Development of an Attitude Survey to Gauge Teacher Attitudes toward Instructional Strategies and Classroom Pedagogy in Support of a Larger Outcomes-based Evaluation Effort

by

Kathryn E. H. Race
Evaluation Department
Teachers Academy for Mathematics and Science
3424 S. State Street
Chicago, IL 60616
www.tams.org

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The psychometrics of a 56-item attitude survey were assessed based on two distinct samples of elementary school teachers from participating schools within the Chicago Public School system and two regional school districts in the state of Illinois ($n^1 = 336$, $n^2 = 320$). The results from the first sample were used to modify the revised survey. A four-factor solution, based on principal components and varimax rotation, suggested that the revised survey measures the following constructs: Inquiry-based Instructional Strategies, Reluctance to Use Traditional Teaching Approaches/Pedagogy, Use of Computers and Technology in the Classroom, and Confidence/Understanding in Teaching Mathematics and Science. The internal reliability of each sub-scale was high, .91, .83, .81, and .80, respectively. Supportive analyses suggest the usefulness of these sub-scales as these measures relate to other teacher-related outcomes used to assess an intensive professional development program in mathematics and science.

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 macrorepresentation of change relative to the whole system (Webb, 1999). For present purposes we have focused on the former, that is, more detailed information on the teacher (see Race & Powell, 2000 for a detailed discussion on a tool to assess student perceptions). More specifically, within the context of a larger outcomes-based evaluation directed toward school-wide change, the focus of this paper is on the assessment 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.

Recent 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 achievement. 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). 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 & Loeb, 2000).

After brief background information on the program, this paper will overview the assessment of the psychometric properties of a teacher attitude survey and highlight preprogram results that support the usefulness of these sub-scales as these measures relate to other teacher-related outcomes used to assess an intensive professional development program in mathematics and science.

Background

The Teachers Academy for Mathematics and Science is a non-profit organization located in Chicago. The Academy offers an intensive 3-year professional development program designed to meet the needs of underprepared 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. As revised, the program content is offered by instructional level (primary, intermediate and upper), that blends mathematics and science curricula with technology. The program is designed to provide 60 hours of instruction that is developmentally appropriate, based on national and state standards in mathematics and science, content driven and inquiry based using nationally recognized curricula. In addition, 15 visits occur that involve coaching and reflective instructional support in the classroom per year during the first two years. 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 & Powell, 2000).

Method

All teachers participating in the intensive professional development program were asked to complete a teacher attitude survey. For the first sample, teachers completed the questionnaire during the first instructional session. A total of 385 teachers completed the original teacher attitude survey from 16 participating elementary schools in the Chicago Public School system. The second sample received a copy of the questionnaire via mail and all teachers were asked to bring the completed form to their first instructional session. A total of 365 teachers from 20 participating schools in East St. Louis and Joliet Illinois completed the revised survey.

First Sample: 1999-2000 Analysis

Questionnaire. Items were selected from various existing questionnaires 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 teacher attitude survey consists 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.

Data Analysis. Item analysis consisted of the 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. The internal reliability of the survey was assessed using Cronbach's alpha (Cronbach, 1951). 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 how many factors to extract (Thompson & Daniel, 1996).

Results

Of the 385 returned questionnaires from teachers in participating Chicago Public schools, 336 or 87% were used in these analyses.

Internal Reliability. A preliminary item analysis, based on item-to-total score correlations, suggested that six items had low correlations and should be eliminated from the survey. Computing a total score from the retained 48 items, resulted in a mean attitude score of 137.96 (SD = $\pm$19.30), with a possible range of 48 to 192. The higher the score, the more positive the attitudes.[1] The internal reliability for these 48 items was high (alpha = .89).

Construct Validity. Initial analyses suggested that the individual items could be grouped into 14 factors (based on factors with eigenvalues of greater than one); too many factors to likely produce a stable and ultimately meaningful solution. The results of a parallel analysis suggested the retention of no more than six factors. Solutions based on four or five factors were explored more thoroughly with several different models tested, based on comparisons of results from principal components and principal axis factoring.

On this basis, a four-factor solution was accepted. Together, these four factors accounted for 33% of the common variance with eigenvalues of 8.60, 2.84, 2.45, and 1.96, respectively. These four factors were identified as follows:

> **Factor 1. Constructivism:** included items related to inquiry-based learning, problem solving, real-life situations, and tasks that foster a connection between application and understanding. (14 items)

[1] For purposes of these analyses, negatively worded items were reversed coded, such that a high score reflected a positive attitude.

Factor 2. Teacher's Confidence/Understanding in Mathematics and Science: included items that addressed teacher's level of confidence in teaching mathematics and science as well as their understanding of these disciplines. (6 items)

Factor 3. Reluctance to Use Traditional Teaching Approaches/Pedagogy: included items related to using the textbook as a primary source, students learning best through teacher explanations, and stressing drill as a learning strategy. (9 items)

Factor 4. External Support and Information Sources: included items assessing the use of technology in the classroom as well as support from parents inside and outside the classroom. (9 items)

The results of the factor analysis led to the elimination of 10 additional items. Thus, the sub-scale scores were based on a total of 38 items. The corresponding alpha coefficients of these sub-scales suggested reasonable internal reliability, that is, .82, .82, .74, and .74, respectively. The alpha coefficients of factors 3 and 4, however, suggest the need for improvement. Also, the last factor suggests a very poorly constructed concept, which may relate to the use of computers and technology in the classroom but remained ambiguously defined at this stage of analysis. Future efforts need to strengthen these sub-scales in terms of internal reliability and clarify the underlying construct of the fourth factor. The efforts intended to accomplish this are described in the next section.

Second Sample: 2000-2001 Analysis

<u>Questionnaire Revisions</u>. On the basis of the results of the initial analysis, the questionnaire was revised with the following goals in mind: 1) to improve the reliability of each of the sub-scales, and 2) to develop a less ambiguous factor that addressed 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). Also, suggestions were obtained from internal staff of the Teachers Academy for Mathematics and Science. This process resulted in the inclusion of an additional item for the sub-scale on teacher's confidence/understanding in teaching mathematics and science, and an additional item on the sub-scale comprised of items related to traditional methods or approaches to teaching. Several items that focused on general strategies and approaches to teaching were also included. A few previously discarded items were salvaged. Each of these items was reworded to clarify its intended underlying meaning. The revised survey consisted of a total of 56 items for a net gain of two items. These items were divided 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).

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

Data Analysis. All psychometric analyses for the second sample were conducted using the same methodology for data analyses based on the first sample. Subsequent comparisons to investigate the usefulness of these data relative to other outcome measures were conducted using bivariate correlations, a 2 by 2 analysis of variance (school district by instructional level) for each individual sub-scale as well as stepwise multiple regression. Whenever appropriate, statistical significance levels are reported as well as the proportion of explained variance.

Results

Of the 365 returned questionnaires from teachers in participating East St. Louis and Joliet schools, 320 or 88% were used in this analysis.

Internal Reliability. A preliminary item analysis suggested that six items should be eliminated from the questionnaire. Computing a total from these 50 retained items resulted in a mean attitude score of 196.50, (SD $\pm$17.40), with a possible range of 50 to 250. As in the original analysis, recoding occurred such that the higher the score, the more positive the attitude.

Construct Validity. The initial factor analysis suggested retaining 12 factors (each with eigenvalues greater than one). The decision to retain only four factors was based on the following: the results of the original analysis from the first sample; results of a scree plot from sample two, which showed a large break at factor 4 and a much smaller break at factor 8; and, from a parallel analysis that suggested the retention of no more than four factors. Thus, four-factor models were explored using both principal components and principal axis factoring to extract the factors. These explorations suggested very stable models based on these extraction methods. Using principal components and a varimax rotation, a four-factor solution was accepted. This solution accounted for 40% of the common variance. The eigenvalues for these four factors were 9.91, 4.61, 3.03, and 2.63, respectively. These four factors clustered as follows:

> **Factor 1. Inquiry-based Instructional Strategies** comprised of all of the original items but one (this item had previously cross-loaded on another factor) plus 10 new items. (23 items)
>
> **Factor 2. Reluctance to Use Traditional Teaching Approaches/Pedagogy** included one new item and all but two of the original items; was originally factor 3. (8 items)
>
> **Factor 3. Use of Computers and Technology in the Classroom** included items such as use of computers for learning, confidence in using technology as a learning resource, use of computers to aid decision making. (11 items)

Factor 4. Teacher's Confidence/Understanding in Teaching Mathematics and Science comprised of all original items plus one new item on teacher's confidence in ability to teach hands-on science. (7 items)

The factor solution, based on the revised survey, is shown in Appendix A . Table 1 provides a summary of the psychometric results from both sample one and two. The similarity of factor solutions for both the original and revised surveys was evident also at the factor loading level for the majority of items. On the revised survey, five items did show cross-loadings on one additional factor of a magnitude greater than .30 but in only one case did this value approach .40 (i.e., *Using computers for learning takes students away from important instructional time.*). The corresponding alpha coefficient suggests improved reliability for three of these sub-scales, that is, .91, .83, .81, and .80, respectively.

These results support the use of a sub-scale that addresses computer and technology use in the classroom, clarifying the previously ambiguous factor. Also, the internal reliability of three of these sub-scales was increased from the first to second sample with only a marginal decrease in internal reliability for the sub-scale on teacher's confidence/ understanding in teaching mathematics and science (from .82 to .80).

Teacher Attitudes

The mean attitude score for each of these sub-scales for all participating teachers in the second sample was as follows: the Inquiry-based Instructional Strategies sub-scale mean was 99.35 (SD $\pm$ 9.54) with a possible score range of 23 to 115; and the Reluctance to Use Traditional Approaches/Pedagogy sub-scale mean was 26.74 (SD $\pm$ 5.59) with a possible range of 8 to 40. The Using Computers/Technology in the Classroom sub-scale mean was 41.26 (SD $\pm$ 6.44) with a possible score range of 11 to 55; and the Teacher's Confidence/Understanding in Mathematics and Science sub-scale mean was 25.52 (SD $\pm$ 4.41) with a possible range of 7 to 35.

Relationship to Other Outcome Measures

Using data from the second sample, several comparisons were conducted based on total sub-scale scores as dependent measures (or as predictor variables in a subsequent stepwise, multiple regression analysis). These findings are summarized as follows. Basic skills in mathematics and science, as measured by a 1-hour basic skills test in select areas of mathematics and science, were positively related to teacher attitudes toward reluctance to use traditional pedagogy in the classroom [$r_{(274)} = .33$, $p < .001$]. In addition, technology self-assessment skill scores were positively related to attitudes toward using computers in the classroom [$r_{(206)} = .36$, $p < .001$] as were attitudes related to inquiry-based instruction [$r_{(339)} = .38$, $p < .001$]. Moreover, attitudes toward using computers in the classroom were positively correlated with teachers' confidence/ understanding in mathematics and science [$r_{(341)} = .28$, $p < .001$].

Table 1

Summary of Results from the Assessment of
The Teacher Attitude Survey: Samples from Two Different School Years

Teacher Attitude Survey	Summary of Results	
	Chicago 1999-2000	**East St. Louis/Joliet 2000-2001 Revised Survey**
Number of surveys used in analysis	336	320
Length of survey	54 items (6 items eliminated)	56 items (6 items eliminated)
Internal reliability – whole survey	48 items .89	50 items .89
Summary of Factor Analysis Factor 1. Renamed in revised survey. Comprised all of the original items, but one, plus 10 new items.	38 items **Constructivism** (14 items; alpha = .82)	49 items **Inquiry-based Instructional Strategies** (23 items; alpha = .91)
Factor 2. Same factor on both analyses, comprised all of the original items, except two; one new item was added; was factor 3 in original analysis.	**Reluctance to Use Traditional Teaching Approaches/Pedagogy** (9 items; alpha = .74)	**Reluctance to Use Traditional Teaching Approaches/Pedagogy** (8 items; alpha = .83)
Factor 3. Not well defined in the original analysis, mix of items related to other sources and computers (was factor 4). Construct better defined in revised survey; contained 11 items related to using computer applications in the classroom.	**External Support and Information** (9 items; alpha = .74)	**Use of Computers and Technology in the Classroom** (11 items; alpha = .81)
Factor 4. Revised survey comprised all original items plus one new item	**Teacher Confidence/ Understanding in Teaching Mathematics and Science** (6 items; alpha = .82)	**Teacher Confidence/ Understanding in Teaching Mathematics and Science** (7 items; alpha = .80)

Regarding differences in attitudes between teachers from different school districts and those who taught at different grade levels, primary teachers reported more positive attitudes compared to intermediate-level teachers regarding inquiry-based instructional strategies (a mean of 100.3 for primary teachers versus 97.6 for intermediate teachers) [$F_{(1, 341)} = 5.65$, $p < .02$, $eta^2 = .016$]. Primary teachers also indicated a higher level of confidence and understanding in mathematics and science compared to intermediate-level teachers, with a mean score of 25.9 compared to 24.7, respectively [$F_{(1, 342)} = 6.14$, $p < .02$, $eta^2 = .017$].

On the other hand, Joliet teachers reported a greater reluctance to use traditional pedagogical approaches in the classroom with a mean score of 28.1 compared to 25.8 for participating East St. Louis teachers [$F_{(1, 331)} = 11.43$, $p < .001$, $eta^2 = .033$]. In support of this, students in participating Joliet schools perceived an increase in hands-on/ cooperative learning activities in their classroom across early grade levels.

Participating East St. Louis teachers, however, expressed a more positive attitude toward using computers and technology in the classroom (mean scores of 42.5) than participating Joliet teachers (mean scores of 39.4) [$F_{(1, 342)} = 21.84$, $p < .001$, $eta^2 = .06$]. These attitudes were present despite the fact that East St. Louis teachers self-reported very low technology skills (data not shown). Student perceptions of use of computers and technology in the classroom did not seem to corroborate these teacher attitudes. Finally, based on a stepwise regression analysis, four measures were related to the *pre-program* basic skill level in mathematics and science of participating teachers. In order these were technology skills, number of years teaching, attitudes toward reluctance to use traditional pedagogy in the classroom, and attitudes towards use of computers and technology in the classroom [$F_{(4, 148)} = 11.52$, $p < .001$, $R^2 = .237$].

Discussion

Present results point to the utility of this teacher attitude survey in gauging perceptions of classroom methods and pedagogy as this relates to the instruction of mathematics and science in elementary school classrooms. The underlying construct validity of these sub-scales suggests that the teacher attitude survey emphasizes dimensions that are aligned with concepts fostered during the intensive professional development program offered by the Teachers Academy for Mathematics and Science. These measures include the use of inquiry-based 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 teacher’s 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.

The psychometric analyses based on these two samples also suggest that each of the identified sub-scales has reasonable internal reliability. Of importance, the present results suggest that these attitude sub-scales are related to other outcome measures and preliminarily suggest their relevance to student perception data also collected from these participating schools.

Finally, this work underscores the importance of obtaining detailed information at the teacher level (as well as the student level) in the context of a large scale outcomes evaluation directed toward systemic change (Webb, 1999).

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Appendix A

Table 1
Summary of Teacher Attitude Factors (Scales) and Individual Items

Factor/Item Description	Factor			
	1	**2**	**3**	**4**
Factor 1. Inquiry-based instructional strategies				
23. Worthwhile science skills and activities foster a connection between application and understanding.	.70			
18. Teachers should provide students with the opportunity to develop and build upon their own understanding of mathematics and science concepts.	.68			
26. Students learn best in science when they are allowed to explore problems and test ideas about possible solutions.	.68			
22. A student's scientific ability is strengthened by developing his/her inquiry skills.	.67			
17. Assessments in mathematics and science should stress a variety of ways to arrive at an answer.	.66			
25. Students learn best in mathematics when they are allowed to explore problems and test ideas about possible solutions.	.65			
20. Worthwhile mathematical tasks foster a connection between application and understanding.	.64			
19. A primary objective of mathematics is to develop the ability to identify and solve problems generated from real-life situations.	.63			
5. Reflective thought is an important criteria in mathematics and science learning activities.	.62			
24. Knowledge of science and technology helps individuals deal with everyday problems.	.62			
16. It is important for teachers to mentor each other in their instructional practices.	.61			

Table 1 (continued)
Summary of Teacher Attitude Factors (Scales) and Individual Items

Factor/Item Description	Factor			
	1	**2**	**3**	**4**
Factor 1. Inquiry-based Instructional Strategies (continued)				
27. It is essential that students at all grade levels know and understand good scientific methodology.	.55			
9. Problem solving can be facilitated by students working in groups.	.53			
11. It is important that preparation time include teacher collaboration.	.53			
4. It is important to be willing to try new things in my teaching.	.49			
28. All students are capable of understanding science.	.49			
12. Parents should be partners with teachers regarding the education of their children.	.48			
21. All students are capable of understanding mathematics.	.47			
6. Understanding the process in mathematics and science is as important as obtaining the right answer.	.47			
13. It is important for parents to communicate with teachers about the educational needs of their children.	.46		.36	
2. Instructional strategies I use as a teacher can increase a child's interest in a particular subject area.	.42			
14. Using state goals and standards helps me to better plan my lessons.	.41			
3. Problem solving can be taught when teachers explain to students the prevalent strategies used to address problems.	.34			

Table 1 (continued)
Summary of Teacher Attitude Factors (Scales) and Individual Items

Factor/Item Description	Factor			
	1	**2**	**3**	**4**
Factor 2. Traditional Approaches to Teaching Pedagogy				
39. Students learn best in mathematics through teacher explanations.		.74		
44. Students learn best in science through teacher explanations.		.74		
45. If more time could be spent on recall of facts, students would do better in science.		.70		
37. If more time could be spent on drill and practice, students would be better in mathematics.		.69		
43. Students learn best in science through science textbooks.		.66		
41. Students cannot be successful in mathematics until they have mastered computation skills.		.64		
40. I organize my math curriculum around the textbook.		.60		
36. The textbook should be the primary instructional tool for mathematics and science.		.54		

Table 1 (continued)
Summary of Teacher Attitude Factors (Scales) and Individual Items

Factor/Item Description	Factor 1	2	3	4
Factor 3. Using Computers and Technology in the Classroom				
51. Technology makes my professional work more difficult.		.31	.64	
50. Using computers for learning takes students away from important instructional time.		.40	.62	
48. Computers should be as important and available to students as pencils and books.			.59	
49. I am confident using technology as a learning resource.			.49	
47. I feel out of place when confronted with technology.			.47	.31
46. I do not believe the quality of mathematics and science education is improved by the use of technology.			.42	
53. I am concerned that technology might interfere with student interactions.			.63	
54. There is not enough time to incorporate technology into the subjects I teach.			.61	
55. I really enjoy using computers and the Internet instructionally.			.58	
52. Students should be able to use computers to help them solve problems in mathematics and science.			.47	
56. Students can use computers and technology to help make informed decisions.			.47	

Table 1 (continued)
Summary of Teacher Attitude Factors (Scales) and Individual Items

Factor/Item Description	Factor 1	Factor 2	Factor 3	Factor 4
Factor 4. Teachers' Understanding Confidence in Teaching Mathematics and Science				
32. I am confident in my understanding and teaching of scientific concepts.				.74
33. I understand science concepts well enough to be effective in teaching science for my grade level.				.72
35. I am confident in my ability to teach hands-on science.				.71
29. I am confident in my understanding and teaching of mathematical concepts.				.66
30. I understand mathematics concepts well enough to be effective in teaching mathematics for my grade level.				.61
34. When a student has difficulty understanding a science concept, I sometimes do not know how to help the student understand it better.				.48
31. When a student has difficulty understanding a mathematics concept, I sometimes don't know how to help the student understand it better.			.34	.47