Confirming the Factor Structure of a Survey to Gauge Teacher Attitudes toward Instructional Strategies and Classroom Pedagogy

by

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In an investigation that encompassed three cohorts of teachers, an attitude survey was developed, refined and then tested for the robustness of its factor structure. Each cohort of teachers was approximately equal in size (≈300) and included elementary school teachers from participating schools within the Chicago Public School system, and two regional school districts in the state of Illinois. A four-factor solution emerged from the refined survey and confirmed in a subsequent sample suggesting the following constructs: Inquiry-based Instructional Strategies, Reluctance to Use Traditional Teaching Approaches/ Pedagogy, Confidence/Understanding in Teaching Mathematics and Science, and Use of Computers and Technology in the Classroom. Composite scores based on these constructs yielded high internal reliability, that is, .94, .87, .88, and .83, respectively. Pre and post comparisons using these composite scores showed increased positive attitudes for one cohort of teachers, for which these comparisons were available, after participation in an intensive professional development program.

Evaluating systemic reform requires both the capacity to focus on very detailed student and teacher information and to elucidate equally well a global view and overall macro-representation of change relative to the whole system (Webb, 1999). Within the context of a larger outcomes-based evaluation directed toward school-wide change, we have focused our attention on detailed information on the teacher. More specifically, that focus is on the development of an instrument designed to assess teacher attitudes toward instructional strategies and pedagogy in the classroom as these relate to teaching mathematics and science within elementary schools. To this end, these measures are gathered along with other teacher-related outcome measures such as content knowledge changes within an evaluation framework comprised of a cohesive set of intermediate, long-term and ultimate outcomes (Race, 2000).

Research suggests linking differential teacher effectiveness as a strong determinant of differences in student learning (Darling-Hammond, 1999). Moreover, teacher attitudes about students' ability to learn influence student achievement and influence the instructional practices and pedagogical approach teachers use in their classroom (Graham, 1990; Ames & Archer, 1988; Maehr & Midgley, 1991). Furthermore, research suggests that students are more engaged in the learning process when teachers have high expectations and are willing to take personal responsibility (Firestone & Rosenblum, 1988). Under these circumstances, students will tend to learn more as well (Cooper & Tom, 1984). Results from recent research suggests that the construct of the collective responsibility by teachers for student learning also is associated with increased academic performance by students (Lee & Leob, 2000).

After brief background information on an intensive professional development program offered by the Teachers Academy for Mathematics and Science, this paper will summarize the assessment of the psychometric properties of a teacher attitude survey and highlight pre/post comparisons using composite attitude scores obtained from this instrument to demonstrate its sensitivity in detecting attitude changes over time.

Background

The Teachers Academy for Mathematics and Science is a non-profit organization located in Chicago. The Academy "is an autonomous alliance of leaders from education, government, science, mathematics, business, and the community" (Teachers Academy for Mathematics and Science, 1998, p. 4). Since 1990, the Academy has offered an intensive 3-year professional development program in mathematics and science designed to meet the needs of under-prepared elementary school teachers in Chicago and select school districts in Illinois (Brett, 1996). The program recently underwent a major redesign effort to better serve the needs of its target audience. At its core, the program is designed to provide approximately 60 hours of training per year for the first two years. This instruction is developmentally appropriate by grade level, based on national and state standards in mathematics and science, content driven and inquiry based using nationally recognized curricula. In addition, school-based visits are scheduled and conducted during the first two years. The program is supported by distributed teacher materials, student manipulatives and technology resources (Feranchak, Avichai, Langworthy & Triana, 2001). This intervention occurs within the context of a school-wide systemic effort that requires that a high percent of mathematics and science teachers within each school participate in the program. The third year provides a year of transition to help the school sustain progress after the program. The program is based on a cohesive set of ultimate, long-term, and intermediate outcomes, which has formed the basis of the evaluation framework (Race, 2000).

Overview of the Development of the Survey

The development of this survey evolved over the administration of it to three separate cohorts of elementary teachers who, at the time, were participating in the Academy's intensive professional development program. For the first sample (1999-2000), a total of 336 teachers from 16 participating elementary schools in the Chicago Public School system completed the survey during the first instructional session of the program. The second sample was sent a copy of the survey via mail and all teachers were asked to bring the completed form to their first instructional session. For this sample, (2000-2001), a total of 320 teachers from 20 participating schools in East St. Louis and Joliet, Illinois completed the revised survey. In the third sample (2002-2003), a total of 305 teachers from 29 participating schools in the Chicago Public School system completed the survey after the survey was distributed to them during an orientation session. Again, teachers were requested to return the survey during their first instructional session.[1]

Original Survey

Survey items were selected from various existing surveys that focused on attitudes toward instructional strategies and pedagogy applied in the elementary school classroom with specific attention given to instruction in mathematics and science (Olson & Sakshaug, 1996; National Council of Supervisors of Mathematics, 1994; Salish I Research Project, 1997; Ellis, 1999). In original form, the survey consisted of 54 items, divided into four sections: general (17), technology (6), mathematics (16), and science (15). Teachers were asked their attitudes toward, for example, inquiry skills, problem solving, and traditional methods (e.g., drills) as well as less traditional teaching strategies and activities. Items were rated on a 4-point, Likert-type scale (Likert, 1932) from 1 = strongly disagree to 4= strongly agree. (For the purpose of analysis, negatively worded items were reversed coded, such that a high score reflected a positive attitude.)

Revised Survey

On the basis of the results from the initial sample, the survey was revised with the following goals in mind: 1) to improve the reliability of each of the scales, and 2) to develop a less ambiguous factor that focused on the use of computers or technology in the classroom. To this end, additional items were adopted from a survey developed by the North Central Regional Educational Laboratory, an organization that specializes in educational applications of technology to improve learning, to address questions related to the use of computers and technology in the classroom (NCREL, 2000). As revised, the survey consisted of 56 items organized into the following sections: general (15), instructional strategies (13), teacher understanding and confidence in teaching mathematics and science (7), other methods and approaches to teaching (10), and use of computers and technology in the classroom (11).

In addition, the response category used to rate each item was changed from a 4 to 5-point, Likert scale (Likert, 1932) from 1 = strongly disagree to 5 = strongly agree (an option of 3 = neutral was added).

Final Version

In final form, the survey was expanded to include an additional scale related to teachers as life long learners. Other items were added or revised to support existing scales or to help clarify items that were previously ambiguous. As modified the survey consisted of 67 items divided into the following sections: general statements about teaching (13), teaching and learning (11), instructional strategies (14), understanding and confidence in teaching mathematics and science (9), methods and approaches to teaching (9), and using computers and other technology in the classroom (11). Again, a 5-point Likert-type scale was used as the response category for this survey.

Preliminary results of analysis for the final version of the survey suggested the elimination of the new scale since it was redundant and ambiguously defined relative to the instructional strategies scale. This scale was dropped from analysis and is not presently discussed.

Overview of Analyses

For each sample, data analysis began with an item analysis, which consisted of descriptive assessment of item-to-item correlations, item-to-total score correlations as well as assessment of the distribution, skewness, and peakness of responses to each item. To investigate the construct validity of the items, a factor analysis was conducted based on principal components analysis and varimax rotation. To support these analyses, principal axis factoring was also used to test the variability of solutions and to seek factor groups that remained relatively stable across models (Kleinbaum, Kupper & Muller, 1988). A parallel analysis, based on a matrix of randomly generated numbers with similar parameters regarding sample size, number of items, and response category options, was conducted as well to help guide decisions on the number of factors to extract (Thompson & Daniel, 1996). For the last sample only, factor solutions were also compared based on a correlation or covariance matrix used as raw data.

The internal reliability of the scales was assessed using Cronbach's alpha (Cronbach, 1951). Pre and post program comparisons were conducted using analysis of variance.

Results

Results from the first two samples are briefly highlighted with more detail given for the third sample and final version of the survey. An overview of the results from the analyses of each of the three samples is shown in Table 1.

First Sample

Analysis of the first sample suggest the following: 1) the reduction of the survey from 54 to 38 items, 2) a four-factor solution, and 3) the need to better define two of the factors, in particular the scale labeled *Constructivism,* and the last factor, *External Support,* which was very poorly defined at this point in the investigation. In addition, although the reliability coefficients of these scales were promising, need for improvement was evident.

Second Sample

From this analysis the results suggested the following: 1) the reduction of the survey from 56 to 49 items, and 2) a better defined four-factor solution. In particular, this resulted in a re-labeled first factor of *Inquiry-based Instructional Strategies*, and a clear, less ambiguous factor labeled, *Use of Computers and Technology in the Classroom*. Moreover, the internal reliability of these scales was markedly improved.

Table 1
Summary of Results from the Assessment of the
Teacher Attitude Survey Samples from Three Different School Years

Teacher Attitude Survey	Summary of Results		
	Third Sample	**Second Sample**	**First Sample**
	Chicago Public Schools 2002-2003	East St. Louis – Joliet 2000-2001	Chicago Public Schools 1999-2000
Number of surveys used in analysis	305	320	336
Length of survey	67 items	56 items	54 items
Number of items retained	41 items	49 items	38 items
Summary of Factor Analysis Factor 1. Inquiry-based Instructional Strategies	14 items; alpha = .94	23 items; alpha = .91	14 items[1]; alpha = .82
Factor 2. Reluctance to Use Traditional Methods and Approaches to Teaching	9 items; alpha = .87	8 items; alpha = .83	9 items[2]; alpha =.83
Factor 3. Understanding and Confidence in Teaching Mathematics and Science	7 items; alpha =.88	7 items; alpha =.80	9 items[3]; alpha = .74
Factor 4. Using Computers and Technology in the Classroom	11 items; alpha = .83	11 items[4]; alpha = .81	6 items; alpha =.82

[1] Labeled *Constructivism* in analysis of the first sample.
[2] Was factor 3 in analysis of the first sample.
[3] Labeled *External Support and Information* and was factor 4 in analysis of the first sample.
[4] Was factor 3 in analysis of the second sample.

Third Sample

Preliminary item and factor analyses of the final version of the survey resulted in the elimination of 16 items. This was further reduced to a total of 41 items after more extensive analysis suggested the elimination of items contained in the general statement section, the teacher and learner section, and two more items eliminated in the final stages of analysis.

The decision to retain four factors from the third and final sample was supported by the results from previous analysis. Also in support of this decision, a scree plot of the eigenvalues associated with these identified factors suggested a break after four factors. Results from a principal axis factoring also suggested a four-factor solution. Moreover, the results from a parallel analysis suggested the retention of four factors. Finally, factor solutions were compared based on input data using a correlation matrix and covariance matrix.

Based on principal components and varimax rotation, a four-factor solution was accepted, which accounted for 53% of the common variance, with eigenvalues of 10.87, 4.49, 3.85, and 2.72, respectively. The factor solution, which summarizes the results from the third sample, is shown in the Appendix. These four factors clustered as follows:

Factor 1. Inquiry-based Instructional Strategies comprised of 14 items. Examples include: "*A primary objective of mathematics is to develop the ability to identify and solve problems generated from real-life situations*." "*Mathematical learning activities should be relevant to my students*." "*Knowledge of science and technology helps individuals deal with everyday problems*."

Factor 2. Reluctance to Use Traditional Methods and Approaches to Teaching comprised of 8 items. Examples include: *"The textbook is the primary instructional tool I use in my classroom(s)." "Students cannot understand mathematical concepts until they have mastered computation skills." "Students learn best in science through teacher explanations."*

Factor 3. Understanding and Confidence in Teaching Mathematics and Science comprised of 9 items. Examples include: *"I am confident in my understanding of mathematical concepts." "I am confident in my ability to teach scientific concepts." "I understand science concepts well enough to be effective in teaching science for my grade level."*

Factor 4. Using Computers and Other Technology in the Classroom comprised of 6 items. Examples include: "*I do not believe the quality of elementary school education is improved by the use of technology*." *"I am confident using technology as a learning resource."* "*Technology interferes with student interactions."*

The internal reliability of these scales was improved for all four scales, that is. .94, .87, .88, and .83, respectively.

Pre and Post Program Comparisons

A comparison of pre and post program attitudes was possible for the second sample of participating teachers. Overall changes in attitude from pre to post program were evident for all four scales with increased positive attitudes, on average, based on *Inquiry-based Instructional Strategies* scores [$F_{(1, 169)} = 21.53$, $p < .001$], were more *Reluctant to Use Traditional Teaching Methods* [$F_{(1, 169)} = 8.58$, $p < .001$], had more positive perceptions of their own *Confidence and Understanding in Teaching Mathematics and Science*

[$F_{(1, 169)} = 86.49$, $p < .001$], and had more positive scores regarding the *Use of Computers and Technology in the Classroom* [$F_{(1, 168)} = 24.70$, $p < .001$].

Charges in attitudes were also noted based on school district (East St. Louis versus Joliet), and level of instruction (primary versus intermediate grade levels). Results of these analyses suggest that changes in attitudes toward *Inquiry-based Instructional Strategies and Reluctance to Use Traditional Methods and Approaches to Teaching* appeared to have been even-handed (on average) for participating teachers across regions and across instructional level. Overall effect size from pre to post program attitude change was nonetheless large for each of these attitude scales (30% and 37%, respectively). Changes in level of attitudes in *Confidence and Understanding in Mathematics and Science* appear to have been differentially influenced based on school district. That is, East St. Louis teachers showed a greater gain in positive attitudes compared to participating Joliet teachers [$F_{(1,163)} = 4.25$, $p < .05$]. Primary teachers showed greater attitude gains as compared to intermediate-level teachers [$F_{(1,163)} = 6.41$, $p < .05$]. Overall effect size was large (32%). Also, there were school district differences in the change in attitudes toward *Use of Computers and Technology in the Classroom* with East St. Louis teachers showing more positive attitudes [$F_{(1,164)} = 4.99$, $p < .03$]. A large effect size was also evident (39%).[2] Figures 1 and 2 show attitude scores by region and instructional level, respectively.

Discussion

Present results point to the utility of this teacher attitude survey in gauging perceptions of classroom methods and pedagogy as these relate to the instruction of mathematics and science in elementary school classrooms. The underlying construct validity of these scales suggests that the teacher attitude survey emphasizes dimensions that align with concepts fostered by the intensive professional development program offered by the Teacher Academy for Mathematics and Science. These measures include the use of instructional strategies that align with best practices of content-driven and inquiry-based curriculum, and the reluctance to rely on traditional approaches to teaching such as repetitive drill. The importance of using computers to support instruction (Raizen, 1988) is emphasized as well in the program as is building teachers' confidence and comfort level with teaching mathematics and science, disciplines that teachers often report they are less qualified to teach (Weiss, 1987). Thus, the dimensions of the attitude survey and constructs of the program seem well aligned.

Importantly, the dimensions measured by this survey are consistent with emergent best practices within the field of education. As such, these constructs are likely to be applicable in the assessment of other related professional development programs for elementary school teachers, particularly as this relates to attitudes toward pedagogy and classroom practices in mathematics and science.

The psychometric analyses based on these two samples also suggest that each of the identified scales has a high level of internal reliability. Of importance, analysis, based on composite scores from these constructs, suggest that these are sensitive to detecting

Figure 1. Comparison of Attitudes for Participating Teachers by Region: 2000-2002 Pre and End of Second Year Post Program

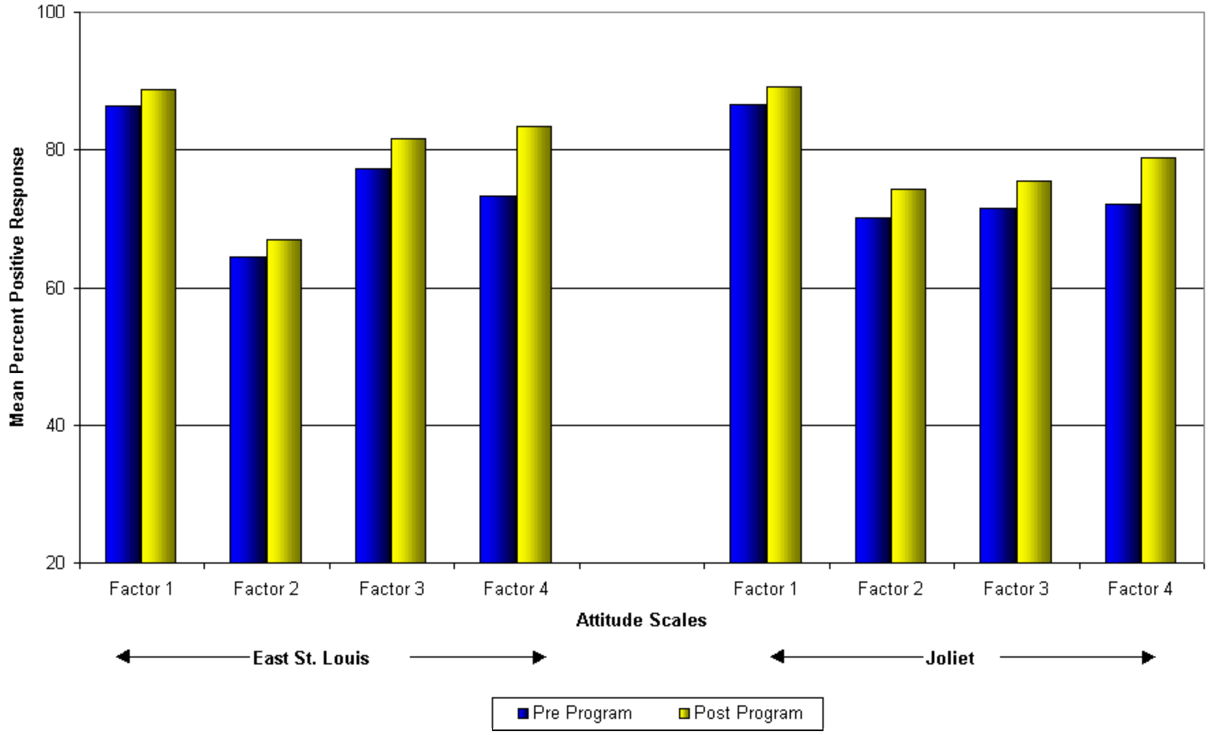
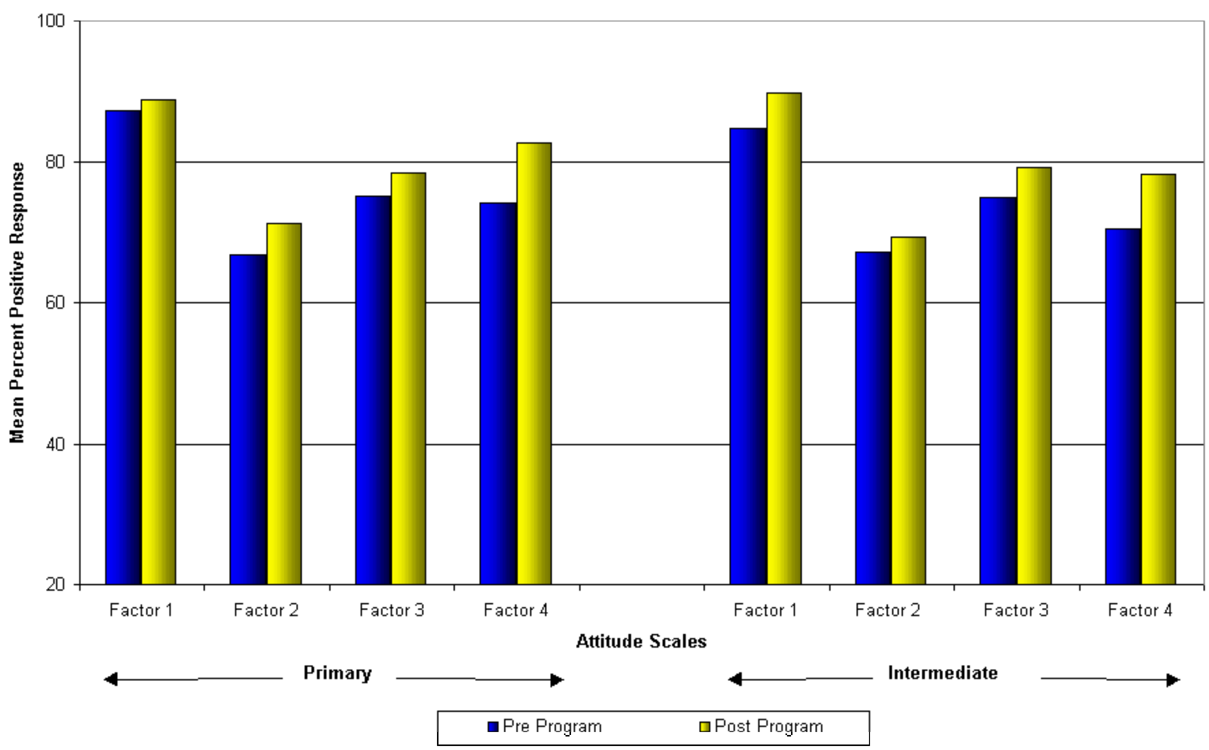


Figure 2. Comparison of Attitudes for Participating Teachers by Instructional Level: 2000-2002 Pre and End of Second Year Post Program



changes in attitudes over time. Analysis show that the pattern of attitude change was consistent across two local school districts as well as instructional levels, where these attitudes were assessed. Other results based on past research suggest the relevance of these constructs to student perceptions of classroom methods and activities (Race & Powell, 2000).

Within the context of an outcomes-based evaluation effort, these measures can be used in conjunction with other outcomes measures such as basic skill sets and/or observed practices in the classroom by participating teachers. And finally, this work underscores the importance of obtaining detailed information at the teacher level (as well as the student level) in the context of large scale outcomes evaluation (Webb, 1999).

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Footnotes

[1]The reported sample sizes are based on the number of teachers who completed all items included in these analyses (i.e., listwise deletion). Actual sample sizes were larger. In the first sample, a total of 385 surveys were returned of which 336 (or 89%) were used in analysis. For the second sample, a total of 365 surveys were returned of which 320 were used in analysis (or 88%). In the third sample, a total of 381 surveys were returned; of these, 305 were included in analysis (80%).

[2]Intepretations of pre and post program differences based on school district and instructional level are made more complicated because of noted initial differences identified at the pre program level. Attempts to correct these initial difference was made using analysis of co-variance. The appropriateness of using this technique is not the focus of this discussion. Rather, its focus is to demonstrate that these scales are sufficiently sensitive to detect pre and post program differences.

Appendix

Table 1
Summary of Teacher Attitude Factors (Scales) and Individual Items
Solution based on Principal Components and Varimax Rotation

Factor/Item Description	Factor			
	1	2	3	4
Factor 1. Inquiry-based Instructional Strategies				
25. Assessment in mathematics and science should stress a variety of ways to arrive at an answer.	.67			
26. Teachers should provide students with the opportunity to develop and build upon their own understanding of mathematics and science concepts.	.78			
27. A primary objective of mathematics is to develop the ability to identify and solve problems generated from real-life situations.	.76			
28. *Mathematical* learning activities should be relevant to my students.	.76			
29. Worthwhile *mathematical* tasks foster a connection between application and understanding.	.80			
30. All students are capable of understanding mathematics.	.61			
31. Helping students understand the scientific process will strengthen students' science ability.	.80			
32. *Science* activities should foster a connection between application and understanding.	.83			
33. Knowledge of science and technology helps individuals deal with everyday problems.	.73			
34. Students learn best in *mathematics* when they are allowed to explore problems and test ideas about possible solutions.	.79			

Table 1 (con't.)
Summary of Teacher Attitude Factors (Scales) and Individual Items
Solution based on Principal Components and Varimax Rotation

Factor/Item Description	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1. Inquiry-based Instructional Strategies (continued)				
35. Students learn best in *science* when they are allowed to explore problems and test ideas about possible solutions.	.82			
36. It is essential that students at all grade levels know and understand good scientific methodology.	.75			
37. Worthwhile *science* activities foster a connection between application and understanding.	.78			
38. All students are capable of understanding science.	.76			
Factor 2. Reluctance to Use Traditional Methods And Approaches to Teaching				
48. The textbook is the primary instructional tool I use in my classroom(s).		.61		
49. If more time could be spent on drill and practice, students would be better in mathematics.		.68		
50. Students learn best in mathematics through teacher explanations.		.68		
51. I organize my math curriculum around the textbook.		.59		
52. Students cannot understand mathematical concepts until they have mastered computation skills.		.67		
53. Students cannot understand the scientific process without mastering scientific facts.		.69		

Table 1 (con't.)
Summary of Teacher Attitude Factors (Scales) and Individual Items
Solution based on Principal Components and Varimax Rotation

Factor/Item Description	Factor 1	Factor 2	Factor 3	Factor 4
Factor 2. Reluctance to Use Traditional Methods and Approaches to Teaching (continued)				
54. Students learn best in science through science textbooks.		.72		
55. Students learn best in science through teacher explanations.		.75		
56. If more time could be spent on learning facts, students would do better in science.		.77		
Factor 3. Understanding and Confidence in Teaching Mathematics and Science				
39. I am confident in my *understanding* of mathematical concepts.			.68	
40. I am confident in my *ability* to teach mathematical concepts.			.73	
41. I understand *mathematics* concepts well enough to be effective in teaching mathematics for my grade level.			.65	
43. I am confident in my *understanding* of *scientific* concepts.			.85	
44. I am confident in my *ability* to teach *scientific* concepts.			.87	
45. I understand *scientific* concepts well enough to be effective in teaching science for my grade level.			.79	
47. I am confident in my ability to teach hands-on science.			.71	

Table 1 (con't.)
Summary of Teacher Attitude Factors (Scales) and Individual Items
Solution based on Principal Components and Varimax Rotation

Factor/Item Description	Factor 1	2	3	4
Factor 4. Using Computers and Other Technology in the Classroom				
57. I *do not* believe the quality of elementary school education is improved by the use of technology.				.60
58. I am uncomfortable when using technology in my classroom.				.39
59. Computers should be as important and available to students as pencils and books.				.63
60. I am confident using technology as a learning resource.				.59
61. Using computers for learning takes away from important instructional time for students.		.30		.60
62. Technology makes my teaching more difficult.				.66
63. Students should be able to use computers to help them solve problems in science and mathematics.	.30			.56
64. Technology interferes with student interactions.				.58
65. There is not enough time to incorporate technology into the subjects I teach.				.59
66. I really enjoy using computers and the Internet instructionally.				.64
67. Students can use computers and technology to help make informed decisions.	.32			.61