DOCUMENT RESUME

ED 430 931 SP 038 513

AUTHOR Storti, Janet
TITLE Short-Term Teacher Workshops: Examining the Assumption of Teacher-to-Student Transfer.
PUB DATE 1999-04-23
NOTE 43p.; Paper presented at the Annual Meeting of the American Educational Research Association (Montreal, Quebec, Canada, April 19-23, 1999).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Attitude Change; Attitude Measures; Elementary Secondary Education; *Faculty Development; Inservice Teacher Education; *Science Education; Science Teachers; Student Attitudes; Teacher Attitudes; Teacher Behavior; Teacher Improvement; *Teacher Workshops; Transfer of Training
IDENTIFIERS National Aeronautics and Space Administration; Subject Content Knowledge; Teacher Knowledge

ABSTRACT

This study explored the feasibility of evaluating the effectiveness of learning transfer from National Aeronautics and Space Administration (NASA) short-term (1 day or less) workshops to the teacher and through the teacher to the student, focusing on attitude toward science, science-related behavior, and knowledge variables. Participants were 33 teachers of grades 3-9 from rural, suburban, and urban schools (public, private, and home schools) in six states. Teachers had attended 17 NASA off-site workshops in which aerospace specialists worked with workshop sponsors to plan program content. The objectives of the workshops were to enhance teachers' knowledge, experiences, and skills so they could use aerospace as a vehicle for improving student learning. Researchers collected survey data on teachers' attitudes, knowledge, and behavior before and after the workshops, and they interviewed a sample of workshop participants. They also surveyed students about knowledge, attitudes, and behavior before and after being taught with NASA resources. Findings support the NASA focus on teacher workshops, which are expected to have a ripple effect from participants to their students and colleagues. The workshops positively affected teachers' knowledge, attitudes, and behavior. Students and teachers supported the NASA focus on teacher workshops. (Contains 24 references.) (SM)

Short-term Teacher Workshops: Examining the Assumption of Teacher-to-Student Transfer

Janet Storti, Ph.D.
NASA Glenn Research Center

Paper presented at the Annual Meeting
of the American Educational Research Association
Montreal, Canada
April 23, 1999

Janet Storti, Ph.D., NASA Glenn Research Center, Cleveland, Ohio 44135
janet.storti@grc..nasa.gov (216) 433-8137

Introduction

This study explored the feasibility of evaluating the effectiveness of learning transfer from NASA short-term (1 day or less) workshops to the teacher and through the teacher to the student, in the context of attitude (toward science), behavior (science-related), and knowledge variables. If results of effectiveness could be found after short-term teacher workshops, the assumption of teacher-to-student transfer after longer-term teacher workshops (National Research Council, 1994, p. 49) may be extended to short-term teacher workshops. But what constitutes effectiveness?

The literature abounds with studies of the effectiveness of longer-term teacher programs (under the aegis of staff development), but is virtually silent about the effectiveness of short-term programs, although the short-term NASA programs may be considered as staff development. Staff development is an inclusive term that describes an array of efforts directed at improving teacher and, ultimately, student effectiveness. It is amorphous, with its many forms.

> It can take place in the workplace or in some other environment, it can be required or voluntary, it can be offered by an organization or sought independently by an individual. Two-hour lectures, three-day conferences and yearlong courses can all be considered staff development. (Butler, 1992)

Within this context, NASA's short-term teacher workshops can be considered a staff development effort. Sparks and Loucks-Horsley (1990) proposed five types of staff development models. Training is one of the five models, whereby teachers acquire knowledge or skills through group instruction, and is the model resembled most closely by the short-term NASA workshops, which primarily target inservice teachers.

According to Bennett (1987), implementation occurs when whatever is targeted in the training, be it increasing knowledge and/or skills or altering an attitude, is transferred from the program through the teacher into the classroom and maintained, i.e., observed several years later. According to Mathison (1992), we ". . . think of the staff development process as the provision of an inservice experience, the implementation of new techniques/skills/ knowledge by teachers, followed by changes in student learning" (p. 257). Student change, then, not merely implementation, appears to be the indicator of successful staff development, yet the staff development literature is lacking research on the relationship of short-term workshops to student outcomes.

Mathison's description supported the idea that a teacher workshop is part of a system.

> A system is a whole that is both greater than and different from its parts. Indeed, a system cannot validly be divided into independent parts as discrete entities of inquiry because the effects of the behavior of the parts on the whole depend on what is happening to the other parts. (Patton, 1990, p. 79)

For this study, Bennett's (1987) definition of implementation was expanded to incorporate Mathison's (1992) and was labeled "systemic implementation." Therefore, systemic implementation occurs when whatever is targeted in the training is transferred from the program through the teacher into the classroom as noted by changes in both teachers and students. This definition led to the question of what can and should be measured to indicate the effectiveness of short-term workshops.

To explore the first question, the goals and objectives of all NASA teacher programs had to be examined. Since NASA does not <u>do</u> education, but supports education (B. Bluth, personal communication, August 29, 1998), the intent of the NASA workshops is to <u>enhance</u> teachers' knowledge (content), experiences (confidence/attitude), and skills (competence/behaviors) so they use aerospace (aeronautics and space) as a vehicle for improving student effectiveness in science and mathematics. Three variables—knowledge, attitude, and behavior—were identified as variables of interest consistent with the goals and objectives of the NASA teacher workshops and the definition of systemic implementation. The issue of whether attitude and behavior are the same was considered. From past teacher feedback and the experience of this researcher, there was evidence that behaviors and attitudes may be incompatible and, for this study, were treated as distinct. Therefore, changes in teachers and students for these three variables were hypothesized as evidence of workshop effectiveness.

The Study Population

The study population was distributed throughout six states and represented grade levels K-12; rural, suburban, and urban areas; and public, private, religious, and home-schools. Participating teachers usually attended the workshops voluntarily and had varying degrees of preparation and experiences and varying degrees of administrative support for implementation. Participation in the research was ultimately offered to workshop participant teachers of Grades 3 through 9 because those grades represented most past and current workshop participants. The idea of controlling for demographics was discarded to maintain the considerable variability of the population.

The Sample

The sample of 33 teachers was drawn from 399 participants who attended 17 NASA off-site workshops in Ohio and Illinois, with no attempt to control for any variables. The self-selection bias factor was noted as a potential threat to internal validity, yet appeared unavoidable in the interest of remaining true to the components of the NASA education goals and the simulation of actual workshop conditions, given that the usual population of workshop participants is self-selected.

These workshops were provided by aerospace education specialists from the Office of Educational Programs at NASA Glenn (formerly Lewis) Research Center located in Cleveland, Ohio, and followed the typical workshop format. Short-term teacher workshops vary in length (2 hours to 1 day) and target grade levels and content that meet the needs of the sponsoring organization. Workshops may be requested by and for school districts, individual schools, the states' regional professional development centers, universities, educational conference providers, and others interested in science, mathematics, and technology education. The content of NASA as an agency is the substance of its education outreach programs. NASA generates knowledge and has within its mission the task of disseminating that knowledge. All workshop content related to one or more of the four NASA enterprises: Earth Science, Aerospace Technology, Human Exploration and Development of Space, and Space Science.

The aerospace specialists work with the workshop sponsor to plan the content appropriate for the audience and for the time constraints. Whereas the content of the workshops may vary, all specialists address the national science and mathematics standards and model inquiry-based science and cooperative learning. Despite the theoretical consistency, each specialist has a different presentation style and a different degree of proficiency in each of the content areas. Respectively, each teacher takes back something different to the classroom, depending on his/her interests, proficiency, needs, and the influence of the presenting specialist.

Joyce and Showers (1981) examined effective staff development programs. After identifying common elements, they developed five components they posited as increasing the chances for successful transfer of the workshop knowledge and skills by the teacher into the classroom. The NASA specialists incorporate four of the components into the typical workshop: theory, modeling, practice, and feedback. The fifth component, coaching, is not a formal option, although the specialists do respond to occasional inquiries from past participants.

For this study, 15 of the 17 workshops were of 1 full day's duration; two were shorter. Fourteen utilized the same content and format and were conducted by the same specialist. The others involved that specialist and two others. The researcher attended nine of the workshops in order to recruit volunteers. At the other eight workshops, the presenter used the established script and protocol to recruit additional volunteers.

The sample of 823 student participants was separated into two levels, depending on the level of the student forms their teacher selected as appropriate to that group. Ultimately, results were based on an n of 256 for students who used the level one forms and an n of 567 for students who used the level two forms. From demographic data collected on the Teacher Survey I form, both samples were found to be representative of the teacher and student populations in the two states on the following variables: numbers of public and private school teachers, highest degree earned and number of years of full-time teaching experience for public school teachers (state data not available for private school teachers), and the distribution of student enrollment by race. Additional demographics of the teachers, their schools, and districts reflected the heterogeneity of the sample of teachers and students.

The Teacher Subsample of Interviewees

A subsample of 10, 30% of the sample, was deemed a suitable number to be interviewed. Everyone in the sample had given consent for an interview. In order to create a subsample that would be representative of the sample, specific demographics were designated as important to match proportionately: school location (urban, other urban, suburban, rural), race/ethnicity, age range, sex, school level, number of years teaching, highest degree, and school type. The subsample was considered to be representative of the full sample. For confirmation, the means of several other demographics of the subsample were compared to the full sample. Representation was considered confirmed.

Design of the Study

The design of the study was nonexperimental. This was appropriate since there was no attempt to manipulate the independent variables and randomization was not present (Pedhazur & Schmelkin, 1991, p. 304). Multiple measures of attitude, behavior, and knowledge were used.

The intent/objectives of NASA workshops are to enhance teachers' knowledge (content), experiences (confidence/attitude), and skills (competence/behavior) so they use aerospace (aeronautics and space) as a vehicle for improving student effectiveness. Therefore, in this study, *systemic implementation* occurred when that which was targeted in the training was transferred from the program through the teacher into the classroom as evidenced by changes in teachers' and students' *knowledge* of, *attitude* toward, and *behaviors* related to science. Assuming that attitude is related to confidence and competence is related to behavior, in this study the same distinction was given to confidence and competence as was given to attitude and behavior, i.e., they were considered separately. Henceforth, these terms will be used interchangeably—content with knowledge, confidence with attitude, and competence with behavior.

Research Question and Hypotheses

The research question asked if there were changes in terms of knowledge, attitude, and behavior of teachers and students after the interventions. This question translated to six different sets of hypotheses. The null hypotheses stated that there were no differences between population average scores for teachers and students on the pre- and postmeasures of knowledge, attitude, and behavior. The alternative hypotheses stated that the population average scores on the premeasures were less than the population average scores on the post measures.

Key Definitions

Systemic implementation is a term coined for this study to define an expansion of Bennett's (1987) definition which incorporated Mathison's (1992) description of the staff development process. Systemic implementation is the transfer of the workshop objectives to the teacher and through the teacher to the student as evidenced by changes in both teachers and students. This definition became the basis for the research question which investigated the existence of such changes.

The *independent variables* in the study were (a) the workshop and (b) whatever the teacher taught from the workshop. It was recognized that everyone takes away from workshops different ideas and interests. In order to make the research project realistic, participants were free to choose how they wanted to use the resources, e.g., as a lesson, as a unit, integrated. The teachers reported on the final survey the resources that were used and how they were used.

The identification of the three *dependent variables* for teachers and the same three dependent variables for students generated the six operational definitions shown below, which were intended to provide answers to the research question.

1. Enhancement of <u>teacher knowledge</u>: increase in knowledge from pre- to postmeasure in the workshop setting
2. Enhancement of <u>teacher confidence</u>: improved attitude toward teaching science from self-report before the workshop and again after using the NASA resources
3. Enhancement of <u>teacher competence</u>: increased science-related behaviors reported before and after using the NASA resources
4. Change in <u>student knowledge</u>: increase/improvement in pre- and postmeasures of knowledge before and after their teachers used the NASA resources
5. Change in <u>student attitude</u>: pre- and postself-reports of attitude before and after their teachers used the NASA resources
6. Change in <u>student behavior</u>: pre- and postself-reports of science-related behaviors before and after their teachers used the NASA resources, along with

teacher observation and reports.

Data Sources and Collection

Attitude Variable

Multiple measures of teacher attitude were included because attitude is a complex construct. Self-report was selected as a method for this and other measures, because its efficacy is theory-based. For example, according to the learning theory of Carl Rogers (1997), one of the qualities of experiential learning is self-evaluation as the principal method of assessing progress or success. Malcolm Knowles' (1997) theory of adult learning includes self-evaluation as one of the most useful strategies for instruction.

The preworkshop form asked participants to rate their expectations/ enthusiasm for the workshop. Participants also had the opportunity to describe their expectations. A quick and early perusal of expectations was expected to assist the presenter in ensuring that expectations were met and in clarifying the workshop objectives, particularly for cases where the expectations would not match the objectives.

After the workshop, participants again rated themselves. The questions provided indicators of attitude toward the workshop, the presenter, using knowledge and skills gained from the workshop, attending another NASA workshop, and recommending the workshop to their colleagues. The Teacher Survey II form, completed after teaching with the NASA resources, provided additional attitude indicators by asking participants' comfort level teaching with the resources and the type of follow-up they desired. Finally, both the postworkshop form and the Teacher Survey II form had an open-ended question to say anything else about the workshop experience.

With support from the literature (Ofir, Reddy, and Bechtel 1987; Emmerson, 1988; Kearney as cited in Rubin et al., 1994), a semantic differential attitude questionnaire was chosen from the quantitative tradition, ". . . because it is a highly controlled method of attitude assessment . . . provides a measure of the direction and intensity of the respondent's evaluation. . . ." (LeSourd, 1984).

An existing measure of motivation was adapted for the teachers and for students in Grades 6 through 9. The Student Motivation Scale (SMS) is an established instrument that employs the semantic differential scale and was adapted for this study. It was included on the teachers' preworkshop form as a measure of attitude toward teaching science. It was included again as a postassessment on the Teacher Survey II forms that teachers completed after they used the NASA resources with their students. The SMS was also used as the level two forms for students. The researcher to provide similar feedback from students who would use the level one form created a corresponding elementary level Likert scale. Recall that teachers selected the level of forms appropriate for their students. Open-ended questions on the student attitude pre- and postmeasures provided additional information on this variable. Students were asked about their career goals on both the pre- and postmeasures and were asked on the postmeasure to write what they liked about studying science. Teachers, on their Teacher Survey II forms, reported whether student interest was higher for the NASA topics than for other science topics. In addition, during telephone interviews some teachers discussed student attitude/interest.

Behavior Variable

As with the attitude variable, several measures of behavior were used. The instrument to assess behaviors associated with interest in science, e.g., watching TV science programs, was developed by the researcher from a list collected in a poll of 35 teachers who were asked how they know, other than from standardized test scores, that their students are interested in science. From that list, instruments were developed for the teachers and for both levels of students.

For teachers, the majority of indicators came from the Teacher Survey I and II forms. On the initial Teacher Survey I form, which the volunteers submitted prior to teaching the NASA content, teachers used a 6-point Likert scale to describe themselves. "About You as a Teacher" asked them to rate behaviors such as watch science-related TV shows and subscribe/read science-related professional journals. On that form teachers also estimated similar behaviors of their students. "About Your Students" asked teachers to rate the percentage of their students on a scale of 0-25%, 26-50%, 51-75%, 76-100% on behaviors such as watch science programs (not assigned) on TV and read science-related materials (not assigned). A second survey of teacher behaviors and reported student behaviors was completed by teachers after teaching the material from the workshop as part of the Teacher Survey II form, which also included evaluative questions related to the workshop and teaching experiences. One additional indicator came from the postworkshop form and asked when, how, and what NASA resources they expected to use from the workshop. The Teacher Survey II form addressed when, how and what they actually used.

For students, variations of the self-report behavior instrument were designed for the two levels of student forms and were given by the teacher as pre- and postmeasures.

These included an open-ended question by which they could say more about what they do related to science. Additional data about the students came from teacher comments on the Teacher Survey II form and during the telephone interviews.

Knowledge Variable

Because the workshops covered different knowledge areas, four different pre- and postmeasures were developed for each of the targeted workshops, i.e., one for each of the three pilot workshops and one for all the Illinois workshops, although three questions were consistent overall. Questions for the teacher knowledge tests were developed jointly by the researcher and the aerospace education specialists who conducted the workshops to ensure that the knowledge measured met the objectives of the topic(s). These were included with the pre- and postworkshop forms. For the knowledge portion of the postworkshop forms, participants were instructed as follows:

> These are the same questions you answered before the workshop. There is no need to repeat what you wrote earlier. Simply add anything that you learned from the workshop that you did not include before.

Not only did this process save time, critical in short workshops, but it also provided a dichotomous measure of knowledge (gain yes or no, i.e., additional items were or were not added). The teachers' content questions were adapted by the researcher as pre- and postmeasures for use at an education level of Grades 3 through 5 and for use at an education level of Grades 6 through 9. After rater training, a panel of three rated teacher gains and a different panel of six rated student gains.

In addition to the gain indicator, the same three knowledge questions for both teachers and students provided quantitative data. Two were simple recall questions asking about NASA missions and objects in the solar system. The third question required problem solving by asking what is needed to live in space. A simple scoring system was used to award points to the premeasure question and then to the corresponding postmeasure question. The researcher scored the teacher forms. A graduate assistant scored the student forms. With input from the specialists, it was decided to have teachers and students give a self-rating of knowledge of the topic on both pre- and postmeasures, which provided a third measure of the variable.

Interrater reliability. Two methods were used for determining interrater reliability of the teacher gain measure. After training, three raters each rated the same five practice tests. After each of the first three practices, the results were discussed. Since all raters were in agreement for practice tests four and five, the remaining tests were scored without further discussion. With the Average Percent Agreement method, agreement was 97%. Because of such a high percentage, the second method was used in order to take out chance occurrence, a limitation of the Average Percent Agreement method. GWISE (Dimitrov, 1997) is designed to provide kappa coefficients of agreement among multiple raters for nominal scales. The coefficients provide agreement over and above the agreement that may occur by chance. The ratings for each question were consistent between any two raters and all three raters. The coefficients were high. The reliability of the raters could be trusted.

Because of the large student N (823), not all raters of the student forms were able to rate all test sets as was done for the teacher sets, a requirement of the GWISE method. Interrater reliability was ascertained only by the Average Percent Agreement method.

After training, six raters each rated the same 10 practice tests. After each practice, the results were discussed and the process was further refined. Raters, by consensus, increased the list of acceptable responses. Then 30 test sets were scored by all without discussion. Since total Average Percent Agreement was 84%, the panel decided that the reliability of the raters could be trusted and the remaining tests were split among the raters for scoring. Nevertheless, the GWISE method is preferred and is recommended if an actual evaluation results from this study.

Telephone Interviews

A sample of workshop participants who gave their permission (on the consent form) was interviewed by telephone. Interviews were audiotaped. Some participants asked to hear the tape before authorizing use of the data in this study. The audiotapes were destroyed after the results of the study were written.

Interview questions included some structured and some open-ended questions. For example, indicators of use in the classroom of knowledge and skills gained in the workshop were questions that asked which activities, strategies, and materials from the workshop were used. An indicator of the success of the thematic approach taught in the workshop was whether participants integrated aerospace education into curricular areas other than science. Indicators of more general outcomes were descriptions of use of the workshop gains outside of their classrooms, such as conducting a workshop for other teachers.

Methods and Analyses

Both quantitative and qualitative analyses were selected to provide triangulation, the objectivity of quantitative methods and the rich contribution of the qualitative. Quantitative analyses of data from instruments for the three variables were done for teachers before and after the workshop and before and after teaching and for students before and after their teachers used the NASA resources. Quantitative analyses were done at the .05 level of significance and included descriptives, dependent t tests, repeated measures, post hocs, profile plots, group profiles, factor analysis, canonical correlation, and two methods of interrater reliability (previously discussed).

Qualitative data sources for teachers for the variables of attitude, behavior, and knowledge were taped telephone interviews with nine teachers and notes from a telephone interview with one teacher. Source data for the same variables related to students came from several open-ended questions on the student instruments and from teachers' reports of their students. Data were analyzed by the Grounded Theory procedure, which is often referred to in the literature as "the constant comparative method of analysis" (Glaser & Strauss as cited in Strauss & Corbin, 1990, p. 62). This method was selected because it provided a complement to the quantitative methods; it is highly regarded and well accepted in the field of qualitative data analysis. With this procedure, data were examined individually for themes and then across the data for similarities and differences, or patterns, which led to categorization and conceptualization.

Results

Of the original 80 teachers who submitted Consent Forms, 58 provided the initial

Teacher Survey I form, thereby indicating to the researcher intent to complete the research project. Of these 58 teachers, considered the actual number of volunteers, 46 (12% of the 399 total workshop participants; 79% of the volunteers) reported that they actually taught what they learned in the workshop. Of those 46, 33 (8% of the total workshop participants; 57% of the volunteers) provided documentation by completing the Teacher Survey II form and submitting student pre- and postdata for their students.

The number of workshop participants who did not volunteer for this project yet did implement what was learned was unknown. Confidence intervals were estimated using a chart found in Glass and Hopkins (1984, p. 280), which provided .95 confidence limits for the population proportion, given the sample proportion. In this case, the sample proportion was the documented 33, i.e., 8% (p = .8) of total workshop attendees (399) who transferred what they learned into the classroom. From the chart, it was determined that the lower limit of the .95 confidence interval was .06 and the upper limit was .13. Therefore, one can be 95% confident that if the entire population of workshop participants had been surveyed, rather than the 80 who submitted Consent Forms, between 6% and 13% would have transferred what they learned into the classroom. The sample proportion of 8% appeared representative of the population of workshop participants.

For teachers, statistically significant differences were found in behavior and knowledge. Statistically significant differences were found in behavior and knowledge for all students and for the attitude variable for students who used the level two forms. While results of quantitative measures can be summarized in the previous two sentences, it is interesting to examine results separately.

Teachers

Attitude

For the attitude variable for teachers, the first instrument was a semantic differential to determine attitude toward teaching science before the workshop and after teaching. Group results were plotted on the instrument itself. The profiles were nearly identical, allowing for the conclusion that there was no change in attitude toward teaching science. To confirm the results of the profiles and test the null hypothesis, a dependent t test compared average pre- and postscores for individuals and indicated no significant difference in attitude from pre- to postmeasure. This was not unexpected and is consistent with what is commonly known with regard to workshop attendance. The fact that 94% of the teachers voluntarily attended the workshop explained the high positive attitude toward teaching science and was also consistent with expectations.

A dependent t test compared attitude toward the workshop from premeasure (expectations/enthusiasm) to postmeasure (satisfaction with the workshop). There was no significant difference from pre- to postmeasure. This was consistent with the average ratings (maximum score of 4) for workshop expectations/ enthusiasm (3.7) on the premeasure and satisfaction (3.8) on the postmeasure. It appeared that expectations were met. The presenter received an average score of 3.9 and all would recommend the workshop to colleagues and take another NASA workshop. Of 87 desired types of follow-up, 14% wanted high level content, 33% wanted materials, and 26% wanted teaching strategies. None said they wanted no follow-up. An average score of 3.8 for using in the classroom knowledge and skills gained was not unexpected since 93% of participants already taught science.

The results are incomplete without the contribution of the qualitative data. Although there was no significant statistical difference in the attitude of teachers, there were reports of inspiration, increased confidence, and increased knowledge that led to behavior changes. For example, one teacher said she had taken several university courses in astronomy, because of her interest in the topic, but did not feel comfortable teaching astronomy to her 5th-grade students until the NASA workshop. The workshop provided her with the materials, activities, and language to do so, thereby increasing her confidence (attitude). Some teachers simply noted feeling more comfortable with teaching the subject after the workshop. Other teacher comments reported high student interest, helpful information, easy activities, increased confidence. All of the teachers had positive things to say about their experiences with the NASA workshop and about teaching with the NASA resources. This was expected, since teachers volunteered to participate in the study.

Behavior

The first measure consisted of 14 questions which were rated on a scale of 1 to 6 (1 = low, 6 = high) to best describe the behaviors that teachers do. One item was discarded after noting comments from several teachers that they knew how to and desired to use the Internet yet had no access. Therefore, the item "use Internet" would not be a valid indicator of actual Internet behavior. All other items presented options that were realistic and were retained.

Through principal components analysis three components were identified and accounted for 62% of the variance on the premeasure. Three components were also identified for the postmeasure and accounted for 65% of the variance. Statistically these were nice groupings, but conceptually they did not make sense; the items were combined and averaged and a t test compared the average scores of individuals on the 13 items. The p value was significant.

The next measure of behavior examined what participants said they would use from the workshop and what they actually used. Those who said they would use "all" or "most all" were not included in the count. Many materials were distributed and discussed at the workshops. Only some could be used at the workshop because of time constraints. It appeared that the number of activities/resources that were actually used exceeded the number forecast. This was unexpected, given that teachers in general have said they usually use only what they actually "practice" in the workshop because they have no time to "practice" otherwise and do not like to do activities they have not tried themselves. It is suggested that the degree of confidence (attitude) affects the selection of resources used.

The interviews generated additional information that supported the quantitative results. A few of the teachers had already covered the space topics earlier in the year, yet were able to revisit them for the research project because these NASA resources were current and new to their students. Several teachers borrowed Moon Rocks from the Educator Resource Center. Two teachers said they did more with aeronautics and flight this time. Frequently lauded were the posters and new activities. Electronic resources were also mentioned. Some teachers commented that they planned to continue and do more in the upcoming school year.

Knowledge

The first measure used was the self-rating by participants of their knowledge of aerospace before and immediately after the workshop. A dependent t test compared scores on the pre- and postmeasures. The significant p value was not unexpected, since the postmeasure was given merely 6 hours after the premeasure, unlike the tests of the null hypotheses for attitude and behavior where for some participants as much as 5 months had elapsed between the pre- and postmeasures.

The second measure of knowledge used a combination of three questions on the workshop pre- and postmeasures. These questions were selected because they were asked of both teachers and students and were easily quantified, while the other questions were open-ended. The researcher assigned 1 point for each correct response per question. The questions were coded as NASA (names of NASA missions), NEED (what's needed to live in space), and OBJ (objects in our solar system). To test the null hypothesis, repeated measures, with time as the within-subjects factor, compared pre- and postscores of individuals by question while accounting for the correlations among the three questions. The Wilks' Lamda statistic was significant (F (3,24) = 18.52, $p < .0005$), indicating a difference between pre- and postmeasures for at least one of the questions. Univariate tests showed significance for all of the questions. One possible explanation may be the short time between the two administrations.

Next, the model was upgraded by successively including one of the following between-subjects factors: sex, race, highest degree, undergraduate major, graduate major, school type (public, private), and school site (urban inner-city, urban-other, suburban, rural). A significant main effect was found only for the between-subjects factor school site ($\underline{F}$ (2,24) = 3.65, $\underline{p} < .05$) on the variable OBJ, indicating a significant difference between the average OBJ score for at least two of three levels of school site (only one school was categorized as urban-other and was excluded from the analysis by the program). Post hocs (Tukey $\underline{a}$) reported a significant difference for pre- and postmeasure scores between rural and urban inner-city teachers. This was an unexpected finding, prompting further examination. A graph of the means defined an ordinal interaction between the OBJ question with teachers from both urban inner-city schools and rural schools. Once the topic of that question was examined, the fact that interaction occurred with only one of the questions was not surprising. The content of the OBJ question is available to the general public through the media, electronic resources, books, toys, games, museums, science sites, and so forth, educational resources that are more likely accessible to suburban settings. Supporting this premise was the fact that there was no gain from pre- to postmeasure for suburban teachers for the OBJ question.

The next measure of teacher knowledge utilized a rating panel of three and all the knowledge questions. The panel compared each premeasure question with the corresponding postmeasure question and assigned either a "yes" or "no" to the postmeasure question to indicate whether or not there was a gain in knowledge. Then they noted the percentage of questions for which they had given a "yes." No one had a zero gain; 30% showed a gain on seven or nine of the 10 questions; 70% had a gain on two to five questions.

It was also important to examine the percentage improvement for each individual question to inform any redesign of the workshop. Conclusions need to be perceived in the context of the questions and participant responses. For example, the low percentage (7%) of improvement noted for Question 7 was the result of a straightforward question ("The first 'A' in NASA stands for ______"). Since most participants answered correctly on the premeasure, there was low gain on the postmeasure. However, the 22% for question 9 ("Give an example of how 'drag' helps us and how it hinders us") was the result of a difficult question. The data in combination with the questions could be used for normative evaluation leading to improvements in the workshop design and delivery.

The quantitative analyses showed significant differences from pretest to posttest on the self-knowledge rating and on each of the three knowledge questions. The interviews, which were conducted 3 to 6 months after the workshops, supported the perception by participants of knowledge gained, which was a highlight for many of the teachers.

Students

Attitude

The first measure examined attitude toward science before and after being taught with the NASA resources. For students who used the level one forms, the mean pre- and postscores for each individual question were examined by question and showed minuscule changes in the means for all questions from pre- to postmeasure. For students who used the level two forms, group pre- and postprofiles were examined. The profiles were nearly identical. It appears that there was no change on this measure in student attitude relative to the NASA resources.

To test the null hypothesis, a dependent t test compared the average pre- and postscores for individuals on the first measure, attitude toward science. For students who used the level one forms, the t value showed no significant difference from pre- to postmeasure. This was not unexpected and was consistent with what is commonly known with regard to attitude changes following an intervention. For students who used the level two forms, the p value was significant. This result was not expected and was inconsistent with commonly held beliefs about attitude changes following an intervention.

As with the teachers, the qualitative data provided additional information. Students were asked about their career goals. Although nothing conclusive could be ascertained, it appeared that the exposure to the NASA resources might have caused some students to think positively about careers related to aerospace, thereby signifying a possible change in attitude. From teacher reports, the materials and activities stimulated interest in their students. The newness of the resources and the fact they were easy to incorporate also added to student interest. Some of the teachers reported high interest when they used the materials with children in their families and with one's church group. It is safe to speculate that a connection exists between the attitudes of these teachers and their students' attitudes.

Behavior

The first measure consisted of a self-report instrument for each of the two levels of forms. Students who used the level one form rated 12 behaviors, e.g., "I watch science programs on TV," as "Never," "Sometimes," or "Often." An additional open-ended question asked them to write what else they liked to do in science and math. Students who used the level two form rated 13 behaviors on a scale of 1 to 6 (1 = low, 6 = high). An additional open-ended question asked them to write what else they do that is related to science. The item "use Internet" was discarded from the student analysis just as it was from the teacher analysis as an invalid indicator of actual Internet behavior. Students might know how to and desire to use the Internet yet have no access. The final analysis included 11 items from the level one form and 12 items from the level two form.

Principal components analysis with Promax oblique rotation provided a structure matrix for each level form with the criterion of retaining only those components whose eigenvalues were greater than 1. For students who used level one forms, four components were identified for the premeasure and accounted for 57% of the variance. After learning from the NASA resources, there was a regrouping of some of the variables, indicating a positive change. Three components were identified for the postmeasure and accounted for 53% of the variance.

Statistically these were good groupings, but conceptually they did not make sense. For example, "school-related behaviors" had been theorized as a label for one factor. On the premeasure, "like to come to school," "like to learn about careers in science and math," and "like to solve problems" loaded together. On the postmeasure, "like to come to school" loaded with "use the library for fun things," "like to solve problems," and "like to read about science for fun." On the premeasure, "complete my homework" loaded with "visit science places outside of school," while on the postmeasure it loaded with "like presents like science books, games, or models," "like to talk about science things," and "like to watch science programs on TV." Speculating that students in the earlier grades used the level one forms, school attendance and completion of homework were probably integral to the total learning experience. Since it made sense conceptually to group all the items for this level, the items were combined and averaged.

For the students who used the level two form, the same two factors emerged for both the pre- and postmeasures, accounting for 48% and 50%, respectively, of the variance. Homework and attendance loaded together both times as the only two items on the second factor, confirming the theorized label of "school-related." The other 10 items loaded together both times on the first factor, although in a different order, and confirmed the theorized label of "science-related."

To test the null hypothesis for level one data, a t test compared the average scores of individuals on the 11 items. To test the null hypothesis for level two data, a t test compared the average scores for individuals on the 10 science-related items; an additional t test compared the average scores for individuals on the two school-related behaviors. For students who used the level one forms; the p value was significant. For students who used level two forms, the p value was significant for factor one, but not for factor two.

To examine which relations of variables on the pre- and postmeasures remained stable across the treatment, canonical correlation analysis was used. Although the requirement of 20:1 (Stevens, 1992) was not met with an n of 256 for level one forms, it was appropriate to use the standardized scores from the canonical correlation analysis to attempt to reduce the variables. The n (567) for level two forms did meet the first ratio criterion of 20:1 but not the second. However, since the factor analysis had shown two definite factors, it was decided to interpret the first two canonical correlations for level two data.

All canonical correlations were significant for data from both levels between the sets of questions on the pre- and the post postmeasures. For level one data, the first canonical variate represented the relationship between variable 11 ("I like to come to school.") on both pre- and post postmeasures. It was significant and of magnitude .83.

$$R_1 = .83\ (\lambda = .02,\ \chi^2\ (121) = 804.65,\ p < .01)$$

Both of these canonical variates had the highest canonical loadings as well as the highest standardized canonical coefficients.

For level two data, the first canonical variate represented the relationship between items 1 ("Watch science programs [not assigned] on TV"), 4 ("Talk about science-related events"), and 10 ("Read science-related materials") on both pre- and posttests. It was significant and of magnitude .84.

$$R_1 = .84\ (\lambda = .00,\ \chi^2\ (144) = 2417.45,\ p < .01)$$

It is interesting to note that all 10 items previously grouped as one factor (science-related) had high canonical loadings, ranging from .46 to .76 on both the pre- and postmeasures for the first canonical variate. As such, all 10 items could be interpreted as contributing together to that first canonical correlation. The second canonical variate represented the relationship between the two items previously grouped as factor two (school-related) for both pre- and postmeasures. It was significant and of magnitude .78.

$$R_2 = .78\ (\lambda = .01, \chi^2\ (121) = 1879.46, p < .01)$$

An examination of the z scores showed there were some redundant variables. To make the instrument more parsimonious and for stability from pre- to post postmeasures, the number of variables was reduced by eliminating those with the smallest z scores, i.e., those below .1. For level one data the premeasure items were reduced from 11 to 5; the postmeasure items were reduced from 11 to 6. For level two data, the premeasure items were reduced from 12 to 6; the postmeasures items were reduced from 12 to 8.

The last measure of student self-report was an open-ended item. For students who used level one forms, the item simply said, "Write what else you like to do in science and math." For students who used level two forms, the directions instructed them to "Write what else you do that's related to science." Recall that the questions were different because of the expectations of delivery by workshop participants. Teachers of students using level one forms were more likely to teach both science and mathematics, thereby providing the possibility of using NASA resources in either class. Students who used level two forms most likely received the NASA materials in a science class, since the overwhelming majority of workshop participants teach science.

For students who used level one forms, the majority of the responses mentioned liking multiplication, problem solving, projects/experiments, computers/Internet, and planets/space on both the pre- and postmeasures. For students who used level two forms, the majority of responses on both pre- and postmeasures included experiments, computers, reading about science, science fairs, space/stars, field trips, and models. Differences in percentages between pre- and postmeasures in all categories for both levels were so slight that no inferences could be made.

Teachers provided further insight into student behaviors. Thirteen teachers made a total of 19 comments about noticeable positive student behaviors related to use of the NASA resources. None reported negative behaviors. Of the comments, nine addressed the involvement of the students in the hands-on activities, two addressed the use of teams and cooperative learning, two provided competitions with the activities, two reported science-related behaviors of students of teachers with whom resources were shared, and three addressed voluntary additional time and work by students. One teacher, who would have the same class the following year, spoke of the request by her students to do more next year. Clearly, the richness of the qualitative data expanded the results of the study.

Knowledge

The first measure used was the self-rating by students of their knowledge of flight and space (level one forms) and aerospace (level two forms) before and after working with the NASA resources. To test the null hypothesis, a dependent t test compared scores on the pre- and postmeasures; there were significant p values for both levels. The results were particularly noteworthy in that the time lapse between pre- and postmeasures varied considerably from class to class. Although teachers did not report the actual amount of time spent, the number and complexity of resources used could provide an estimate.

The second measure of knowledge used a combination of three questions on the premeasure and the same three questions on the postmeasure. Recall that these questions were selected because they were asked of both teachers and students and were easily quantified. Following the same procedure used with the teacher data, a graduate assistant assigned one point for each correct response per question. The questions were coded as NASA (names of NASA missions), NEED (what's needed to live in space), and OBJ (objects in our solar system).

To test the null hypothesis, repeated measures, with time as the within-subjects factor, compared pre- and postscores of all students (N = 823) by question while accounting for the correlations among the three questions. The Wilks' Lamda statistic was significant (F (3, 701) = 327.65, $p < .05$), indicating a difference between pre and postmeasures for at least one of the questions. Univariate tests for all students showed significance for all the questions. Next, the model was upgraded by including form level as the between-subjects factor. A significant main effect was found with all three questions. Post hocs (Tukey a) were not permitted by the program since there were fewer than three groups. To examine which level contributed to the significant findings, t tests for each form level compared average scores for each question. The t statistic was significant for each question at each form level.

The next measure of student knowledge utilized a rating panel of six and all the knowledge questions. Each panelist rated part of the groups by comparing each premeasure question with the corresponding postmeasure question and assigning either a "yes" or "no" to the postmeasure question to indicate whether or not there was a gain in knowledge. For each individual, they also noted the percentage of questions for which they had given a "yes." For most questions, there was a substantial gain. However, conclusions need to be perceived in the context of the questions with participant responses. A low percentage of gain might result from most participants answering correctly on the pretest. Information from the data in combination with the questions could be used for normative evaluation leading to improvements in teaching.

Overall, only 16 students who used the level one form (8%) and 11 students who used the level two form (3%) showed no gain on the instrument. Those students were scattered throughout the sample and not from single classes. Only two students who used the level two form gained 100%. The majority of students from both form levels showed a gain of more than 60%.

Comments by teachers enhanced the understanding of this variable. Past comments to the researcher by some teachers that the NASA materials and activities would not work with their students (e.g., Special Education, primary grades) were disproved by several of the teachers in the research project. The teacher of 7th- and 8th-grade Special Education students reported that her students' scores "soared." A teacher who integrated the NASA resources into reading because her school was on probation, reported that her fourth and fifth graders learned a lot, which helped when they got ready to take the science part of the test. In addition to the pre- and postmeasures provided for the research project, teachers reported other evidence of student gains: their observations, the use of peer coaching, and cooperative learning.

As with student attitude and student behavior, it appears that knowledge was increased for these students after their teachers used the NASA resources. This finding might be evidence of transfer of learning from these teachers to their students, with notable changes in both groups.

Discussion

Findings support the NASA focus on teacher workshops, which are expected to have a "ripple" effect from participants to their students and colleagues. Each act of the workshop or act of teaching related back to the objectives of the workshop, demonstrating reciprocity and recursiveness. A positive attitude (increased confidence) appears to have led to increased competence (behaviors). Knowledge might have been the catalyst or the outcome.

NASA workshops appeared to have affected the attitudes of these teachers, thereby enhancing their perception of their effectiveness. A teacher's positive attitude is not only critical in developing student interest, but may be considered critical to the effectiveness of teaching. "One teacher characteristic that has been consistently related to student achievement, but which is not systematically measured is teacher efficacy" (Huitt, 1997). Teachers have long considered reaching just one student in a class an indication of success. It is suggested that reaching only one teacher at a workshop should also be counted a success, especially when one considers the "ripple effect"—the numbers of students and colleagues who will be touched by that one teacher.

Of the measures of behavior, descriptives from questions related to extensions of the workshop (NASA resources used, integration, sharing with colleagues, sharing with other classes) appeared to support the dependent t test which showed a significant difference in behaviors related to teaching science. Some of the activities extended beyond the individual classrooms to involve other classes or the entire school. All these teachers reported doing some things they had not done before. The evidenced behaviors support the NASA focus on teacher workshops. It is suggested that the statistically significant increase in behaviors reflected a practically significant increase in confidence (attitude) of the sample.

Several measures of teacher knowledge provided expected and unexpected findings. The significant difference from pre- and postmeasure on the self-ratings was supported by the significant difference from pre- to postmeasure on the three knowledge questions scored by the researcher. Investigation of gains scored by a rating panel provided information relevant to each question and to the workshop design.

One of the knowledge questions, which showed a significant difference from pre- to postmeasure asked participants to name NASA missions. The workshop provided the teachers with much new knowledge about current NASA missions. In attendance during half the number of workshops, the researcher observed participants asking many questions related to the Mars Pathfinder and Cassini missions, MIR, and the forthcoming International Space Station. Participants also appeared eager for additional sources with which to stay current, yet appreciated having the opportunity to interface with a NASA person. It appears that increased knowledge influenced these teachers' comfort levels and thus improved their attitudes. As noted earlier, a positive attitude about science appears to have influenced these teachers' behaviors. It seems safe to speculate that increased knowledge was critical to their sense of improved effectiveness.

In examining student attitudes, an open-ended question asked what students liked about studying the space topic. For students who used the level one forms, 81% reported positively and 19% negatively, compared to the students who used the level two forms, where 65% reported positively and 35% reported negatively. Speculating that students who used the level two form were in higher grades than those who used the level one forms, this finding was consistent with what is accepted in the field, that students are interested in science in the early grades and tend to lose interest as they move up. Also consistent was the fact that the t test for the students who used the level one forms revealed no significant difference related to attitude toward science. On the other hand, despite the 35% negativity for students who used the level two forms, the statistically significant t value related to attitude toward science suggested that a change in attitude could be effected with this intervention. This reinforces NASA's efforts to target middle school teachers.

Corroborating the positive aspects, 91% of the teachers reported higher student interest for the NASA topic than for other science topics. In general open-ended questions, several teachers commented on the high student interest. These results supported the value of the NASA educational resources for generating student interest and positive attitude. Not surprising was that teacher attitude appeared to influence student attitude.

Results of the various analyses of student behavior, reported by the students themselves and their teachers, support the NASA focus on teacher workshops. These results provided evidence of the predicted "ripple effect" from participants to their students and colleagues. Note that significant differences were found in student self-reports of science-related behaviors for students who used both level one and two forms.

The fact that there were no significant differences from teacher reports of the same behaviors may be due to a limitation of the study which is discussed later. Perhaps, though, self-assessment is a more accurate measure, for individuals may continue to model the way they perceive themselves as behaving. Recall also that 13 teachers made a total of 19 comments about noticeable positive student behaviors related to use of the NASA resources and none reported negative behaviors. For the behavior variable, as with student attitude, materials and activities played a critical role. The teacher of 7th- and 8th-grade Special Education students reported that her students did things that people just didn't think they would be able to do and that she knew it came from using the NASA materials.

An unexpected finding was related to the research project itself. One teacher was surprised to learn that there was a real lack of experiences with science outside of school. Also unexpected were the reports by some teachers of fewer science-related behaviors on the postmeasure. Discrepancies were attributed by some to "guesses" on the premeasure followed by greater attention to the actual frequencies of the behaviors. The project served to inform those teachers. For this group of teachers, it appears that positive teacher attitude and the NASA resources contributed to the perceived increases in science-related behaviors of their students.

An examination of student results on the three knowledge questions raised an interesting issue. For the question NASA (name NASA missions), students who used the level two forms scored higher on both the pre- and postmeasures with a larger gap on the postmeasure, indicating that these students gained more than the students who used the level one forms. On the OBJ question (name objects in the solar system), students who used the level two forms again scored higher on both and showed a slightly larger gap on the postmeasure. For the NEED question (what is needed to live in space), however, the students who used the level one forms scored higher on both the pre- and postmeasures, with the gap on the postmeasure only slightly smaller than that on the pretest.

These results may be explained by noting the type of questions and speculating that the older students used the level two forms and the younger students used the level one forms. Scores on both the NASA and OBJ questions would most likely be higher for individuals who have more background in science, i.e, older students who not only had more science education but who were probably more aware of world news and science events. Describing what is needed to live in space required problem solving and critical thinking skills. Higher scores by the younger students might simply be a result of younger students not yet being afraid to be "wrong." On the other hand, it might be evidence of the success of the current reform efforts resulting from the National Science Standards and the National Mathematics Standards.

In summary, several measures of knowledge provided expected and unexpected findings. The significant difference from pre- to postmeasure on the self-ratings was supported by the significant difference from pre- to postmeasure on the three knowledge questions scored by the researcher. Investigation of gains scored by a rating panel provided information relevant to each question. These results also supported the theorized "ripple effect" of the NASA teacher workshop.

Examining the Study: Limitations and Lessons Learned

Following the idea of formative evaluation, the study was examined for limitations and ways to improve it. First, recall that the method used for the attitude and behavior variables was self-report, which, for this study, was a practical choice and supported by the fact that it is theory-based (Rogers, 1997; Knowles, 1997). Nevertheless, self-report may be considered a limitation.

Second, although none of the workshops was held at a NASA center, and although the NASA workshop format may be similar to workshops from other providers, the simple fact of a NASA workshop might be a limitation of the study, for people tend to associate excellence with NASA. Participants may experience a sense of elitism, which may influence them to use the materials and share with colleagues. The NASA association lends credibility to what they take back to their schools. Teachers previously reluctant to teach certain concepts may do so using NASA materials. Despite the limitation, this study may inform the designs of other workshop providers.

Examination of the instruments revealed opportunities for improvement. First, the instruments themselves could be refined. Based on responses, several questions on the Teacher I Survey should be rewritten. From the way the questions were worded, there was no way to determine whether the NASA workshop where teachers were recruited was included in the teacher report of the number of science workshops or the number of NASA workshops attended. When the subsample was questioned, some teachers included NASA workshops in the number of science workshops attended; others did not. From questions teachers asked the researcher during some of the workshops, it was noted that some schools did not differentiate between "professional days" and "workshop days" while others did. The data were not usable from these questions.

Although choices for the levels of the schools were listed on the form as K-4, 5-8, and 9-12, to be consistent with designations in the national science and mathematics standards, 39% of the respondents selected "other," which required the creation of new variables based on the grades these teachers taught. Surprisingly, the "other" designations were not just in rural areas as one might expect. The high percentage that answered "other" should serve to inform agencies that collect such data, including NASA whose online tracking system also uses these designations in an effort to be consistent with the education community.

Also on the first survey was the instrument for teacher report of science-related behaviors of students. The instrument should be revised to avoid the wide ranges. For example, a teacher would check the range of 26% to 50% on the pretest to indicate that 30% of the students talked in class about science topics in the news. If that number increased to 50%, the teacher would again check the range of 26% to 50%, camouflaging the gain.

Finally, examination of the protocol also revealed areas that could be improved. Because of the brevity of the workshops, there were some teachers who were unable to complete the Teacher Survey I form at the workshop itself, but mailed it later. Recall that the instrument for teacher report of student science-related behaviors was part of that survey. Teachers who completed the form during the workshop had to estimate their students' behaviors while those who mailed them back later were able to more accurately calculate the percentages that exhibited each behavior. It is suggested that the teacher report of student science-related behaviors be completed when teachers do not have to estimate. It is also recommended that the protocol be revised to include a procedure for reminders, such as is done for mail-in surveys. Perhaps earlier reminder calls might have resulted in a larger sample. An additional suggestion is to include questions in the final survey that would inform the protocol.

Implications

This study provided pieces of information not previously available. It showed that it is feasible to evaluate NASA's short-term teacher workshops. It appears that the overall directional research hypotheses of the study were confirmed for these samples. In other words, NASA short-term teacher workshops led to transfer and increased teacher and student effectiveness in knowledge, attitude, and behavior. The findings support NASA emphases on teacher workshops, middle schools, and rural and urban areas. Although the samples were small, participant demographic characteristics were consistent with the average populations of the two states, lending credibility to the results.

It is up to Agency management to decide if this study is sufficient evidence for an assumption that the short-term workshops are effective. Building upon lessons learned from this study, similar results from studies in additional states could provide a stronger basis of evidence for the effectiveness of the NASA short-term teacher workshops and the assumption of student-to-teacher transfer. Continued feedback via NASA's current online Education Evaluation System will continuously inform the design of future workshops. Meanwhile, "Be satisfied with the evidence if absolute proof isn't possible to attain" (Kirkpatrick, 1996, p. 57).

The study may also have implications for the training community, because it achieved the four levels of the esteemed Kirkpatrick model, first introduced in 1959, that is widely used to evaluate organizational training. Put simply, the four levels are reaction, learning, behavior, and results. According to Kirkpatrick (1996), "Evaluation becomes more difficult, complicated, and expensive as it progresses from level 1 to level 4—and more important and meaningful" (p. 56). He went on to say that, although the four levels are not always used, they are necessary for a meaningful evaluation.

Most importantly, however, this study has implications for the education community. Concerns about our public educational system are evidenced by the growth of home schooling, charter schools, reform strategies and other increasing efforts to better educate the nation's youth. As teacher accountability grows, staff development grows even more important. One of the National Education Goals in the Goals 2000: Educate America Act (1994, p. 42109) states

> The Nation's teaching force will have access to programs for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to instruct and prepare all American students for the next century. (p. 42109)

As professionals, educators must be concerned about the structure of that staff development and ensure that whatever the structure, it contributes to teacher effectiveness and student improvement.

REFERENCES

Bennett, B. B. (1987). The effectiveness of staff development training practices: A meta-analysis. Unpublished doctoral dissertation, University of Oregon.

Butler, J.A. (1992). Staff development. School improvement research series (SIRS): Research you can use. Close-Up #12. [On-line]. Available: http://www.nwrel.org/scpd/sirs/6/cu12.htm (1 November 1998)

Curriculum and Evaluation Standards for School Mathematics. (1989). Reston, Va.: National Council of Teachers of Mathematics.

Dimitrov, D. (1997). GWISE program for multirater agreement on nominal scales. Kent, OH: Kent State University, Bureau of Research and Training Services.

Emmerson, G.J. (1988). Two adaptable, valid, and reliable data-collection measures: Goal attainment scaling and the semantic differential. The Counseling Psychologist, 16 (2), 261-271.

Glass, G.V. & Hopkins, K.D. (1984). Statistical methods in education and psychology. Boston: Allyn and Bacon.

Goals 2000: Educate America Act, (March 31, 1994). United States Congress. Public Law 103-227.

Huitt, W. (1996). Teacher characteristics. [On-line]. Available: http://www.vldosta.peachnet.edu/~whuitt/ (5 May 1997).

Joyce, B., & Showers, B. (1981). Transfer of training: The contribution of "coaching." Journal of Education. 163. 163-172.

Kirkpatrick, D. (1996, January). Great ideas revisited. Training & Development. 54-59.

Knowles, M. (1997). Androgogy. [On-line]. Available: http://www.lincoln.ac.nz/educ/tip/ 12.htm (9 May 1997).

LeSourd, S.J. (1984). An exploratory comparison of two methods of assessing teacher attitude toward instructional strategies. Theory and Research in Social Education, 12. (1), 31-41.

Mathison, S. (1992). An evaluation model for inservice teacher education. Evaluation and Program Planning, 15. 255-261.

National Center for Education Statistics. (1997). Schools and staffing survey, 1993-94. [On-line]. Available: http://www.ed.gov/NCES/pubs97/97371.html (6 September 1997).

National Research Council Committee on NASA Education Program Outcomes. (1994) NASA's education programs: Defining goals and assessing outcomes. Washington, D.C.: National Academy Press.

National Research Council (1996). National Science Education Standards. Washington, D.C.: National Academy Press.

Ofir, C., Reddy, S.K., & Bechtel, G.G. (1987). Are semantic response scales equivalent? Multivariate Behavioral Research, 22. 21-38.

Patton, M.Q. (1990). Qualitative evaluation and research methods (2nd ed.). Newbury Park, CA: Sage.

Pedhazur, E.J. & Schmelkin, L.P. (1991). Measurement, design and analysis: An integrated approach. Hillsdale, NJ: Lawrence Erlbaum Associates.

Professional Standards for Teaching Mathematics. (1991). Reston, Va.: National Council of Teachers of Mathematics.

Rogers, C. Experiential learning. [On-line]. Available: http://www.lincoln.ac.nz/educ/tip/28.htm (9 May 1997).

Rubin, R.B., Palmgreen, P., & Sypher, H.E. (Eds.). (1994). Communication research measures: A sourcebook. New York: Guilford.

Sparks, D., & Loucks-Horsley, S. (1990). "Models of Staff Development." In W. R. Houston (Ed.), Handbook of research on teacher education (pp. 234-250). New York: MacMillan.

Strauss, A. & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Newbury, CA: Sage.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

ERIC

REPRODUCTION RELEASE

(Specific Document)

AERA 1999

I. DOCUMENT IDENTIFICATION:

Title: Short-term Teacher Workshops: Examining the Assumption of Teacher-to-Student Transfer

Author(s): Janet Storti

Corporate Source: NASA Glenn Research Center

Publication Date: April, 1999

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY ______ Sample ______ TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY ______ Sample ______ TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY ______ Sample ______ TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1	Level 2A	Level 2B
☑	☐	☐
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, → please

Signature: Janet Storti	Printed Name/Position/Title: Dr. Janet Storti, Education and Evaluation Specialist	
Organization/Address: NASA Glenn Research Center 21000 Brookpark Rd MS-7-4 Cleveland, OH 44135	Telephone: (216) 433-8137	FAX: (216) 433-3344
	E-Mail Address: janet.storti@grc.nasa.gov	Date: 5/6/99

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility attn. Linda Lee
1100 West Street, 2nd Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com