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MEASURING AND PREDICTING GRADUATE STUDENTS' ATTITUDES TOWARD STATISTICS

LİSANSÜSTÜ ÖĞRENCİLERİN İSTATİSTİĞE İLİŞKİN TUTUMLARINI ÖLÇME VE YORDAMA

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ABSTRACT: This article reports on 2 investigations of graduate students' attitudes toward learning statistics. First, the use of the Survey of Attitudes Toward Statistics (SATT) for graduate students in the educational sciences was supported through exploratory factor analysis, which identified 3 dimensions (i.e., commitment to the discipline, beliefs about the utility of the discipline, affective/emotional components) and evidenced high internal consistency. In the second investigation, departmental affiliation, previous statistics experience, and sex were regressed upon the 3 attitudinal dimensions of the SATT. In each of the analyses, between 16% and 26% of the variance was accounted for by departmental affiliation. The authors recommend that future research involve the instructor's contribution to the development of attitudes toward the statistics discipline.

Keywords: attitude scale, factors affecting attitude, validity

ÖZET: Bu makalede lisans üstü öğrencilerin istatistik dersine ilişkin tutumlarını inceleyen 2 çalışma ele alınmaktadır. İlk olarak, İstatistik Tutum Ölçeği (İTÖ) eğitim bilimleri lisans üstü öğrencilerine uygulanarak açıklayıcı faktör analizi yapılmış ve 3 boyut ortaya çıkmıştır (alana olan bağlılık, alanın yararına ilişkin inançlar, duyuşsal boyut). Bu boyutların yüksek iç tutarlılığı olduğu görülmüştür. İkinci çalışmada, İTÖ'nin her 3 tutum boyutunda, öğrencinin kayıtlı olduğu bölüm, önceki istatistik deneyimi ve cinsiyet değişkenleri ile regrasyon analizi yapılmıştır. Tüm analizlerde, öğrencinin bölümünün varyansın %16 ile %26 sını açıkladığı görülmüştür. Yazarlar, sonraki çalışmalarda disipline ilişkin tutumların gelişmesinde öğretim elemanının katkısının da araştırılmasını önermektedirler.

Anahtar Sözcükler: tutum ölçeği, tutumu etkileyen faktörler, geçerlik

1. INTRODUCTION

Recent attention has focused on the effectiveness with which students experience the required statistics course(s) in the social and behavioral sciences. As several studies have noted (Schutz, Drogosz, White, & DiStefano, 1998; Tremblay, Gardner, & Heipel, 2000), students enter the required, introductory statistics courses from a variety of academic, statistical, and mathematical backgrounds. For some of those students, the course is merely a review; others are anxious about the course content, concerned about their quantitative abilities, and worried about using computers. Forte (1995) reported that students enrolled in social work programs have frequently failed previous math courses, are unable to identify commonly known statistical symbols, and have high anxiety for learning quantitative methods.

In an attempt to predict achievement in statistics, researchers are turning toward examining the role of the students' attitudes in the teaching and learning process (e.g., Roberts & Reese, 1987; Tremblay, et al., 2000; Wise, 1985). Tremblay et al. (2000) defined attitudes toward learning statistics as, "generally positive vs. negative feelings and evaluations about statistical material, courses, and instructors" (p. 41). In many of the investigations, which have considered attitudes and affective issues toward statistics, affect/attitude has been used as a predictor or independent variable that is paired

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with the criterion or dependent variable, student achievement. The purpose of our study was to further evaluate the reliability and validity of an instrument used in assessing student's attitudes toward statistics and to evaluate relevant student variables that are believed to predict students' attitudes toward statistics.

Balı (2000) surveyed 143 graduate students attending four universities in Turkey. Results of her study indicated that students believe statistical skills and knowledge to be important, yet they perceive themselves as lacking that knowledge base. Moreover, perceived competency in statistics was a function of the students' attitudes toward statistics and mathematics, and learning styles, university affiliation, and gender.

In an investigation that evaluated the relations between motivational variables, learning strategies, and academic performance, Schutz et al. (1998) accounted for 47% of the variance in achievement in an introductory graduate statistics course. Using hierarchical multiple regression techniques, the investigators tested four sets of variables. Of those, the student's background (i.e., prior statistics knowledge, prior math skills, test anxiety), the student's attitudes toward statistics (i.e., positive affect for statistics, the value of statistics), and motivational variables (i.e., control of learning beliefs, confidence in mastering statistics) all contributed significantly to the variance in the course performance. The fourth set of variables, learning strategies, did not contribute over and above the previous three sets. Interestingly, a qualitative analysis by the same authors suggested that students who were successful in the class used deeper learning strategies such as visualization, studying on a regular basis, self-monitoring, and connecting material to the real world.

Using a socio-educational model to study the phenomenon of performance in statistics courses, Lalonde and Gardner (1993) have suggested that learning statistics is similar to learning a foreign language. In their structural equation modeling investigation, Lalonde and Gardner included mathematical background, statistical anxiety, motivational intensity, and attitudinal components and concluded that effort and mathematical aptitude have direct influences on achievement in the course, while attitudinal variables and situational anxiety have indirect influences on achievement. Specifically, regarding affective and attitudinal issues, Lalonde and Gardner found significant negative correlations between statistical and numerical anxiety and the final statistics grade, and a significant positive correlation between the attitude toward the statistics course and final grades.

In another investigation that used structural equation modeling techniques, Tremblay et al. (2000) investigated the variables believed to influence statistics achievement of first-year undergraduate students. Predictor variables included attitudinal and anxiety measures (i.e., motivational intensity, desire to learn statistics, interest in psychology, interest in mathematics, numerical anxiety, statistical anxiety, attitude toward learning statistics, attitude toward the statistics course, attitude toward the statistics professor) and prior achievement measures (i.e., introductory psychology grade, first year mathematics grade). The criterion measure was the final statistics exam. Tremblay et al. found that motivation and aptitude contributed to the prediction of achievement in the statistics course. Additionally, they found a direct link between anxiety and achievement. Results did not indicate a link between performance in statistics as a function of previous mathematics and psychology university courses.

The implications of the final model are interesting. In Tremblay et al.'s (2000) model, it was clear that aptitude had a direct effect on anxiety, but not in any of the other predictor variables in the model. Moreover, it demonstrated that anxiety is negatively influenced by two correlated exogenous variables, interest in mathematics and attitude toward the course. Thus, low levels of aptitude,

lack of interest in mathematics, and unfavorable attitudes toward the course resulted in high levels of anxiety which, in turn, resulted in poor performance.

In summary, previous research in the area of university-level statistics education has suggested that attitudes toward statistics contribute to the performance in the statistics course. However, most of the research has been conducted with undergraduate student populations, and most has used achievement in the statistics course as the dependent variable. Thus, the purpose of our project was twofold. In the first investigation, we sought to better understand attitudes toward statistics through the evaluation of an instrument designed to assess attitudes toward statistics. In the second investigation, we readministered the instrument in order to evaluate many of the same variables used in the aforementioned studies of statistics achievement (i.e., academic discipline, previous coursework in statistics, sex of students) to predict the students' attitude toward statistics. In both investigations, graduate students enrolled in the Faculty of Education were the focus.

2. INVESTIGATION 1

2.1. Method

2.1.1. Procedure

Students enrolled in graduate courses in the Educational Sciences Department (EDS) at Middle East Technical University (METU), Ankara, Turkey, were invited to participate in a study designed to understand the affective components of teaching and learning statistics. Trained research assistants administered surveys during the final two weeks of the semester in all of the graduate courses taught by the EDS department. The students were informed both verbally and on the survey itself that participation was voluntary, that confidentiality was guaranteed (i.e., students did not place their name on any of the materials in the study), and that by returning the survey they were giving their informed consent to allow the researchers to use their data as part of the project. Because students were often enrolled in more than one course taught by the EDS department, they were instructed not to complete the survey if they had already done so in another class.

2.1.2. Participants

Participants consisted of 88 (82% female, 18% male) students enrolled in graduate courses in the EDS Department at METU. Ages of the participants ranged from 21 to 41 with a mean age of 26 (SD = 3.61). Participants represented all five of the departments in the Faculty of Education. More than half (61%) were from the Educational Sciences Department (which includes Educational Administration, Curriculum and Instruction, Guidance and Counseling, and Measurement and Evaluation core areas). The remaining departments included Sciences Education (16%), Computer Education and Instructional Technology (13%), Foreign Language Education (5%), and Physical Education Sciences (5%). Sixty-three percent of the students were at the masters level; 34% were at the doctoral level. Eighty-five percent of the students were currently enrolled in, or had previously taken courses in, statistics.

2.1.3. Instruments

2.1.3.1. Demographic information.

Brief demographic information about the participants was requested from the participants. This information included their age, sex, academic department, academic classification (i.e., masters vs. doctoral level), undergraduate major, and a listing of the previous statistics coursework.

2.1.3.2. Attitudes toward statistics.

The Scale of Attitudes Toward Statistics (SATT) was modified from the Scale of Attitudes Toward Mathematics or Science (SATMS; Aiken, 1979). The SATMS was originally composed of 24, Likert-type questions to be answered, "Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), or Strongly Agree (SA)." The SATMS was originally composed of four subscales:

enjoyment of mathematics or science, motivation in mathematics or science, importance of mathematics or science, and freedom from fear of mathematics or science. Aiken also advocated the use of the total score scale. Half of the items were positively stated; half were negatively stated. The scale was designed in such a way that when it was measuring attitudes toward mathematics, the word, "Mathematics" was used in the stem of the item; when it measured attitudes toward science, the word "Science" was used in the stem of the item. Aiken suggested when studying other disciplines, the appropriate word could be substituted into the item. Aiken reported alpha coefficients for a variety of subsamples from a total sample of 300 students to range from .50 to .86 for the subscales and from .81 to .91 for the total scale score. An examination of intercorrelations among the items and total score supported the interpretation of three of the intended subscales: perceived importance or value, freedom from fear or anxiety, and enjoyment or interest.

Similar to its predecessor, the SATT is composed of 24 items designed to assess a student's opinion toward statistics. Half of the items are positively stated (i.e., "I want to develop my statistical skills and study this subject more.") and half are negatively stated (i.e., "Statistics is not a very interesting subject."). After the data were entered into SPSS for Windows, but prior to their analysis, the items stated in the negative direction were reverse-scored.

2.1.4. Analyses

The dimensionality of the 24 items of the SATT was analyzed using maximum likelihood factor analysis. Three criteria were considered when evaluating the most appropriate number of factors to extract: the scree test, the eigen-value-greater-than-one criteria, and the interpretability of the factor solution.

2.2.Results

The scree test indicated one factor and the eigenvalue – greater – than - one criteria suggested that up to five factors were appropriate. The interpretability of the factor structure was used to make the final decision. While the results of five possible solutions were investigated (and results are available from the investigators), the solution deemed to be most appropriate is reported here.

When a three-factor solution is extracted, the first factor accounts for 19.8% of the variance, the second factor 19.0%, and the third factor 16.2% of the variance. The first factor that is termed "Commitment" is composed of 10 items and appears to measure a student's personal commitment to learning statistics and taking statistics courses. The second factor termed "Affect," is composed of five items and appears to measure the affective/emotional component related to learning statistics. The third factor which we termed, "Beliefs" is composed of eight items, appears to measure beliefs about the utility of the discipline of statistics. In the three-factor solution, there is one complexly determined item. Internal consistency coefficients (alphas) for the three scales were .87 (N = 84), .94 (N = 85), and .91 (N = 83), respectively.

3. INVESTIGATION 2

3.1. Method

3.1.1. Procedure

Students enrolled in graduate courses in the Faculty of Education at METU were invited to participate in a study designed to understand the affective components of teaching and learning statistics. Trained research assistants administered surveys during the first two weeks of the semester in all of the courses where instructor permission was granted. The students were informed both verbally and on the survey itself that participation was voluntary, that confidentiality was guaranteed (i.e., students did not place their name on any of the materials in the study), and that by returning the survey they were giving their informed consent to allow the researchers to use their data as part of the project.

Table 1. Correlations Between the SATT Items and their Factors

Item		F1	F2	F3
	Commitment: Personal commitment to statistics			
2.	I want to develop my statistical skills and study this subject more.	**.55**	.06	.31
6.	I don't want to take any more statistics than I have to.	**.82**	.27	.17
7.	Other subjects are more important to people than statistics.	**.45**	.16	.04
10.	I am interested in acquiring further knowledge of statistics.	**.64**	.22	.34
14.	I am not willing to take more than the required amount of statistics.	**.60**	.26	.18
15.	Statistics is not especially important in everyday life.	**.31**	.21	.23
18.	I plan to take as much statistics as I can during my education.	**.73**	.14	.28
22.	I am not motivated to work very hard on statistics lessons.	**.60**	.34	.35
23.	Statistics is not one of the most important subjects for people to study.	**.44**	.08	.17
24.	I don't get upset when trying to do statistics lessons.	**.56**	.49	.12
	Affect: Affective components of statistics			
4.	Statistics makes me feel nervous and uncomfortable.	.35	**.80**	.33
8.	I am very calm when studying statistics.	.23	**.80**	.30
12.	Statistics makes me feel uneasy and confused.	.15	**.79**	.34
16.	Trying to understand statistics doesn't make me anxious.	.26	**.69**	.25
20.	Statistics is one of my most dreaded subjects.	.22	**.77**	.21
	Beliefs: Beliefs about the utility of the statistics discipline			
1.	Statistics is not a very interesting subject	.33	.41	**.48**
3.	Statistics is a very worthwhile and necessary subject.	.32	.21	**.41**
9.	I have seldom liked studying statistics.	.33	.30	**.62**
11.	Statistics helps to develop the mind and teaches a person to think.	.18	.13	**.51**
13.	Statistics is enjoyable and stimulating to me.	.42	.44	**.70**
17.	Statistics is dull and boring.	.39	.43	**.62**
19.	Statistics has contributed greatly to the advancement of civilization.	.04	.12	**.54**
21.	I like trying to solve new problems in statistics.	.31	.34	**.69**
	Complexly determined item			
5.	I have usually enjoyed studying statistics in school.	.47	.36	.49

Note: F1 = Factor 1. F2 = Factor 2. F3 = Factor 3.

3.1.2. Participants

Participants in this project were 140 (73% female, 27% male) graduate students who ranged between the ages of 21 and 44 (M = 26.62, SD = 4.27). Ninety of the students were enrolled in master's level programs, 48 were in doctoral level programs, and 2 were special students (i.e., guests at the university, enrolled in no specific program of the study). Nearly half (42%) were from the Educational Sciences Department, the remaining departments included Foreign Language Education (30%), Computer Education and Instructional Technology (13%), Physical Education Sciences (10%), and Sciences Education (6%). Among those students who reported having taken previous courses in statistics (63%), 50 of them had taken between 2 and 12 credit hours as undergraduate students (M = 4.56, SD = 2.29) and 57 had taken between 3 and 13 credit hours

as graduate students (M = 5.12, SD = 2.18). Students' undergraduate majors ranged a full spectrum of disciplines; the most common were: Foreign language education (36%), educational sciences (14%), computer education and instructional technology (10%), and physical education sciences (9%).

3.1.3. Measures

3.1.3.1. Participant demographic form.

This author-constructed form included questions assessing age, sex, current academic department, and academic classification (i.e., master's or doctoral level student). We also asked the students if they had previously taken statistics courses (i.e., yes, no); if they had, we asked them to specify the number of undergraduate and graduate course credits.

3.1.3.2. Attitudes toward statistics.

Given the reasonable reliability and validity characteristics demonstrated in Investigation 1, the unmodified SATT was used in Investigation 2. In our study, the reliability coefficient (alpha) for the overall scale was .94. Curiously, the alpha coefficients were .86 for each of the subscales: personal commitment to statistics, affective components of statistics, and beliefs about statistics.

3.1.4. Analyses

In this non-experimental design, multiple regression analyses were used to evaluate three sets of predictor variables (i.e., departmental affiliation, previous coursework in statistics, and sex of the student) upon the three criterion variables: personal commitment to learning statistics, affect toward statistics, and beliefs about the utility of the statistics discipline. The three sets of predictor variables were treated as unordered sets, thus the goal of the project was to examine the validity of each set of predictors, the incremental validity of each set of predictors over the other sets of predictors, and the validity of all sets in combination. It might be noted that a fourth set of predictors, undergraduate degree was considered. However, because of its high positive correlation with departmental affiliation ($f = .77, N = 130, p < .001$), we were concerned about issues of multicollinearity, and chose to use departmental affiliation as an indication of choice of academic discipline. In these three sets of regression analyses, the dependent variable was the subscale score (i.e., commitment, affect, beliefs) from the SATT. The first set of variables was the student's departmental area of study. Student's departmental affiliation were grouped into five areas: educational sciences, physical education, math and physical sciences, technology, and languages. These categorical variables were dummy-coded into four (i.e., k –1) variables prior to their entry into the equation as a set of predictor variables. The second set of variables, previous coursework in statistics, included two variables: number of undergraduate credit hours in statistics coursework and number of graduate credit hours in statistics coursework. These were entered as quantitative variables. The third set of variables was sex of the participant. Again, this was entered into the equation as a categorical variable.

3.2. Results

3.2.1. Commitment

Three multiple regression analyses were conducted to predict the score on the SATT subscale that measures one's personal commitment to learning statistics. The first analysis included the dummy-coded set of variables that indicated the student's departmental affiliation. This analysis was significant, R^2 = .24, adjusted R^2 = .22, F (4, 130) = 10.47, p < .001. The second analysis evaluated the sex of the student as the predictor variable. This predictor was not significant, R^2 = .02, adjusted R^2 = .01, F (1, 133) = 2.75, p = .100. The third analysis evaluated previous coursework in statistics. This was significant, R^2 = .05, adjusted R^2 = .04, F (2, 132) = 3.48, p = .034.

Next, a multiple regression analysis was conducted with number of undergraduate and graduate statistics course credits and departmental affiliation as predictors. The linear

combination of the two sets of variables was significantly related to personal commitment to statistics, $R^2 = .24$, adjusted $R^2 = .21$, F (6, 128) = 6.87, $p < .001$. Departmental affiliation predicted significantly over and above previous coursework in statistics R^2 *change* = .194, F (4, 128) = 8.21, $p < .001$, but previous coursework in statistics did not predict significantly over and above departmental affiliation, R^2 *change* = .000, F (2, 128) = .032, $p = .968$. Based on these results, it seemed clear that previous coursework in statistics added no additional predictive power beyond that contributed by departmental affiliation. Table 2 shows the bivariate and partial correlations associated with the analyses of all three subscales; Table 3 lists the means and standard deviations.

3.2.2. Affect

Similarly, three multiple regression analyses were conducted to predict the affective component of learning statistics. The first analysis included the student's departmental affiliation. This analysis was significant, $R^2 = .15$, adjusted $R^2 = .13$, F (4, 131) = 5.94, $p < .001$. The second analysis evaluated the sex of the student as the predictor variable. This predictor was statistically significant, $R^2 = .04$, adjusted $R^2 = .03$, F (1, 134) = 4.88, $p = .029$. The third analysis evaluated previous coursework in statistics. This was not significant, $R^2 = .04$, adjusted $R^2 = .03$, F (2, 133) = 4.39, $p = .058$.

Table2. The Bivariate and Partial Correlations of the Predictors with the SATT Subscale

	Commitment		Affect		Beliefs	
Predictors	r	r_p	r	r_p	r	r_p
Department						
Languages	-.49***	-.33***	.36***	-.22*	-.52***	-.37
Math/Science	.13	.07	.08	.09	-.76	.04
Physical Educ.	.13	.03	-.05	-.06	.08	.01
Educational Sci.	.18*	.00	.25**	.08	.31***	.09
Previous Coursework						
Graduate Credits	.20	-.15	-.08	.09	.10	-.11
Undergraduate Credits	.11	-.01	.12	-.12	.02	-.07
Sex of Participant	.14	.10	.19*	.21*	.16	.15

*$p < .05$, **$p < .01$, $p < .001$

Table3. Means and Standard Deviations of SATT Subscales as a Function of Department and Sex

	Commitment			Affect		Beliefs	
Predictors	N	M	SD	M	SD	M	SD
Department							
Math/Science	9	3.73	0.75	3.48	0.92	3.76	0.67
Physical Educ.	15	3.65	0.69	3.08	1.04	3.73	0.84
Computer Educ.	19	3.61	0.68	3.47	0.77	3.74	0.80
Educational Sci.	59	3.53	0.63	3.46	0.76	3.82	0.54
Languages	31	2.72	0.61	2.63	0.84	2.84	0.55
Sex of Participant							
Female	99	3.31	0.71	3.11	0.87	3.49	0.69
Male	37	3.55	0.77	3.49	0.99	3.75	0.86

**Note.* The means and standard deviations were calculated on the basis of the SATT subscale scores, then divided by the number of items on the subscale to represent their position on the original 5-point liker-type scale.

Next, a multiple regression analysis was conducted with the student's departmental affiliation and the sex of the student as predictors. The linear combination of the two sets of variables was significantly related to statistics, $R^2 = .19$, adjusted $R^2 = .16$, F (5, 130) = 5.968, $p < .001$. Sex predicted over and above departmental affiliation R^2 *change* = .033, F (1, 130) = 5.32, $p < .023$, and departmental affiliation predicted over and above sex, R^2 *change* = .152, F (4, 130) = 6.06, $p < .001$. However, given the small magnitude of the contribution of the sex variable, it appeared that departmental affiliation was the most meaningful indicator of the affective component of learning statistics.

3.2.3. Beliefs

Again, three multiple regression analyses were conducted to predict one's personal beliefs about the utility of the statistics discipline. The first analysis included the departmental affiliation. This analysis was significant, R^2 = .29, adjusted $R^2 = .26$, F (4, 131) = 13.09, $p <$ .001. The second analysis, which evaluated the sex of the student as the predictor variable, was not significant, $R^2 = .03$, adjusted $R^2 = .02$, F (1, 134) = 3.46, $p < .065$. The third analysis, which regressed previous coursework in statistics onto beliefs, was also not significant, R^2 = .03, adjusted $R^2 = .01$, F (2, 133) = 1.99, $p < .141$. Given the lack of significance of previous coursework and sex, no further regressions were performed.

4. DISCUSSION

The results of first investigation supported the construct validity of SATT. Moreover, it supported the interpretation of three attitudinal dimensions of learning statistics: (a) commitment to learning statistics, (b) affective and emotional issues, and (c) beliefs about the importance and utility of the statistics discipline. It is most interesting to note that the results of our project are quite similar to that of Dauphinee, Schau, and Stevens (1997), where the resultant factors of a different instrument that was designed for a similar purpose included: (a) affect, (b) value, (c) cognitive competence, and (d) difficulty. Moreover, in a study of Turkish students, Balı constructed and administered the Attitudes Towards Statistics Scale (ATST; 2000). Factor analysis resulted in five dimensions: (a) difficulty in learning, (b) enjoyment and interest towards, (c) using statistics, (d) the impact of statistics on daily life, and (e) importance. The similarity of results of the three projects suggests that attitudes toward statistics clearly involve emotional/affective components and beliefs about the value of the discipline.

The results of the second investigation indicated that departmental affiliation/academic discipline was the sole predictor of the three attitudinal dimensions of attitudes toward statistics (e.g., commitment, affect, beliefs). Of the three sets of variables regressed onto the equation, it is departmental affiliation that may best represent the student's vocational/ educational choice. As such, in-as-much-as statistics is involved in their chosen field of study, the personal commitment to succeeding in the academic discipline may simultaneously reflect their commitment, beliefs about, and affect toward learning statistics. Looking specifically at the mean scores of the SATT subscales (see Table 3) as a function of department, some trends become apparent.

First, the means (reported as a function of their place on the original 5-point likert-type scale) range from 2.72 to 3.73 on the Commitment Scale, from 2.63 to 3.49 on the Affect Scale, and from 2.84 to 3.82 on the Beliefs Scale. As such, they tend to reflect an "Undecided" or "Agree" perspective toward learning statistics. Students in the Math/Sciences appear to have the highest personal commitment toward learning statistics. These are followed by students in Physical Education, Computer Education, Educational Sciences, and Languages. Regarding affect/emotional issues, students in the

Math/Sciences have the most positive feelings about learning statistics, followed by students in Computer Education, Educational Sciences, Physical Education, and Languages. Finally, with regard to the beliefs about the utility of statistics, students in the Educational Sciences have the highest scores, followed by students in the Math/Sciences, Computer Education, Physical Education, and Languages. While it may not be surprising that Math/Sciences students have the most positive attitudes toward statistics, it is interesting that students in the Educational Sciences, who scored fourth and third on the commitment and affect subscales, respectively are the students who have the most positive beliefs about the utility of the discipline. This may indicate that while Educational Sciences students question their own commitment toward and become uneasy about learning statistics, they respect and value the role that statistics plays in research and practice in the social sciences.

We expected that previous experience in statistics would be positively related to the student's attitudes toward the discipline. While prior research regarding students' previous quantitative experience, has not been used to predict attitudes toward statistics, it has been used to predict statistics achievement. In the area of predicting statistics achievement, results have been mixed. Two sets of authors reported positive relations between quantitative background and statistics achievement (Lalonde & Gardner, 1993; Schutz, et al., 1998) and one found no relation (Tremblay et al., 2000).

Although the investigation of sex differences in mathematical/quantitative disciplines has had a long research history in the educational sciences, the finding that sex did not contribute to the variance of attitudes toward statistics is not surprising. In recent research, Dauphinee, Schau, and Stevens (1997) reported no differences as a function of sex, in the aforementioned four-dimensional scale of attitudes toward statistics. Moreover, Tremblay et al. (2000) reported that women had higher levels of motivational intensity, higher levels of numerical anxiety, and lower levels of attitude toward statistics than men. However, the effect sizes associated with those findings were trivial and when Bonferroni adjustments were made to control for Type I error, the differences became insignificant.

Given that the student's departmental affiliation appears to predict between 16% and 26% of the variance of students' attitudes toward learning statistics, and sex and previous experience failed to contribute to the regression equation in meaningful ways, more research is required. Perhaps a next area of research would be to look at the instructor's contribution to facilitating positive attitudes toward statistics. In fact, Tremblay et al. (2000) reported a positive correlation between attitude toward the professor and attitude toward the statistics course. Moreover, results of their structural equation model indicated that course achievement was influenced by motivation, which was influenced by valance, which was influenced by interest in psychology, interest in mathematics, and a favorable attitude toward the course. The authors proposed that when the instructor develops a stronger rapport with students, then achievement may be partially mediated through motivation.

Other researchers are also looking at the role of the statistics instructor. In a single sample pre-test post-test design, Berk and Nanda (1998) reported that the inclusion of humor in the statistics course resulted in improved attitudes toward the course and reduced levels of anxiety. Still other researchers are proposing classroom activities for teaching specific statistical issues (Peden, 2001; Perkins & Saris, 2001) and theory-based strategies for developing the statistics course (Forte, 1995; Lovett & Greenhouse, 2000) that are designed to improve attitudes, decrease anxiety, and increase performance.

In summary, results of this project supported the use of the SATT toward investigating attitudes toward learning statistics. Moreover, it

evaluated the relative contribution of variables believed to be important in predicting attitudes toward statistics. While departmental affiliation was the only variable to predict attitudes in a meaningful way, this may point to the role of the student's vocational/educational choice as it relates to valuing and approaching this quantitative discipline. It appears that future research should focus on the role of the instructor in shaping attitudes toward statistics.

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