



**Assessing Student Perceptions of  
Classroom Methods and Activities in the  
Context of an Outcomes-based Evaluation**

by

Kathryn E. H. Race  
Evaluation Department  
Teachers Academy for Mathematics and Science

Paper presented at the Annual Meeting  
American Evaluation Association  
November, 2000

## **Assessing Student Perceptions of Classroom Methods and Activities in the Context of an Outcomes-based Evaluation**

Kathryn E. H. Race  
Evaluation Department  
Teachers Academy for Mathematics and Science

Within the context of a larger outcomes-based evaluation, student perceptions were assessed regarding activities and methods used by teachers during mathematics and science instruction and other related activities within their school. To this end, 2,150 students from 10 elementary schools within the Chicago Public School system completed a 47-item questionnaire. Based on an analysis using principal components and varimax rotation, three underlying dimensions were identified, that is, Nontraditional Pedagogical Approaches in the Classroom, Hands-on/Cooperative Learning, and School/Learning Environment (internal reliability of .84, .82, and .75, respectively). A fourth dimension, External Support/ Information Source had very low internal reliability ( $\alpha = .48$ ) and was not used in subsequent analyses. Further analysis showed a negative linear relationship between grade level and each of the three sub-scales. That is, student perceptions declined from third through eighth grade ( $r = -.30, -.32, \text{ and } -.42$ , respectively). Mean attitude scores across grades were statistically significant ( $p < .001$ ) with grade level and grade-within-school effects associated with notable estimates of variance. These attitude data were shown to mirror student performance based on state standardized math scores for these individual schools and statewide data. Implications of these findings are discussed.

Within the context of a larger outcomes-based evaluation directed toward school-wide change, the focus of this paper is on the assessment of student perceptions of classroom and school-related activities as these relate to instruction in mathematics and science. Although the program that will be described shortly is a professional development program for teachers, the ultimate accountability of the program is likely to be evidenced by changes in the classroom experience of students as well as student achievement levels. Recent research supports linking differential teacher effectiveness as a strong determinant of differences in student learning (Darling-Hammond, 1999).

As noted by Webb (1999), evaluating systemic reform requires both the capability to focus on very detailed student and teacher information and to elucidate equally well a global view and overall macro-presentation of change relative to the whole system. For present purposes, we have focused on the former, that is, more detailed information on students; specifically, on measuring students' enthusiasm for mathematics, science and technology, which we have identified as one of three ultimate outcomes of our program. Such an endeavor, however, precludes a means to measure student perceptions of classroom activities and methods used by teachers to guide student instruction. Accordingly, after brief background information on the program, this paper will overview

the assessment of the psychometric properties of such an instrument and highlight pre-program results that support its utility in gauging student perceptions.

## **Background**

The Teachers Academy for Mathematics and Science is a non-for-profit, independent organization located in Chicago. The Academy offers an intensive 3-year professional development program designed to meet the needs of under-prepared elementary 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 targeted audience. As revised, the program content is offered by grade level, that is, primary, intermediate, and upper, that blends mathematics and science curricula with technology. It is designed to provide 60 hours of instruction that is standards-based, developmentally appropriate and content driven plus 15 hours of school-based instructional support per year during the first two years. The third year provides a year for planned 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 (*Program Redesign*, Teachers Academy for Mathematics and Science).

## **Method**

A total of 16 elementary schools within the Chicago Public School system have participated in the Academy's intensive 3-year professional development program during the 1999-2000 school year. Although participation in the Academy program by schools is voluntary, each participating school agrees to an 80% commitment level from their mathematics and science teachers to attend professional development sessions and receive instructional support in the classroom. These participating schools had a high percent of low-income (on average 88%), minority students (a high percent of African-American or Hispanic students many of whom are also of limited English proficiency), an average mobility rate of 30%, and a large percent of students who have performed poorly on standardized assessments. Ten (or 63%) of these Academy schools participated in this pre-program student perspectives survey effort.

## **Students**

Questions were distributed by teachers at participating schools to students during classroom instruction in the fall of 1999. Questionnaires were collected on a school-wide basis and then returned to the Academy. In this way, a total of 2,150 students returned questionnaires. Of these, 990 (or 46%) of the questionnaires were completed by boys and 1,089 (or 51%) were completed by girls (3% of the cases had missing data). Students that completed these questionnaires were from third grade (433 or 20%), fourth (452 or 21%), fifth (354 or 17%), sixth (350 or 16%), seventh (258 or 12%), and eighth (273 or 13%).

## **Questionnaire**

An earlier version of this student questionnaire had been developed, based on select items adapted from existing questionnaires (e.g., Salish, 1997) and was designed to aid in a school climate assessment rubric. Although the rubric was assessed in a large validation study (Stake, Souchet, Migotsky, Clift, Davis, & Dunbar, 1997), the internal reliability and construct validity of this scale was not assessed at that time. Subsequently, the questionnaire was revised to its present form, comprised of 47 items. These items were presented in three sections, general questions (16 items), questions about science class (16 items), and questions about math class (15 items). Students were asked about their perspectives on their classroom environment and the environment within the school. Examples of items include: “*My teacher usually makes me think hard.*” and “*We keep a collection of my science work.*” Items were rated on a 4-point scale (1 = never, 2 = sometimes, 3 = most of the time, and 4 = all of the time).

## **Data Analysis**

The internal reliability of the questionnaire was assessed using Cronbach’s alpha (Cronbach, 1951). To investigate its construct validity, 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 groupings that remained relatively stable across models (Kleinbaum, Kupper & Muller, 1988). Subsequent comparisons were based on general linear models, with each sub-scale score used as the dependent variable and variance components estimated by grade-level and grade-within-school partitions.

## **Results**

### **Internal Reliability**

A total of 1,801 questionnaires or 84% of the total sample were used in this analysis. A preliminary item analysis based on item-to-item correlations and item-to-total score correlations led to the elimination of six items. Computing a total score with the remaining 41 items, resulted in a mean student perspective score of 110.53 (SD  $\pm$  20.63), with a possible range of 41 to 164. The higher the score, the more positive the perceptions. The internal reliability of these 41 items was high (alpha = .91).

### **Construct Validity**

Initial steps in finding a final factor solution, suggested these individual items could be grouped into 10 factors; too many factors to likely produce a meaningful and stable solution. Several different models were explored with comparisons made between models based on principal components and principal axis factoring. The results of a parallel analysis, based on a matrix of randomly generated numbers with similar parameters regarding sample size, number of items, and response category options, suggested the retention of at least five factors (Thompson & Daniel, 1996). In particular,

solutions based on four or five factors were more thoroughly explored. Based on these analyses, a four-factor solution was accepted. Together, these four factors explained 38% of the common variance, with eigenvalues of 9.29, 1.92, 1.76, and 1.61, respectively. See Table 1 for a summary of this rotated solution. These four factors were labeled as follows:

**Factor 1. Nontraditional Pedagogical Approaches in the Classroom:** included items related to searching for things in science and mathematics, applying creative thinking in science and mathematics, being asked for the student's view regarding mathematics and science problems, using different approaches to solve mathematics and science problems, keeping a collection of individual student's work in science, and real world application of mathematics and science problems. (14 items)

**Factor 2. Hands-on/Cooperative Learning:** included items related to maintaining a log or journal, conducting projects in science and mathematics, working in groups in science and mathematics, and hands-on mathematics and science activities. (10 items)

**Factor 3. School/Learning Environment:** included items related to perceptions regarding whether the school is a safe place, whether the classroom is a fun place to learn, whether the school is a fun place to learn, whether the teacher listens, fairness of punishment, whether the Principal welcome suggestions by students, and whether all students get to participate. (9 items)

**Factor 4. External Support/Information Source:** included items related to whether the students can talk to their parent(s) about their classes or the school, and the use of computers when involved in mathematics and science activities or problem solving. (5 items)

The large sample of students that returned a questionnaire permitted a further check on the robustness of this model. That is, completed questionnaires were randomly split into two samples of approximately equal size ( $n_1 = 898$  and  $n_2 = 903$ ). Comparisons of the factor solutions from each of these samples then were compared to the overall model. Except for a few items, each sample solution showed the same groupings of items that were evident from the original four-factor model. The factor loadings for individual items did vary across models but these variations tended to be small in magnitude.

The corresponding alpha coefficient for each of these factors suggest that all but the last factor could be used to assess specific perspectives of these students (i.e., .84, .82, .75, .48, respectively). The last factor was not used in subsequent analyses because of its low internal reliability. The third factor was used, although its alpha coefficient suggests the need for improvement in future sub-scale development.

**Table 1**

**Summary of Final Factor Solution by Sub-scales and Individual Items**

Factor/Item Description	Factor 1	Factor 2	Factor 3	Factor 4
<b>Factor 1. Nontraditional Pedagogical Approaches in the Classroom</b>				
42. My teacher encourages me to search for things I am curious about (math).	.70			
40. My teacher asks my view of how well I am doing (math).	.63			
41. My teacher helps me apply math to my life.	.62			
27. My teacher encourages me to search for things I am curious about (science).	.60			
33. We use different ways to help us understand the lessons (math).	.55			
25. My teacher asks my view of how well I am doing (science).	.53			
35. We keep a collection of my math work.	.50			
44. We do creative thinking assignments (math).	.48			
39. We get to be creative (math).	.46	.44		
29. We do creative thinking assignments (science).	.46	.34		
36. We work on problems that relate to my life.	.45			
18. We use different ways to help us understand the lessons (science).	.41			
17. My teacher usually makes me think hard.	.35			
20. We keep a collection of my science work.	.33			

**Table 1** (continued)

**Summary of Final Factor Solution by Sub-scales and Individual Items**

<b>Factor 2. Hands-on Activities/Cooperative Learning</b>	<b>Factor 1</b>	<b>Factor 2</b>	<b>Factor 3</b>	<b>Factor 4</b>
21. We work on experiments.		.75		
22. We work on projects (science).		.75		
28. We do hands-on experiments and handle the equipment (science).		.68		
37. We work on projects (math).		.62		
23. We work in groups (science).		.55		
24. We get to be creative (science).	.34	.51		
26. My teacher helps me apply science to my life.	.43	.45		
38. We work in groups (math).	.37	.43		
43. We do hands-on activities and handle the materials (math).	.30	.42		
19. We record and write in a log or journal.		.40		
<b>Factor 3. School/Learning Environment</b>				
5. I like my school because it's a fun learning environment.			.70	
1. This school is a safe place for me to learn.			.63	
8. In this school the principal welcomes students' suggestions.			.60	
6. When students act up the punishment is fair.			.58	

**Table 1** (continued)

**Summary of Final Factor Solution by Sub-scales and Individual Items**

<b>Factor/Item Description</b>	<b>Factor 1</b>	<b>Factor 2</b>	<b>Factor 3</b>	<b>Factor 4</b>
<b>Factor 3. School/Learning (continued)</b>				
4. The temperature in my classroom is comfortable in the winter and summer.			.49	
13. My teacher listens to what I have to say.			.49	
15. I think it's important for me to study science.			.45	
2. My teacher makes the classroom fun for learning.	.31		.40	
14. In this class all the students get to participate.			.38	
<b>Factor 4. External Support/Information Source</b>				
46. We use computers (math).				.57
11. I talk to my parent(s) about my school.				.55
10. I talk to my parent(s) about my classes.				.54
31. We use computers (science).				.54
16. I think it's important for me to study math.				.40

**Student Perspectives**

The mean score for each of these sub-scales for all participating students was as follows: the Nontraditional Pedagogical Approaches in the Classroom sub-scale mean was 39.29 (SD  $\pm$  8.71), with a possible score range of 14 to 56. The Hands-on Activities/ Cooperative Learning sub-scale mean was 24.15 (SD  $\pm$  6.90), with a possible score range of 10 to 40; and the School/Learning Environment sub-scale mean was 25.50 (SD  $\pm$  5.36) with a possible score range of 9 to 36.

## Differences in Perspectives

Although girls tended to have more positive perceptions toward classroom activities, especially as measured by the Nontraditional Pedagogical Approaches in the Classroom (Factor 1) and perceptions of School/Learning Environment (Factor 3), these mean differences were small in magnitude and contributed little in explained variance.

In contrast, student perspectives based on grade level were notably different. These findings are summarized in Figure 1 with student data aggregated by grade level (collapsed across gender and schools). Although not shown, a similar pattern of declining student perceptions across grade level was evident for each participating school, and for boys and girls as well. For each of these sub-scales, grade level and student perspectives were negatively related ( $r = -.30$ ,  $r = -.32$ , and  $r = -.42$ , respectively). Moreover, mean perspective scores across grades were statistically significant (see Table 2) with explained variance components for grade-level estimated at 8.4%, 10.7%, and 20.3%, respectively, for each measure. Grade-within-school effects explained a large portion of the variance as well (estimated at 11.6%, 39.2%, and 11.7%, respectively).

Finally, Figure 2 parallels these findings based on student performance in mathematics. These data are based on the 1999 Illinois Standards Achievement Test (ISAT) scores. The graph reflects the percent of students who met or exceeded standard for all public schools in Illinois, 10 schools that are participating in the Academy program this year and who also participated in the student perspectives survey (although performance data includes students who may not have taken the perspectives survey), and six Academy schools who did not participate in the student perspectives survey. Although not intended to imply causality, the decline in student performance mirrors the noted decline in classroom perspectives by students. A similar performance decline is also reflected in national level data. More specifically, the National Assessment of Educational Progress (NAEP) recently reported that, in math, 38% of eighth graders scored below basic level. These results were based on representative national samples using performance levels of basic, proficient, and advanced (Ravitch, 1999).

## Discussion

Present results point to the utility of this student perspectives survey in gauging perceptions about relevant mathematics and science related activities in the classroom. As such, scores are intended to reflect a perception that these activities or methods are occurring at a given rate of frequency (e.g., low or high) in the classroom and not an attitude (e.g., poor or good) toward the discipline per se. This is in contrast to other instruments that have been developed, directed toward student attitudes about mathematics and science (e.g., Salisch I Research Project, 1997).

Table 2

Mean Attitude Scores by Participating School, Grade Level and Sub-scale

School	Grade	Factor 1 Nontraditional Pedagogical Approaches in the Classroom <sup>a</sup>			Factor 2 Hands-on/ Cooperative Learning <sup>b</sup>			Factor 3 School/ Learning Environment <sup>c</sup>		
		N	Mean	Std. Error	N	Mean	Std. Error	N	Mean	Std. Error
1										
	4	80	37.13	.864	81	17.80	.592	82	24.94	.494
	5	117	34.33	.715	118	19.01	.490	120	24.79	.408
	6	94	33.29	.797	92	19.08	.555	94	22.20	.462
	7	73	34.63	.905	72	16.26	.627	74	20.43	.52
	8	96	32.18	.789	97	18.26	.541	98	21.45	.452
2	3	25	46.16	1.55	30	29.00	.972	33	28.64	.789
	4	27	45.70	1.49	25	30.36	1.07	26	29.12	.878
	5	46	35.80	1.14	43	19.88	.812	50	25.26	.633
	6	25	37.04	1.55	26	24.65	1.04	26	22.85	.878
	7									
	8	48	38.69	1.12	49	25.27	.761	49	25.74	.639
3	3	56	42.46	1.03	58	28.74	.699	58	29.55	.588
	4	73	41.73	.905	68	27.59	.646	75	29.37	.517
	5	50	41.88	1.09	49	28.27	.761	51	29.43	.627
	6	42	34.67	1.19	42	22.29	.821	44	26.34	.675
4	3	41	43.85	1.21	48	31.63	.768	51	28.12	.627
	4	47	41.68	1.13	54	28.67	.724	54	24.67	.609
	5	34	40.62	1.33	34	28.71	.913	37	26.78	.736
	6	35	40.91	1.31	32	30.00	.941	38	25.08	.726
	7	22	39.64	1.65	22	26.86	1.14	23	23.09	.933
5	3	58	43.12	1.02	59	27.05	.693	60	28.07	.578
	4	60	43.80	.998	58	25.60	.699	58	28.93	.588
	5	38	42.24	1.25	38	21.50	.864	39	24.21	.717
	6									
	7	29	41.66	1.44	28	24.96	1.01	30	24.17	.817
	8	26	34.19	1.52	31	21.42	.956	28	24.54	.846

Table 2 (con't.)

## Mean Attitude Scores by Participating School, Grade Level and Sub-scale

School	Grade	Factor 1 Nontraditional Pedagogical Approaches in the Classroom			Factor 2 Hands-on/ Cooperative Learning			Factor 3 School/ Learning Environment		
		N	Mean	Std. Error	N	Mean	Std. Error	N	Mean	Std. Error
6	3	61	42.82	.990	62	29.50	.676	66	27.64	.551
	4	41	41.46	1.21	43	24.44	.812	44	25.84	.675
	5	22	42.41	1.65	23	26.22	1.11	25	26.80	.895
	6	40	41.85	1.22	40	24.18	.842	44	25.55	.675
	7	42	37.12	1.19	42	24.33	.821	42	23.00	.690
	8	34	40.35	1.33	35	25.26	.900	38	22.42	.726
7	3	22	46.27	1.65	25	32.64	1.07	26	29.54	.878
	4	45	38.29	1.15	51	23.47	.745	53	26.72	.615
	5	26	47.54	1.52	25	23.44	1.07	27	28.48	.861
	6	52	40.08	1.07	52	27.62	.738	51	25.37	.627
	7	23	37.17	1.61	24	23.63	1.09	24	21.29	.913
	8	20	33.60	1.73	18	24.94	1.26	20	24.25	1.00
8	3	19	37.79	1.77	19	26.74	1.22	20	25.55	1.00
	4									
	5									
	6	25	34.16	1.55	25	18.56	1.07	25	15.80	.895
	7	22	33.77	1.65	25	19.36	1.07	24	20.67	.913
9	3	38	45.26	1.25	39	21.15	.852	43	29.84	.682
	4	36	40.72	1.29	35	25.63	.900	40	28.05	.708
	5									
	6	22	36.18	1.65	23	23.22	1.11	23	24.70	.933
	7	32	43.03	1.37	33	20.76	.927	33	21.61	.779
	8	30	38.87	1.41	32	24.25	.941	34	22.59	.767
10	3	52	45.92	1.07	55	32.26	.718	56	30.50	.598

$${}^a F_{(5, 1943)} = 43.06, p < .001$$

$${}^b F_{(5, 1977)} = 63.94, p < .001$$

$${}^c F_{(5, 2052)} = 101.72, p < .001$$

Based on these analyses, the questionnaire was shown to consist of three usable sub-scales, each with reasonable internal reliability. As important, these sub-scales were related to classroom assessments by grade level, perspectives that tended to mirror student performance levels in mathematics. This decline in perspectives seems to be of interest for future research, especially given the percent of variance explained by it. Moreover, subsequent analyses to this present study suggests that these student perceptions compare well with attitudes toward mathematics and science instruction obtained from teachers at these same schools. That is, teachers at the primary level (K-3) reported more favorable attitudes toward using nontraditional pedagogical approaches in the classroom as compared to teachers at more intermediate elementary levels (grades 4-6) (Race & Bower, 2000).

Clearly, the School/Learning Environment sub-scale needs to be improved; no doubt adding relevant items to this scale should improve its overall internal reliability. Also of interest for future work is to develop the External Support/Information Source sub-scale, especially if a technology-related sub-scale would emerge from these efforts.

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

## References

- Brett, B. (1996). Using a Template for a Summarizing Assessment of the Teachers Academy for Mathematics and Science. *New Directions for Evaluation*, 72, 49-79.
- Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, 297-234.
- Darling-Hammond, L. (1999, December). *Teacher quality and student achievement: A review of state policy evidence*. University of Wisconsin: Center for the Study of Teaching and Policy.
- Kleinbaum, D. G., Kupper, L. L., & Muller, K. E. (1988). *Applied regression analysis and other multivariable methods*. Belmont, CA: Duxbury.
- Ravitch, D. (1999, March). Student performance: The national agenda in education. In, Kanstoroom, M., & Finn, C. E., Jr. (Eds.), *New Directions: Federal Education Policy in the Twenty-first Century*. Washington, DC: The Thomas B. Fordham Foundation and the Manhattan Institute for Policy Research.
- Salish (1997, June). Secondary science and mathematics teacher preparation programs: Influences on new teachers and their students instrument package & user's guide: A supplement to the final report. Salish I Research Project. Washington, DC: U.S. Department of Education,

Stake, R., Souchet, T., Migotsky, C., Clift, R., Davis, R., & Dunbar, C. (1997). *SOAP validation: Validation study of the School Organizational Assessment Profile*. Urbana-Champaign: Center for Instructional Research and Curriculum Research (CIRCE), University of Illinois.

Thompson, B., & Daniel, L. G. (1996). Factor analytic evidence for the construct validity of scores: A historical overview and some guidelines. *Educational and Psychological Measurement*, 1996, 197-208.

Webb, N. L. (1999, February). *Challenges to evaluating systemic reform*. Paper presented at the Fourth Annual Forum of the National Institute for Science Education, Arlington, VA.