Preparing Prospective Teachers: An Examination of Attitudes Toward Statistics

Linda Reichwein Zientek, Ph.D. †
Tamara Anthony Carter, Ph.D. ‡
Judy M. Taylor - LeTourneau University, Ph.D. §
Robert M. Capraro - Texas A&M University, Ph.D. ¶

Abstract

Teachers' attitudes and knowledge of statistics may impact the K-12 classroom implementation of the NCTM data-analytic standards. Presented in this study is a set of benchmarks for future studies investigating prospective teachers' attitudes toward statistics. The results suggested that (a) prospective teachers' attitudes toward statistics impacted their academic achievement in a senior level education course; and (b) students' perceptions of the instructor's explanations and teaching methods were related to prospective teachers' attitudes toward statistics.

Background

Statistics, the study of data, is vitally important in people's daily lives (Ben-Zvi & Garfield, 2008). According to Mooney (2002), a lack of understanding of statistics hinders a person's ability to be a productive citizen. Until the 1980s, probability and statistics typically were not viewed as important in primary and secondary education. Today, probability and statistics are considered fundamentally important in preparing students who can make intelligent decisions about quantitative information (Ben-Zvi & Garfield, 2008). In 1990, Bratton concluded teachers were not prepared to teach statistics, and, in order for teachers to become better prepared, teacher preparation programs would need to undergo major changes to include instruction on probability and statistics. Today, advocates for statistics in the K-12 curriculum include the Conference Board of the Mathematical Sciences (CBMS; 2001) and the National Council of Teachers of Mathematics (NCTM; 1989, 2000). The success of the NCTM's data analysis and probability strand will depend on teachers' knowledge of and attitudes toward statistics (ATS). The purpose of the present study was to investigate prospective teachers' beliefs and ATS and the relationship between students' ATS and statistical achievement.

Attitudes Toward Statistics (ATS)

In 1992, Shaughnessy noted that the success of the NCTM probability and statistics standard depends on teachers, and recommended future research focus on investigating teachers' conceptions and attitudes toward stochastics (i.e., probability and statistics) at the pre-service and in-service levels. In 2001, after almost a decade of mathematics reform, the CBMS (2001) supported Shaughnessy's proposition that teachers were least prepared to teach probability

and statistics. Fifteen years later, Shaughnessy (2007) reiterated the need to investigate students' and teachers' ATS by reporting that "there has been very little research into students' and teachers' beliefs and attitudes toward statistics" (p. 1001). When comparing the sample of public school teachers enrolled in a graduate class and a sample composed of graduate psychology and undergraduate students found that the teachers exhibited less positive ATS (Onwuegbuzie, 1998). The increased emphasis on statistics in the K-12 curriculum and the uncharted research on preservice teachers' ATS justify the need to further examine ATS and beliefs of preservice and inservice teachers.

Four facets of attitudes toward statistics (SATS) have been identified: Affect, Cognitive Competence, Value, and Difficulty. Affect refers to the positive and negative feelings or emotions concerning statistics; Cognitive Competence refers to the attitudes about intellectual knowledge and skills when applied to statistics; Value refers to the attitudes about the usefulness, relevance and worth of statistics; and Difficulty refers to the attitudes about the difficulty of statistics as a subject (Schau, Dauphinee, & Del Vecchio, 1995). The negative feelings of Affect are behaviors typically exhibited by those suffering from high levels of statistics anxiety. Schau (2005) added Effort and Interest in learning statistics for a total of six facets.

Gal and Ginsberg (1994) suggested that perhaps those who have difficulty learning statistics it is becasue of "non-cognitive factors, such as negative attitudes or beliefs toward statistics that can impede learning of statistics, or hinder the extent to which students will develop useful statistical intuitions and apply what they have learned outside the classroom" (p. 1). Learning statistics may be challenging because (a) "statistical ideas and rules are complex, difficult, and/or counterintuitive"; (b) "many students have difficulty with the underlying mathematics . . . and that interferes with learning the related statistical concepts"; (c) the context of the problem may mislead students resulting in incorrect statistical procedures; and (d) "students [may] equate statistics with mathematics and expect the focus to be on numbers, computations, formulas, and only one right answer" (Ben-Zvi & Garfield, 2008, p. 356). Perfectionists tend to look for the one right answer and researchers have found a link between perfectionism and difficulties in statistical achievement and statistics anxiety (Onwuebguzie & Daley, 1999; Walsh & Ugumba-Agwunobi, 2002).

Statistics attitudes and anxieties have been shown to be related to the Surface-Disintegrated Study (SDS) construct of the Mathematics Information Processing Scale (MIPS). The SDS factor includes items related to unproductive problem-solving experiences, students' preferences for instruction that is structured or supervised, and students' perceived inability to learn mathematics and statistics concepts or their ability to obtain a deeper understanding of important concepts. The Metacognitive Problem Solving construct of the MIPS was slightly related to statistics anxiety and modestly related to statistics attitudes (Bessant, 1997).

Mathematics and Statistics

Mathematics and statistics courses should not be equated (Cobb & Moore, 1997; Rossman, Chance, & Medina, 2006). Statistics and mathematics are two distinct disciplines, and "statistics can be viewed as a type of bridge that connects mathematics and science" (Ben-Zvi & Garfield, 2008, p. 359). While research has shown ATS to be related to statistical achievement, the relationship between (a) prior mathematics knowledge and mathematics attitudes and (b) statistical achievement is unclear. Woodward and Galagedera (2006) found prior mathematical knowledge did not impact success in an elementary statistics course but did find that aptitude, effort, and motivation were predictors of statistical achievement. They found support for their "hypothesis that statistical thinking at the elementary level is mostly intuitive and nonmathematical and downplays the need for mathematics prerequisite courses or a mathematics review before entering a first course in statistics" (p. 638). Dillon (1982) found evidence her students were equating their attitudes toward mathematics with ATS and believed addressing how to overcome mathematics anxiety (MA) was helpful in relieving anxieties in the statistics classroom. As noted by Ben-Zvi and Garfield, some of the difficulties in learning statistics (a) involves students' perceptions that statistics *is* mathematics and (b) may be due to students' inability to solve and understand essential mathematical concepts introduced prior to algebra such as fractions, decimals, proportional reasoning and algebraic skills.

In tandem, mathematics and statistics anxiety should not be equated. However, the relationship between MA and statistical achievement has been shown to be inversely related (Bendig & Hughes, 1954; Fisch, 1971; Hunsley, 1987) leading one to believe that the factors related to MA are closely related to statistics anxiety. For example, Perney and Ravid (1990) showed that MA was directly related to statistics anxiety with similar underlying factors (Onwuegbuzie, DaRos, & Ryan, 1997). In particular, MA has been shown to impede students' conceptual understanding of statistics by resulting in students who tend to memorize how to conduct statistical procedures rather than concentrating on understanding statistical principles (Blalock, 1987). Therefore, in light of our focus on preservice teachers and the relationship between statistics and MA, a discussion on MA of preservice teachers is warranted.

MA has been shown to negatively impact student learning (Hembree, 1990; Ma, 1999), and preservice teachers have tended to exhibit relatively high levels of MA (Hembree; Zientek, Yetkiner, & Thompson, 2010). For example, Hembree's review of research studies found prospective teachers enrolled in a mathematics for prospective elementary teachers and an elementary education course exhibited higher MA levels as measured by the 98-item Mathematics Anxiety Rating Scale than students enrolled in an elementary statistics course. An investigation by Akinsola (2008) of in-service mathematics teachers found that while teaching efficacy, locus of control, and study habits were predictive of teachers' problem solving abilities, MA was the best predictor of problem solving abilities.

Statistics Anxiety

Statistics anxiety, as defined by Onwuegbuzie et al. (1997), "occurs when an individual experiences anxiety as a result of encountering statistics in any form, and at any level" (p. 28). Factors have been identified that mediate the influence of statistics anxiety on the learning of statistics (cf. Forte, 1995; Onwuegbuzie et al.; Onwuegbuzie, Slate, Patterson, Watson, & Schwartz, 2000; Onwuegbuzie & Wilson, 2003). Onwuegbuzie (2003) found statistics anxiety had a direct impact on achievement and "both statistics anxiety and expectation mediate the relationship between statistics achievement and other cognitive, affective, and demographic variables" (p. 1032).

High levels of statistics anxiety can inhibit learning and has been linked to procrastination in people who are perfectionists. Onwuegbuzie and Daley (1999) found a positive relationship between socially-prescribed perfectionism and (a) interpretation and test and class anxiety, (b) computational self-concept, and (c) fear of asking for help. Walsh and Ugumba-Agwunobi (2002) also found "self-oriented perfectionism proved predictive both of fear of statistics teachers and, exclusively, of computational self-concept" (p. 246). The onset of statistics anxiety has typically been known to occur in college (Onwuegbuzie & Wilson, 2003); however, as statistical concepts are introduced into the elementary curriculum, the onset of statistics anxiety may occur earlier in a student's academic career. Therefore, the K-12 teacher will play an important role in making statistics interesting and alleviating anxiety in their students.

Antecedents of Statistics Anxiety

In a qualitative study of students enrolled in an intermediate level education statistics course, Onwuegbuzie et al. (1997) identified three antecedents that seemed to foster statistics anxiety: dispositional, situational, and environmental. In a review of literature, Onwuegbuzie and Wilson (2003) categorized relevant research findings across a number of studies into one of these three antecedents.

Dispositional antecedents. Dispositional antecedents were defined as an individual's unique characteristics that determined "how a student will react to a potentially stressful situation" (Onwuegbuzie et al. 1997, p. 17). Dispositional antecedents appeared to be related to mathematics anxiety (MA), self-concept, self-esteem, perceived course difficulty, need for approval, and ATS prior to enrolling in the course. An individual's need for perfectionism was also a dispositional antecedent that may increase statistics anxiety, particularly when there was not one correct answer or method to conduct a statistical analysis.

Environmental antecedents. Environmental antecedents include "perceptions, attitudes, and experiences which have affected the individual prior to the statistics course" (Onwuegbuzie et al., 1997, p. 19). These included (a) students' age and (b) the number, difficulty, and success in previous mathematics and statistics courses. Most research on the role of mathematics occurred prior to the widespread availability of statistical software; therefore, more research needs to be conducted on the relationship between a person's mathematical background and statistics anxiety (Onwuegbuzie & Wilson, 2003). Baloglu (2001) found the role of usefulness of statistics (i.e., Value) may play a different role according

student's age. In their sample, older students tended to be more likely to understand the value of statistics than their younger counterparts, but exhibited higher levels of anxiety.

Situational antecedents. Situational antecedents were defined as "immediate factors which arise from the course that determine the level of anxiety" (Onwuegbuzie et al., 1997, p. 19). Situational antecedents were related to the instructor, textbook, and study habits. Positive feedback from the instructor tended to decrease anxiety levels whereas the pace of the course, introduction of Greek symbols and statistical terminology, and complex formats of textbooks often increased anxiety levels. When students who were typically quick-independent learners found statistics required them to be dependent on others to learn the concepts and required more time to understand statistical concepts, students' anxiety levels increased (Onwuegbuzie et al.).

Nature of Statistics Anxiety and SATS

While positive relationships have been found between MA and statistics anxiety (Zeidner, 1991), the two constructs have been hypothesized to be different. Baloglu (2004) noted conflicting results between the relationship of MA and statistics anxiety may be due to a lack of agreement on the nature of statistics anxiety; however, Zeidner (1991) found the nature of MA and statistics anxiety to be similar. A qualitative examination of the nature of statistics anxiety indicated statistics anxiety was "a multidimensional phenomenon which relates negatively to statistics achievement" (p. 23) and was "a learned response" (p. 32). The major components of statistics anxiety were identified as (a) instrument anxiety, (b) content anxiety, (c) interpersonal anxiety, and (d) failure anxiety (Onwuegbuzie et al., 1997). The interpersonal nature of statistics anxiety was related to the degree to which students would ask questions or meet with the instructor. Both of these were identified by Sutarso (1992) as important when investigating statistics attitudes. In addition, many of the facets of ATS identified by Schau et al. (1995) and Schau (2005) appear to be related to the multidimensional nature of statistics anxiety identified by Onwuegbuzie et al.

In the Onwuegbuzie et al. (1997) sample, higher anxiety levels were exhibited when students found statistics irrelevant. Some students exhibited higher levels of statistics anxiety when statistical equations and notations were introduced. According to Onwuegbuzie et al. (1997) addressing statistics anxiety is the responsibility of the instructor and "instructional methods can be more effective when instructors develop a greater sensitivity and heightened awareness of their students and the potential role of statistics anxiety" (p. 33) and statistics anxiety was related to students' perceived difficulty of the course, study habits, and fear of failure. Woodward and Galagedera (2006) recommended teachers alleviate students' anxieties by emphasizing that elementary statistics is mostly "intuitive and nonmathematical" (p. 638). Teaching methods such as humor and labs have been shown to reduce anxiety and increase interest in statistics. Humor in the form of cartoons was shown as an effective method for reducing anxiety in a statistics course (Schacht & Stewart, 1990). Further including statistics labs, which were designed to encourage statistical thinking by providing more in-

depth experiences than presented in typical statistics textbooks, resulted in an increased atypical interest in statistics (Nolan & Speed, 1999).

Purpose

The present study differs from previous studies in that attitude toward statistics (ATS) of *prospective teachers* enrolled in an *undergraduate educational* statistics course were the focus. Relationships between prospective teachers' (a) ATS, (b) perceptions of teaching methods and explanations, and (c) statistical achievement were investigated. The research questions were: (1) What were preservice teachers ATS?; (2) To what extent did prospective teachers' statistical achievement depend on ATS?; (3) To what extent did prospective teachers' ATS and effort directed toward learning statistics differ by their perceptions of instructors' teaching methods and explanations?; and (4) Did prospective teachers in different classrooms differ on their ATS?

Methodology

Participants

The sample consisted of 95 prospective teachers enrolled in two sections of a statistics course required of people preparing to teach early childhood through 8th grade. Eight percent of the participants completed more than four mathematics courses; 88% successfully completed 2, 3, or 4 mathematics courses; 91% were White; 6% were Hispanic/Latino, 1% was Asian, and two reported other ethnicity. To detect possible differences between classes, statistical differences were examined between classes on statistical achievements and number of mathematics courses. A Kruskal-Wallis test indicated no statistically significant differences existed between the two classes on statistical achievement (χ^2 [1, N = 95] = 1.98, p = .16). A bivariate correlation indicated no statistically significant differences existed between statistical achievement and number of mathematics courses (r[85] = .115, p = .287).

Instruments

An online survey was administered to prospective teachers nearing completion of an introductory statistics course offered in the summer. A review of syllabi, instructor responses about topics covered in the course, and classroom observations indicated that both instructors were similar with respect to pedagogical strategies, content delivery, scope and sequence, and inclusion of technology; however, Instructor A was an associate professor and Instructor B was a graduate student who had been a student of the first. The researchers were not the instructors. Because a standardized assessment measuring statistical knowledge was lacking, statistical achievement was measured by the intervally-scaled final course grade (cf. Onwuegbuzie et al., 1997).

Survey of statistics attitudes. Prospective teachers' attitudes toward statistics were examined from a composite of two surveys measuring attitudes toward statistics. The Survey of Attitudes Toward Statistics (SATS) was modified based

on published psychometric data (cf. Schau et al., 1995). Two versions of the SATS are available: version one contains four factors and version two contains six factors. Version two was administered in the present study. Schau et al. validated scores on their administration of the first version of the SATS using confirmatory factor analysis (CFA) and correlated those results with an administration of Wise's Attitudes Toward Statistics. Four facets of attitudes toward statistics were identified: (a) Affect, (b) Cognitive Competence, (c) Value, and (d) Difficulty. Version two also includes items linked to Effort and Interest in learning statistics (Schau, 2005). Items 8 and 25 of the SATS were omitted from this study because they were not immediately relevant to prospective EC-8 (Early Childhood through Grade 8) teachers. Item 24 was modified from "learning statistics requires a great deal of discipline" to "learning statistics requires a great deal more effort than my other courses". Two items from the Student's Attitudes Toward Statistics (STATS; Sutarso, 1992) regarding prospective teachers' perception of their instructor's explanations and pedagogy and whether or not this impacted whether or not the students liked statistics were identified as a theoretically important factor in the research but were not present on Schau's. Analyses were conducted on composite scores, which were created by taking an arithmetic mean across all items linked to a factor. For the multiple regression analyses, we created a composite score for the two items comprising Instructor's Explanations and Methods. For the CCA, these were entered as two separate items.

Results

Validity and Reliability

Because the sample size was small and factors were not defined by four or more variables with structure coefficients larger than |.6| (Thompson, 2006), factor analysis results were not suitable for the data in hand. The factors were defined according to (Schau, 2005; Schau et al., 1995) and from previous research findings (Bandalos et al., 2003; Onwuegbuzie, 2003). Reliability scores must be reported for the data in hand (Capraro, Capraro, & Henson, 2001; Thompson, 2003). Coefficient alpha for the entire survey (.79) and for Value (.84), Affect (.88), Cognitive Competence (.80), Effort extended to learning statistics (.69), Interest in Statistics (.88), and Instructor's Explanations and Methods (.89) were in the acceptable range for score reliability whereas Difficult (.66) was lower than would be desired (Thompson, 2003).

Attitudes Toward Statistics (ATS)

Statistics achievement. Multiple regression results indicated that the six SAT factors and the factor on instructor's teaching methods and instructions explained 37% of the variance in statistical achievement ($F[7, 87] = 7.35$, $p < .001$, $R^2 = .37$). Interpretations of beta (β) weights and structure coefficients (Thompson, 2006) provided in Table 1 along with commonality analysis results (Nimon, Lewis, Kane, & Haynes, 2008; Zientek & Thompson, 2006) suggested statistical achievement was explained mostly by Affect and Effort; however,

prospective teachers' Cognitive Competence, Interest in Statistics, and the Instructor's Explanations and Methods (measured by prospective teachers' perceptions of their instructor's ability to explain and teach concepts in a manner that made them like statistics) also impacted statistical achievement. Means and standard deviations along with the bivariate correlations of the theorized factors are presented in Table 2. Rated on a scale from 1 to 5 with 5 indicating the most positive attitudes, mean scores indicated prospective teachers' Affect was-on average-not very positive.

The instructor. Multiple regression results indicated six factors explained 34% of prospective teachers' perceptions of instructors teaching methods and explanations in regards to helping prospective teachers like statistics (F[6, 88] = 7.58, $p < .001$, R^2=.34), particularly Affect (β = .528, r_s^2 = .87) and Interest (β = .218, r_s^2= .62) followed by Cognitive Competence (β = .024, r_s^2= .52), Value (β = -.111, r_s^2 = .27), and Difficulty (β = -.146, r_s^2 = .12). Figure 1 illustrates the relationship between the prospective teachers' perceptions of their Instructors' Explanations and Affect and Interest in statistics. ANOVA results indicated the prospective teachers in the two classes differed slightly by Instructor on their Value of and their Interest in statistics with small but somewhat noteworthy effect sizes (F[1, 93] = 6.56, p = .012, η^2 = .07; F[1, 93] = 7.53, p = .007, η^2 = .08; Value and Interest in statistics, respectively). Students taught by the experienced associate professor exhibited more Value and Interest in statistics, which are illustrated in Figure 2. Effect sizes indicated prospective teachers in different classes did not differ on Affect (η^2 =.01), Cognitive Competence (η^2 <.001), Difficulty (η^2 =.01), or Effort (η^2 =.02).

Students' perceptions of instructors' explanations and ability to make the course interesting and negative feelings of affect; CCA results indicated a noteworthy relationship between Negative Feelings of Affect and prospective teachers' perceptions of their instructors' teaching methods and explanations as defined by "I like statistics because of my instructor's method of teaching" and "The instructor's explanations help me to like statistics" (Sutarso, 1992, p. 19). Two functions were statistically significant. For Function I (Wilks' lambda = .64, F[8, 178] = 5.50, $p < .001$, R_c^2 = .26), the variables comprising Negative Affective Feelings: Stress (Function Coefficient = .669; r_s^2 =.86), Frustration (Function Coefficient = .431; r_s^2 =.67), Insecurity (Function Coefficient = .143; r_s^2 =.45), and Fear (Function Coefficient = -.110; r_s^2 =.37), depended on both prospective teachers' perceptions of instructor's explanations (Function Coefficient = .594; r_s^2 =.92) and instructor's methods in terms of helping prospective teachers like statistics (Function Coefficient = .462; r_s^2 =.87). For Function II (Wilks' lambda = .86, F[3, 90] = 4.75, p = .004, R_c^2 = .14), Fear (Function Coefficient = 1.153; r_s^2 =.57) depended on both perceptions of instructor's methods(Function Coefficient = -1.573; r_s^2 =.13) and instructor's explanations (Function Coefficient = 1.529; r_s^2 =.08) in regards to helping prospective teachers like statistics.

Discussion

The ability of the current and future generations to make educated decisions depends on their ability to interpret visual displays of data and understand basic statistical concepts (Steen, 1999). In order for statistics to secure a position in primary and secondary education, teacher preparation programs must produce teachers who are competent and comfortable in implementing statistics standards in the curricula and who are able to apply these concepts to real-world data. In keeping with recommendations by Shaughnessey (1992, 2007), we investigated prospective teachers' attitudes towards statistics (ATS).

Prospective Teachers' Attitude Toward Statistics (ATS)

Sutarso (1992) and Watson (2001) suggested high achievement in statistics courses is related to positive ATS. In the present sample, multiple regression results indicated prospective teachers' ATS impacted their statistical achievement. Achievement was impacted most by Affect followed by Effort, Cognitive Competence, and prospective teachers' perceptions of their instructor's methods and explanations in regards to helping them like statistics.

Perceived *Interest, Value,* and *Difficulty* of the course were predictive of the present sample's statistical achievement, although not as much as other factors of ATS. Interest in statistics differed by instructor and a noticeable amount of variability existed in prospective teachers' interest within and between classes. This suggests that despite teaching methods, variability can exist within a classroom on prospective teachers' value and interest in statistics. Noteworthy correlations between ATS factors indicated that if instructors are going to increase prospective teachers' interest in the course, other facets of ATS may need to be addressed. Caution should be warranted when interpreting findings on perceived Difficulty because of the low Cronbach's alpha.

Because there were only two instructors in the present study, specific instructor effects of presentation style or pedagogy were not investigated. However, participants' interpretations on the effect of teaching methods and explanations in regards to helping prospective teacher s like statistics were deemed relevant, particularly Affect and Interest. Prospective teachers' Value and Interest in statistics differed by instructor, albeit the differences were small. ANOVA results indicated the instructor explained about 7% of the variance in prospective teachers' Value of statistics and about 8% of the variance in Interest in statistics.

CCA results indicated the negative feelings linked to Affect (e.g., feelings of fear, scared, insecurity, and stress) were impacted by prospective teachers' perceptions of their instructor's ability to explain and teach statistics in a manner that helped prospective teachers like statistics. Some of these negative feelings are related to anxiety.

Conclusion

Evaluating prospective teachers' ATS provides insight into teachers' desire, capability, and motivation they may express when faced with implementing the

NCTM standards pertaining to statistics. The present study enhances the research base by studying prospective teachers' ATS and showing that in the present sample (a) prospective teachers' ATS impacted their statistics achievement in a senior level education course; (b) prospective teachers' ATS differed by instructor; and (c) prospective teachers' perceptions of instructor explanations and teaching methods was related to their ATS, particularly Affect and Interest.

Because the present study was limited to one university, the ATS in the present sample cannot be generalized to the prospective teaching population at large. To obtain a better understanding of the extent of teachers' ATS, additional studies should be conducted with preservice and in-service teachers. Future studies should also investigate the extent to which teachers transfer their statistical attitudes to their students and the teaching methods that increase positive ATS.

Table 1

Regression Results with the Dependent Variable Statistical Achievement

Variables	β	r_s^2	Unique	Common	Total
Affect	.685	.65	11.57	12.64	24.21
Effort in Learning Statistics	.315	.26	9.02	0.47	9.49
Cognitive Competence	–.050	.33	0.08	12.17	12.25
Instructor's Explanations and Methods	.029	.29	0.06	10.63	10.69
Interest in Statistics	–.115	.23	0.47	8.06	8.53
Value	–.029	.13	0.04	4.98	5.02
Difficulty	–.100	.22	0.53	1.49	2.02

Note. β = Beta-weight, r_s^2 = squared structure coefficient.; Total = Unique + Common.

Table 2

Means, Standard Deviations, and Correlations of the Theorized Factors

			Correlations						
	Mean	SD	1.	2.	3.	4.	5.	6.	7.
1.	87.03	8.14							
2.	3.69	.94	.327**						
3.	3.06	.88	.292**	.459**					
4.	2.86	.83	.492**	.545**	.688**				
5.	3.45	.64	.224*	.302**	.727**	.560**			
6.	2.70	.52	.142	.203*	.391**	.585*	.373**		
7.	3.51	.63	.350**	.419**	.581**	.799**	.532**	.616**	
8.	4.41	.60	.308**	.087	.039	–.047	.026	–.248*	–.049

Note. * p <.05, ** p < .001. 1. = Statistical Achievement; 2. = Perceptions of Instructor's Explanations and Methods; 3. = Interest in Statistics; 4. = Affect; 5. = Value; 6. = Difficulty; 7. = Cognitive Competence; 8. = Effort in Learning Statistics.

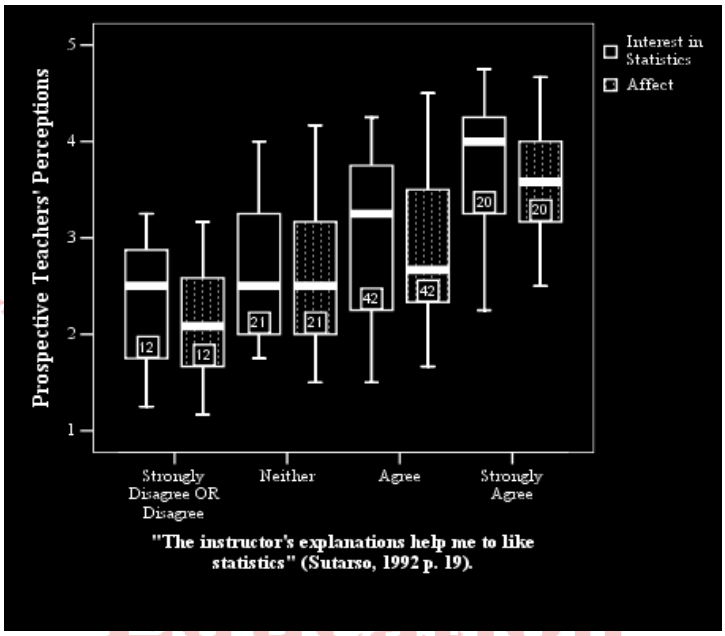

Figure 1
Prospective Teachers Perceptions' of Their Instructors' Explanations and Prospective Teachers' Interest in Statistics and Affect.

Note. Because of the small number who responded with a 1 (n = 2), scales 1 and 2 were collapsed.

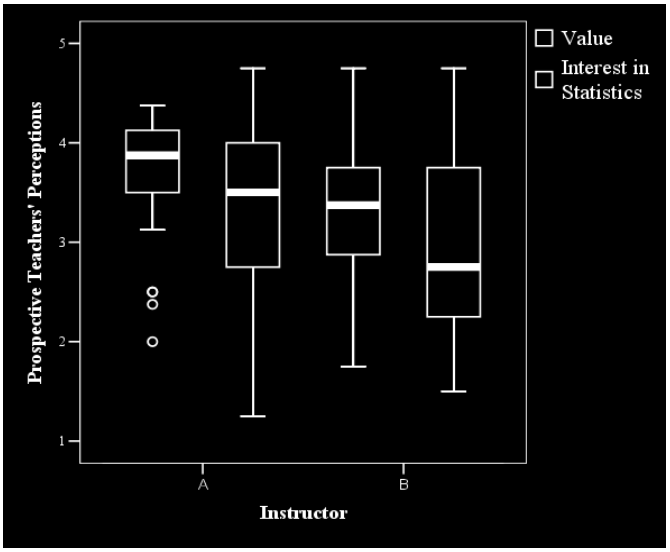

Figure 2
Instructor and Prospective Teachers' Value and Interest in Statistics

Note. Boxes represent the number of respondents. Circles represent outliers.

† *Linda Reichwein Zientek, Ph.D.*, Sam Houston State University, USA
‡ *Tamara Anthony Carter, Ph.D.*, Oklahoma City Community College, USA
§ *Judy M. Taylor, Ph.D.*, LeTourneau University, USA
¶ *Robert M. Capraro , Ph.D.*, Texas A&M University, USA

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