, a process which might promote the stronger skills needed for careers in research. Lastly, the course should relate the statistics learning process to students' research areas. This connection between education and practice could inspire students' interests and strengthen motivations to develop more a specific knowledge of statistics.

The first activity of emphasizing basic concepts to ensure mastery is consistent with the recommendation from Garfield and Everson (2009), that teaching should emphasize statistical literacy and basic concepts. This suggestion also works for teaching graduate students statistics, even in the preparation of graduate students as teaching assistants, or for other individuals to follow academic careers in mathematics or statistics. For the second finding, the decision to leave more time for statistics learning is consistent with the previous finding that adult learners usually have many personal issues, such as family, friends, work, and the need for personal time for the individual quality. In fact, the shortage of time might well be the primary constraint for adult learners, as a basic cause for statistics anxiety (Pappas, 2013). The third finding is that focusing on fewer materials each time in order to increase learning is also consistent with the recommendation from Garfield and Everson (2009), who noted that a statistics course should stress conceptual understanding, rather than a mere knowledge of procedures. Moreover, this finding also supports the research from Pappas (2013) that aging does affect learning, and that although adult learners are slower learning, yet they acquire more integrative knowledge. Adults tend to learn less rapidly with age. However, the depth of learning tends to increase over time, navigating knowledge and skills to unprecedented personal levels. The fourth finding is to relate statistics learning to students' research areas, which also supports the recommendation from Garfield and Everson (2009), who advocated the use of real data.

5. Limitations

There are several limitations in this study. Firstly, even though a mixed method research was used in this study, the sample size of thirteen participants for the quantitative part could be small. It is particularly the case when the target population is variable in nature. Secondly, a selection bias may exist. Although the study attempted to balance the samples to construct a representation of the target population by including both male and female students, different ethnicities, and diversity in ages, it is still very possible that the student volunteers who participated in this interview studied very hard, liked statistics, and were willing to spend more time in statistics, such as those who took the interviews. Thus, a larger sample size and a more representative sample for the quantitative part might be discussed in the future. Moreover, the comparisons between students' anxiety levels before and after the introductory statistics course were from two different groups of people. Since the individual variate could be huge, the researcher suggests that future research be performed on one group of people, to compare their anxiety conditions before-and-after the introductory statistics course. Despite the limitations, this mixed research methodology with the clinical interview presents a viable way to gain more information not easily obtained through the quantitative method alone.

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