STUDENTS' ATTITUDES: THE "OTHER" IMPORTANT OUTCOME IN STATISTICS EDUCATION

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The ultimate goal of statistics education is to produce adults who appropriately use statistical thinking. Most college students take only one statistics course, the introductory course. This course, then, is where we, as statistics instructors, do or do not motivate students to apply the statistics that they have learned in their jobs and in their lives.

Yet, Butler (1998) entitled an AmStat Forum article "On the Failure of the Widespread Use of Statistics." He suggested that, in spite of the increasing numbers of adults who complete introductory statistics courses, these adults often do not use statistical methods in their jobs and, when they do try, "the results are shambles" (p. 84).

The appropriate use of statistical understanding requires persistence. Students, of course, first need to complete their introductory statistics course successfully, rather than drop out. In their lives outside of class, they then need to be able to recognize when they require additional statistical knowledge and skills; obtain this additional statistical understanding or better yet enlist the aid of a statistician; and accurately use the skills they possess.

The accomplishment of these goals requires more from students than a good grade in a statistics course. Students who will use their statistical knowledge appropriately must:

- Think that statistics is useful in their professional and personal lives,
- Believe that they can understand and use statistics, and
- Know that they don't understand everything they might need based only on what they learned in their introductory statistics course.

These statements describe attitudes about statistics, the "other" important outcome in statistics education (Gal, Ginsburg, & Schau, 1997; Garfield, Hogg, Schau, & Whittinghill, 2002). As with any other important educational goal, such as learning, we need to be able to assess attitudes toward statistics and assess them well.

In this paper, I will begin to address the following six questions about students' attitudes toward statistics:

1. What are attitudes, especially attitudes toward statistics?
2. Are attitudes toward statistics important?
3. How do we measure attitudes toward statistics?
4. What do we know about students' attitudes toward statistics?
5. Are attitudes toward statistics and statistics course achievement causally related?
6. How can we influence students' attitudes toward statistics?

What Are Attitudes?

The construct of attitudes plays an important role in social psychology. In spite of this role, however, there are a variety of definitions of attitudes with no accepted consensus. Attitude theorists do agree that the defining characteristic of an attitude is its evaluative aspect. Ajzen (1989) uses a global definition that works well when considering students' attitudes toward statistics: "an attitude is an individual's disposition to respond favorably or unfavorably to … any … discriminable aspect of the individual's world" (p. 241). In our case, the "world" is anything associated with statistics.

This definition helps us think about attitudes toward statistics but we still need to measure them. Once a measure assessing students' attitudes toward statistics is created and used, we then have an operational definition of this construct, one that is useful for identifying and dealing with students' attitudes.

Are Attitudes Toward Statistics Important?

Many statistics educators and most statistics students believe that attitudes toward statistics are important. Students who hold and express negative attitudes can create an uncomfortable classroom climate (Gal, Ginsburg, & Schau, 1997). In addition, many of us believe that attitudes impact students' achievement, course completion, future course enrollment, and

statistical thinking (or lack thereof) in their lives outside the classroom.

A variety of educational and cognitive theories propose that attitudes are important in course achievement and persistence and in the use of course-learned information outside of the classroom (see Sorge, 2001, for a brief description of some of these models). Expectancy-value models of behavior are especially useful in mathematics and statistics education. Eccles and her colleagues have taken these expectancy-value models and applied them to mathematics attitudes and achievement in K-12 students (see, for example, Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983, and Eccles & Wigfield, 1995). We, in turn, have taken their model and applied it to statistics attitudes and achievement.

Eccles and colleagues believe attitudes are multi-dimensional, that is, that attitudes are composed of constructs or factors that, although related, are distinct. The three expectancy-value factors of most use to us in statistics education include:

1. Expectancies for Success - students' self-concepts regarding their ability to do statistics successfully,
2. Task Difficulty - students' perceptions of the difficulty of statistics, and
3. Task Value - students' perceptions of the value of doing statistics successfully.

Each of these three factors suggests an important component to attitudes toward statistics. In addition, students' perceptions of their past academic performances (in math and in statistics, if they have had previous experience in the later) influence each of these three factors.

How Do We Measure Attitudes Toward Statistics?

There are a variety of ways to measure students' attitudes toward statistics. See Gal, Ginsburg, and Schau (1997) for a description of some of these approaches. However, the most common approach by far, especially in post-secondary statistics courses, is to use a Likert survey. This approach is easy and quick to use.

In late 1980's, there were two commonly used surveys purporting to assess post-secondary students' attitudes toward statistics. They included the Statistics Attitude Survey (SAS; Roberts & Bilderback, 1980, and Roberts & Saxe, 1982), and Attitudes Toward Statistics (ATS; Wise, 1985). A third measure, the Statistical Anxiety Rating Scale (STARS; Cruise, Cash, & Bolton, 1985) was designed to assess statistics anxiety, which is only one part of one component of attitudes toward statistics. For a description of these (and other) surveys, see Sorge (2001).

These authors essentially originated survey research into students' attitudes toward statistics. However, their measures, as well as other less frequently used measures, do not present a consistent picture of students' attitudes toward statistics. The creators of these measures disagreed about such fundamentals as what components and how many components comprise attitudes toward statistics. The component names are often misleading and simply incorrect in some of the surveys. The items themselves suffer from a number of problems. The most fundamental is that some items appear to be misplaced in regard to the component they are supposed to be measuring.

Using an extensive development and testing process, I created the Survey of Attitudes Toward Statistics or SATS©. The current version of the SATS consists of 28 items measuring four components of students' attitudes toward statistics. These components and example items from the pretest version follow:

Affect (6 items) – students' feelings concerning statistics
"I am scared by statistics."

Cognitive Competence (6 items) – students' attitudes about their intellectual knowledge and skills when applied to statistics
"I can learn statistics."

Value (9 items) – students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life
"I use statistics in my everyday life."
"Statistics is not useful to the typical professional."

Difficulty (7 items) – students' attitudes about the difficulty of statistics as a subject
"Most people have to learn a new way of thinking to do statistics."

The four components in the SATS are consistent with our application of Eccles and colleagues' three expectancy-value factors to statistics education (although Eccles and

colleagues included affective perceptions within their factor called Task Value, we included *Affect* as a separate attitude component). These same four components also are found in a variety of other theories concerned with the multi-dimensionality of attitudes.

All of the items in the four components use a 7-point Likert response scale (1 = Strongly Disagree, 4 = Neither Disagree nor Agree, 7 = Strongly Agree). Although some of the items are written negatively, responses are reversed before scoring so higher responses always mean more positive attitudes.

The SATS also contains items that assess students' academic backgrounds and demographic information (e.g., gender, age), as well as the grade they expect to receive in their statistics course. In addition, the SATS includes three global items that assess students' attitudes regarding Math Cognitive Competence, Statistics Cognitive Competence, and Career Value of statistics. The SATS can be viewed at http://www.unm.edu/~cschau/infopage.htm.

Students, on average, spend about ten minutes responding to the items on the SATS administered in a paper-and-pencil or a Web format. The SATS is easy to administer in either format.

Before using any kind of measure, it is important to examine the measurement quality of its scores. Usually, both score reliability and validity are examined. A variety of research evidence indicates that scores from the SATS have good measurement properties.

For surveys, reliability usually is assessed as the internal consistency of the items composing each scale, that is, the degree of interrelationship among students' responses to the scale's items. Cronbach's coefficient alpha often is used for this assessment. The SATS component scores generally exhibit reasonably high alpha values indicating good internal consistencies. These values show a consistent picture within each attitude component across studies that vary in terms of student, course, and instructor characteristics and time of administration of the SATS (Cashin & Elmore, 2000; Faghihi & Rakow, 1995; Hilton, Schau, & Olsen, in press; Mayer, 1999; Mills, 2002; Schau, Dauphinee, & Del Vecchio, 1992; Schau, Dauphinee, & Del Vecchio, 1993; Schau, Stevens, Dauphinee, & Del Vecchio, 1995; Schutz, Drogosz, White, & Distefano, 1999; Watson, Lang, & Kromrey, 2002; Wisenbacker & Scott, 1995). The range of alpha values by component includes:

Affect (17 values from 9 studies) .80 to .89,
Cognitive Competence (16 values from 8 studies) .77 to .88,
Value (17 values from 9 studies) .74 to .90,
Difficulty (16 values from 8 studies) .64 to .81.

The *Difficulty* component tends to exhibit the lowest level of internal consistency, but that level is considered at least adequate.

Two kinds of score validity information are available for the SATS. The first kind concerns the score validity of the four-component structure. Two sets of confirmatory factor analyses indicate that the four-component structure fits responses to the SATS well and that the items fit into their hypothesized components (Dauphinee, Schau, & Stevens, 1997; Hilton, Schau, & Olsen, in press; Schau, Stevens, Dauphinee, & Del Vecchio, 1995). These findings imply that scores from the SATS have the same meaning for both genders at both administration times; that is, mean scores by gender, by time of administration, and by their interaction can be compared.

The second kind of score validity information often is called concurrent validity. Scores have concurrent validity if they interrelate as expected with other measures of similar constructs. There is evidence of concurrent validity for the SATS component scores of *Affect*, *Cognitive Competence*, and *Value*. SATS *Affect* scores correlated strongly with scores from Wise's ATS Course scale, which also measures students' affective feelings about statistics (Cashin & Elmore, 2000; Schau, Stevens, Dauphinee, & Del Vecchio, 1995). Scores from the SATS *Value* component correlated strongly with scores from the ATS Field scale, which measures students' attitudes about the value of statistics (Cashin & Elmore, 2000; Schau, Stevens, Dauphinee, & Del Vecchio, 1995).

In addition, the expected relationships between the SATS global attitudes items and the corresponding component scores were found. Correlations greater than +. 5 were found between students' pre-test *Cognitive Competence* component scores and their pre-test responses to the single global *Cognitive Competence* item, as well as between their pre-test *Value* component scores and their pre-test responses to the single global *Career Value* item.

What Do We Know About Students' Attitudes Toward Statistics?

There is not much research on students' attitudes toward statistics. Faculty in education have conducted most of the research that does exist. They usually study the students in their own courses; many of their students are education majors and may be advanced undergraduate or graduate students. We know little about the attitudes of undergraduates who are enrolled in introductory statistics courses and even less about students in these statistics courses offered by mathematics or statistics departments.

In this paper, I emphasize findings from a sample of the students who participated in the development and testing of the SATS. These findings come from data collected from undergraduates who were enrolled in the introductory statistics course offered by the Mathematics and Statistics Department of a major Southwestern research university. The Psychology, Sociology, Engineering, and Business Departments at this University offered their own introductory statistics courses so students with these majors are not well represented in these findings. We collected SATS attitudes and course achievement data in a total of 11 sections of this introductory statistics course across two consecutive semesters.

Five hundred eighty students completed the SATS within the first two weeks of the beginning of their course (the pre-test administration); 287 of these students also completed it within the last two weeks (the post-test administration). Only one student took the SATS during the post-test administration but not during the pre-test administration; that student's data were not included in the analyses.

Of the 293 students who took the pre-test but not the post-test, 201 (69%) did not receive a letter grade (A through F); since they had withdrawn from the course, they could not have participated in the post-test data collection. Their mean pre-test attitude scores were lower than those of the students who took both the pre- and the post-tests by .1 point or less (less than 2% differences on this scale); clearly these differences were small.

Participation rates were high; usually, every student present on the day of SATS data collection participated, with the occasional exception of one or two students. Thus, it is likely that most of the 92 students who received a letter grade but did not take the post-test SATS were absent the day we collected the post-test data. Unfortunately, these students could not afford to miss class. On average, the students who took the SATS at the pre-test but not at the post-test received grades of about C+ (2.45) while those who took both received grades of about B (2.88), a difference of .4 points on the usual numeric grading scale. Whenever possible, pre-test analyses were conducted on both sets of students: all 580 students who took the pre-test and the 287 students from this group who took both the pre- and post-tests.

To date, my analyses have yielded four broad findings of interest, which are summarized below. I have not included the statistical significance tests in this summary. Instead, I emphasize the size of relationships.

1. Students' spoken attitudes were more negative than were responses to the SATS.

Because of the predominance of strong negative words and phrases created during the development phase of the SATS, I expected students' responses to the SATS survey would be at least somewhat negative too. Thus, the results were unexpected. For both sets of pre-test analyses and the post-test analyses, average *Cognitive Competence* scores were somewhat positive (about 1 point above neutral), as was the mean *Value* score at the pre-test administration. The mean post-test *Value* score was slightly positive, about ½ point above neutral. The *Difficulty* scale was the only scale to yield mean negative attitudes, and these means were only slightly negative for both pre- and post-tests (about half a point below neutral). See Table 1. These means generally are similar to those found in research using the SATS with other samples of students (e.g., Cashin & Elmore, 2000; Faghihi & Rakow, 1995; Hilton, Schau, & Olsen, in press; Mayer, 1999; Mills, 2002; Schau, Dauphinee, & Del Vecchio, 1992; Schau, Dauphinee, & Del Vecchio, 1993; Schau, Stevens, Dauphinee, & Del Vecchio, 1995; Schutz, Drogosz, White, & Distefano, 1999; Watson, Lang, & Kromrey, 2002; Wisenbacker & Scott, 1995).

It appears that spoken attitudes are more negative than those recorded on a survey. Perhaps students who hold negative attitudes are more verbal than those who hold neutral and positive ones.

2. Students attributed their attitudes to their achievement and to instructors.

Students in two sections of a required introductory graduate-level statistics course taught in a College of Education were given an extra-credit opportunity to write brief statements about their attitudes and the sources for these

attitudes regarding mathematics and statistics and courses in these disciplines. Although they cited a variety of sources for their feelings, they most often mentioned two general themes: their achievement and teacher (and class) characteristics. At the beginning of the classes, these students attributed positive attitudes to good math achievement that created positive math self-concepts. Students attributed negative attitudes at the beginning of classes to poor teaching that led to poor mathematics self-concepts and poor achievement. Many students also attributed positive change in their attitudes across their statistics course (as well as high achievement) to teacher characteristics.

As one student wrote, "Instructors make a large difference." See the chapter by Gal, Ginsburg, and Schau (1997) and papers by Onwuegbuzie, Da Ros, and Ryan (1997) and Watson, Kromrey, Lang, Hess, Hogarty, and Dedrick (2003) for additional discussion of this important topic.

3. Mean attitudes varied.

Attitudes varied, depending primarily on the component being measured and the section in which the student was enrolled. Mean gender and ethnic attitude differences were small, when they existed at all, although there was some indication that these differences were larger at the end than at the beginning of the course. Similarly, attitudes did not change much from the beginning to the end of the course. *Value* exhibited the largest change; *Value* mean scores decreased by almost twice as much as mean scores on the other three components (.4 points which is a decrease of about 7% on the scale). However, differences among mean scores on the four attitude components were large. As indicated above, on average, students' *Cognitive Competence* and *Value* attitudes were highest and positive. *Affect* attitudes were neutral. *Difficulty* attitudes were slightly negative. See Table 1.

Mean attitudes differences among sections were large at the beginning of the semester and even larger at the end. With 11 sections measured twice on each of four attitude components, we have 88 means. To make this task manageable, I first looked at the mean difference between the sections with the best and the worst attitudes.

The pre-test differences between the highest and lowest mean section scores ranged from about 1/2 point for *Difficulty* (about an 8% difference) for all students who took the pre-test to .9 points for *Affect* (about a 15% difference) for students who took the SATS at both administration times. See Table 2.

At the post-test, the differences between mean scores in the sections with the highest and lowest means were large for all four components, much larger than they were at pre-test. As occurred at the pre-test, mean *Affect* scores showed the largest section differences of almost 2 points (about 32%), twice as large as the mean pre-test difference. The smallest mean post-test difference was for *Value*; this post-test mean difference was over one point (about 20%), again almost twice as large as the *Value* difference that occurred at the pre-test. See Table 3 for the highest and lowest raw mean post-test section scores.

These results suggest that the section in which the student was enrolled is important in regard to their attitudes. To explore the contribution of section to post-test attitude score variability, analysis of covariance was used to adjust component post-test responses for corresponding pre-test responses; section was the predictor variable. Pre-test attitude scores were important in post-test score variability. Pre-test attitude scores shared from 11% (*Affect*) to 22% (*Cognitive Competence* and *Value*) of the variance in post-test attitude scores, depending on the attitude component being studied. See Table 4.

Section, controlling for pre-test scores, also was an important factor in students' post-test attitudes for all four components. Section shared from 11% (*Value*) to 21% (*Affect*) of the variance in post-test attitude scores, depending on the attitude component being studied. See Table 4.

These findings support the idea of the importance of the class experience involving interactions among the course instructor and the group of students in the class in terms of students' attitudes, as well as the importance of the attitudes students bring to this course. It also suggests that some sections of students are easier to work with than other sections.

4. Students' attitudes were positively related to their achievement

Like many others, I believe that statistics attitudes and achievement are positively related. However, research evidence supporting this belief is not yet well established. Until recently, studies exploring attitudes toward statistics have focused on a small part of the complex relationships between attitudes and achievement.

These studies often have explored these relationships by correlating attitude and achievement scores.

The only achievement variable available for my sample was letter grade; it was converted to the usual numeric grading scale and standardized within section due to differences in instructors' grading standards across sections. Attitude component scores also were standardized within section. Table 5 presents correlations from this sample. The relationships among the pre-test attitude components and course grade were small, .20 or below. The relationships among the post-test attitude components and course grade were larger than the pre-test relationships, but they still were not large. These results are consistent with those found in other research (see Sorge, 2001 for a summary of this research).

A hierarchical regression, entering the four standardized pre-test attitude component scores in the first block and the four standardized post-test component scores in the second block, was used to predict standardized grade. The pre-test block shared only 3% of the variance in grade. The post-test block, controlling for the pre-test block, shared an additional 16% of the variance in grade. Together, they shared 20%.

These relationships, although adequate, were not strong. There are at least three reasons these relationships were not stronger. First, letter grade is not the best measure of course achievement to use in analyses due to its limited number of possible values. Total course points would be a better measure. Second, students who didn't participate in the post-test, on average, received lower grades than those who did participate, thus likely restricting the size of the relationships. Third, simple correlations and regressions are unlikely to represent the complexity of the interrelationships among attitudes and achievement.

Are Attitudes Toward Statistics and Statistics Course Achievement Causally Related?

I believe that attitudes toward statistics and course achievement causally impact each other, and that these relationships can be represented in a model. Models often contain constructs that are internal to the model (endogenous constructs) and constructs that are external to the model (exogenous constructs). These models represent the researcher's idea about the causal relationships among the constructs while taking the exogenous constructs as "givens."

In my model, Prior Attitudes and Prior Achievement are related exogenous variables; students who enter our classes already possess attitudes toward statistics and learning that will impact their course performances. Attitudes and Course Achievement also are endogenous variables that impact each other throughout the course and that are impacted by both Prior Attitudes and Prior Achievement. In my model, the four endogenous Attitude constructs match the four components of the SATS. The direction of the impacts among the Attitude components is based on work by Eccles and Wigfield (1995). See Figure 1.

This global model is not testable without refinement. However, using data from engineering undergraduate students in a required introductory engineering statistics course, my colleague Carmen Sorge (2001) and I were able to test a part of this model. With some modifications, the data fit the model adequately. The post-test attitude components together accounted for about 1/3 of the variation in course achievement (pre-test attitudes could not be included in this variation of the model). Prior achievement accounted for the remaining 2/3. I believe that these variance percentages associated with course achievement (1/3 with attitudes and 2/3 with prior achievement) will generalize to other samples.

My model isn't the only reasonable model relating statistics attitudes and achievement. See the work by Harlow, Burkholder, and Morrow (2002) and by Wisenbaker and colleagues (e.g.,Wisenbaker and Scott 1997; Wisenbaker, Scott, & Nasser, 1999; Wisenbaker, Scott, & Nasser, 2000).

The attitude components assessed by the SATS, coupled with students' prior achievement, are not all of the important student inputs into their work in statistics courses. We currently are adding two other components to the SATS. These include:

Interest – students' self-reported level of individual interest in statistics, and
Effort – amount of work students say they expend to learn statistics.

It is not clear, however, if these two constructs are components of attitudes. Other important inputs and outcomes include students' goals for studying statistics and the metacognitive approaches they use in doing so.

How Can We Influence Students' Attitudes Toward Statistics?

There are many things that we as instructors can do to try to influence our students' attitudes and to help them at least complete our courses. Unfortunately, there is little research available on the effectiveness of these approaches. My suggestions, which aren't exhaustive, are based on educational and cognitive theories, what I've tried, and others' suggestions that sound reasonable to try. Whatever you choose to do, however, must be comfortable for you and fit into your vision of yourself as an introductory statistics course instructor. See also Harris and Schau (1999).

1. Encourage students with debilitating negative attitudes to see a counselor.
2. Stress that your statistics course is not a math course (unless it is).
3. Bring positive attitudes to your course.
4. If you believe that students' attitudes are important, acknowledge their importance.
5. If engendering positive attitudes is one of your course goals, assess attitudes twice (pre- and post-tests) to evaluate your success in achieving this goal.
6. Use activities that will help students identify and acknowledge their attitudes.
7. Provide a great deal of structure in your course.
8. Use humor but not sarcasm.
9. Let students know that it is likely that both you and they will make mistakes sometime during the course; use those mistakes as "teaching moments" for content, process, and attitudes.
10. Allow students to use so-called "cheat sheets" on exams.
11. If possible, use more than in-class tests for assigning grades.

There are at least two additional sources of help. Freda Watson, for her doctoral dissertation at the University of South Florida - Tampa, is creating a multi-media program called EncStat to identify students with poor attitudes toward statistics and to help them develop more positive attitudes. A second phase of the project (EncStat – Professor) will provide statistics instructors with information about statistics anxiety and how to help students cope with it. In addition, Anthony Onwuegbuzie (also at the University of South Florida – Tampa) does a prodigious amount of research on the correlates of statistics anxiety, one part of the *Affect* component of attitudes toward statistics.

Conclusion

I began this paper by indicating that many of us want our students to be intelligent users of statistics in their lives. This outcome may have little to do with course achievement and everything to do with their attitudes toward statistics. The SATS is a simple measure that assesses these attitudes. It is easy to use, score, and explain.

We need to better understand students' attitudes toward statistics and their interrelationships with achievement and eventual use in life, and we need to find more methods for promoting positive attitudes. I believe that assessing our students' attitudes and creating, considering, and testing models such as the one I've presented will help us accomplish these tasks.

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Table 1. SATS Attitude Component Mean Scores (Standard Deviations) at Pre- and Post-Test

	Affect	Cognitive Competence	Value	Difficulty
Pre-test*	4.03	4.91	4.86	3.62
	(1.14)	(1.09)	(1.01)	(0.76)
Pre-test **	4.12	5.01	4.96	3.62
	(1.13)	(1.09)	(0.97)	(0.78)
Post-test	3.95	4.84	4.57	3.49
	(1.45)	(1.27)	(1.21)	(1.15)

* Pre-test scores for students who took the pre-test (n=580).
** Pre-test scores for students who took the post-test also (n=287).

Table 2. Lowest and Highest SATS Pre-test Component Mean Scores by Section (Section Number)

	Students Who Took Pre-test			Students Who Took Pre- & Post-test		
	Lowest	Highest	Difference	Lowest	Highest	Difference
Affect	3.57 (3)	4.41 (2)	0.84	3.60 (3)	4.50 (4)	0.90
Cognitive Competence	4.58 (3)	5.21 (6)	0.63	4.65 (3)	5.34 (4)	0.69
Value	4.60 (8)	5.27 (2)	0.67	4.60 (8)	5.33 (6)	0.73
Difficulty	3.31 (9)	3.78 (4)	0.47	3.31 (9)	3.96 (4)	0.65

Table 3. Lowest and Highest Raw and Adjusted SATS Post-test Component Mean Scores by Section (Section Number)

	Raw			Adjusted		
	Lowest	Highest	Difference	Lowest	Highest	Difference
Affect	2.85 (10)	4.74 (8)	1.89	2.90 (10)	4.77 (8)	1.87
Cognitive Competence	3.79 (10)	5.53 (8)	1.74	3.90 (10)	5.49 (8)	1.59
Value	4.09 (10)	5.26 (5)	1.17	3.96 (6)	5.29 (5)	1.33
Difficulty	2.67 (2)	4.05 (8)	1.38	2.69 (2)	4.05 (8)	1.36

Table 4. Percent Variance in Post-test Attitude Scores Associated with Pre-test Attitude Scores and with Section Membership by attitude component

Attitude Component	Pre-test	Section	Total
Affect	11%	21%	32%
Cognitive Competence	22%	18%	40%
Value	22%	11%	33%
Difficulty	14%	14%	28%

Table 5. Correlations among SATS© Attitude Component Scores and Grades*

	Affect	Cognitive Competence	Value	Difficulty
Pre-test**	.12	.20	.08	.09
Pre-test***	.04	.14	.06	.03
Post-test	.35	.36	.30	.17

* Attitude scores and grades were standardized within section.
** Pre-test scores for students who took the pre-test (n=360).
*** Pre-test scores for students who took the post-test also (n=268).

Figure 1. Global Causal Model Interrelating Students' Attitudes Toward Statistics and Course Achievement.