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ABSTRACT

The purpose of this study was to develop and gather initial validity evidence for a scale designed to assess teacher knowledge and practice regarding statistics anxiety and negative attitudes toward statistics. A secondary purpose was to assess the levels of encouragement, knowledge of statistics anxiety, and current teaching practices of respondents as baselines to evaluate the need for training in encouragement of students with statistics anxiety. The study was undertaken in the context of the development of EncStat, a multimedia program to address student statistics anxiety. Responses to a developed instrument were received from 42 statistics educators, who completed self-report surveys. Results suggest that the proposed instrument holds promise for providing valid measures of critical aspects related to teaching statistics, although substantial development work remains. Estimates of consistency for the Assessment, Scaffolding, and Supplementary Teaching Materials section were low, suggesting that special attention must be given to expanding items for these areas of teacher practice. (Contains 7 tables and 11 references.) (SLD)

Development and Initial Validation of the Encouraging Statistics Professor Scale

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Background and Rationale

Onwuegbuzie and Wilson (in press) estimate that "...between 66 and 80 percent of graduate students are uncomfortably anxious about statistics." Other researchers (Gal, Ginsberg, & Schau, 1997) stress that "...attitudes and beliefs can impede (or assist) in learning statistics and may affect the extent to which students will develop useful statistical thinking skills and apply what they have learned outside the classroom." (p. 37)

As McLeod (1992) observes: "Affective issues play a central role in mathematics learning and instruction...If research on learning and instruction is to maximize its impact on students and teachers, affective issues need to occupy a more central position in the minds of researchers." (p. 575) Although the reference is to mathematics education, the relationship applies to statistics education as well. Similarly, Gal, Ginsburg, and Schau (1994) state, "The extensive body of research on affective issues in mathematics education can be used to guide a discussion of affective responses to statistics education." (p. 40) According to McLeod (1992, p. 575) "...if students are going to be active learners of mathematics who willingly attack nonroutine problems, their affective responses to mathematics are going to be much more intense than if they are merely expected to achieve satisfactory levels of performance in low-level computational skills." The same dynamic operates in statistics classes, and likely explains in part, the high rate of statistics anxiety among graduate students

As Garfield and Ahlgren (1988, p. 210) note: "Extensive research shows that statistics and probability concepts are difficult to teach and often poorly understood." Of the several reasons cited by Gal and Garfield (1997) two in particular make learning statistics, for some students, an obstacle that appears enormous in scale: (1) "the '...messiness' or context boundedness of statistics is markedly different from the more precise, finite nature characterizing traditional learning in other mathematical domains..." and (2) ...the need for "... students to be able to render reasons, descriptions, judgments, inferences, and opinions about data..." (p. 6)

Judgment and inferences are at the highest levels of Bloom's taxonomy of learning (Bloom, 1981). For most of the time allotted for one week's classroom lecture, the instructor must quickly lead students through application, analysis, synthesis, and evaluation while

students are still struggling to recall simple definitions and comprehend their meaning. To adequately cover the curriculum, such treatment must happen consistently, week after week. Compounding this problem, the process of learning statistics is hierarchical, as are the processes of learning mathematics or a foreign language. It has been acknowledged that the statistics student must acquire a new vocabulary and a new way of thinking. This recognition translates into allowing graduate students in some programs to substitute one course in graduate level statistics for one course in a foreign language. Even under optimal learning conditions, the challenge is difficult. For the anxious learner, the obstacle truly does assume Everest proportions.

More is becoming known about statistics anxiety (SA) but little regarding intervention. In his introduction to *The Assessment Challenge in Statistics Education*, Gal and Garfield (1997) observe, "Statistics has gained recognition as an important component of the precollege mathematics and science curriculum" (p. 1). New instructional materials are being developed, and more attention is being devoted to statistics education, at all levels. However, as Onwuegbuzie and Wilson (in press) note, most of the recent increase in research activity concerning statistics anxiety has been directed toward undergraduate students. More investigations are needed, especially with respect to graduate students and interventions.

EncStat (Encouraging Excellence in Statistics) is a statistics anxiety intervention program that identifies and helps graduate students with statistics anxiety and negative attitudes toward statistics (NAS). Using a self-help format, *EncStat* administers an assessment of the student's perceptions of statistics and provides instruction on how SA affects learning as well as guidance on how to modify the resultant counterproductive behaviors, thoùghts, and feelings

Students using the program develop burgeoning (but fragile) confidence, motivation, and skills that require an encouraging atmosphere to come to fruition and to produce practically significant, long-lasting results. To paraphrase Rudolph Dreikurs (1964) the statistics anxious student needs encouragement like a plant needs water. Encouragement (which Evans, Dedrick & Epstein, 1997, emphasize focuses on effort or improvement rather than on outcomes as does praise) is especially beneficial for the statistics anxious student. Such students (and those who, although not anxious, have equally debilitating negative attitudes) may be discouraged due to negative experiences with mathematics, hearsay about the

difficulty of statistics, and/or pressures they face as graduate students to successfully complete the statistics courses in their programs of study.

Fears of negative evaluation and/or poor performance fuel anxiety. An encouraging statistics professor can reduce those fears and help students acquire both head and heart knowledge of these empowering truths:

- I'm still a good student, even if I have to work hard just to be average in statistics.
- Other students have trouble with statistics, too, and our professor wants us to learn statistics just as much as those who excel.
- It's OK to admit I'm having trouble and I need help.
- I'm an important part of the class and I can eventually use and participate in research, even if I still have to work hard at it.

As Evans (1995) notes, "more than others, discouraged students need opportunities to feel important, appreciated, and respected." (p. 28)

Most statistics professors are undoubtedly aware of the troubles facing many of their students, and would, of course, like to help. Research is beginning to provide information about the characteristics of the statistics anxious student; however, scant information is available about effective pedagogy for these learners. The purpose of this study was to develop and gather initial validity evidence for a scale designed to assess teacher knowledge and practice regarding SA and NAS, in particular those elements relating to instilling and fostering an adequate view of both self and others, openness, and a sense of belonging for statistics students. A secondary purpose was to assess the respondents' level of encouragement, knowledge of statistics anxiety, and current teaching practices as baselines to evaluate the need for (eventual) encouragement training.

Encouragement

The limited research available shows teacher characteristics, especially encouragement, are crucial. In one of the few studies of direct attempts to alleviate statistics anxiety, Wilson (1999) reports that "...just employing effective teaching strategies is not enough to reduce anxiety in this high-stress arena. According to the students in [her] study, it is also necessary to

exhibit what might be called encouraging behavior: reassuring students that they are able to learn the material and encouraging them in their attempts to complete the assignments. It appears that optimism is contagious and that support given by the instructor can help students make it successfully through what they initially view as an unpleasant—and perhaps undoable—course." Adding strength to that is the fact that the dominant theme in the plethora of supplemental books designed to help students having difficulty with statistics—as well as the substantial body of work on math anxiety--is one of encouragement.

Comments from participants in focus groups related to the current study underscore the importance of encouragement and provide some enlightening perspectives about instructors labeled by students as "the greatest" and "very encouraging":

- "I'm sure he knows I'm not the sharpest blade in the drawer but he never makes me feel dumb";
- "He's so accepting";
- "He never says something is a mistake but says, 'I got this answer'";
- "He never humiliates or insults anyone";
- "His goal obviously is to have everyone of us succeed";
- "He always takes time to answer my questions after class or when I go see him";
- "He's consistently courteous and non-threatening";
- "You can tell he's super smart but he can still talk to me at my level and explain things so that I understand"; and
- "My life would have been very different if I'd had Professor X in first grade..."

Encouragement has been a central concept in Adlerian psychology and has been applied to enhance student-teacher relationships and to create classroom environments that are cooperative, optimistic, and strength-based. These conditions are viewed as central to reducing statistics anxiety and negative attitudes toward statistics.

One of the key ideas underlying the encouragement model is the concept of a fully functioning person. According to this model, a fully functioning encouraging human being possesses four essential characteristics:

1) A positive and adequate view of self (Self). According to the principles of

encouragement, individuals who are encouraging accept themselves, even when things go poorly, and are satisfied with who they are. This positive view of self allows them to meet life expecting to be successful.

2) A positive view of others (Others). Individuals who are encouraging believe and trust in other people. These individuals have strong feelings of identification with others. They believe everyone has potential.
3) Openness to experience (Openness). Individuals who are encouraging are not fearful of mistakes, but are open to their experiences. They realize that all learning involves mistakes, and they view mistakes as challenges -- opportunities for growth and discovery. Encouragers have the courage to be imperfect.
4) A sense of belonging (Belonging). Encouraging individuals perceive that they belong and do not believe that they need to prove their place in life. A basic prerequisite to functioning fully is to be certain of one's life regardless of how well or poorly one performs, and in spite of inherent differences (Evans, Dedrick, Hathaway, & Teixeira, 1992).

Juxtaposing the typical thoughts and feelings of the anxious statistics student against the four elements of encouragement delineates the relevance of this approach for the anxious statistics student:

(1) **A positive and adequate view of self.** SA students in general feel negative about their prospects of learning statistics (often, about even passing a course that can unhinge their entire academic future!); think of themselves as lacking the wherewithal to learn statistics; blame themselves when they do not perform well; and are not satisfied with their statistics performance. Sadly, they do their homework and go to statistics class expecting to be *unsuccessful*.

(2) **A positive view of others.** SA students often think everyone else understands statistics better than they do, feel all alone with their problem, and believe they have little potential. Additionally, they frequently think the professor and other students who "get it" regard them as inferior and would be irritated with them for asking "dumb" questions in class.

(3) **Openness to experience**. Students worried about statistics are afraid of making mistakes; as much as possible they avoid situations where they believe they will err; they have a mindset—usually subliminal but nonetheless toxic—that making occasional and perfectly "normal" mistakes in statistics proves they will never really master the material; and they believe they have to do statistics perfectly.

(4) **Belonging**. If the anxiety is severe enough, the SA student can feel isolated and quite a third wheel in class, believing that the instructor and the "smart" students belong to some mysterious club of the intellectually elite to which they are (rightfully) denied membership.

As further illustration, consider these comments from focus groups concerning:

- **Self** – "I spend an inordinate amount of time on this stuff...some people catch on like it's second nature but it's like pulling teeth for me" and "It's like I took a foreign language and got moved to that country without my having agreed to it.... It's like I moved to Russia and all I know how to say is 'Hello'"

- **Others** – '...like there's a couple of students who ask such deep questions you can tell no one understands it but them and the professor..."

- **Openness** -- "In-class work is hard. I feel pressured and it's hard not to feel dumb. I get the "deer in the headlights syndrome" and I just freeze."

- **Belonging** -- "I don't know enough to ask questions and I don't want to hold everyone else up because even if I ask, I know I won't understand. It's like I have to hear things three times, and then I still don't get it half the time."

Essential aspects of teaching students with anxiety about and negative attitudes toward statistics can be conceptualized as falling into three broad categories: teaching practices, knowledge of SA, and the instructor's own level of encouragement. Based on published research, focus group and interview work, and consensus achieved during discussion with experienced teachers, a list of instructional techniques and habits found to be particularly

helpful to SA students was drafted as an initial attempt to catalog and delineate these behaviors, for later refinement based upon broader input.

Regarding knowledge of the characteristics most typical of SA students, it was assumed that informing instructors about these traits would help them identify which students were most likely to have anxiety about statistics—a propensity not always easily discernible—and alert them to the need to discuss the subject both during class and during one-to-one contacts with students outside the classroom.

Method

While our initial efforts with respect to *EncStat* have focused on the development and validation of a larger set of instruments, this study focuses on one phase of this process, that is, the development of an instrument to effectively measure critical aspects of encouragement with respect to reducing SA and NAS. The instrument development process involved the delineation and refinement of relevant domains for the constructs of interest, item construction, pilot testing, and item analysis and instrument revision.

Domains of Interest

Using the *Encouragement Scale (Educator Form)* developed by Evans, Dedrick, and Epstein (1997) and information obtained from focus groups and interviews as a foundation, an initial outline of information requirements, research questions, and underlying concepts and themes was constructed. Multiple sources of information were used in the development of a domain map, including a literature review, results of earlier focus group research, discussion among members of the EncStat research team, and structured interviews with statistics students. The domains of primary interest for this study fell within three broad categories: current teaching practices, knowledge regarding characteristics of statistics anxiety, and level of instructor encouragement. Each domain was considered essential in assessing how encouraging a student perceives and experiences contact with statistics professors and statistics classes. Furthermore, it was assumed instruction and/or training in each domain was possible and that instructors would be amenable (even eager) to avail themselves of those opportunities.

Once each domain of interest was delineated, a preliminary set of items was created to measure its various aspects. Each of the requisite domains was then reexamined for

comprehensiveness, and after further consideration, a set of 106 items was retained. A pilot survey was designed and reviewed by content experts and was initially administered to a small sample of statistics professors. Participants' comments about item clarity and importance were used to guide minor revisions to the survey content and item wording.

The revised items, grouped within three sections, were ordered according to section length and content and assembled into a four-page booklet format (the actual instrument is available from the first author). The front page of the instrument was used to collect demographic information (e.g., name and type of institution, highest degree earned and academic rank, teaching experience, gender, and ethnicity). Page two consisted of 35 items designed to measure current teaching practices. Responses to these "What I Do in My Teaching" items were provided on a 5-point frequency scale (ranging from *Never* to *Regularly*). These items were concerned with issues such as assessment strategies, classroom climate, scaffolding, the use of supplementary teaching materials, and employment of anxiety reduction strategies. The third page was comprised of items constructed to glean information with respect to professors' knowledge of certain characteristics of statistics anxiety. In this section, survey respondents were asked to classify a series of items as either facts or myths. The items addressed the prevalence of statistics anxiety, tendencies and manifestation of statistically anxious individuals, and perceptions of statistics anxiety. The last page contained items derived from the Encouragement Scale (Evans, Dedrick & Epstein, 1997), which have been shown to measure the trait of encouragement. These items were reported on a 5-point Likert scale (ranging from *Strongly Disagree* to *Strongly Agree*). These items cohered around the four major components of encouragement: positive and adequate view of self, positive view of others, openness to experience, and sense of belonging.

Sample

To pilot test the refined instrument, 120 statistics educators were chosen from special interest groups within the membership of two professional associations, the American Educational Research Association (AERA) and the American Statistical Association (ASA). The resultant sample of 42 respondents, representing an overall response rate of approximately 35%, was 75% male and 25% female. The respondents were predominantly white (86%), with 48% holding the academic rank of Professor, 21% Assistant Professors, and 21% Associate

Professors. Additionally, the sample was comprised primarily of professors teaching statistics at the graduate level from a fairly broad range of universities. The participants taught an average of three courses each semester, reporting an average of 27 students per class. Survey respondents varied considerably with respect to teaching experience, ranging from one year of experience to 42 years of experience, with a mean of 21 years of teaching experience and a mean of 17 years of experience teaching statistics.

Procedure

Survey packets were mailed to individual professors. Each packet contained a copy of the survey instrument; an individually addressed cover letter that explained the purpose of the study and stressed the importance of each participant's response; an open-ended comment sheet requesting information about items that participants found to be confusing or trivial, important areas that were not included in the survey, and areas that participants found made them uncomfortable; and a stamped, self-addressed return envelope. As an incentive for participation, a custom designed refrigerator magnet was included in each packet.

Results

As each of the major parts of the instrument represent distinct domains, each section of the survey was analyzed independently. Items that represented negative perceptions or behaviors were reflected to facilitate interpretation (i.e., higher scores on each subscale represented greater knowledge, greater use of supportive teaching strategies, or greater degrees of encouragement). After the overall internal consistency of each of the larger sets of items was estimated by calculating Cronbach's alpha, the same procedure was followed for calculating the internal consistency within each subsection. Individual item means and standard deviations are presented in Tables 1-3. Evidence of internal consistency and subscale item total correlation minimum and maximum values are displayed in Table 4. The correlations between the subscales for two of the major domains within the instrument, *What I Do in My Teaching* and *Encouragement*, are presented in Tables 5 and 6, respectively. Finally, the correlations between all subscale scores and total domain scores are delineated in Table 7.

Table 1
Descriptive Statistics for *What I Do in My Teaching.*

Item	Mean	SD
Assessment	**3.56**	**0.60**
Allow open book, open note or take-home tests.	3.98	1.28
Provide rubrics for grading.	3.98	1.23
Provide formative feedback on projects and/or take-home assignments before grading.	3.71	1.25
Assess relevant prerequisite math skills.	2.36	1.38
* Require students to give oral presentations.	3.45	1.27
* Give pop quizzes.	4.54	1.00
When administering in-class exams, give generous or no time limits.	3.70	1.45
When administering in-class exams, allow students to take the exam individually outside the classroom	2.70	1.41
Classroom Climate	**4.16**	**0.51**
Maintain a positive and encouraging attitude.	4.80	0.51
Use humor in the classroom.	4.31	0.90
Encourage working with partners or groups on in-class assignments.	4.20	1.12
Allow students to work in groups on research or term projects.	3.71	1.45
Use "real world' examples to illustrate statistical concepts.	4.62	0.62
Suggest students talk to you during office hours.	4.56	0.74
Suggest students form study groups.	4.33	1.00
Maintain a calm, patient attitude.	4.74	0.54
Deliberately speak slowly and repeat often.	4.28	0.78
Provide opportunities to practice in class before moving on to new material.	3.69	1.16
Encourage students to tape record class sessions.	2.59	1.41
Scaffolding	**4.50**	**0.40**
Identify alternative symbols and names for the same concept.	4.29	1.02
Consciously try to use the same terminology and symbols.	4.55	0.71
Consciously try to link and build on earlier concepts (e. g., compare the standard error of the mean to standard deviation).	4.83	0.44
Break down material into small steps.	4.57	0.63
Illustrate all the steps in a process, even though it may be tedious for some students.	4.24	0.82
Supplementary Teaching Materials	**3.08**	**0.82**
Suggest supplemental statistics textbooks.	3.66	1.11
Provide classroom lecture notes before class.	3.46	1.64
Provide vocabulary lists of key concepts and terms.	2.76	1.36
Provide a list of symbols and names of symbols.	2.90	1.43
Supply practice exercises as a review of math skills.	2.46	1.50
Provide web- based materials on statistics.	3.26	1.58
Anxiety Reduction Strategies	**2.28**	**0.81**
Explicitly discuss statistics anxiety or math anxiety in general.	3.29	1.11
Comment on causes of and remedies for statistics anxiety.	2.78	1.21
Suggest students read books on math anxiety and/or books written for students struggling with statistics	1.62	1.15
Discuss relaxation techniques.	1.43	0.86

* Items reflected in scoring

Table 2

Descriptive Statistics for the *Encouragement Scale*.

Item	Mean	SD
Self	3.52	0.62
* I worry too much.	3.45	1.18
My life rarely feels out of control.	3.27	1.20
I seldom feel down.	3.51	1.05
* I always feel exhausted.	3.95	1.05
* I often compare myself to others.	3.17	1.20
I usually feel at peace with myself, even when there is chaos around me.	3.88	0.87
* I tend to complain a lot.	3.51	1.05
I am very flexible.	3.88	0.81
* When things go poorly, I often blame myself.	3.05	1.05
* I am not very satisfied with myself.	4.05	1.02
* I am often critical of myself.	3.02	1.08
Others	3.94	0.38
I am a good friend to others.	4.35	0.58
My family and friends know I respect them.	4.59	0.50
People are usually dependable.	3.59	0.67
* I am usually too busy to be friendly with the people at work.	3.78	1.21
I enter most relationships anticipating things will go well.	4.20	0.71
* I secretly enjoy it when my coworkers have trouble and do poorly.	4.50	0.68
I take time to make friends with others.	3.88	0.84
* People often make mistakes because they are careless.	2.46	0.74
I usually help other people feel confident in themselves.	4.10	0.74
I usually find a way to relate to most people.	4.03	0.66
Openness	3.77	0.32
I seldom second-guess myself about decisions I have made.	3.32	1.19
I often see the humor in a situation.	4.48	0.60
I try to evaluate all the possibilities before making a decision.	4.24	0.70
I make the best out of a situation.	4.17	0.54
* There is a right way to do most things.	2.85	0.88
* I find everyday life to be boring.	4.22	0.91
I look forward to tomorrow and whatever the day brings.	4.17	0.86
* I often wait until the last minute to complete a major project.	3.41	1.26
* I stick to doing only those things I do well.	3.49	0.95
I enjoy change.	3.78	0.94
* I must accomplish something of significance each day to feel valuable.	3.51	1.12
I appreciate others who are different from me.	4.20	0.75
I am a perfectionist.	3.15	1.26
Belonging	3.62	0.34
* I have very few, if any, real friends.	4.02	0.96
* I often feel like I am surrounded by hostility.	4.18	0.87
* I sometimes feel isolated from my friends because of my responsibilities at work.	3.56	1.18
I usually feel a sense of oneness with the world.	3.18	0.87
I participate even when I am not recognized for my contributions.	4.07	0.61
* I often feel like no one really listens to me.	2.29	0.98
I feel comfortable around other people.	4.07	0.79
* I tend to cooperate despite personal misgivings.	3.56	0.84

* Items reflected in scoring

Table 3

Descriptive Statistics for *Characteristics of Statistics Anxiety*.

Items	Mean	SD
Statistics Anxiety is more prevalent....		
... among women than men.	.33	.48
... among minority students than non-minorities.	.14	.35
... among high achieving students than low achievers.	.86	.35
Individuals with statistics anxiety tend to...		
... take fewer math courses in high school and college.	.79	.42
... have lower scholastic ability.	.79	.42
... have fewer friends.	.90	.30
... be more creative.	.88	.33
... have lower linguistic ability.	.02	.15
... have math anxiety.	.88	.33
... have lower mathematical ability.	.48	.51
... lack persistence.	.74	.45
... have test anxiety.	.64	.48
... be perfectionists.	.14	.35
... have computer anxiety.	.43	.50
... lack spatial ability.	.83	.38
... have state/trait anxiety.	.36	.48
... procrastinate on academic tasks.	.14	.35
... lack interpersonal skills.	.88	.33
... be older than individuals without statistical anxiety.	.19	.40
Statistical Anxiety is often manifest as...		
... a blank or frozen mind.	.69	.47
... physical sensations such as increased heart rate, perspiration , feeling faint, nausea..	.76	.43
... replaying negative messages about inadequacies or past math failures..	.83	.38
... embarrassment and shame at being unable to perform satisfactorily.	.71	.46
... intense emotional upset..	.67	.48
Statistics anxiety...		
... is never overcome.	.95	.22
... prevents a student from becoming a successful scholar.	.74	.45
... is overcome only by intensive therapy..	.88	.33
... prevents a student from ever truly understanding statistics.	.69	.47
... is overcome only by prodigious effort.	.60	.50

Table 4

Subscale Internal Consistency and Item Total Correlations.

Subscale	Number of Items	Cronbach's Alpha	Item Total Correlation	
			Min	Max
Teaching	**34**	**.86**	**-.22**	**.65**
Assessment	8	.44	-.18	.59
Classroom Climate	11	.76	.25	.61
Scaffolding	5	.39	.03	.42
Supplemental Materials	6	.62	.16	.59
Anxiety Reduction Strategies	4	.73	.42	.61
Encouragement	**42**	**.82**	**-.59**	**.70**
Self	11	.81	.27	.69
Other	10	.70	-.01	.65
Openness	13	.26	-.26	.50
Belonging	8	.11	-.59	.28
Knowledge	**29**	**.82**	**-.04**	**.77**

Table 5

Correlation Between Subscales Scores in *What I Do in My Teaching*

	Assessment Strategies	Classroom Climate	Scaffolding	Supplementary Materials	Anxiety Reduction Strategies
Assessment Strategies	1.00				
Classroom Climate	.29	1.00			
Scaffolding	.52	.60	1.00		
Supplementary Materials	.43	.19	.43	1.00	
Anxiety Reduction Strategies	.30	.36	.37	.32	1.00

Table 6

Correlation Between Subscales Scores for Encouragement

	Self	Others	Openness	Belonging
Self	1.00			
Others	.41	1.00		
Openness	.55	.62	1.00	
Belonging	.49	.60	.59	1.00

Table 7
Correlation between Subscales Scores and Total Scores

	What I do in My Teaching	Encouragement Scale	Statistics Anxiety Knowledge
Assessment Strategies	.71	.12	.13
Classroom Climate	.72	.02	.37
Scaffolding	.78	.31	.19
Supplementary Materials	.68	-.13	.13
Anxiety Reduction Strategies	.63	.20	.38
Self	-.11	.84	.00
Others	.37	.76	.17
Openness	.13	.83	.05
Belonging	.03	.76	.10
What I do in My Teaching	1.0		
Encouragement Scale	.09	1.0	
Statistics Anxiety Knowledge	.34	.08	1.0

What I Do in My Teaching

The items contained within the "*What I do in My Teaching*" section were designed to measure current teaching practices. Responses to this set of 35 items were provided on a 5-point frequency scale (ranging from *Never* to *Regularly*). These items represent five distinct aspects of teaching: assessment strategies, classroom climate, use of supplementary teaching materials, scaffolding techniques and employment of anxiety reduction strategies. As each set of items was created to capture somewhat different aspects of teaching, each of the five subsections was analyzed separately. The individual items are grouped within each subsection, and the mean and standard deviation for each item and subscale are presented in Table 1.

Items means for those questions aimed toward gaining insight with respect to *Assessment Strategies* ranged from 2.36 for assessing relevant math skills, to a high of 4.54 for giving pop quizzes. Because the item related to pop quizzes was reflected in scoring (i.e., a response of *Regularly* received a value of 1 and a response of *Never* received a value of 5), the mean of 4.54 indicates that pop quizzes were rarely employed. The overall mean for this set of items was 3.56 with a standard deviation of 0.60. The internal consistency for this set of eight assessment items was estimated to be .44. Although an examination of the items in this section reveals a somewhat limited number of common assessment practices, these particular strategies were initially deemed important with respect to the exploration of factors related specifically to statistical anxiety.

For the set of eleven items crafted to measure *Classroom Climate*, item means ranged from 2.59 for encouraging students to tape record class sessions to 4.80 for maintaining a positive and encouraging attitude. These results suggest that while professors rarely or only occasionally encourage tape recording, they regularly maintain a positive and encouraging attitude in the classroom. The overall composite mean for this set of items was 4.16 with a standard deviation of 0.51. Cronbach's alpha for this set of items was estimated to be .76, suggesting a respectable level of internal consistency.

The highest means were evidenced for the set of *Scaffolding* items. The means for this set of items ranged from 4.24 for illustrating all the steps in a process even though it may be tedious for some students to 4.83 for consciously trying to link and build on earlier concepts (e.g., compare the standard error of the mean to standard deviation). The overall mean for this set of

items was 4.50 with a standard deviation of 0.40. Cronbach's alpha for this set of five items was estimated to be .39, indicating a relatively low level of internal consistency. Although this low index of internal consistency is at least partially attributable to the small amount of variability in these responses, it would appear prudent to continue to focus on this area, developing additional sound items with hopes of improving the reliability of scores on this subscale.

With respect to the use of *Supplementary Teaching Materials*, although professors reported that they rarely supplied practice exercises as a review of math skills ($\overline{x}$ =2.46), they were more inclined to suggest supplemental statistical textbooks ($\overline{x}$ =3.66). The overall mean for this set of items was 3.08 with a standard deviation of 0.82. Cronbach's alpha for this set of six items was estimated to be .62.

The individual means for the items that address *Anxiety Reduction Strategies* ranged from a low of 1.43 for the discussion of relaxation techniques to 3.29 for explicitly discussing statistics anxiety or math anxiety in general. Collectively, the composite mean of this set of items was estimated to be 2.28, with a standard deviation of 0.81. A mean of this magnitude suggests that professors rarely incorporate anxiety reduction strategies in their statistics classes. The internal consistency of this set of four items was estimated to be .73.

Finally, we examined the correlation between the five subscales represented in the set of items related to teaching practices (see Table 5). The correlations, all positive in nature, ranged from .60 representing a moderate relationship between *Classroom Climate* and *Scaffolding*, to .19 suggesting a relatively weak positive relationship between *Classroom Climate* and the use of *Supplementary Materials*.

Encouragement

The Encouragement Scale, consisting of 42 items measured on a 5-point Likert scale, was used to measure the four dimensions (self, others, openness, and belonging) underlying the encouragement model. Table 2 presents the individual item and subscale means and standard deviations.

Table 4 presents the Cronbach's alpha internal consistency reliability coefficients for the four subscales. Two of the subscales, Other and Self, possessed reasonably satisfying internal consistency with Cronbach's alphas estimated to be .70 and .82, respectively. The remaining subscales evidenced notably lower internal consistency (.26 and .11 for Openness and

Belonging, respectively). The subscales were approximately normally distributed and were moderately inter-correlated (see Table 6). The Cronbach's alpha for the overall encouragement scale was .82.

Characteristics of Statistics Anxiety

The items contained within the "*Characteristics of Statistics Anxiety*" section were designed to measure knowledge of statistics anxiety. For each of the 29 items, respondents indicated whether the statement was a fact or a myth. The individual items were grouped into sections, where all items in the section had a common stem. The items, along with their means and standard deviation, are presented in Table 3. The means indicate the proportion of respondents who answered the item correctly. These means ranged greatly across items (ranging from a low of .02 to a high of .95). Only 2% of the respondents recognized that individuals with statistics anxiety tend to have lower linguistic ability, while 95% of the respondents recognized that statistics anxiety can be overcome.

Although these items were divided into sections, the sections were not designed to tap different dimensions of statistics anxiety knowledge. Rather, items were grouped conveniently by common stems. Consequently, sections were not analyzed. All items were averaged to create a total score for statistics anxiety knowledge. The internal consistency reliability estimate for these total scores was .82.

Correlations among scales

We then examined the correlations among the total scores for each of the three domains: teaching practices, encouragement, and knowledge of statistics anxiety. These correlations are displayed in Table 7. As anticipated, a positive relationship was evident between knowledge of statistics anxiety and reported teaching behaviors (r = .34). The subscale correlations indicate moderate correlations between knowledge of statistics anxiety and both Classroom Climate (r = .37) and Anxiety Reduction Strategies (r = .38).

Essentially no correlation (r = .08) was observed between encouragement and either knowledge about statistics anxiety or teaching practices. An examination of the subscale correlations, however, suggests a moderate positive relationship between the Others subscale of encouragement and teaching behaviors (r = .37).

Participants' Open-Ended Comments

Thirty-seven of the 42 participants provided comments on the open-ended response sheet provided in the instrument-mailing packet. A content analysis of these data suggested that two areas of the instrument were the focus of many responses. The forced-choice nature of the knowledge section of the instrument (Fact vs. Myth) was troubling to nine of the 37 respondents who provided comments. The participants suggested that a 'Don't Know' option or a greater range of response options (e.g., *Strongly Agree* to *Strongly Disagree*) would be more appropriate for these items than the dichotomous choices provided. Thirteen of the 37 respondents reported confusion about the encouragement scale, many suggesting that the items were too personal in contrast to the remainder of the instrument. A rationale for the inclusion of these items was recommended. Finally, several respondents indicated that some of the terms used in the instrument (e.g., rubric, state/trait) were not familiar to them and should be explicitly defined.

Discussion and Conclusions

The interpretation of these data must be made in the context of the limitations of this research. Most prominent is the small sample size ($N = 42$), which limits the confidence both in terms of the standard errors of the reported statistics and the generalizability of the results. Additionally, the self-report nature of these data relies on the strong assumption of participants' levels of self-awareness and honesty in responses. Augmentation of these data with classroom observations, personal interviews or professorial focus groups may provide evidence of the extent to which the results reported here may be supported through multiple data collection strategies. With these limitations in mind, the results suggest that the instrument holds promise for providing valid measures of critical aspects related to teaching statistics, although substantial development work remains.

What I Do in My Teaching

Because of the relatively low estimates of internal consistency for the Assessment, Scaffolding, and Supplementary Teaching Materials sections (r_{xx} = .44, .39, and .62, respectively), special attention must be given to developing an expanded set of items for these areas of teacher practice. Each of these areas, as well as the Classroom Climate and Anxiety Reduction Strategies sections, is considered critical to effective pedagogy for the SA student.

Especially instructive with respect to designing instructor training were the items having relatively low means: assessing prerequisite math skills; providing practice exercises for review; encouraging tape recorder use; providing lists of vocabulary and symbols, commenting on causes of and remedies for SA; suggesting the use of math anxiety self-help literature; and discussing relaxation techniques.

This section of the instrument will be modified to accommodate suggestions made by respondents, including the addition of a "not relevant" category, inquiring whether instructors attempt to make a "connection" with individual students; clarification of the issue of math anxiety vs. statistics anxiety; asking whether instructors assess level of anxiety and whether instructors perceive that classroom activities are successful; and provision of an option to indicate whether the course is delivered via standard lecture or the web.

Characteristics of Statistics Anxiety

More than 30% of the respondents provided comments on the fact/myth section of the instrument (Characteristics of Statistics Anxiety), classifying the questions as confusing, trivial, or discomfiting. Suggestions from respondents that will be incorporated in the revised instrument include using a Likert scale response indicating extent of agreement, rather than a dichotomous response, with inclusion of a "don't know" category. The revised instrument will also emphasize that the items are based upon available research, admittedly limited in some areas, and are not intended to represent indisputable facts.

Items which fewer than half the respondents correctly labeled as fact (remembering the caveat that the factual nature of the statement is based on available research) include the notions that: SA is more prevalent among women than men and among minorities than non-minorities; that individuals with SA tend to have lower linguistic ability, lower mathematical ability, are perfectionists, have computer and state/trait anxiety, and procrastinate on academic tasks. It was heartening to find that most statistics professors had optimistic attitudes about the likelihood of anxious students overcoming the effects of their anxiety, as evidenced by the last five items in the section (see Table 3).

Statistics professors' knowledge of the characteristics of statistics anxious students is considered critical and will be included in future efforts. The obtained correlation between teachers' knowledge of statistical anxiety and critical aspects of their teaching (i.e., classroom

climate and anxiety reduction strategies) provides empirical support for the importance of this knowledge domain.

Encouragement

Because, ultimately, specific training in encouragement will be an essential element of *EncStat-Teacher*, a measure of this trait is essential. However, this initial effort revealed that a modified approach to assessing instructor encouragement is needed. In retrospect, respondents had good reason to be suspicious and/or resistant to completing the Encouragement Scale because the scale differs radically from the preceding questions in content and could easily be perceived as irrelevant to the expressed intent of the survey. Further, although items that were deemed likely to be perceived as intrusive were removed or modified, some questions remained that tap subjects seldom discussed with casual acquaintances and address topics that are disclosed only to one's closest and trusted confidants.

However, the trait of encouragement is central to the study of statistics anxiety from a theoretical perspective and the results of this study suggest that at least one dimension of encouragement is related to professors' classroom behaviors. Further refinement of this scale will include additional rewording of the items to reduce their reactivity and the provision of an explanatory introduction to this section of the instrument.

In summary, this research has provided an initial investigation of the reliability and validity of scores obtained from an instrument designed to measure essential aspects of teaching students with SA and NAS. While bearing in mind the requisite caveats germane to small sample size and acknowledging that we must be cautiously optimistic about the results obtained, future plans include the development of additional items to assess teaching practices and knowledge of statistics anxiety, as well as a substantial revision of the Encouragement section to reduce the reactivity of these items. As part of our ongoing attempt to derive a measure of and acquire more information about encouraging habits and to identify opportunities for instructor training, professors will be asked to respond to hypothetical scenarios depicting opportunities they have to help the anxious student.

After the instrument has been modified, this study should be replicated with a larger and independent sample to provide additional data on reliability and validity. Further, measures of related constructs such as social interest, teacher efficacy, and social desirability

should be collected and analyzed to provide evidence of discriminant validity. Assuming these subsequent efforts support scale validity and reliability, researchers, statistics educators, and faculty development specialists will have a tool to assess teacher knowledge and practice regarding statistics anxiety and negative attitudes toward statistics. Such assessment will be coupled with future work in teacher development activities to raise awareness and support the development of Encouraging Statistics Professors.

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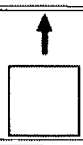
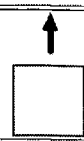
X		
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