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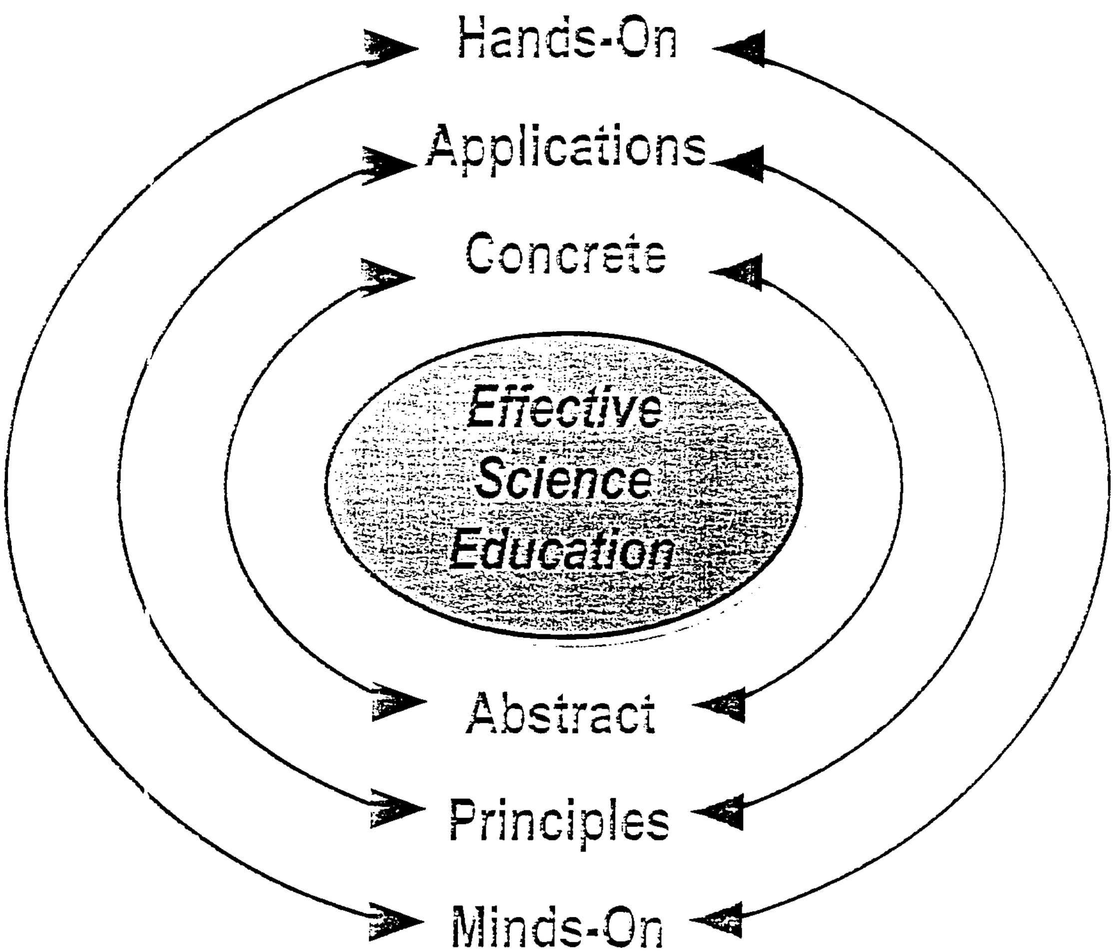
Study of Hands - On Science

(SOHOS)



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September 1997

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Sandia National Laboratories

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Following is a report on a Sandia National Laboratories sponsored study of the use of leading hands-on inquiry-based instructional materials by New Mexico elementary school teachers.

The results indicated teachers found these materials and the hands-on inquiry-based approach to be highly effective, motivational, and enjoyable for both students and teachers. Teachers reported a number of significant changes in their instructional objectives, approaches, and activities occurred while using these materials. All of these changes were consistent with the recommendations of the National Science Education Standards.

While teachers rated all of the materials highly, they also provided feedback on the relative strengths and weaknesses of materials from different suppliers. Their collective opinion provides an important source of information for districts and schools to consider during the upcoming New Mexico Science Instructional Materials Adoption.

We provide the results and recommendations of this study with the hope they will help schools and districts in New Mexico, and beyond, adopt and successfully use the hands-on approach to elementary school science education.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

Sincerely,

Miguel G. Robles

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EXECUTIVE SUMMARY

Two hundred (200) New Mexico elementary school teachers participated in a study of hands-on science instruction during the 1996-97 school year. Each teacher was provided with a hands-on instructional kit from one of four leading suppliers (CHOL, FOSS, Insights, and STC) and used this kit with his/her students for an eight week period. Later in the year, a second kit from a different one of the same four suppliers was provided to and used by each teacher for a similar eight week period. Information was collected and analyzed to measure:

- Changes in teaching practices and attitudes associated with use of the hands-on instructional approach, and
- Strengths and weaknesses of the instructional materials from the four suppliers.

Key findings included the following:

Changes in Teaching Practices and Attitudes

A number of statistically significant changes in teaching practices and attitudes accompanied the use of these hands-on instructional materials. All of these changes were highly consistent with the recommendations of the *National Science Education Standards* and other leading documents in the science education reform movement.

Instructional Objectives: While participating in this study, teachers altered their instructional objectives to place greater emphasis on helping their students:

- Develop an interest in science,
- Understand the application of science in everyday life,
- Develop the ability to examine and draw logical conclusions from information,
- Develop confidence in their ability to understand and apply science concepts,
- Know how to communicate ideas of science effectively, and
- Develop skills in laboratory techniques.

Instructional Approaches and Activities: Teachers also modified their instructional approaches and activities to devote additional attention to:

- Engaging students in hands-on science activities, demonstrations of scientific principles, collaborative problem solving activities, and student writing about science, rather than expecting them to learn science primarily by passive experiences, such as reading textbooks,
- Using activity-based student assessments, rather than paper and pencil tests, and
- Increasing time spent in science instruction—teachers devoted 33% more time to teaching science than they had in the previous year.

Teacher Attitudes and Effectiveness: In reflecting on their experiences during the study, teachers overwhelmingly endorsed the hands-on instructional approach and materials. Specifically, they reported that their attitudes toward hands-on elementary science instruction changed dramatically in the following areas:

- Effectiveness and value of hands-on instruction—the greatest teacher change found in this study was in their level of belief that hands-on science instruction provides a highly effective learning approach, and
- Practicality and ease of hands-on instruction—receiving fully developed instructional activities and all the materials needed for students to do them in small groups or pairs made hands-on instruction an accomplishable task. Teachers reported that using the kits was enjoyable for both their students and them.

Comparison of Materials from Leading Suppliers

While teachers responded favorably to materials from all four suppliers, statistically significant preferences were expressed in a number of areas.

Teachers' Guides: Teachers indicated a preference for the teachers' guides included with the FOSS and CHOL materials. Both of these were judged to contain excellent background information, and CHOL guides were found to be particularly clear and easy to use. STC teachers' guides were also highly rated, but not to quite the same extent. Insights teachers' guides were the least preferred.

Kit Materials: CHOL kits were judged to provide the most complete materials and to require the least amount of preparation and supplementing of any of the suppliers. However, teachers felt the overall benefits of all of the kits made the time investment worthwhile, with significant differences in favor of CHOL, FOSS and STC kits in comparison to Insights kits.

Age Level Appropriateness: FOSS, STC, and CHOL kits were rated equally appropriate for their designated grade levels. Insights kits were judged to be less appropriate, typically more appropriate for older students.

Instructional Activity Effectiveness: Teachers considered the kits to be highly effective in contributing to their students' understanding of science concepts with significant differences in favor of FOSS and STC in comparison to Insights. Student enjoyment of kits was high for all kits with significant differences in favor of CHOL, FOSS, and STC.

Strategies for Successful Implementation of Hands-On Science Instruction

Based on the results of other research and the consensus of leading advocates for enhanced science education (such as the National Research Council, the American Association for the Advancement of Science, the National Science Resources Center, etc.), the following are suggested as essential elements in the development of a successful hands-on elementary school science program:

High Quality Hands-On Instructional Materials: Thematic hands-on science instructional kits such as those used in this study need to be supplied to every teacher for use with every student. Typically, each teacher should use three or four such kits for approximately eight weeks each as the core of his/her science program. The topics studied in each year should be age appropriate and include at least one unit in life science, one in earth science, and one in physical science. CHOL, FOSS, Insights, and STC all provide an appropriate number and range of kits to satisfy this recommendation.

Materials Support System: These instructional materials are very expensive for individual teachers to "own." To be affordable, each kit must be used by at least three or four teachers per year. When shared in this way, most of the materials used in this study are affordable within the constraints of the instructional materials funds supplied by the New Mexico Department of Education. However, this requires a support system to "own" the kits, deliver them to teachers, collect them after they have been used, and most critically, ***replenish*** the kits between uses. Typically this requires planning and organization beyond the level of a single school. Many well-intentioned hands-on science programs have failed for lack of such a support system. This is probably the most overlooked element in establishing a successful hands-on science program, and is the most critical area for the district or cluster to commit to a leadership role.

Professional Development for Teachers: Teachers need opportunities to effectively learn to use hands-on approaches and materials. Professional development activities should provide instruction in how to use specific materials, but should not be narrowly prescriptive. Just as their students will learn and mature in the active process of doing science, teachers need to learn and mature in the process of teaching science using the hands-on approach. This requires that professional development be an ongoing effort in which teachers experiment, grow, and share "lessons learned" with one another as they mature in their use of hands-on instruction. The materials support center personnel are often well-equipped to assist in providing such professional development. Instructional materials suppliers also are frequently willing and able to assist in this effort.

Authentic Assessment: Student progress needs to be assessed consistent with instructional goals. This requires the use of assessment tools that measure things such as the understanding of key science concepts, the ability to apply this understanding, examine information, ask appropriate questions, draw logical conclusions, etc., rather than simply factual recall. Adopting assessment strategies and tools that measure students' real understanding and ability to apply what they have learned provides a great incentive for teachers to emphasize these in their hands-on instruction.

It is hoped that the results and recommendations of this study will help schools and districts in New Mexico and other states adopt and successfully use the hands-on approach to elementary school science education.

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PROJECT BACKGROUND

History Leading Up to the Project

Sandia National Laboratories (SNL) has been encouraging hands-on, minds-on science instruction in New Mexico schools since 1990. From 1990 to 1995, SNL provided "science advisors" (SCIADs) from its technical staff to assist the schools in introducing the hands-on, minds-on instructional approach. The SNL Science Education Resource Center also assembled and loaned hands-on instructional resources to teachers and provided teacher professional development workshops on how to most effectively use these materials.

A number of national developments also helped promote the concept of hands-on, minds-on science instruction during this period. In 1990, the American Academy for the Advancement of Science (AAAS) published *Science for All Americans*, a description of what scientifically literate adults should know about various areas of science, math, and technology, and a strong endorsement of the hands-on, minds-on instructional approach. AAAS then worked with teachers in several large school districts to develop grade-level objectives for what students should learn, published in 1993 in *Benchmarks for Science Literacy*. The National Research Council (NRC) also organized a group of preeminent teachers, scientists, and educational researchers to develop the *National Science Education Standards*. These were extensively reviewed by both the educational and scientific communities prior to their publication in 1996. Hands-on, minds-on learning is the cornerstone of the Standards chapter on recommended instructional approaches.

Several national resources also were developed during this time to help teachers implement hands-on, minds-on instruction. The National Science Foundation supported the development of elementary instructional materials which teachers can use to engage students in these types of learning activities. Three full sets of commercially available instructional materials, utilized in this research study, grew out of these projects: *Full Option Science System (FOSS)*, developed by the Lawrence Hall of Science and now published by Delta Scientific; *Insights*, developed by the Educational Development Center and now published by Kendall/Hunt; and *Science and Technology for Children (STC)*, developed by the National Science Resources Center and now published by Carolina Biological. These are similar in many respects. They provide several units of study for each elementary grade level. The units have a particular age-appropriate topical theme, often linked to topics recommended by the AAAS Benchmarks and the NRC Standards. Each unit consists of a sequence of hands-on, minds-on activities designed to accomplish age-appropriate learning objectives pertinent to the topic, and contains all the materials needed for a class of 30 students to do each activity individually, in pairs, or in small groups.

Local resources also became available to facilitate hands-on, minds-on science instruction. In 1991, Intel gave seed funding to the Center for Hands-On Learning (CHOL) to provide Rio Rancho schools with instructional resources similar to the ones described above, but which were not yet available. CHOL began by enhancing a number of kits which had been adapted from existing curriculum by the Mesa, Arizona schools, and later supplemented these kits with additional kits of their own. In subsequent years, CHOL expanded its activities well beyond the Rio Rancho community, and is now serving schools throughout New Mexico and in surrounding states. Recently they also began providing enhanced kits to support the use of STC and Insights materials.

At the state level, New Mexico was awarded a five-year National Science Foundation grant for the Systemic Initiative in Math and Science Education (SIMSE) beginning in 1991. Numerous schools which participated in SIMSE were introduced to the CHOL, FOSS, Insights, and STC materials during the latter years of this effort.

As SNL completed its five-year SCIAD commitment to the schools, their goal shifted from introducing hands-on, minds-on science instruction and helping schools and teachers begin using this method, to ensuring the widespread adoption and self-sustaining use of this instructional approach. Outstanding commercially available materials, such as those provided by CHOL, FOSS, Insights, and STC, were seen as key instructional resources, and the 1998-1999 New Mexico science instructional materials adoption process was seen as the critical event for implementing widespread use of such materials.

By 1995-96 SNL completed its SCIAD program and used most of its Science Education Resource Center materials to seed several independent teacher support centers, including the Albuquerque Public Schools' Science/Math Resources for Teachers (SMART) center. As a follow-up to the SCIAD program, SNL also began providing workshops to schools to facilitate teachers' and administrators' use of the hands-on, minds-on instructional approach, and to familiarize them with outstanding instructional resources available to assist them in this effort. In addition, SNL sponsored the Study of Hands-On Science (SOHOS) to enable New Mexico teachers to use and assess leading instructional materials prior to the New Mexico science materials adoption process.

Project Overview

During the 1996-97 school year, the Study of Hands-On Science provided 234 teachers from across New Mexico with two kits from four leading suppliers. The teachers used each kit in their classrooms for eight-weeks. Following each kit use, teachers evaluated the relative strengths and weaknesses of each supplier's materials. In addition, teachers completed pre and post-surveys that assessed changes in their teaching approach, attitudes, and effectiveness associated with the use of these materials. The study also identified factors which contributed to successful use of the hands-on science instructional materials.

All of the logistics for this study were coordinated by the Center for Hands-On Learning, in Rio Rancho, New Mexico. They solicited teacher participants from across the state, ordered the science instructional kits, arranged for shipping of these materials to and from the schools, and replenished the kits prior to sending them out for second and third uses. An independent evaluator worked collaboratively with CHOL and SNL throughout the development, implementation, and evaluation of the research study. The evaluator was responsible for the development an appropriate research design based on sound educational research practices, the collection and analysis of all data, and the preparation of the final report.

This document reports the findings of the study. The results will be distributed to New Mexico districts, schools, and teachers to help provide a basis for selecting materials and establishing support infrastructures during the upcoming science instructional materials adoption process.

Selection of Participants

An invitation to participate in the study was extended by the CHOL to all New Mexico elementary teachers in the spring of 1996. Participation was contingent upon teachers' willingness to utilize the materials provided for the full eight weeks, to return materials in a timely manner, and to complete four evaluation instruments: a pre-survey, two kit evaluations, and a post-survey. A final group of 300 teachers representing a broad cross-section of districts and schools from across the entire state was selected. A complete listing of the schools is contained in the Appendix A. Teachers were randomly assigned to groups and materials by CHOL staff under the guidance of the project evaluator.

Selection of Materials

Science instructional kits from four suppliers (CHOL, FOSS, Insights, and STC) were utilized in the study. Two kits per grade level were selected from each of the four suppliers, resulting in a total of 40 hands-on science instructional kits used during the project. Kits were chosen so that, when possible, the same topic was covered by at least two of the suppliers. Topics encompassed such themes as weather, plants, animals, water, electricity, sound, energy, changes, and environments. A complete listing of the kits is contained in Appendix B. It should be noted that the appropriate measurement modules were purchased and included with each FOSS kit and that the FOSS kits were repackaged in containers that would withstand repeated shipping. The materials included in the Insights kits were those specified by Optical Data Corporation and NASCO. In addition, the STC kits used in this study were enhanced kits marketed by the Center for Hands-On Learning, rather than ones obtained from Carolina Biological.

Monitoring Project Implementation

A data base of participants was prepared by CHOL to assist in the management of the project. The data base enabled the CHOL staff and evaluator to monitor the implementation of the project noting any changes in participants or kits, to document who had returned kits and surveys, and to prepare mailing labels for kits and evaluation instruments. Return mailing labels and pre-paid postage for kits and addressed, stamped envelopes for all evaluation instruments were provided so that teachers could participate in the study at no cost. In addition it was thought that this would improve the timely return of materials and the overall response rate on the surveys. Participants who failed to return materials in a timely manner or who did not complete surveys were dropped from the study.

Kits and surveys were mailed and returned three different times during the year as shown in Table 1 in the research design section of the report. As each kit was returned, materials were inventoried, replenished, and prepared for re-mailing by CHOL staff. The evaluator assisted CHOL staff in the mailing of pre and post-surveys and kit evaluations, but surveys were returned directly to the evaluator who documented respondents, prepared the surveys for scanning, developed data files for use in the statistical analysis, and compiled the open-ended responses.

Demographic Information About Participants

Demographic information about participants was collected on the pre-survey. Due to changes in teaching assignment and other reasons, the original group of 300 teachers decreased somewhat. A total of 234 teachers completed pre-surveys which provided demographic information about participating schools and teachers. The demographics of the schools and teachers involved in the study are described in the following paragraphs. This demographic information is also summarized in graphs contained in Appendix C.

Types and Locations of Schools. Of these 234 respondents, 215 (92%) represented public schools, 14 (6%) represented parochial schools, three (1%) represented independent schools, and one teacher represented a BIA school. Nearly half of these teachers (113 or 48%) indicated that they taught at schools in rural areas, 77 (33%) in urban schools, and 35 (15%) in suburban schools.

Grade Level Taught by Teachers. The teaching level of participants was approximately evenly divided among the grades with slightly lower representation in the upper elementary grades. Twenty-five percent taught first grade, 21% taught second grade, 19% taught third grade, 18% taught fourth grade, and 17% taught fifth or sixth grade. The percentages for fifth and sixth grades were combined because most New Mexico elementary schools do not include sixth grade.

Teaching Experience. The study included new, as well as, experienced teachers. Five percent had 1-2 years experience, 18% had between 3-5 years experience, 22% had between 6-10 years experience, 16% had 11-15 years experience, 17% had 16-20 years experience, and 20% had more than twenty years teaching experience. This indicates that nearly half of the participating teachers were very experienced.

In contrast, many of the teachers had taught at their current grade level for a much shorter period of time. Twenty-four percent of the participants had 1-2 years experience at their current grade level, while 35% had 3-5 years experience, 23% had 6-10 years experience, 7% had 11-15 years experience, and five percent each had 16-20 or more than 20 years experience.

Teacher Professional Preparation in Science. Thirty-two (13%) of the teachers in the study had an undergraduate minor in science, 6 (3%) had an undergraduate major in science, 14 (6%) had an undergraduate degree in science, and 8 (3%) had a graduate degree in science.

In the previous year, about one-fourth (24%) of the teachers had not participated in any inservice education in science or the teaching of science, 30% had participated in less than 6 hours, 22% had participated in 6-15 hours, 12% had participated in 16-35 hours, and 8% had more than 35 hours of inservice. In the last three years, the percentages were: none (10%), less than 6 hours (21%), 6-15 hours (20%), 16-35 hours (20%), and more than 35 hours (21%).

Teachers were involved in other professional development activities in science in addition to inservice. During the last year, 26% of the teachers had served on a school or district science curriculum committee, 16% had attended a national or state science teacher meeting, 13% had taught an inservice workshop or course in science or the teaching of science, and 10% had received a local, state, or national grant or award for science teaching.

As another indicator of professional development in science, teachers reported their familiarity with the national science standards on a five point Likert-type scale ranging from 1 (unfamiliar) to 5 (very familiar). Forty-three percent (a response of "1" and "2" combined) indicated they were unfamiliar or only slightly familiar with the national science standards, 35% (those who selected "3" on the 5-point scale) were familiar, and 22% were very familiar (a response of "4" and "5" combined).

Teachers in many of the participating schools had participated in a variety of educational and science reform programs. Twenty-four percent of participants indicated that teachers at their school had participated in RE: Learning, while 19% had participated in Goals 2000. Forty-four percent had participated in the statewide SIMSE project, 41% in SNL's SCIAD program, 7% in the Lockheed Martin Academy, 6% in Teacher Opportunities to Promote Science (TOPS), 2% in Southeastern New Mexico Educational Resource Center (SNMERC), and less than one percent in Community Academy for Science and Mathematics (CASM), which is part of the New Mexico Regional Center for Minorities, and the Utah Colorado Arizona New Mexico Rural Systemic Initiative (UCAN-RSI). One third (33%) indicated they have a science contact person in the community who provides assistance to them.

RESEARCH DESIGN

The research design was primarily quantitative in nature. Some qualitative information was also collected to supplement the numerical findings. The design is summarized below in Table 1.

TABLE 1.
SOHOS RESEARCH DESIGN

	SEPTEMBER-NOVEMBER	JANUARY-FEBRUARY	MARCH-MAY
GROUP 1	Pre-Survey, Kit 1	Kit 2, Post-Survey	
GROUP 2		Pre-Survey, Kit 1	Kit 2, Post-Survey
GROUP 3	Pre-Survey, Kit 1		Kit 2, Post-Survey

Teachers were randomly assigned two science kits from different suppliers on different topics. The teachers were then placed in one of three groups. Teachers in group 1 used their first science kit during autumn and their second kit during winter. Group 2 teachers used their first kit during winter and the second kit during spring. Group 3 teachers used their first kit during autumn and their second kit in the spring.

Each teacher completed a pre-survey directly before using their first kit, and a post-survey directly after using the second kit. Kit evaluations were also completed and submitted directly after using each kit. The random assignment of teachers to groups and the time at which teachers completed surveys controlled for the effects of changes that might naturally occur during the course of the school year.

Instruments

Three instruments—a pre-survey, a post-survey, and a kit evaluation form were collaboratively developed by the evaluator, CHOL staff, and Sandia National Laboratories personnel. The instruments were subsequently reviewed by statewide representatives of SIMSE and recommendations from this group were incorporated. Many of the items on the instrument, especially in the areas of professional development and teaching practices, were similar or identical to items from major national studies such as the National Assessment of Educational Progress (NAEP) and the 1993 National Survey of Science and Mathematics Education (NSSME). Copies of the three instruments used in the study are contained in Appendix D.

Pre-Survey. The pre-survey was designed to collect information in three major areas: demographics of participating schools and teachers, prior professional development in science of the participating teachers, and prior science instructional practices of the participating teachers. Demographic information was collected on the type and location of schools, participation of schools in a variety of educational reform and science education programs, grade level taught by participants, and teacher experience. Information in the area of professional development in science included degrees in science, familiarity with national science standards, and participation in a variety of professional development activities such as inservice on science or the teaching of science, attendance at national or state science teacher meetings, and participation on science curriculum committees. Previous teaching practices information included science instructional objectives, instructional approaches and activities, time spent on science instruction, teaching methods used, and self-assessment of the difficulty and effectiveness of the science teaching method(s).

Post-Survey. A primary purpose of the post-survey was to document changes in teacher instructional practices, attitudes toward science instruction, and perceived instructional effectiveness which occurred in conjunction with use of the hands-on science kits. Accordingly, many of the questions from the pre-survey were repeated on the post-survey. The post-surveys also asked the teachers to provide a retrospective assessment of the effectiveness and difficulty of teaching science using the kits, their opinions regarding the value and practicality of hands-on science instruction, and their level of interest and commitment to continuing to use this approach in their classrooms. In addition, the post-surveys also provided an opportunity for each teacher to compare the two kits used during the study and to provide paired-comparison ratings of these kits in various areas relating to their quality and instructional effectiveness. Finally, four open-ended questions requested teacher comments on outstanding features and serious shortcomings of the kits; the most memorable experiences that occurred in their classrooms during their use; and what they gained from the study that would alter their future science instruction.

Kit Evaluation. Kit evaluations were completed by teachers immediately following the use of each kit. These obtained detailed teacher assessments of each suppliers' materials in categories such as the effectiveness and ease of use of teachers' guides, the amount of time required to prepare for activities, the ease of use and durability of materials, the integration of kit activities into other curricular areas, the appropriateness and effectiveness of kit content, the necessity for additional assistance to effectively utilize the kits, and recommendations regarding use and adoption of kits. Teachers also were invited to write open-ended comments about the kits. These comments provided qualitative information to supplement the quantitative results obtained from analysis of the numerical responses.

The remaining sections of the report present the results of the research study in three areas:

- changes in teaching practices and attitudes towards hands-on science instruction,
- teacher-perceived strengths and weaknesses of the hands-on science kits used in the study, and
- strategies for successful implementation of hands-on science programs in New Mexico schools.

The statistical procedures used to analyze the data collected during the project are presented with the results.

CHANGES IN TEACHING PRACTICES AND ATTITUDES

Methods Used to Analyze Data

A major focus of the study was to determine if and how the use of hands-on science kits substantially changed the way elementary teachers taught science—their instructional objectives, the approaches and activities they used, the amount of time devoted to science instruction, as well as their attitudes towards the use of hands-on materials. An analysis of data from the pre and post-surveys provided answers to these questions. This section of the report will describe the statistical methods used and then present the results in each of the areas discussed above.

Because of the interest in individual survey items, multiple dependent t-tests were used to analyze the data from the pre and post-surveys, however, an adjustment to the alpha level based on family-wise comparisons was made. This procedure, known as the Bonferroni method, tests each comparison at the alpha level for the t-test (.05) divided by the number of comparisons. This decreases the probability of finding significant differences on items that were not truly significant (Green et al., 1997). For example, teachers responded to twelve questions in the area of instructional objectives. Since twelve t-tests were conducted on this set of items, the alpha level of $p \leq .05$ was divided by 12 resulting in an alpha level of $p \leq .004$. Only those t-tests that met the adjusted alpha level of $p \leq .004$ were considered indicative of statistically significant changes. Similarly, five t-tests were conducted on the set of items on instructional approach, resulting in an adjusted alpha level of $p \leq .01$ for these items. Nine t-tests were conducted on the set of items measuring instructional activities, resulting in an adjusted alpha of $p \leq .006$ for these items. All other t-tests regarding time, difficulty, effectiveness, value and practicality of hands-on science instruction, and familiarity with the national science standards were grouped together resulting in an adjusted alpha of $p \leq .008$ for these items. Discussion of the results follows. Complete statistical information for all analyses on changes in teaching practices and attitudes is contained in Appendix E.

Instructional Objectives

The pre and post-surveys contained 12 items on instructional objectives in science, with the pre-survey items referring to how much emphasis teachers gave each instructional objective during the previous school year and the post-survey items referring to how much emphasis teachers gave the corresponding objectives during the time they were using the hands-on science kits provided by the study. Possible response choices were: "3" heavy emphasis, "2" moderate emphasis, "1" little emphasis, and "0" no emphasis. Table 2 below gives each of the 12 instructional objectives listed in order from most to least emphasis according to teaching practices used during the previous school year. The statistically significant changes are indicated by an * next to the post-mean.

TABLE 2.
Emphasis Given Science Instructional Objectives
by SOHOS Participants on Pre and Post-Survey

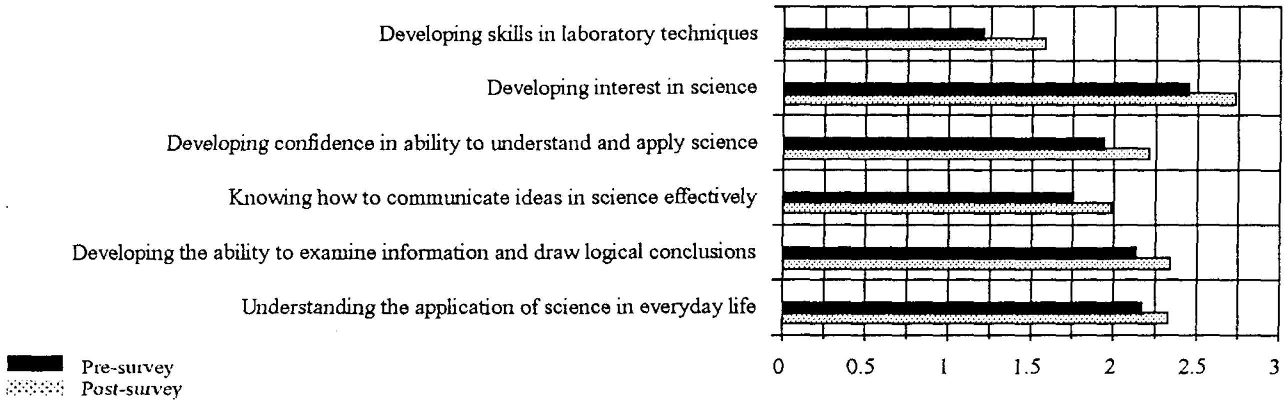
ITEM	PRE-MEAN	POST-MEAN
Developing interest in science	2.44	2.72*
Developing problem solving/inquiry skills	2.37	2.49
Understanding key science concepts	2.23	2.33
Understanding the application of science in everyday life	2.16	2.32*
Developing the ability to examine information and draw logical conclusions	2.12	2.33*
Developing confidence in ability to understand science and apply understanding	1.93	2.20*
Learning about the relevance of science to society	1.91	1.93
Knowing science facts and terminology	1.82	1.91
Preparing for further study in science	1.79	1.91
Knowing how to communicate ideas in science effectively	1.75	1.98*
Understanding the nature of science as a discipline	1.41	1.46
Developing skills in laboratory techniques	1.19	1.58*

Statistically significant changes occurred in the emphasis given to half of the science teaching objectives surveyed by the study. Each of these items and relevant statistical information are given in Table 3. The items are listed in order from the greatest to the least amount of change in emphasis. Figure 1 provides a graphic presentation of the statistically significant changes in instructional objectives. Discussion of the items follows Figure 1.

TABLE 3.
Significant Changes in Emphasis Given to Science Instructional Objectives

ITEM	t	df	p
Developing skills in laboratory techniques	5.53	165	$\leq .001$
Developing interest in science	5.36	165	$\leq .001$
Developing confidence in ability to understand science and apply that understanding	4.00	164	$\leq .001$
Knowing how to communicate ideas in science effectively	3.64	165	$\leq .001$
Developing the ability to examine information and draw logical conclusions	3.22	162	$\leq .002$
Understanding the application of science in everyday life	2.90	164	$\leq .004$

FIGURE 1.
Significant Changes in Emphasis Given to Science Instructional Objectives



In Table 3, the column labeled "t" gives the t-values, which is a measure of the strength of the change in emphasis given each instructional objective by teachers in the study from pre to post-survey. The fact that all of these t-values are positive indicates that teachers gave significantly *more emphasis* to each of these instructional objectives while using the kits (negative t-values would indicate significantly *less emphasis*). The column labeled df, stands for degrees of freedom, which is the number of teachers minus 1. The column labeled p gives the probability or significance level. A p value of ≤.001 indicates only 1 chance in 1,000 or less that the result could have occurred by chance, i.e., that the finding of a change in teaching objective was fortuitous, rather than real.

Skills in Laboratory Techniques. The largest change in emphasis on instructional objectives occurred in the development of skills in laboratory techniques. It is interesting to note that, although at least 35% of the teachers had used experiments or hands-on science kits during the previous year's teaching of science, they placed significantly more emphasis on this students' developing "laboratory" skills during the time they used the hands-on instructional materials provided by this study. The National Center for Improving Science Education (NCISE, 1989) suggests the importance of the development of practical age skills in elementary science. These can range from simple skills, such as reading thermometers and connecting wires to a batteries and basic electrical devices, to more complex skills, such as using microscopes or wiring miniature houses. NCISE emphasizes that practical "laboratory" skills are best developed in context as students engage in hands-on activities.

Student Interest in Science. While during the previous school year teachers placed moderate emphasis on developing students' interest in science, they placed significantly greater emphasis on this instructional objective as they taught science during the research study. Developing an interest in science is a highly appropriate objective in elementary science instruction (NCISE, 1989). A number of reports have documented that the use of hands-on instructional materials results in significant increases in student interest and enthusiasm (Bredderman, 1982; Kyle et al., 1985; Shymansky and Pennick, 1981). The excitement and enthusiasm generated by hands-on science activities in the elementary grades is one of the reasons teachers like to use this approach. Many teachers in this study remarked that using the kits was very motivational to students, increasing their interest in and enthusiasm for science and resulting in increased learning. A sampling of teacher comments follows. "It is great to see the enthusiasm that the experiments elicit." "Children loved all the activities and parents remarked that children were talking about science a great deal more." "I think the hands-on experiences led children to seek out further information on their own—very motivational!" "The kits really motivated the students to do science. A lot of learning went on and they thought it was fun." "The electricity kit fired up the students to investigate further."

Understanding and Applying Science. Developing confidence in the ability to understand science and apply that understanding was given moderate emphasis by teachers prior to the study, but received substantially greater emphasis as they focused on hands-on science instruction. In *Science for All Americans*, the American Association for the Advancement of Science emphasized that science instruction should model the scientific process of investigating, reasoning, finding out, and then applying new understanding, rather than simply memorizing a body of factual information (AAAS, 1990). The *National Science Education Standards* and other leading science education reform publications have consistently echoed this theme (Council for Educational Development and Research, 1993; NCISE, 1989; NRC, 1996; U.S. Department of Education, 1993).

One teacher who used a kit about balance and motion said that the most memorable experience was "watching the children make connections about the different balances and how they connected this experience to everyday." Another teacher commented on how students applied what they were learning long after the kits had been returned. "One day as the students and I were crossing the street, there was a truck in the parking lot with the engine running and no one in the vehicle. The students all began commenting on how that person was wasting energy." Another example of applying scientific understanding occurred when students were involved in an activity about "black holes." A teacher said, "We had been studying space and discussed black holes before your kit arrived. Some children had a hard time understanding the hypotheses about black holes. Even though (the activity) "Black Box" drove them crazy because they couldn't open them to find out what was inside, they finally understood the concept ... much better."

Communicating Scientific Ideas. Teachers participating in SOHOS reported having given moderate emphasis to students learning how to communicate ideas in science effectively. This emphasis was significantly increased as they taught science using a hands-on, minds-on approach. The AAAS (1990) stressed the importance of communicating scientific ideas in *Science for All Americans*. "Effective oral and written communication is so important in every facet of life that teachers of every subject and at every level should place a high priority on it for all students. In addition, science teachers should emphasize clear expression, because the role of evidence and the unambiguous replication of evidence cannot be understood without some struggle to express one's own procedures, finding, and ideas rigorously, and to decode the accounts of others" (p. 202). NCISE (1989) also states, "Not only do children need to amass direct experience with natural phenomena, they also need time to accommodate their experience by talking about it with their classmates and their teachers." They further state, "When students collaborate with others on school science tasks, they sharpen their communication skills and acquire a deeper understanding of what they are doing" (p. 5).

It has been documented that involvement in hands-on elementary school science activities helps students develop language and communication skills (Bredderman, 1982; Wellman, 1978). This is particularly true for students with limited proficiency in English (Rodriguez and Bethel, 1983), and when science and reading are intentionally coupled (Romance and Vitale, 1996).

In the present study, a number of teachers commented on the communication and language development they observed among their students as they pursued the hands-on activities. "Both kits really engaged the students and made them excited about what they were observing and learning. The students naturally communicate when they have something to get their hands on." Another teacher remarked how memorable it was "watching the kids daily write, draw, and share observations" as they cared for their terrariums and aquariums.

Examining Information and Drawing Conclusions. In previous science teaching, teachers placed moderate emphasis on their students' ability to examine information and draw logical conclusions. When they used the science kits provided by the study, they significantly increased the emphasis on this objective.

The development of such "logical thinking skills" is foundational to the *National Science Education Standards* and other key documents dealing with enhancement of science education (AAAS, 1990; 1993, NCISE, 1989; NRC, 1996). It has also been shown that elementary students who participate in hands-on science activities make substantial advances in developing science process and logical thinking skills (Bredderman, 1982).

Such development was noted by a number of teachers in the current study. For example, one teacher said, "This kit was very effective and strengthened my students' understanding of scientific processes." A fifth grade teacher commented that using the kit made the students "feel like scientists" and that she began to hear "good investigation language." Another felt the weather kit led to a "better understanding of the scientific process by our children."

Application of Science in Everyday Life. The final significant change in instructional objectives was on the emphasis teachers gave to the application of science in everyday life. This objective initially was moderately emphasized by teachers but received significantly more emphasis as teachers used the kits provided by the study. The AAAS (1990) endorses this focus, noting "Sound teaching usually begins with questions and phenomena that are interesting and familiar to students, not with abstractions or phenomena outside their range of perception, understanding, or knowledge" (p.201). Since many of the kits focused on activities that were part of students' everyday surroundings such as observations of weather, plants, and animals, this objective was given more emphasis by teachers during the study. One teacher said, "The weather watch was especially exciting every day." "Especially nice was the live specimens we received to explore. Fifth graders studied these creatures when they did phylums of living things. They were very excited to view and compare the live specimens to what they had learned."

Instructional Approach

The pre and post-surveys contained five items on instructional approaches in science, with the pre-survey items referring to how much emphasis teachers gave each instructional approach during the previous school year and the post-survey items referring to how much emphasis teachers gave the corresponding approaches during the time they were using the hands-on science kits provided by the study. Possible response choices were: "3" heavy emphasis, "2" moderate emphasis, "1" little emphasis, and "0" no emphasis. Table 4 below gives each of the 5 instructional approaches listed in order from the most to least emphasis during the previous school year. The statistically significant changes are indicated by an * next to the post-mean.

TABLE 4.
Emphasis Given Science Instructional Approaches
by SOHOS Participants on Pre and Post-Survey

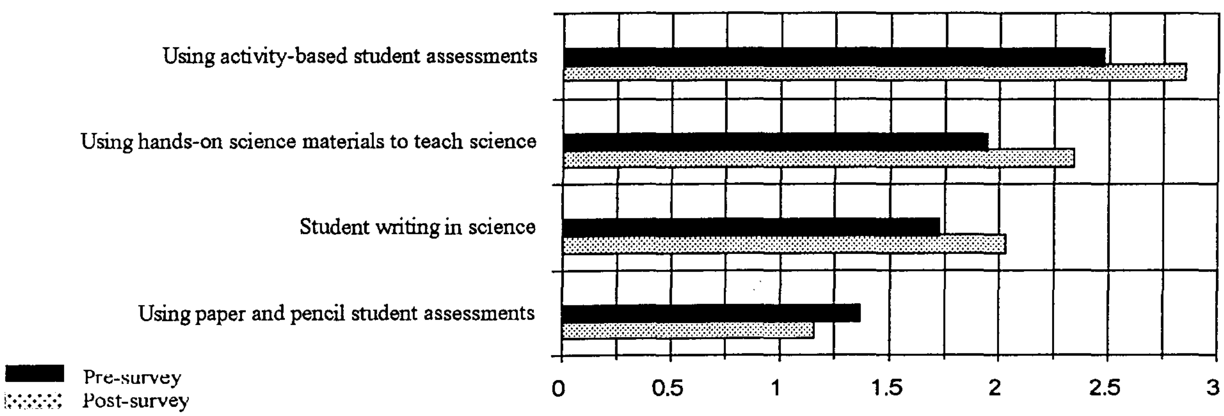
ITEM	PRE-MEAN	POST-MEAN
Using hands-on science materials to teach science	2.47	2.84*
Integrating science with other curricular areas	2.17	2.07
Using activity-based student assessments	1.94	2.33*
Student writing in science	1.72	2.02*
Using paper and pencil student assessments	1.36	1.15*

Statistically significant changes in emphasis occurred in four of the five instructional approaches. Each of these items and relevant statistical information are given in Table 5. The items are listed in order from the greatest to the least amount of change in emphasis. Figure 2 provides a graphic presentation of the statistically significant changes in instructional approaches. Discussion of the items follows the table.

TABLE 5.
Significant Changes in Emphasis Given to Science Instructional Approaches

ITEM	t	df	p
Using hands-on activities to teach science	6.78	165	≤.001
Using activity-based student assessments	5.70	164	≤.001
Student writing in science	4.51	165	≤.001
Using paper and pencil student assessments	-2.91	165	≤.004

FIGURE 3.
Significant Changes in Emphasis Given to Science Instructional Approaches



Use of Hands-On Activities. Although the teachers participating in the study indicated that they gave moderate emphasis to the use of hands-on science materials during the previous year's teaching, their use increased dramatically during the study. This is not surprising, as teachers were provided with these hands-on instructional materials as part of this study. Nevertheless, this is an important result because the use of hands-on materials has been positively related to improvements in student's science achievement in several large studies. Bredderman (1982) showed this to be true for ~13,000 elementary school students in a meta-analysis of the results of nearly 60 independent studies. Reynolds et al. (1991) showed that the gains made in elementary school persisted through middle and high school. Storr-Hunt (1996) also showed that science achievement among nearly 25,000 eighth-grade students correlated with the frequency of their involvement in hands-on science activities.

Use of Activity-Based Assessments. The use of hands-on science kits was associated with a significant increase in the use of activity-based assessments, an approach to assessment that is highly recommended (Hibbard, 1996; McTighe, 1997; NCISE, 1989; NRC, 1996; Rhoton and Bowers, 1996). McTighe (1997) states, "Growing concern over the inadequacy of conventional tests has spurred interest in performance assessments, such as performance tasks, projects, and exhibitions. To many supporters, these performance assessments are better suited than traditional tests to measure what really counts: whether students can apply their knowledge, skills, and understanding in important, real-world contexts" (p.7). Sivertsen (1993) says, "A new link between assessment and instruction is being forged through the reform movement. By using more authentic assessments such as performance-based or portfolio assessment or multiple choice tests that require thought beyond recognition and recall, more higher order thinking skills can be assessed, and students can learn though the process of assessment itself" (p.11).

Many of the kits used in this study incorporate suggestions for authentic assessment. Teachers responded favorably to these. For example, one teacher commented about a FOSS kit, "The assessment portion is well done and looks at all learning styles. The information is very appropriate and useful." A fourth grade teacher indicated that after using the hands-on science kits she felt much more comfortable conducting "informal assessments." A teacher of third graders said she planned to continue using the "format of surveying prior knowledge and misconceptions" while another teacher "liked the idea of interviewing small groups" prior to and after using the kit.

Use of Student Writing in Science. Significantly more emphasis was given to student writing in science during the research study. The use of student writing in science, which was promoted by the kits, is a highly recommend practice (AAAS, 1990; NCISE, 1989). In addition, it has been shown that students frequently develop improved communication, language, and reading skills in conjunction with their involvement in hands-on science activities (Bredderman, 1982; Romance and Vitale, 1992; Rodriguez and Bethel, 1983; Wellman, 1978).

Teachers referred to student journals as a way to stress writing in science. For example, one teacher said, "They kept a journal and wrote the changes that were happening in the ecosystems." In conjunction with a unit on earthquakes a teacher said, "The students wrote wonderfully creative legends." A first grade teacher extended the students' learning and emphasized writing at the same time. Another teacher remarked, "I had never done science journaling or other science writing. I saw it as very valuable when students kept track of the growth of their plants. They enjoyed putting together books using all the papers they had recorded on."

Use of Traditional Assessments. Along with the increase in use of activity-based assessments was a significant decrease in paper and pencil student assessments (indicated by an examination of the means in Table 4 and the negative t-value in Table 5). Although this group of teachers was perhaps unusual in the little emphasis given to the use of paper and pencil assessments during the previous year's teaching, the use of this assessment strategy further decreased during the study. The *National Science Education Standards* recommends decreasing the use of more traditional paper and pencil-type tests of student knowledge and increasing the variety of assessment approaches with a focus on assessing what is most highly valued; assessing rich, well-structured knowledge; and assessing scientific understanding and reasoning (NRC, 1996).

Instructional Activities

The pre and post-surveys contained nine items on instructional activities in science, with the pre-survey items referring to how frequently teachers utilized each instructional activity during the previous school year and the post-survey items referring to frequency during the use of hands-on science materials. Possible response choices were: "3" almost daily, "2" once or twice a week, "1" once or twice a month, and "0" never. Table 6 below gives each of the nine instructional activities and the pre and post means. The items are listed in order from most to least frequent use according to teaching practices used during the previous year's teaching of science. The statistically significant changes are indicated by an * next to the post-mean.

TABLE 6.
Frequency of Use of Science Instructional Activities
by SOHOS Participants on Pre and Post-Survey

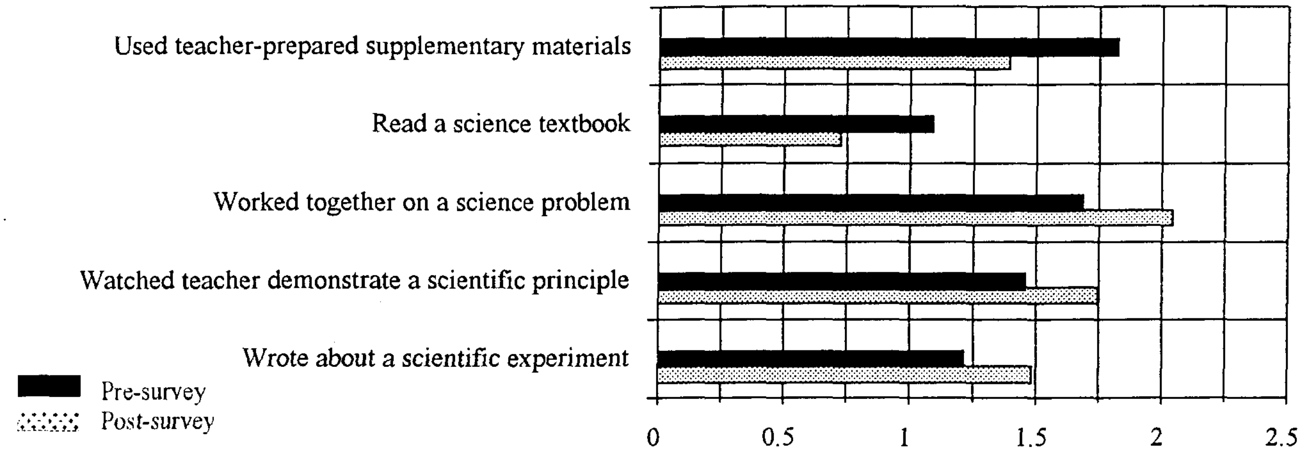
ITEM	PRE-MEAN	POST-MEAN
Used teacher-prepared supplementary materials	1.82	1.38*
Worked together on a science problem	1.68	2.04*
Watched teacher demonstrate a scientific principle	1.45	1.74*
Discussed a science news event	1.28	1.42
Wrote about a scientific experiment	1.21	1.48*
Listened to a lecture about science	1.20	1.12
Read a science textbook	1.08	0.72*
Gave an oral or written science report	0.70	0.82
Used a computer for simulations or data collection & analysis	0.37	0.40

Statstically significant changes in frequency of use occurred in five of the nine instructional activities surveyed in the research study. Each of these items and relevant statistical information are given in Table 7. The items are listed in order from the most to least change in frequency. Figure 3 provides a graphic presentation of the statistically significant changes in instructional activities. Discussion of the items follows Figure 3.

TABLE 7.
Significant Changes in Frequency of Use of Science Instructional Activities

ITEM	t	df	p
Used teacher-prepared supplementary materials	-6.14	159	≤.001
Worked together on a science problem	5.34	161	≤.001
Read a science textbook	-5.18	157	≤.001
Watched teacher demonstrate scientific principle	4.52	161	≤.001
Wrote about a science experiment	3.39	161	≤.001

FIGURE 3.
Significant Changes in Frequency of Use of Science Instructional Activities



Use of Teacher-Prepared Supplementary Materials. The group of teachers participating in the study used a variety of methods to teach science during the previous year. Thirty-one percent used a hands-on science kit, 16% used a science program such as GEMS or Wild Goose, 12% used a textbook publishers kit such as Discover the Wonder or Scott Foresman, 11% developed their own science curriculum, 5% used a text and experiments, 2% used primarily a textbook, 1% didn't teach science, and 11% used a variety of other methods. In addition, teachers had students read a science textbook, on average, once or twice a month.

Examination of the means in Table 6 shows that prior to the study teachers used materials they prepared themselves nearly weekly. The dramatic decrease in this activity during the time of the study suggests that when teachers are provided with hands-on science kits which contain everything required to teach science using a hands-on, minds-on approach, they no longer need to devote time to developing their own supplemental materials. Analysis of teacher evaluations of the kits used in the study substantiates this notion, as teachers reported having to spend very little time preparing materials to accompany the lessons.

Cooperative Learning. The kits selected for use in this study suggested many cooperative learning activities which resulted in teachers devoting significantly more time, at least once or twice a week, to students working together to solve a problem. Increasing the amount of time students engage in cooperative learning is a recommended part of science education reform. The AAAS (1990) recommends, "The collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom" (p.202). The *National Science Education Standards* (1996) state, "Working collaboratively with others not only enhances the understanding of science, it also fosters the practice of many of the skills, attitudes, and values that characterize science. Effective teachers design many of the activities for learning science to require group work, not simply as an exercise, but as essential to the inquiry. The teacher's role is to structure the groups and to teach students the skills that are needed to work together" (p.50).

Teachers expressed positive attitudes towards students working collaboratively in science. "I liked the children working in small groups for science, rather than individually." One teacher said that at the end of the time in which they had been using the hands-on science kits, "My team teacher and I stood back and marveled at the extent of cooperative learning that was taking place during an investigation—while we stood and watched!" Another poignant example of student collaboration occurred in a class in which the teacher had included four special needs students. She said the most memorable experience was "watching my regular students work with them and help one particular student "light" the light bulb for the first time."

Use of Science Textbooks. Although teachers in this study used textbooks only once or twice a month during the previous year's teaching, they spent significantly less time having students read from textbooks during the use of hands-on science kits. Traditionally, "textbooks have defined the curriculum" and as Sivertsen (1993) explains "while textbooks may have a place in the curriculum as a support to inquiry and experimentation, a more experimental base is needed at all levels involving use of instructional materials and equipment and thought-provoking questions and dialogue" (p.6). The National Science Education Standards recommend less emphasis on learning science by lecturing and reading and more emphasis on learning science through investigation and inquiry (NRC, 1996). A recent elementary school study which combined hands-on science activities with science-content reading resulted in significant increases in student achievement in both science and reading (Romance and Vitale, 1996).

Teachers in this study strongly supported the contention that students learn better from active engagement in hands-on science activities than from only passive reading of textbooks. One teacher expressed the opinion that the kit she used was "definitely a good kit for teachers who are using only textbooks to teach science. It may introduce them to ways that actually work to teach the kids in a way that is motivational and meaningful to them. Ideas like this should replace a text style of teaching." A first grade teacher who used a kit on living things said, "I think the close examination of an insect and actually growing plants will stay with students much more than reading about insects and plants from a text."

Teacher Demonstration of Scientific Principles. Although it is better for students to gain an understanding of scientific principles through active involvement rather than through watching teachers demonstrate scientific principles, teacher demonstrations are preferable to attempting to understand scientific principles merely by reading about them. As teachers used the hands-on science materials, they demonstrated scientific principles to students several times a month, a significant increase from their previous teaching style. This result may be attributed to the increased amount of time teachers used the hands-on, minds-on approach in comparison to the previous year. However, as one teacher discovered, the students preferred conducting experiments themselves, rather than watching the teacher demonstrate. She said, "One day I decided to do one of our lessons in the Soils kit as a demonstration because an assembly had shortened our regular science time. I was surprised at the students' loud expression of disappointment that they were not going to get to do the experiment with their partner." This teacher concluded that the "hands-on nature of science is very powerful for children."

Student Writing About Experiments. Students spent significantly more time writing about scientific experiments when they used hands-on materials. An examination of the means in Table 6 shows that teachers increased the frequency of this activity to several times a month. Representative comments were included in the instructional approaches section of the report.

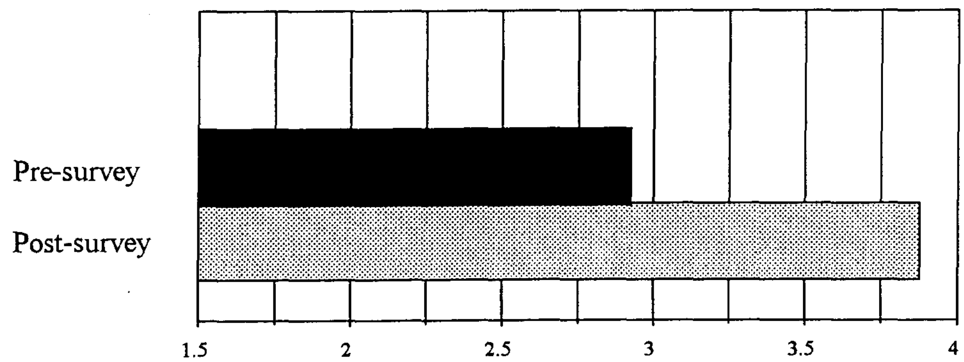
Time Devoted to Science Instruction

Teachers were asked to report the amount of time they devoted to science instruction, rounded to the nearest half hour, during the previous year, as well as during the time they used the hands-on, minds-on approach recommended by the science kits. Table 8 gives the average number of hours spent on science instruction on the pre and post-survey and relevant statistical information. Figure 4 provides a graphic presentation of the statistically significant change in time devoted to science instruction.

TABLE 8.
Average Number of Hours Devoted to Science Instruction
by SOHOS Participants on Pre and Post-Survey

ITEM	PRE-MEAN	POST-MEAN	t	df	p
Hours devoted to science instruction	2.92	3.87*	5.67	158	≤.001

FIGURE 4.
Average Number of Hours Devoted to Science Instruction



Current studies indicate that less than half of the fourth grade students in the country attend schools where science is even taught on a regular basis (Weiss, 1993). In dramatic contrast to this, the teachers involved in the SOHOS study spent an average of 3.87 hours per week on science instruction while using the hands-on science kits. This represents a 33% increase over the time they devoted to science instruction in the previous year.

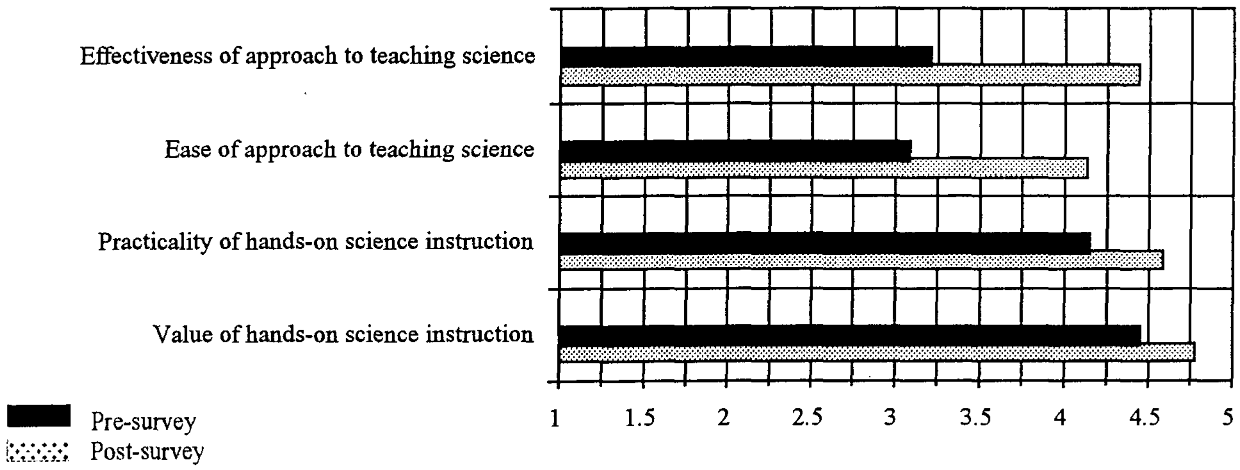
Attitudes Toward Hands-On Science Instruction

This section of the report contains information on a variety of changes in teacher attitudes about science instruction, including teacher perceptions regarding the difficulty, effectiveness, value, and practicality of teaching using hands-on materials compared to the method(s) they had used previously. Teachers were asked to respond to these items using a five point Likert-type scale with "1" indicating the negative response (e.g. very difficult, ineffective) and "5" indicating the positive end of the scale (e.g. very easy, very effective). Table 9 presents relevant statistical information about teacher changes in attitudes toward hands-on science instruction. It is important to note that *highly significant* changes occurred in teacher attitudes in *each* of these areas. Figure 5 provides a graphic presentation of the changes in attitudes. Discussion of the items follows the table.

TABLE 9.
Significant Changes in Attitudes Toward Hands-On Science

ITEM	MEAN PRE	MEAN POST	t	df	p
Effectiveness of approach to teaching science	3.20	4.42*	8.58	73	≤.001
Ease of approach to teaching science	3.07	4.12*	6.89	74	≤.001
Practicality of hands-on science instruction	4.14	4.58*	6.77	170	≤.001
Value of hands-on science instruction	4.44	4.77*	5.87	170	≤.001

FIGURE 5.
Significant Changes in Attitudes Toward Hands-On Science



Effectiveness of Kit-Based Approach to Science. Teachers were asked on the pre-survey how effective they considered their previous year's teaching method to be, and on the post-survey how effective they considered the kit-based approach to science to be. Teachers who used hands-on science kits as the primary teaching method on the pre-survey were excluded from the analysis, resulting in a matched group of 74 teachers. Although this group of teachers considered their previous teaching methods to be moderately effective, they rated the kit-based approach to science as being far more effective. The t-value of 8.58 indicates that this is an exceptionally highly significant change. In fact, this is the item that shows the most highly significant change in the entire SOHOS research.

This is a very important finding since research has shown that teachers' beliefs about the efficacy of hands-on science instruction significantly affect their intentions to implement recommended science education reform (Haney et al., 1996). Hands-on science programs have been shown to lead to significant student gains. Bredderman (1982) in a study of 13,000 elementary students in 1,000 classrooms throughout the country determined that activity-based science programs lead to substantially improved performance in science processes and creativity; moderately increased performance on tests of perception, logic, language development, science content, and math; improved attitudes toward science; and pronounced benefits for disadvantaged students. Despite such documented improvements, however, Haney's (1996) work showed that teachers need to experience the success of the hands-on instructional approach for themselves before they become believers in this approach and commit to using it in their own classrooms. The New Mexico teachers who used the kits as part of their involvement in the SOHOS study became such believers. This provides a good example of teachers learning about constructivist instruction via a constructivist, or active hands-on engagement approach. This has profound implications regarding professional development activities to prepare teachers for using hands-on science instructional materials which will be elaborated on in the last chapter of the report.

Not only does the professional literature support the efficacy of hands-on science instruction (AAAS, 1990; NRC, 1996), but New Mexico teachers, as well, experienced that the hands-on science kits provided by the SOHOS research study were extremely effective—much more effective than any of the other teaching methods they had used previously. Teachers provided examples of how specific kits had contributed to their students' understanding of science. "In the arthropod kit students understood and remembered what we were trying to teach." One teacher said, "This study reminded me how important hands-on activities are for learning. The kids were much more involved and evidenced much more learning than if they had done 'fill in the blank stuff.'" Another teacher said she was "even more committed to teaching through this manner," that use of the materials "affirmed my goal of advocacy for inquiry-based science in the primary grades and all levels!" A third grade teacher said, "I gained the knowledge of the importance of hands-on science. Being able to witness how excited students got over the activities themselves made a believer out of me."

In addition to increased student enthusiasm and learning, teachers indicated that using the hands-on science kits positively affected their teaching. One teacher remarked, "I have not felt comfortable teaching science until I used this kit." Another teacher said, "I think every teacher should be given a chance to use one of these kits. It really opened my eyes to how much the students enjoyed science. I even got excited to teach science." A fourth grade teacher said that as a result of participating in the study her "teaching style has become more student-centered," while a fifth grade teacher "witnessed a growth in my knowledge in the areas of the kits I used." As a result of using the kits provided by the study, one teacher indicated that her questioning strategy had improved. Several teachers remarked that the kits were especially helpful to beginning teachers, as exemplified in these quotes: "My student teacher commented that this kit would be useful for her as a beginning teacher with little or no curriculum development skills." Another new teacher said the most important thing she gained from participating in the study was ideas: "As a new teacher I am not fully loaded with resources and supplies. I found these kits to be fantastic and ideal for my teaching style."

<u>Ease of Kit-Based Approach to Science Instruction</u>. Not only did teachers consider the kit-based approach to science instruction very effective, they also found it to be significantly less difficult than other methods of teaching science. This was evident from both the dramatic change in teacher opinions reflected in the pre- and post-mean scores on this question, as well as the teachers' comments about the kits. For example, a second grade teacher said, "I was surprised at the relative simplicity and ease involved in getting across some of the concepts (about balance and motion)." Another teacher said, "I loved this kit. I have taught science many different ways—mostly hands-on using the old science kits (1976-85). I found this to be user-friendly and extremely easy to use. This gave me more time to enjoy the activities and have fun along with my students." A second grade teacher using a CHOL kit said, "It was unbelievably easy to use and what a treat to have *all* materials in the kit ready for us." A teacher of first graders remarked, "I would highly recommend this kit to other primary teachers. It was very well organized and easy to use." Finally, one teacher said, "I was very impressed with this method of teaching science. I was able to give hands-on science/math to my class, without any expense on my part. Everything was included and easy to follow."

These comments support the findings of the Teachers Laboratory Inc. in Brattleboro, Vermont. According to a recent survey, "by far the biggest reason cited by science and math teachers (for not using hands-on instructional materials) is a lack of time for planning, organizing, and gathering materials" (Rose, 1990, p. 9). By providing high quality kits this was no longer an obstacle for teachers who participated in SOHOS.

Practicality of Kit-Based Approach to Science Instruction. Although this particular group of teachers was fairly convinced of the practicality of hands-on science instruction prior to the study, they were significantly more convinced after having used the kits. In addition to the dramatic change in teachers' opinions regarding the practicality of this approach, many teachers made positive comments about how easy it was to teach science using the kits because all of the materials were provided (representative comments are contained in the next chapter of the report).

This is consistent with the findings of others (NSRC, 1994). It is important to note, however, that a number of previous reforms based on hands-on science instructional materials lacked longevity because no mechanism was established to replenish the kits between teacher uses. One of the keys to the success of hands-on science programs is that all of the materials need to be present in the kit and in good working order every time a kit is delivered to a teacher. If teachers regularly find items missing, broken, or unworkable, they become discouraged and soon discontinue using the kits. The critical need for a materials support system to replenish and distribute the kits will be discussed further in the last chapter of this report.

Value of Hands-On Science Instruction. Both quantitative results and comments indicated that teachers also were significantly more convinced of the value of hands-on science instruction after having participated in the study. A fourth grade teacher concluded, "I will always value the concept of hands-on science. I also am more comfortable not requiring a lot of written work at this level. I truly trust this learning process and the natural curiosity of each child. I know they are learning, building self-confidence and are very open to science as a result of those activities."

Commitment to Continuing to Use Hands-On Instruction Approach. When asked how committed they were to continuing hands-on science instruction in their classrooms, 95% of teachers indicated they were highly committed (75% selected "5" and 20% selected "4" as their response). In addition, many of their comments about the kits indicated a desire to continue teaching in this manner. "I will definitely continue to use hands-on activities when teaching science." "I have decided to use more hands-on approaches in conjunction with our textbooks." "I would like to teach all my science from kits, if possible." "I plan to try to make everything hands-on in the future."

Teacher commitment is an important first step, however, as the literature suggests, there is an entire support structure that needs to be in place to provide excellent hands-on materials as well as to facilitate teaching that is consistent with the nature of scientific inquiry (AAAS, 1990; NRC, 1996). This will be discussed in greater detail in the final chapter of the report on strategies for successful implementation.

COMPARISONS OF HANDS-ON SCIENCE KITS USED IN THE STUDY

A major focus of the research study was to determine teacher-perceived strengths and weaknesses of hands-on elementary science instructional materials from four leading suppliers. Two types of assessment information were collected and analyzed in this regard. First, kit evaluations were completed by each participating teacher immediately after the use of *each* kit. These documented teacher opinions while their recollections of the kit were very fresh in their minds. In addition, paired comparisons were completed by each teacher following the use of *both* kits. These provided retrospective teacher opinions about the *relative* strengths and weaknesses of materials from the four suppliers. Information will first be presented on the kit evaluations that were completed by teachers directly after use of the kits.

Methods Used to Analyze Kit Evaluation Data

Analyses of variance (ANOVAs) were conducted to determine if statistically significant differences existed between the four suppliers (CHOL, FOSS, Insights, and STC). Because of the multiple comparisons (ANOVAs on 22 items of the kit evaluation), the Bonferroni approach was used so that the overall alpha would remain at $p \leq .05$. As mentioned previously in the report, this entails dividing the alpha level of .05 by 22, resulting in an adjusted alpha of $p \leq .002$.

A significant result with an ANOVA indicates that there were significant differences on that item among suppliers, but does not tell where the difference lies. Post-hoc tests answer this question. Two post-hoc tests were used, the Tukey HSD and the Dunnett's T3. The adjusted alpha level was used for the post-hoc tests, as well.

The kit evaluation contained 28 items, 22 of which were statements about the kits in four areas: teachers' guide, materials, appropriateness of kit, and kit effectiveness. Teachers responded to each of these items using a five point Likert-type scale ranging from "1" strongly disagree to "5" strongly agree. Significant differences among suppliers occurred on 15 of the 22 items on the kit evaluation. Due to the multiple steps involved in the statistical analysis of the kit evaluations, only the significance levels for differences among suppliers will be given in the text. Complete statistical information is included in the Appendix F. In the tables which follow significant differences are marked with a * at the beginning of the statement. Where the significant difference lies is indicated with "+" and "-" below the mean. For example, if FOSS kits were judged by teachers to be significantly better than Insights kits, but no different than STC or CHOL kits, the mean for FOSS would be marked with "+," the mean for Insights would be marked "-," and the means for STC and CHOL would have no mark.

Teachers' Guides

Teachers responded to five items rating the teachers' guides. In examining the means for each of the five items evaluating the teachers' guides it should be noted that all of the suppliers received a mean rating of at least a "3." This indicates that the teachers' guides for all suppliers were considered acceptable by teachers. However, as shown in Table 10 there were significant differences among suppliers on two of the five items. Discussion of each item where significant preferences were found follow this table, along with representative teacher comments.

TABLE 10.
Ratings of Teachers' Guides

ITEM	CHOL	FOSS	INS	STC
*The teacher's guide contained sufficient background information to make me feel comfortable teaching the unit.	4.34 +	4.43 +	3.88 -	4.30
The teacher's guide contained suggestions for effective classroom management techniques to use during the lessons.	3.87	4.06	3.69	4.01
The teacher's guide contained valuable ideas for student assessment.	3.69	4.03	3.75	4.09
The teacher's guide contained useful ideas for extending the kit content to other curricular areas.	3.76	3.86	3.61	3.89
*Overall, the teacher's guide was clear and easy to use.	4.34 +	4.23	3.78 -	4.11

Background Information. It is evident that teachers agreed that all of the kits contained sufficient background information to make them feel comfortable teaching the unit. However, teachers more strongly agreed with this statement for the CHOL ($p \leq .001$) and FOSS ($p \leq .001$) teachers' guides than for the Insights teachers' guides. For example, one teacher said about an Insights kit, the "Teacher's edition needs to have more help for us on electricity."

Clarity and Ease of Use. Although all of the teacher's guides were considered to be clear and easy to use, there was a statistically significant difference in favor of the CHOL ($p \leq .001$) teacher's guides compared to the Insights teachers' guides. One teacher said about a CHOL kit, "The teacher's guide was easy to use and I did not have to spend a lot of time duplicating materials." A few teachers thought the guides for Insights kits contained too much information and were difficult to use. Comments about Insights teachers' guides included the following: "The instruction booklet/teacher's manual was tedious to read." "The teaching manual is very hard to follow." "The guide was difficult to use. I do better with the information more compact—not as scattered and not spread over so many pages." "The materials were great, but the teacher manual was too wordy."

Kit Materials

Teachers responded to six items rating the materials in the kits. Items 6-9 on the kit evaluation (items 2-5 in Table 11) are negatively worded; therefore a lower mean score is desirable on these four items. It is apparent when reviewing the means contained in Table 11 below that there are important differences in materials among the kits. Teachers expressed statistically significant preferences in all of the items except one. Discussion of each item where significant preferences were found follow this table, along with representative teacher comments.

TABLE 11.
Ratings of Materials in Kits

ITEM	CHOL	FOSS	INS	STC
The materials in the kit were durable.	4.26	4.31	4.14	4.46
*I had to spend a lot of time duplicating student materials for this kit.	1.46 +	2.34 -	2.88 -	2.57 -
*I had to purchase many materials not provided in the kit.	1.14 +	1.91 -	1.61 -	1.40
*I had to gather many materials not provided in the kit.	1.19 +	1.85 -	1.91 -	1.45
*I had to prepare many materials to do the activities in the kit.	1.44 +	2.47 -	2.56 -	2.11 -
*The overall benefits of the kit made the amount of time I invested worthwhile.	4.36 +	4.29 +	3.66 -	4.43 +

Duplicating Student Materials. The kits provided by the CHOL required significantly less time to be dedicated to duplicating student materials than the FOSS, Insights, and STC kits (all significant at $p \leq .001$). Typical comments about the kits provided by CHOL included the following: "The kit was extremely well-organized. *Everything* I needed was included." "The teacher's guide was easy to use and I did not have to spend a lot of time duplicating materials." One teacher said about an STC kit, "I didn't like how there were two sections of student papers. I found I spent a lot of time debating on which page was best. Most schools can't afford to run both. I would rewrite the student book into one easy-to-copy format." A comment about an Insights kit was, "It put a real strain on my allotted copying capacity to teach this kit."

Purchasing Additional Materials. For the most part, teachers did not have to purchase many additional materials as most everything was provided in the kits. However, teachers indicated they had to purchase significantly fewer materials for CHOL kits than for FOSS or Insights kits (both significant at $p \leq .001$). One teacher commented about a CHOL kit, "I really enjoyed using the kit. Everything was provided. I didn't expect the kit to be so well stocked." Another said, "I really appreciate everything being provided. I didn't have to search for or buy anything to complete the lessons." A comment about an Insights kit was, "We found that there were items missing from the kit, so attention to quality control in packing is recommended." One teacher complained about a FOSS kit, "The very first experiment asked for items not in the kit. I spent $7.00 on vegetables. I was asked to buy watermelon, but didn't. The second half of the kit depended upon crayfish which were not available at this time of year."

Gathering Materials. In addition to purchasing fewer materials, teachers said they also had to gather significantly fewer materials to conduct the activities in the CHOL kits than in the FOSS or Insights kits (both $p \leq .001$). Typical comments about CHOL kits included: "It was great not having to run all over for everything." "It was unbelievably easy to use." One teacher said about a FOSS kit, "It did not have enough wire for the electromagnets. I had to get some wire from our custodians." A teacher who used an Insights kit said, "At this time of year I just didn't have the time to go out and get all the stuff needed to do the kit—large pieces of lumber, buckets of sand, etc. Maybe I was spoiled because the last kit had everything for me." As one teacher concluded, "Many times I put science aside so I won't have to gather all the materials. Having it all in one kit is very useful and time saving."

Preparation Time. Teachers were asked how much preparation time was involved in utilizing the kit activities. Again, statistically significant differences emerged. CHOL kits required significantly less preparation time than FOSS, Insights, and STC kits (all $p \leq .001$). For example a teacher said that her Insights kit had a "tremendous amount of preparation time. I had to run off materials, cut wires, etc. It took hours to get each lesson ready." Another teacher said the Insights kit "requires lengthy preparation and clean-up time." A teacher commented that although she thought the Insights kit she used was excellent, "the preparation and clean-up required extensive time. Our teachers have little prep time and I spent about two hours preparing by reading and examining the materials, two more hours preparing the liquids and about one and a half hours cleaning the containers before returning the kit." A comment about an STC kit was, "This particular kit requires way too much advanced preparation. If I didn't have a mother helper, I could not use it each week. There are too many bottles, containers, bags to fill each week." However, a typical comment about a CHOL kit was: "The activities were both educational and fun with very little preparation or clean-up time."

Time Investment Worthwhile. Teachers agreed that the overall benefits of the kits made the amount of time they invested worthwhile, however, there were significant differences in favor of CHOL, FOSS, and STC kits (all $p \leq .001$) when compared to Insights kits. For example a teacher using an STC kit said, "The set up time for each lesson is substantial, but worth the time."

Age Level Appropriateness of Kit

Teachers responded to two items measuring appropriateness of kit content and one of these items was significant as shown in Table 12 below.

TABLE 12.
Appropriateness of Kit Content

ITEM	CHOL	FOSS	INS	STC
*The content of the kit was appropriate for my students.	4.30 +	4.35 +	3.71 -	4.35 +
The kit is appropriate for LEP students.	3.83	4.00	3.56	3.92

The means given in Table 12 indicate that teachers agreed that the content of all of the kits were appropriate for their students. However, the content of CHOL, FOSS, and STC kits (all $p \leq .001$) was significantly more appropriate than the content of Insights kits. One teacher said about a CHOL kit, "The strength of this kit is that it so very age appropriate. First graders love magnets." Comments about STC kits were, "I think this is an excellent kit to use at the fourth and fifth grade level. It integrates well with other curricular areas, especially health and language arts." "The kit was very appropriate for its designated grade level." A teacher using an Insights kit said, "The kit was too difficult for my second grade class. We did not use much of it. The scientific concepts were too hard for my students to grasp."

Effectiveness of Kit

Nine items were used to measure the effectiveness of the kits—effects on students, effectiveness of kits in relation to other science materials, the need for help to effectively utilize the kits, and teachers' recommendations about the kits to colleagues. Statistically significant preferences were expressed in six of these items, as shown in Table 13.

Discussion of each item where significant preferences were found follow this table, along with representative teacher comments.

TABLE 13.
Effectiveness of Kits

ITEM	CHOL	FOSS	INS	STC
*My students enjoyed using the kit.	4.54 +	4.52 +	4.05 -	4.58 +
*The kit effectively contributed to my students' understanding of science concepts.	4.25	4.33 +	3.89 -	4.46 +
*The kit was more effective than other hands-on science kits I have used.	3.91 +	3.87	3.30 -	4.02 +
*The kit was more effective than textbook-based instruction.	4.52	4.61 +	4.14 -	4.66 +
I was able to use this kit without additional help.	4.49	4.43	4.07	4.45
It is important to have inservice training to successfully use this kit.	1.92	2.17	2.21	2.07
I shared some of the ideas and activities in this kit with other teachers at my school.	3.63	3.69	3.13	3.67
*If funds were available, I would recommend this kit to another teacher.	4.41 +	4.33 +	3.58 -	4.50 +
*If funds were available, I would recommend this kit for adoption as part of my school's science instructional program.	4.31 +	4.24 +	3.54 -	4.50 +

Student Enjoyment. It is apparent in Table 13 that the students very much enjoyed using all of the kits. The CHOL ($p \leq .001$), FOSS ($p \leq .002$) and STC ($p \leq .001$) were rated by teachers as significantly more enjoyable to students than the Insights kits. A comment about an STC kit was, "I thought the kit was great. My students were able to experience things that they never had before. It made science interesting and fun for them." "The students really enjoyed this science kit and I did also. I think hands-on is a super way to learn and the kids really got involved." Teachers using CHOL kits said, "The children absolutely loved this kit!" "The students loved the activities." Typical comments about FOSS kits included the following: "The children thoroughly enjoyed these activities." "Excellent kit! My students and I both enjoyed using this kit." One teacher using an Insights kit said, "The activities were not as engaging as those I have used from other kits." "They did not get very excited over this kit—melting ice did not excite them."

Student Understanding of Kit Concepts. In addition to students enjoying the kits, teachers thought the FOSS ($p \leq .002$) and STC ($p \leq .001$) kits contributed significantly more to their students' understanding of science concepts than the Insights kits. One teacher said about an STC kit, "The unit was very well organized. I was also impressed with the way the lessons were carefully built on one another so there was a logical progression." A comment about a FOSS kit was, "The purpose for the content/concepts was much clearer. The sequence of activities made much better sense as to why are we doing this." Teachers who used Insights kits made the following comments, "This kit seemed to move too slow at times. The material was often obvious and redundant. I supplemented my own materials more often with this kit." "The activities were difficult to understand."

Effectiveness of SOHOS Kits Compared to Kits from Other Sources Used in Past Years. Teachers agreed that most of the hands-on science kits provided by the study were more effective than other hands-on science kits they had used in previous years. While they indicated that this was true for kits from all four of the suppliers included in the SOHOS study, they reported it to be particularly true for the CHOL and STC kits (both $p \leq .001$), but less true for the Insights kits. For example one teacher summarized an STC kit in the following manner. "Excellent, well-thought out activities. This kit was truly designed with a teacher in mind, yet provided all of the science elements that excite and educate children. I have used many kits and this one was the most effective."

Effectiveness of Kits Compared to Textbooks. Kits from all four of the suppliers were considered by teachers to be *much* more effective than textbook-based instruction. However, this was judged to be particularly true for the FOSS ($p \leq .002$) and STC ($p \leq .001$) kits, and less pronounced for the Insights kits. For example one teacher said, "Hands-on kits are the best; too much money is spent on textbooks whether the teachers want them or not."

Teacher Recommendations. The mean scores indicate that teachers would recommend the kits from any of the four suppliers to other teachers or for adoption as part of their school's science instructional program. However, they would be even *more* likely to make such recommendations for the CHOL, FOSS, and STC kits (all $p \leq .001$) relative to the Insights kits. Teachers made the following comments about CHOL, FOSS, and STC kits. "I would highly recommend this kit to other primary teachers." "I would love to see this put on our state adoption list." "Hopefully we can purchase complete hands-on science kits in the future." "Our school has recommended buying them for our school across all grades." "What a blessing! The strong point is the accessibility of all materials needed to teach a science lesson. Kids love it and can't wait for science. I would really like to see it on the state adoption list."

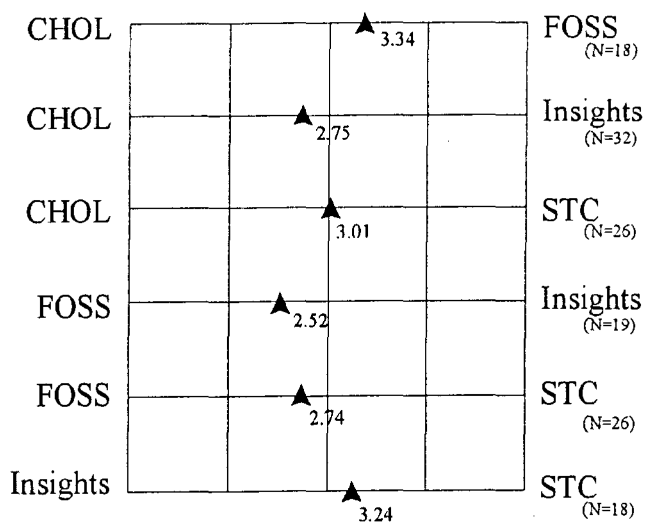
Methods Used to Analyze Paired-Kit Comparison Data

After using both kits, teachers were asked to rate the kits in three areas: teachers' guides, kit materials, and instructional effectiveness. Although many of these items were similar to those contained in the kit evaluations, there were slight differences in the teachers' guide and materials categories and many additional items measuring instructional effectiveness. In addition, the sample sizes were quite small in comparison to the kit evaluation data which pooled all responses for each supplier. This is likely to decrease significant findings.

Teachers responded to each of the 21 items on the paired comparisons using a five point Likert-type scale ranging from "1" kit 1 much better, "2" kit 1 somewhat better, "3" kits 1 and 2 about the same, "4" kit 2 somewhat better, and "5" kit 2 much better. The individual items in each of the three categories (teachers' guides, kit materials, and instructional effectiveness) were summed and averaged. Single sample t-tests were then conducted to determine if differences existed in each of these three categories for all six supplier comparisons (CHOL and FOSS, CHOL and Insights, CHOL and STC, FOSS and Insights, FOSS and STC, and Insights and STC). Since three t-tests were conducted on each set of data, the overall alpha level of .05 was divided by three resulting in an adjusted alpha of .02. The items representing each of the three categories and the results of the statistical analyses are contained in Appendix G.

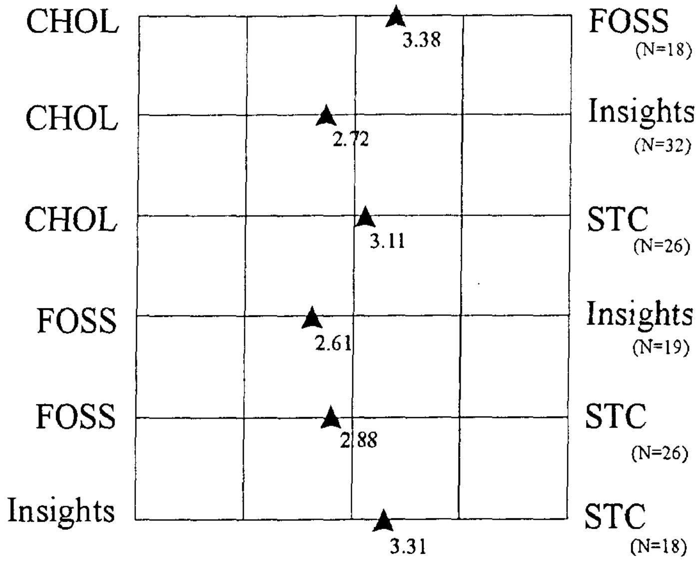
Teachers' Guides: Seven items were used to rate the teachers' guides in the paired comparisons: background information, teacher instructions, clearly-stated learning objectives, classroom management ideas, student assessment ideas, ideas for curricular extensions, and the overall quality of the guides. No significant differences emerged in the paired comparisons on teachers' guides, which may be due to the small sample size. An examination of the means in Figure 6 shows that teachers most preferred FOSS teachers' guides, followed by CHOL and STC, which were equivalently-rated. Insights teachers' guides were the least preferred. In interpreting the data, a mean of 3.00 indicates no difference between the kits, while a mean of less than 3.00 indicates a preference for the supplier indicated on the left side of the figure and a mean of greater than 3.00 indicates a preference for the supplier indicated on the right side of the figure.

FIGURE 6.
Paired Comparisons of Teachers' Guides



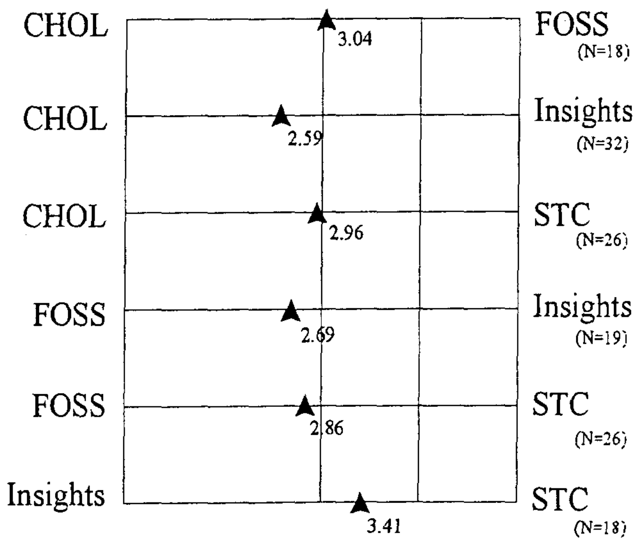
Kit Materials. Five items comprised the ratings of materials contained in the hands-on science kits, including: completeness, durability, quality, ease of use, and an overall rating. The materials contained in CHOL kits were judged by teachers as significantly better than Insights materials ($p \leq .001$). No significant differences emerged in the other comparisons, perhaps because of the smaller sample sizes of these groups. It is evident from examining the means in Figure 7, that teachers most prefer the materials contained in CHOL kits, closely followed by FOSS and STC materials. The materials contained in Insights kits were less preferred.

FIGURE 7.
Paired Comparisons of Kit Materials



Instructional Activities. Nine items were used to rate the instructional activities of the kits used in the research study. These were: development of logical thinking skills, social skills, communication skills, problem solving skills; increased student interest and student understanding of science concepts; grade level appropriateness; appropriateness for limited English proficient students; and overall effectiveness. CHOL activities were significantly better than Insights activities ($p \leq .01$). An examination of the means in Figure 8 indicates that FOSS activities were most highly rated, closely followed by STC and CHOL, and the least preferred activities were those contained in Insights kits.

FIGURE 8.
Paired Comparisons of Instructional Effectiveness



STRATEGIES FOR SUCCESSFUL IMPLEMENTATION OF HANDS-ON SCIENCE PROGRAMS

National Science Education Standards

The National Science Education Standards contain specific recommendations in several areas: science teaching standards, professional development standards for teachers, science content standards, assessment standards, science program standards, and science education system standards. Publications such as the National Science Teachers Association's *Pathways to the Science Standards: Guidelines for Moving the Vision into Practice* (Lowrey, 1997) provide specific recommendations about how to implement standards-based elementary school science instruction.

Basically, there are four elements that need to be in place to ensure the success of an active, hands-on, student-centered inquiry approach to science education. These are:

- Hands-on instructional materials,
- A materials support system,
- A professional development program, and
- Authentic assessment.

Each of these will be discussed in light of national recommendations and the findings of this study.

Hands-On Instructional Materials

Lopez and Tuomi (1995) recommend that instructional materials "should be research-based, developmentally appropriate, designed by educators and knowledgeable scientists, and thoroughly field-tested. They should enable children to conduct long-term investigations, (say, eight weeks), not with a series of single-shot activities, but with activities that build on one another. The activities should encourage inquiry, address a variety of learning styles, and connect to other parts of the curriculum" (p.78). Hein et al. (1995) indicates that successful elementary science curriculum reform would result in a program that uses "materials-based curriculum units as the primary source of science instruction, supplemented by trade books, and other print, visual, and technology-based materials. Textbooks, as they are currently formatted and designed, would be used as supplementary resources, if at all" (p.13).

In the SOHOS, New Mexico teachers used and evaluated four sets of hands-on science instructional materials that meet these criteria. In spite of individual strengths and weaknesses of particular suppliers, all of the materials were well-received by New Mexico teachers, regardless of the location of the school, the experience of the teacher, or the teacher's confidence in teaching hands-on science. These kits, which emphasized the hands-on, minds-on instructional approach, were rated by teachers as clear and easy to use; appropriate for students (including those with limited English proficiency); enjoyable for both students and teachers; and highly effective instructionally. Teachers indicated that kits from these four suppliers were much more effective than textbook-based instruction and more effective than other hands-on science kits they had used in previous years. Many teachers expressed that they would like to be able to use the kits every year and wished they could be included on the New Mexico science materials adoption list.

While teacher responses have been similarly positive at hands-on science workshops conducted at nearly 50 schools, a persistent concern has been expressed that insufficient funds are available to support the use of such materials in New Mexico schools (Eckelmeyer, 1997). Analysis of the costs of the materials used in this study do not support this concern.

New Mexico provides instructional materials funding to schools annually. The amount of this funding varies from year to year, but in recent years has been approximately $60 per student. Science instructional materials are evaluated and adopted once every six years—the next adoption occurs during the 1998/99 school year. Instructional materials funds distributed at the beginning of the year following this evaluation and review process are intended to be dedicated primarily to science. Hence, approximately $60 per student is available once every six years to purchase science instructional materials. If hands-on kits, such as those used in the SOHOS, were selected for use by schools, this funding would have to cover not only the cost of purchasing the kits, but also replenishing them for a six year period.

The kit suppliers suggest that three to four kits should be used by each teacher during the school year with each kit being used for six to eight weeks. It is cost prohibitive for each teacher to have these kits permanently assigned to his or her class. In order for such hands-on instruction to be practical, kits must be shared. Ideally, three to four teachers use each kit in a year, and a materials support center replenishes the kits between each use (replacing expendable items, etc.). The costs per student shown in Table 14 were calculated using July 1997 prices of the kits used in the SOHOS for a hypothetical district in which each teacher used three kits per year with a class of 30 students (the number of students accommodated by the supplies in most kits). The first year costs include the purchase price of the kits, as well as the cost of two replenishments per kit (replenishing supplies are also available from each of the suppliers). The following years costs are for three replenishments per kit. The six-year total cost corresponds to the first year costs plus five subsequent years of replenishment. The "affordability" of using such materials in New Mexico schools can be evaluated by comparing these 6-year totals to the ~$60 per student provided to districts every six years following the science adoption process.

Table 14.
Approximate Costs of Kits and Replenishing Supplies Over a Six Year Cycle

Supplier	First Year Cost	Following Years' Cost	Six-Year Total Cost
CHOL	$11.05	$3.51	$28.60
FOSS	$18.30	$3.73	$36.95
Insights	$20.51	$9.92	$70.11
STC	$16.66	$6.34	$48.36

As shown in Table 14, material from three of the four suppliers used in the SOHOS could be purchased and replenished for a six year period for less than the ~$60 amount provided by New Mexico. It is important to recognize, however, that prices could change prior to 1999. In addition, prices vary from kit to kit. Table 14 is based on the kits which were used in the SOHOS study, and do not necessarily reflect the "average" cost of materials from a particular supplier. Finally, these figures do not include the labor and overhead costs involved in replenishing the kits or transporting them to and from the classrooms several times per year.

Materials Support System

One of the primary reasons that earlier attempts at using hands-on instructional materials were unsuccessful was due to the lack of a system for distributing and refurbishing kits (NRC-RISE, 1995; Hein et al., 1995). Hein et al. (1995) says "the most consistent, definitive, and unambiguous message related to elementary science from all National Science Resources Center's activities and publications is the need for, and value of, an effective materials support system for school districts or consortia that encompass at least seven elementary schools." Teachers do not have time to gather the materials necessary to implement a hands-on science program. Therefore, kits need to be delivered to teachers completely intact with all materials available and requiring as little advance preparation as possible. At the end of their use, they need to be returned to a central location to be replenished and made ready for distribution to another teacher (Lopez and Tuomi, 1995). In the absence of this type of materials support system, kits eventually fall into disrepair and are no longer used by teachers.

The results of the current study support the need for such a materials support system. Teachers considered issues related to the completeness of the materials supplied in the kits to be an important distinguishing factor between different suppliers. For example, they expressed great appreciation for the fact that they found CHOL kits to be significantly better in terms of completeness of materials and the amount of time required to prepare for activities. One teacher commented, "The kit was beautifully stocked. The only problem with these kits are the consumable items. Who replaces the items or oversees the kits? Many teachers won't use the kits if it is their responsibility to refill or write the purchase orders to get refills." This is precisely the issue to which Hein refers in the previous paragraph. His answer to this question is, "the materials support center." Such centers have been found to be a vitally important component of virtually every successful program of hands-on elementary science.

Teachers find well stocked hands-on science kits to be highly beneficial. However, assembling, refurbishing, and delivering such kits to large numbers of teachers requires a great deal of effort. Typically this simply doesn't happen unless clear provisions are made and responsibilities assigned. Numerous districts (and groups of small districts) have found that science kits can be more effectively serviced if one central location in is responsible for ordering consumable items, replenishing the kits, providing any live specimens required, and doing as much advanced preparation as possible prior to delivering the kits to the teachers (Hein et al., 1995; NSRC, 1994).

Professional Development of Teachers

SOHOS did not provide professional development to teachers on the National Science Education Standards; on hands-on, minds-on instructional approaches; or on the use of specific kits. In studying the teacher responses, however, an analysis was conducted to determine whether teacher involvement in prior professional development activities or science education enrichment programs contributed significantly to the emphasis given to standards-based instructional objectives. Significant correlations were found with only two items, familiarity with the National Science Education Standards, and leadership of workshops in science or science teaching. Teachers who indicated a high level of familiarity with the standards, and those who had led workshops for others were significantly more inclined to emphasize standards based instructional objectives.

It is interesting to note that even without a specific focus on the National Science Education Standards, New Mexico elementary teachers who used the hands-on science kits provided by the study were significantly more familiar with them after having used the materials. This suggests that teachers' overall interest in science education reform was heightened through the use of the hands-on materials.

As shown in Table 13, most teachers indicated that inservice training was not crucial to their successful use of the kits. However, a number of teachers wrote comments expressing that such preparation would have been helpful. FOSS kits contain videos for teachers to watch prior to conducting the activities with their students. Teachers responded favorably to these as exemplified in the following comments: "The video was an outstanding benefit." "The video in the FOSS kit made every construction and extension more obvious and effortless. Diagrams were fine—demonstrations were better." "I liked the video as a resource because it makes it faster and easier to do this kit." Other teachers made comments indicating a desire for inservice. "Though complete and easy to understand it felt extremely intimidating to present to students and so I got into it very slowly. I wish I had inservice or could watch another teacher use it." Since this group of teachers volunteered to participate in the study they may be especially interested in science and, consequently, more comfortable using the materials provided. Therefore, it is probably even more important for the majority of elementary teachers to receive the type of well-planned, comprehensive professional development recommended in the discussion which follows.

A number of authors in the area of elementary science education assert that no other area is as important to the successful implementation of hands-on science than that of the professional development of teachers (Kober, 1993; Lopez and Tuomi, 1995; NCISE, 1989; Smith, 1991; Sivertsen, 1993). Sivertsen (1993) says, "The teacher is the key to improved instruction. Since teaching for understanding demands a role that the teacher's preservice training often did not model, opportunities for inservice training are essential in transforming science instruction." Kober (1993) states, "Teaching is an art, acquired slowly and carefully through mentors, self-discipline, and self-evaluation. Any effort to reform science education must recognize this and place teacher preparation and staff development high on the agenda for sustained attention and funding."

Research shows that many elementary school teachers do not feel at ease teaching science. According to one study, only 27% of kindergarten through sixth grade teachers felt qualified to teach life science and only 15% felt qualified to teach physical and earth or space science (Kober, 1993). Teachers who feel unprepared are likely to avoid teaching science and devote less time to this subject than to math or reading. "Even the best teachers with quality preservice preparation and recognized skill in the classroom still need opportunities to keep up with burgeoning science knowledge and promising instructional practices" (Kober, 1993, p.65).

The National Science Education Standards contain detailed recommendations regarding the professional development of teachers (NRC, 1996). Research in the area of staff development suggests that professional development programs that result in meaningful changes in teachers' behavior have certain common characteristics. "Among other things, they allow for intense study of and engagement with the new knowledge or skill over time, with time to practice and work through with others the problems of implementation. This combination of theory and application, time to reflect and practice, self study, and cooperative learning, rarely is found in the more traditional inservice workshops or college courses" (Loucks-Horsley et al., 1989). The most effective staff development activities:

- are continuous, ongoing, and interrelated rather than short-term, sporadic efforts,
- model a constructivist approach to teaching (in other words, teachers should learn in the same active, inquiry-based method that they will be using to teach their students),
- provide opportunities for teachers to reflect on current teaching practices and work collaboratively with colleagues to develop new approaches to teaching; and
- provide an opportunity to practice in the classroom with students and receive feedback from trained administrators or peers. (Haney et al., 1996; Kober, 1993; NCISE, 1989; NRC, 1996; Sivertsen, 1993).

Haney et al. (1996) conducted an extensive study of factors which influenced teachers' level of commitment to implementing science education reform. The results indicated that the strongest influence was teacher belief that such implementation would result in worthwhile outcomes, such as increased student learning. Haney suggests that effective professional development activities need to take this into account. Specifically, she proposes that such activities not be hierarchically structured, where the leader simply tells everyone what to do. Instead, professional development needs to engage teachers in ways that will lead them to experience the advantages of hands-on instruction, thus enabling them to conclude for themselves that this in a superior approach.

This is precisely what happened during the Study of Hands-On Science in New Mexico and suggests that one extremely effective way of increasing teachers' commitment to hands-on science is to provide them with materials to use in their classrooms. Teachers experienced the effectiveness of these materials in a very concrete way as they watched their enthusiastic students gain an understanding of science concepts. They rated the hands-on minds-on approach to science instruction as much more effective than any other approach they had used to teach science. They also found this approach to be easy and practical to implement. As a result, 95% of the teachers who participated in the study indicated that they were highly committed to continuing hands-on science instruction in their classrooms.

Other recommendations of Haney's (1996) study regarding teacher professional development include:

- reform must be implemented in a grassroots fashion by local school districts,
- inservice should foster positive teacher attitudes towards science education reform and develop perceptions of social support (national, state, local, parent, administrator, and community),
- an immersion model rather than a trainer-of-trainers model should be used to provide inservice to at least 80% of faculty in each school, and
- attention must be paid to teacher efficacy (opportunities for teachers to experience success and observe successful modeling).

New Approaches to Assessment

An important part of science education reform is to change the way in which learning is assessed. "Many researchers have become deeply concerned that assessment is not being used well in most science education programs. Concerns center around whether assessment instruments, such as norm-referenced, standardized tests, are being used for too many purposes for which they were not designed, and whether the results of tests are being misunderstood and misapplied. Some researchers have asserted that the most common assessment formats, particularly conventional standardized tests, reinforce outmoded or ineffective instructional practices. For these and other reasons, many argue that assessment is an area of science that is ripe for reform" (Kober, 1993, p.58). Sivertsen (1993) concludes, "A view of assessment as the servant, not the master, of curriculum is transforming assessment practice" (p.11).

The National Education Standards (NCR, 1996) identify essential characteristics of exemplary assessment practices that illustrate "how assessment and learning are two sides of the same coin" (p.76). Authentic assessments such as performance-based or portfolio assessments, as well as multiple choice type tests that require higher order thinking skills provide opportunities for students to demonstrate what they know as well as to learn during the process of assessment itself (Sivertsen, 1993).

Teachers in this study significantly increased the emphasis they placed on activity-based student assessments and significantly decreased their emphasis on paper and pencil type student assessments. It is likely that these changes were facilitated by the use of the hands-on science kits, many of which contain suggestions for authentic assessment.

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Appendix A

New Mexico Schools Participating in SOHOS

School	City	Number of Teachers Participating
Alameda Elementary	Las Cruces	2
Alamosa Elementary	Albuquerque	11
Alvord Elementary	Santa Fe	1
Amistad Elementary	Amistad	1
Animas Elementary	Animas	3
Annunciation School	Albuquerque	2
Anthony Elementary	Anthony	12
Apache Elementary	Kirtland	1
Blanco Elementary	Bloomfield	3
Bosque Farms Elementary	Bosque Farms	2
Buena Vista Elementary	Tucumcari	1
Capital Christian School	Santa Fe	4
Carlos Rey Elementary	Albuquerque	2
Central Elementary	Bloomfield	1
Chaparral Elementary	Albuquerque	1
Chee Dodge Elementary	Yah-ta-hey	2
Church Rock Elementary	Church Rock	9
Cimarron Elementary	Cimarron	3
Cochiti Elementary	Albuquerque	1
Columbian Elementary	Raton	9
Columbus Elementary	Columbus	4
Corrales Elementary	Corrales	7
Crownpoint Community School	Crownpoint	2
Datil Elementary	Datil	1
Del Norte Elementary	Roswell	1
Don Cecilio Martinez Elementary	Las Vegas	6
Dowa Yalanne Elementary	Zuni	1
Dulce Elementary	Dulce	1
Duranes Elementary	Albuquerque	3
E.G. Ross Elementary	Albuquerque	2
Eagle Nest Elementary	Eagle Nest	1
East Grand Plains Elementary	Roswell	1
Eddy Elementary	Carlsbad	3
Edgewood Elementary	Edgewood	5
Emerson Elementary	Albuquerque	5
Esperanza Elementary	Farmington	1
Fairacres Elementary	Las Cruces	1
Fr. Hay Catholic School	Alamogordo	2
Gallup Catholic School	Gallup	2
Grace Christian Indian School	Counselor	1
Highland Elementary	Clovis	1
Hillcrest Elementary	Carlsbad	1
Inez Elementary	Albuquerque	2
John Baker Elementary	Albuquerque	15
Kirtland Elementary	Kirtland	2
La Luz Elementary	La Luz	1
La Merced Elementary	Belen	2

School	City	Number of Teachers Participating
Lavaland Elementary	Albuquerque	2
Lew Wallace Elementary	Albuquerque	2
Los Lunas Elementary	Los Lunas	1
Los Padillas Elementary	Albuquerque	3
Mark Twain Elementary	Albuquerque	6
Martin Luther King Elementary	Rio Rancho	4
Mary Ann Binford Elementary	Albuquerque	2
Maxwell Elementary	Maxwell	3
McCormick Elementary	Farmington	2
Memorial Elementary	Deming	1
Mesa Elementary	Shiprock	1
Mesa View Elementary	Grants	1
Mesilla Elementary	Las Cruces	2
Mesquite Elementary	Mesquite	1
Military Heights Elementary	Roswell	6
Missouri Avenue Elementary	Roswell	2
Monte Vista Elementary	Albuquerque	1
Mountainair Elementary	Mountainair	5
Mt. Taylor Elementary	Grants	4
Naaba Ani Elementary	Bloomfield	3
North Elementary	Alamogordo	2
Ojo Amarillo Elementary	Fruitland	1
Parkview Elementary	Roswell	8
Penasco Elementary	Penasco	1
Petroglyph Elementary	Albuquerque	3
Pojoaque Elementary	Santa Fe	11
Queen of Heaven School	Albuquerque	3
R.M. James Elementary	Portales	4
Rio Grande Elementary	Belen	2
Roy Elementary	Roy	1
Ruth N. Bond Elementary	Kirtland	2
S.Y. Jackson Elementary	Albuquerque	1
San Diego Mission School	Jemez Pueblo	1
San Lorenzo Elementary	San Lorenzo	4
Santo Domingo Elementary	Bernalillo	1
Sombra del Monte Elementary	Albuquerque	1
St. Francis Cathedral School	Santa Fe	2
St. Luke's Episcopal School	Anthony	1
Stapleton Elementary	Rio Rancho	3
Sweeney Elementary	Santa Fe	2
Tomasita Elementary	Albuquerque	3
Valencia Elementary	Portales	5
Valle Vista Elementary	Albuquerque	3
Wherry Elementary	Albuquerque	1
Wood Gormley Elementary	Santa Fe	1
Zia Elementary	Tucumcari	2

Appendix B

Hands-On Science Instructional Kits Used in SOHOS

Center kits are produced by the Center for Hands-On Learning. The Center is a non-profit corporation founded and run by teachers.

Grade	Title
1	Magnets
1	Measurement
2	Changes
2	Energy
3	Earthquakes and Volcanoes
3	Finding Out
4	Count Down for Earth
4	Due to the Weather
5	Arthropods
5	Current Electricity

For more information, contact:

The Center for Hands-On Learning
206A Frontage Road
Rio Rancho, NM 87124
505-896-1122 or 800-894-1492 in New Mexico

FOSS kits are now being produced by Delta Education. The kits used in the study were from Encyclopedia Britannica (the former publisher) and may differ from what is currently available.

Grade	Title
1	Air and Weather
1	New Plants
2	Balance and Motion
2	Pebbles, Sand, and Silt
3	Physics of Sound
3	Structures of Life
4	Magnetism and Electricity
4	Water
5	Environments
5	Mixtures and Solutions

For more information, contact:

Delta Education
P.O. Box 915
Hudson, NH 03051
800-258-1302

Insights teachers' guides are now published by Kendall/Hunt. The kits in the study were from Optical Data Corporation and NASCO (the former publisher) and may differ from what is currently available. Kits supporting the Insights program are available from both Kendall/Hunt and in enhanced versions from the Center for Hands-On Learning.

Grade	Title
1	Balls and Ramps
1	Living Things
2	Lifting Heavy Things
2	Liquids
3	Growing Things
3	Sound
4	Changes of State
4	Circuits and Pathways
5	Reading the Environment
5	The Mysterious Powder

For more information, contact: Kendall/Hunt Publishing Company
4050 Westmark Drive
Dubuque, IA 52002
800-542-6657

Or: Center for Hands-On Learning
505-896-1122 or 800-894-1492 in New Mexico

Science and Technology for Children (STC) is published by Carolina Biological Supply. Although kits are available from Carolina Biological Supply, the kits used in this study were enhanced versions produced by the Center for Hands-On Learning. The Center STC kits include many materials listed as "teacher provided," have much of the preparation already done, and include additional teacher information, tools, and background.

Grade	Title
1	Organisms
1	Weather
2	Balancing and Weighing
2	Soils
3	Plant Growth and Development
3	Sounds
4	Electric Circuits
4	Food Chemistry
5	Ecosystems
5	Microworlds

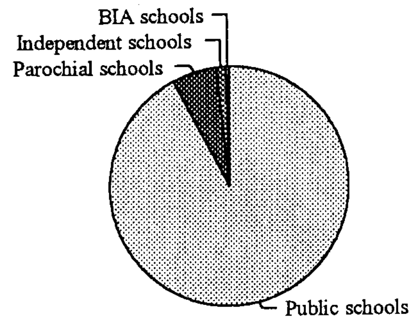
For more information, contact: Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215
800-334-5551

Or: Center for Hands-On Learning
505-896-1122 or 800-894-1492 in New Mexico

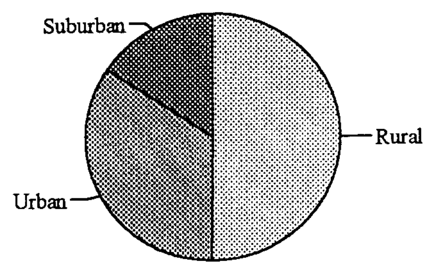
Appendix C

Graphic Presentation of Demographics on Schools and Teachers

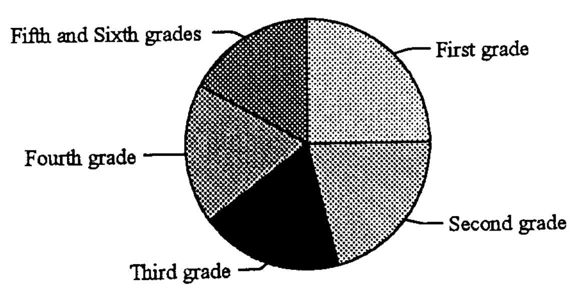
Type of School



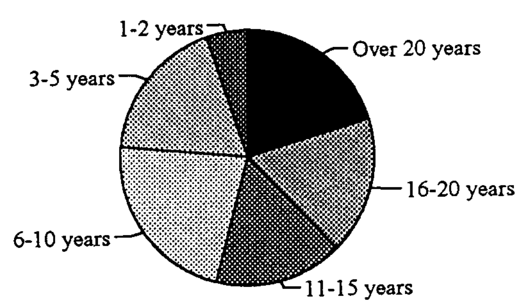
Location of Schools



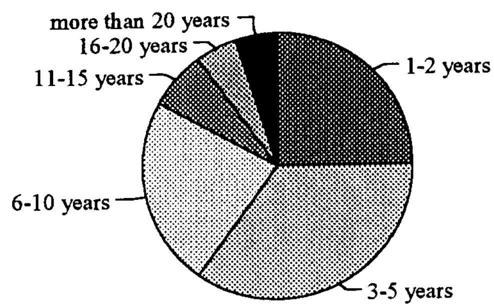
Grade Level Taught by Teachers



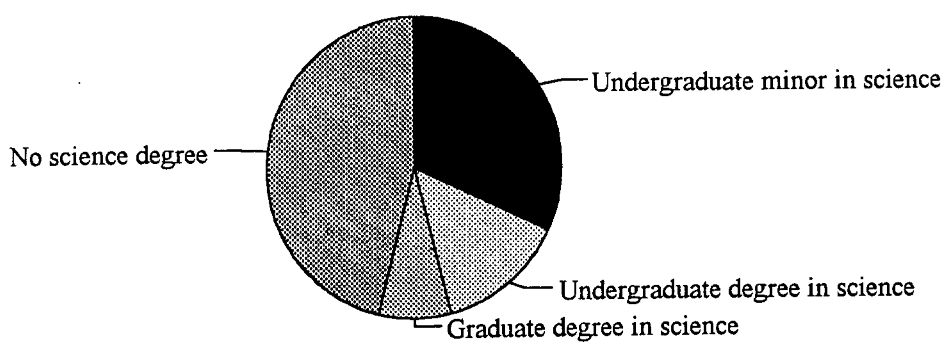
Years of Teaching Experience



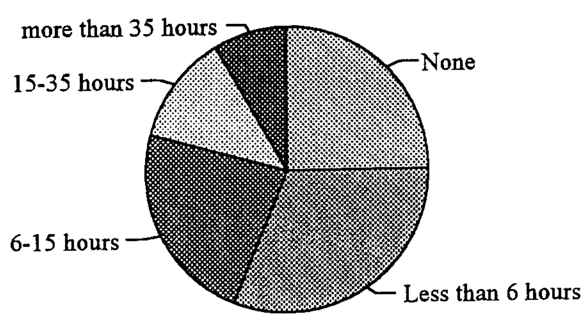
Years Teaching at Current Grade Level



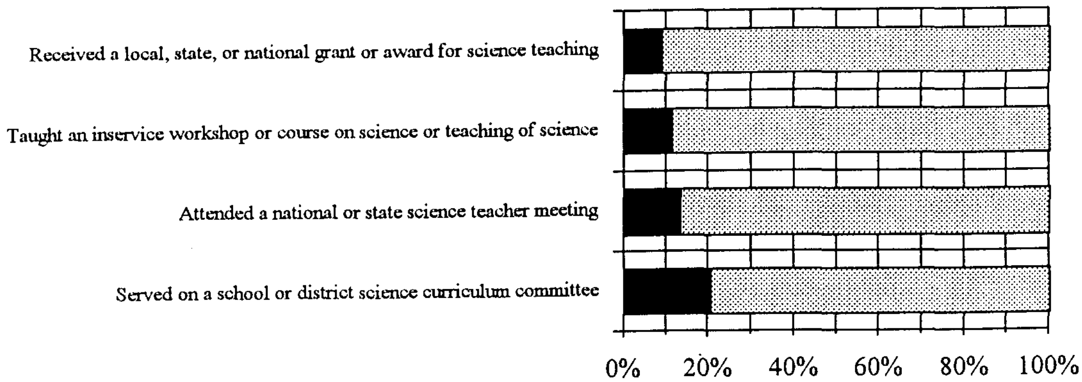
Science Degrees



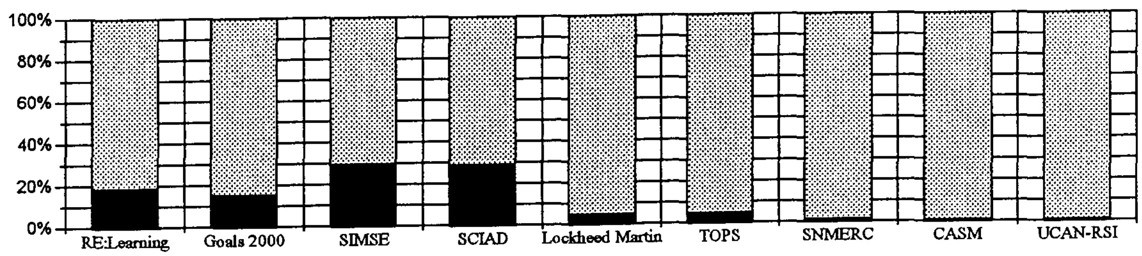
Teacher Participation in Inservice



Teacher Participation in Other Professional Development Activities



Teacher Participation in Educational and Science Programs



Appendix D

Instruments Used in SOHOS

Study of Hands-on Science (SOHOS)
TEACHER PRE-SURVEY
Demographic Information

Teacher Name:

School Name:

Phone number where it is easiest to contact you (____) _____ -- _______ **Best time _________**

Please answer the following questions by filling in the oval with the best response.

1. Have you or your school participated in any of the following programs? (Mark all that apply.)
   - ○ CASM
   - ○ CRCM
   - ○ Goals 2000
   - ○ Lockhead Martin Teacher Award
   - ○ NTEP
   - ○ Re:Learning
   - ○ SCIAD
   - ○ SIMSE
   - ○ SNMERC
   - ○ TOPS
   - ○ UCAN-RSI
   - ○ Other: ____________________

2. Which of the following best describes your school?
   ○ Public ○ Independent ○ Parochial ○ BIA

3. Which of the following best describes the community in which your school is located?
   ○ Rural ○ Urban ○ Suburban

4. Do you have a science contact person in the community who provides assistance to you?
   ○ Yes ○ No

5. What grade(s) are you teaching this year? ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6

6. How many years have you been teaching the grade level(s) indicated above?
   ○ 1-2 ○ 3-5 ○ 6-10 ○ 11-15 ○ 16-20 ○ 20+

7. How many years teaching experience do you have?
   ○ 1-2 ○ 3-5 ○ 6-10 ○ 11-15 ○ 16-20 ○ 20+

Professional Development in Science

8. Please mark all of the following that apply to you.
   - ○ undergraduate minor in science
   - ○ undergraduate major in science
   - ○ undergraduate degree in science
   - ○ graduate degree in science

9. What is the total amount of time you have spent on in-service education in science or the teaching of science in the last 12 months? In the last 3 years?

Hours of in-service education	Last 12 months	Last 3 years
None	○	○
Less than 6 hours	○	○
6-15 hours	○	○
16-35 hours	○	○
More than 35 hours	○	○

(Please continue on back.)

10. In the past 12 months, have you.... *(Answer each one "no" or "yes.")*

a) attended any national or state science teacher meetings? No Yes

b) taught any in-service workshops or courses in science or teaching science? No Yes

c) received any local, state, or national grants or awards for science teaching? No Yes

d) served on a school or district science curriculum committee? No Yes

11. How familiar are you with the national science education standards?

Unfamiliar **Very familiar**

Instructional Objectives

How much emphasis did you give each of the following objectives for your students **last year**? Fill in one oval for each item.

	Heavy emphasis	Moderate emphasis	Little emphasis	None
12. Knowing science facts and terminology				
13. Understanding key science concepts				
14. Developing problem solving/inquiry skills				
15. Learning about the relevance of science to society				
16. Understanding the nature of science as a discipline				
17. Understanding the application of science in everyday life				
18. Knowing how to communicate ideas in science effectively				
19. Developing skills in laboratory techniques				
20. Developing confidence in ability to understand science and apply that understanding				
21. Developing interest in science				
22. Preparing for further study in science				
23. Developing the ability to examine information and draw logical conclusions				

Instructional Approach and Activities

Please indicate how much emphasis you gave **last year** to each of the science instructional strategies listed below. Fill in one oval for each item.

	Heavy emphasis	Moderate emphasis	Little emphasis	None
24. Using hands-on activities to teach science				
25. Integrating science with other curricular areas				
26. Student writing in science				
27. Using paper and pencil student assessments				
28. Using activity-based student assessments				

(Please continue on next page.)

About how often did the students in your class **last year** take part in the following types of activities? Fill in one oval for each item.

	Almost daily	Once or twice a week	Once or twice a month	Never
29. Listened to me give a lecture about science	○	○	○	○
30. Watched me demonstrate a scientific principle	○	○	○	○
31. Read a science textbook	○	○	○	○
32. Used supplementary science materials I prepared myself	○	○	○	○
33. Discussed a science news event	○	○	○	○
34. Worked together on a science problem	○	○	○	○
35. Wrote about a scientific experiment	○	○	○	○
36. Gave an oral or written science report	○	○	○	○
37. Used a computer for simulations or data collection and analysis	○	○	○	○

38. What was the **primary** method you used to teach science **last year**?
Please mark only ***one*** answer.

- ○ Didn't teach science
- ○ Textbook
- ○ Text and experiments
- ○ Textbook publishers kit (e.g. Discover the Wonder, Scott Foresman, etc.)
- ○ Other commercial program (e.g. GEMS, Wild Goose, etc.)
- ○ Hands-on science kits (e.g. FOSS, Insights, STC, CHOL, etc.)
- ○ Developed my own science curriculum
- ○ Other ____________________

39. How difficult was it for you to teach science this way?

Very difficult ○ ○ ○ ○ ○ **Very easy**

40. How effective was this approach to teaching science?

Ineffective ○ ○ ○ ○ ○ **Very effective**

41. How many hours per week (round to the nearest 1/2 hour), on average, did you spend on science instruction last year?

○ 0	○ 0.5	○ 1.0	○ 1.5	○ 2.0	○ 2.5	○ 3.0
○ 3.5	○ 4.0	○ 4.5	○ 5.0	○ 5.5	○ 6.0	○ 6.5
○ 7.0	○ 7.5	○ 8.0	○ 8.5	○ 9.0	○ 9.5	○ 10.0

Thank you for your thoughtful answers!

Please return this survey directly to the evaluator.

Jennifer S. Johns
PO Box 20352
Albuquerque, New Mexico 87154

Study of Hands-on Science (SOHOS)
KIT EVALUATION

PLEASE USE NO. 2 PENCIL

RIGHT	WRONG

Teacher Name:

School Name:

Kit Unit Title:

What session is this? ○ September/November ○ January/February ○ March/May

Please fill in the oval that indicates your level of agreement with each of the statements below. Use **"1"** to represent strongly disagree and **"5"** to represent strongly agree.

	Strongly Disagree				Strongly Agree
1. The teacher's guide contained sufficient background information to make me feel comfortable teaching the unit.	1	2	3	4	5
2. The teacher's guide contained suggestions for effective classroom management techniques to use during the lessons.	1	2	3	4	5
3. The teacher's guide contained valuable ideas for student assessment.	1	2	3	4	5
4. The teacher's guide contained useful ideas for extending the kit content to other curricular areas.	1	2	3	4	5
5. Overall, the teacher's guide was clear and easy to use.	1	2	3	4	5
6. I had to spend a lot of time duplicating student materials for this kit.	1	2	3	4	5
7. I had to purchase many materials not provided in the kit.	1	2	3	4	5
8. I had to gather many materials not provided in the kit.	1	2	3	4	5
9. I had to prepare many materials to do the activities in the kit.	1	2	3	4	5
10. The overall benefits of the kit made the amount of time I invested worthwhile.	1	2	3	4	5
11. The content of the kit was appropriate for my students.	1	2	3	4	5
12. The kit is appropriate for limited English proficient (LEP) students.	1	2	3	4	5
13. My students enjoyed using the kit.	1	2	3	4	5
14. The kit effectively contributed to my students' understanding of science concepts.	1	2	3	4	5
15. The kit was more effective than other hands-on science kits I have used.	1	2	3	4	5

(Please continue on back)

Please continue to fill in the oval that indicates your level of agreement with each of the statements below. Use **"1"** to represent strongly disagree and **"5"** to represent strongly agree.

	Strongly Disagree				Strongly Agree
16. The kit was more effective than textbook-based instruction.					
17. The materials in the kit were durable.					
18. I was able to use this kit without additional help.					
19. It is important to have inservice training to successfully use this kit.					
20. I shared some of the ideas and activities in this kit with other teachers at my school.					
21. If funds were available, I would recommend this kit to another teacher.					
22. If funds were available, I would recommend this kit for adoption as part of my school's science instructional program.					

Please write your answer or fill in the appropriate oval for the remaining questions.

23. What percentage of the activities in the kit did you use during the 8 weeks?
    - 0-25% - 26-50% - 51-75% - 76-100%

24. Did you integrate any of the science kit topics into other curricular areas? (Mark all that apply.)
    - Writing - Reading - Math - Social Studies - Fine Arts - PE

25. In conjuction with this research study, what type of inservice did you receive on the use of this kit?
    - None - Workshop - Video - Other ____________________

26. Prior to this study, have you ever received inservice on this particular kit? - Yes - No

27. How many times did you call the research study's toll-free number for assistance?
    - 0 - 1 - 2-5 - 6-10 - 10+

28. How many times did you call the publisher for assistance? - 0 - 1 - 2-5 - 6-10 - 10+

Use the space below for additional comments regarding the strengths and weaknessess of this kit that you think would be helpful to other teachers.

____
____
____
____
____
____
____

Thank you for your assistance in evaluating this kit.
Please return this form directly to the evaluator:
Jennifer S. Johns
PO Box 20352
Albuquerque, New Mexico 87154

Study of Hands-On Science (SOHOS)
TEACHER POST-SURVEY

PLEASE USE NO. 2 PENCIL	
RIGHT	WRONG

Teacher Name:

School Name:

Please answer the following questions by filling in the ovals with the best response.

1. What is the total amount of time you have spent on in-service education in science or the teaching of science in the last 12 months? In the last 3 years?

Hours of in-service education	Last 12 months	Last 3 years
None	○	○
Less than 6 hours	○	○
6-15 hours	○	○
16-35 hours	○	○
More than 35 hours	○	○

2. In the past 12 months, have you... *(Answer each one "no" or "yes.")*

	No	Yes
a) attended any national or state science teacher meetings?	○	○
b) taught any in-service workshops or courses in science or teaching science?	○	○
c) received any local, state or national grants or awards for science teaching?	○	○
d) served on a school or district science curriculum committee?	○	○

3. How familiar are you with the national science education standards?

Unfamiliar				Very familiar
○	○	○	○	○

4. During the time that you used the kits, how much emphasis did you give each of the following objectives for your students? *(Fill in one oval for each item.)*

	Heavy Emphasis	Moderate Emphasis	Little Emphasis	None
Knowing science facts and terminology	○	○	○	○
Understanding key science concepts	○	○	○	○
Developing problem solving/inquiry skills	○	○	○	○
Learning about the relevance of science to society	○	○	○	○
Understanding the nature of science as a discipline	○	○	○	○
Understanding the application of science in everyday life	○	○	○	○
Knowing how to communicate ideas in science effectively	○	○	○	○
Developing skills in laboratory techniques	○	○	○	○
Developing confidence in ability to understand science and apply that understanding	○	○	○	○
Developing interest in science	○	○	○	○
Preparing for further study in science	○	○	○	○
Developing the ability to examine information and draw logical conclusions	○	○	○	○

(Please continue on next page.)

5. During the time that you used the kits, how much emphasis did you give to each of the science instructional strategies listed below? *(Fill in **one** oval for each item.)*

	Heavy Emphasis	Moderate Emphasis	Little Emphasis	None
a) Using hands-on activities to teach science	○	○	○	○
b) Integrating science with other curricular areas	○	○	○	○
c) Student writing in science	○	○	○	○
d) Using paper and pencil student assessments	○	○	○	○
e) Using activity-based student assessments	○	○	○	○

6. During the time that you used the kits, about how often did your students take part in the following types of activities? *(Fill in **one** oval for each item.)*

	Almost daily	Once or twice a week	Once or twice a month	Never
a) Listened to me give a lecture about science	○	○	○	○
b) Watched me demonstrate a scientific principle	○	○	○	○
c) Read a science textbook	○	○	○	○
d) Used supplementary science materials I prepared myself	○	○	○	○
e) Discussed a science news event	○	○	○	○
f) Worked together on a science problem	○	○	○	○
g) Wrote about a scientific experiment	○	○	○	○
h) Gave an oral or written science report	○	○	○	○
i) Used a computer for simulations or data collection and analysis	○	○	○	○

7. How difficult was it for you to teach science using the kits?

Very difficult ① ② ③ ④ ⑤ **Very easy**

8. How effective was the kit-based approach to teaching science?

Ineffective ① ② ③ ④ ⑤ **Very effective**

9. How convinced were you of the value of hands-on science instruction **prior** to this study?

Very skeptical ① ② ③ ④ ⑤ **Totally convinced**

10. How convinced are you of the value of hands-on instruction **now**?

Very skeptical ① ② ③ ④ ⑤ **Totally convinced**

11. How convinced were you of the practicality of hands-on science instruction **prior** to this study?

Very skeptical ① ② ③ ④ ⑤ **Totally convinced**

12. How convinced are you of the practicality of hands-on science instruction **now**?

Very skeptical ① ② ③ ④ ⑤ **Totally convinced**

13. How committed are you to continuing hands-on science instruction in your classroom?

Not at all committed ① ② ③ ④ ⑤ **Very committed**

(Please continue on next page.)

14. During the time you used the kits, how many hours per week (round to the nearest 1/2 hour), on average, did you spend on science instruction?

◯ 0	◯ 0.5	◯ 1.0	◯ 1.5	◯ 2.0	◯ 2.5	◯ 3.0
◯ 3.5	◯ 4.0	◯ 4.5	◯ 5.0	◯ 5.5	◯ 6.0	◯ 6.5
◯ 7.0	◯ 7.5	◯ 8.0	◯ 8.5	◯ 9.0	◯ 9.5	◯ 10.0

Comparison of Kits

15. The remaining questions ask you to compare the two kits that you used on a variety of variables. For example, if you were rating the two kits on durability of materials and you thought the materials in Kit 1 were somewhat better (more durable) than those in Kit 2, you would darken the oval on the left side of the scale under "KIT 1 Somewhat Better."

TEACHER'S GUIDE:	Kit 1 Much Better	Kit1 Somewhat Better	Kits 1 & 2 About the same	Kit 2 Somewhat Better	Kit 2 Much Better
Background information	◯	◯	◯	◯	◯
Teacher instructions	◯	◯	◯	◯	◯
Clearly-stated learning objectives	◯	◯	◯	◯	◯
Classroom management ideas	◯	◯	◯	◯	◯
Student assessment ideas	◯	◯	◯	◯	◯
Ideas for curricular extensions	◯	◯	◯	◯	◯
Overall quality of teacher's guide	◯	◯	◯	◯	◯
MATERIALS:					
Completeness	◯	◯	◯	◯	◯
Durability	◯	◯	◯	◯	◯
Quality	◯	◯	◯	◯	◯
Ease of use	◯	◯	◯	◯	◯
Overall rating of materials	◯	◯	◯	◯	◯
INSTRUCTIONAL ACTIVITIES:					
Development of logical thinking skills	◯	◯	◯	◯	◯
Development of social skills (e.g. team work)	◯	◯	◯	◯	◯
Development of communication skills	◯	◯	◯	◯	◯
Development of problem solving skills	◯	◯	◯	◯	◯
Student interest	◯	◯	◯	◯	◯
Student understanding of science concepts	◯	◯	◯	◯	◯
Grade level appropriateness	◯	◯	◯	◯	◯
Appropriateness for limited English proficient (LEP) students	◯	◯	◯	◯	◯
Overall effectiveness of instructional activities for students	◯	◯	◯	◯	◯

(Please continue on next page.)

Please answer the remaining questions as completely as possible. You may include additional pages if necessary but please do not staple to survey.

16. Please describe any outstanding features of either kit that were not covered in the survey questions. Indicate to which kit your comments refer.

17. Please describe any serious shortcomings of either kit that were not addressed in the survey questions. Indicate to which kit your comments refer.

18. What was the most memorable experience during the time you used the hands-on science kits? Please indicate to which kit your comments refer to, if this is relevant.

19. What ideas, activities, or approaches did you gain from this study that you will use in your teaching in the future?

Thank you! Please return this survey directly to:
Jennifer S. Johns, PO Box 20352, Albuquerque, New Mexico 87154

Appendix E

Statistical Results for Teaching Practices and Attitudes (t-tests)

T-Test: Instructional Objectives (#12-23 Pre)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	OBJ1PRE Know sci facts & terms	1.8232	164	.5749	4.489E-02
	OBJ1PST	1.9085	164	.5291	4.131E-02
Pair 2	OBJ2PRE Understand key sci concepts	2.2335	167	.6106	4.725E-02
	OBJ2PST	2.3293	167	.5854	4.530E-02
Pair 3	OBJ3PRE Develop prob solving/inquiry skills	2.3653	167	.6619	5.122E-02
	OBJ3PST	2.4850	167	.5998	4.641E-02
Pair 4	OBJ4PRE Learn about relevance of sci to society	1.9096	167	.7120	5.526E-02
	OBJ4PST	1.9337	166	.6799	5.277E-02
Pair 5	OBJ5PRE Understand sci as discipline	1.4096	166	.7309	5.673E-02
	OBJ5PST	1.4578	166	.7435	5.770E-02
Pair 6	OBJ6PRE Understand app of sci in life	2.1576	165	.6621	5.155E-02
	OBJ6PST	2.3152	165	.6228	4.848E-02
Pair 7	OBJ7PRE Know how to commun ideas in sci	1.7470	166	.7682	5.962E-02
	OBJ7PST	1.9819	166	.7424	5.762E-02
Pair 8	OBJ8PRE Develop skill in lab techniques	1.1928	166	.8802	6.832E-02
	OBJ8PST	1.5783	166	.8961	6.955E-02
Pair 9	OBJ9PRE Develop conf in understand sci & apply	1.9333	165	.7819	6.087E-02
	OBJ9PST	2.2000	165	.7002	5.451E-02
Pair 10	OBJ10PRE Develop interest in sci	2.4398	166	.6174	4.792E-02
	OBJ10PST	2.7169	166	.5027	3.902E-02
Pair 11	OBJ11PRE Prepare for further study in sci	1.7914	163	.8124	6.363E-02
	OBJ11PST	1.9080	163	.8521	6.674E-02
Pair 12	OBJ12PRE Develop ability to examine info & draw concl	2.1227	163	.7095	5.557E-02
	OBJ12PST	2.3313	163	.6672	5.226E-02

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	OBJ1PRE Know sci facts & terms & OBJ1PST	164	.330	.000
Pair 2	OBJ2PRE Understand key sci concepts & OBJ2PST	167	.390	.000
Pair 3	OBJ3PRE Develop prob solving/inquiry skills & OBJ3PST	167	.325	.000
Pair 4	OBJ4PRE Learn about relevance of sci to society & OBJ4PST	166	.238	.002
Pair 5	OBJ5PRE Understand sci as discipline & OBJ5PST	166	.422	.000
Pair 6	OBJ6PRE Understand app of sci in life & OBJ6PST	165	.411	.000
Pair 7	OBJ7PRE Know how to commun ideas in sci & OBJ7PST	166	.396	.000
Pair 8	OBJ8PRE Develop skill in lab techniques & OBJ8PST	166	.488	.000
Pair 9	OBJ9PRE Develop conf in understand sci & apply & OBJ9PST	165	.336	.000
Pair 10	OBJ10PRE Develop interest in sci & OBJ10PST	166	.306	.000
Pair 11	OBJ11PRE Prepare for further study in sci & OBJ11PST	163	.471	.000
Pair 12	OBJ12PRE Develop ability to examine info & draw concl & OBJ12PST	163	.279	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	OBJ1PRE Know sci facts & terms - OBJ1PST	-8.5E-02	.6402	4.999E-02	-.1841	1.335E-02	-1.708	163	.090
Pair 2	OBJ2PRE Understand key sci concepts - OBJ2PST	-9.6E-02	.6607	5.113E-02	-.1968	5.136E-03	-1.874	166	.063
Pair 3	OBJ3PRE Develop prob solving/inquiry skills - OBJ3PST	-.1198	.7347	5.685E-02	-.2320	-7.5E-03	-2.106	166	.037
Pair 4	OBJ4PRE Learn about relevance of sci to society - OBJ4PST	-2.4E-02	.8595	6.671E-02	-.1558	.1076	-.361	165	.718
Pair 5	OBJ5PRE Understand sci as discipline - OBJ5PST	-4.8E-02	.7924	6.151E-02	-.1696	7.325E-02	-.784	165	.434
Pair 6	OBJ6PRE Understand app of sci in life - OBJ6PST	-.1576	.6980	5.434E-02	-.2649	-5.0E-02	-2.900	164	.004
Pair 7	OBJ7PRE Know how to commun ideas in sci - OBJ7PST	-.2349	.8306	6.447E-02	-.3622	-.1077	-3.644	165	.000
Pair 8	OBJ8PRE Develop skill in lab techniques - OBJ8PST	-.3855	.8989	6.977E-02	-.5233	-.2478	-5.526	165	.000
Pair 9	OBJ9PRE Develop conf in understand sci & apply - OBJ9PST	-.2667	.8563	6.667E-02	-.3983	-.1350	-4.000	164	.000
Pair 10	OBJ10PRE Develop interest in sci - OBJ10PST	-.2771	.6663	5.172E-02	-.3792	-.1750	-5.358	165	.000
Pair 11	OBJ11PRE Prepare for further study in sci - OBJ11PST	-.1166	.8563	6.707E-02	-.2490	1.588E-02	-1.738	162	.084
Pair 12	OBJ12PRE Develop ability to examine info & draw concl - OBJ12PST	-.2086	.8274	6.481E-02	-.3366	-8.1E-02	-3.219	162	**.002**

T-Test: Instructional Approach (#24-28 Pre)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	APR1PRE Use hands-on act to teach sci	2.4699	166	.6576	5.104E-02
	APR1PST	2.8373	166	.3702	2.873E-02
Pair 2	APR2PRE Integrate sci with other curric areas	2.1747	166	.7132	5.536E-02
	APR2PST	2.0723	166	.6566	5.096E-02
Pair 3	APR3PRE Student writing in sci	1.7169	166	.8079	6.270E-02
	APR3PST	2.0241	166	.7382	5.729E-02
Pair 4	APR4PRE Use paper & pencil student assess	1.3614	166	.8027	6.230E-02
	APR4PST	1.1506	166	.8357	6.486E-02
Pair 5	APR5PRE Use activity-based student assess	1.9394	165	.8092	6.300E-02
	APR5PST	2.3333	165	.6926	5.392E-02

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	APR1PRE Use hands-on act to teach sci & APR1PST	166	..166	.032
Pair 2	APR2PRE Integrate sci with other curric areas & APR2PST	166	.374	.000
Pair 3	APR3PRE Student writing in sci & APR3PST	166	.357	.000
Pair 4	APR4PRE Use paper & pencil student assess & APR4PST	166	.352	.000
Pair 5	APR5PRE Use activity-based assess & APR5PST	165	.308	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	APR1PRE Use hands-on act to teach sci - APR1PST	-.3675	.6988	5.424E-02	-.4746	-.2604	-6.775	165	.000
Pair 2	APR2PRE Integrate sci with other curric areas - APR2PST	.1024	.7678	5.959E-02	-1.5E-02	.2201	1.719	165	.088
Pair 3	APR3PRE Student writing in sci - APR3PST	-.3072	.8785	6.818E-02	-.4419	-.1726	-4.506	165	.000
Pair 4	APR4PRE Use paper & pencil student assess - APR4PST	.2108	.9330	7.241E-02	6.787E-02	.3538	2.912	165	.004
Pair 5	APR5PRE Use activity-based student assess - APR5PST	-.3939	.8882	6.915E-02	-.5305	-.2574	-5.697	164	.000

T-Test: Instructional Activities (#29-37)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ACT1PRE Listened to lecture about sci	1.2038	157	.8223	6.562E-02
	ACT1PST	1.1210	157	.9292	7.416E-02
Pair 2	ACT2PRE Watched demo of sci principle	1.4506	162	.6110	4.800E-02
	ACT2PST	1.7407	162	.7846	6.164E-02
Pair 3	ACT3PRE Read a sci textbook	1.0759	158	1.0192	8.108E-02
	ACT3PST	.7152	158	.8965	7.132E-02
Pair 4	ACT4PRE Used suppl sci materials I prepared	1.8188	160	.6623	5.236E-02
	ACT4PST	1.3813	160	.9033	7.141E-02
Pair 5	ACT5PRE Discussed sci new event	1.2795	161	.6443	5.078E-02
	ACT5PST	1.4161	161	.8258	6.508E-02
Pair 6	ACT6PRE Worked together on sci problem	1.6790	162	.6655	5.229E-02
	ACT6PST	2.0432	162	.7750	6.089E-02
Pair 7	ACT7PRE Wrote about sci experiment	1.2099	162	.7595	5.967E-02
	ACT7PST	1.4753	162	.8719	6.851E-02
Pair 8	ACT8PRE Gave oral or written sci report	.6962	158	.6745	5.366E-02
	ACT8PST	.8165	158	.8204	6.527E-02
Pair 9	ACT9PRE Used computer for sim, data coll & analysis	.3727	161	.6405	5.048E-02
	ACT9PST	.3975	161	.7523	5.929E-02

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	ACT1PRE Listened to lecture about sci & ACT1PST	157	.429	.000
Pair 2	ACT2PRE Watched demo of sci principle & ACT2PST	162	.336	.000
Pair 3	ACT3PRE Read a sci textbook & ACT3PST	158	.588	.000
Pair 4	ACT4PRE Used suppl sci materials I prepared & ACT4PST	160	.369	.000
Pair 5	ACT5PRE Discussed sci new event & ACT5PST	161	.438	.000
Pair 6	ACT6PRE Worked together on sci problem & ACT6PST	162	.280	.000
Pair 7	ACT7PRE Wrote about sci experiment & ACT7PST	162	.261	.001
Pair 8	ACT8PRE Gave oral or written sci report & ACT8PST	158	.451	.000
Pair 9	ACT9PRE Used computer for sim, data coll & analysis & ACT9PST	161	.456	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	ACT1PRE Listened to lecture about sci - ACT1PST	8.280E-02	.9403	7.504E-02	-654E-02	.2310	1.103	156	.272
Pair 2	ACT2PRE Watched demo of sci principle - ACT2PST	-.2901	.8166	6.416E-02	-.4168	-.1634	-4.522	161	.000
Pair 3	ACT3PRE Read a sci textbook - ACT3PST	.3608	.8758	6.968E-02	.2231	.4984	5.177	157	.000
Pair 4	ACT4PRE Used suppl sci materials I prepared - ACT4PST	.4375	.9020	7.131E-02	.2967	.5783	6.135	159	.000
Pair 5	ACT5PRE Discussed sci new event - ACT5PST	-.1366	.7945	6.261E-02	-.2603	-1.30E-02	-2.182	160	.031
Pair 6	ACT6PRE Worked together on sci problem - ACT6PST	-.3642	.8688	6.826E-02	-.4990	-.2294	-5.336	161	.000
Pair 7	ACT7PRE Wrote about sci experiment - ACT7PST	-.2654	.9956	7.822E-02	-.4199	-.1110	-3.393	161	.001
Pair 8	ACT8PRE Gave oral or written sci report - ACT8PST	-.1203	.7929	6.308E-02	-.2449	4.348E-03	-1.906	157	.058
Pair 9	ACT9PRE Used computer for sim, data coll & analysis - ACT9PST	-2.48E-02	.7327	5.775E-02	-.1389	8.920E-02	-.430	160	.668

T-Test: Time Spent on Science Instructions (#41 Pre)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TIME1PRE Time spent on science instruction	2.9151	159	1.7915	.1421
	TIME1PST	3.871	159	2.142	.170

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	TIME1PRE Time spent on science instruction & TIME1PST	159	.428	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	TIME1PRE Time spent on science instruction - TIME1PST	-.9560	2.1253	.1685	-1.2889	-.6231	-5.672	158	.000

T-Test: Difficulty & Effectiveness of Pre/Post Teaching Method (#39-40 PreSurvey)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	DIFFPRE How difficult to teach sci this way	3.07	75	1.11	.13
	DIFFPST	4.12	75	.91	.11
Pair 2	EFFPRE How effective this approach to teach sci	3.20	74	.99	.12
	EFFPST	4.42	74	.78	9.03E-02

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	DIFFPRE How difficult to teach sci this way & DIFFPST	75	.152	.193
Pair 2	EFFPRE How effective this approach to teach sci & EFFPST	74	.066	.576

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	DIFFPRE How difficult to teach sci this way - DIFFPST	-1.05	1.32	.15	-1.36	-.75	-6.888	74	.000
Pair 2	EFFPRE How effective this approach to teach sci - EFFPST	-1.22	1.22	.14	-1.50	-.93	-8.580	73	.000

T-Test: Value & Practicality of Hands-on Scinece (#8-11 Post Survey)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	VAL1 How convinced of value of hands-on sci instruction	4.44	171	.81	6.16E-02
	VAL2	4.77	171	.56	4.26E-02
Pair 2	PRAC1 How convinced of practicality hands-on sci instruction	4.14	171	.91	6.96E-02
	PRAC2	4.58	171	.72	5.49E-02

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	VAL1 How convinced of value of hands-on sci instruction & VAL2	171	.496	.000
Pair 2	PRAC1 How convinced of practicality hands-on sci instruction & PRAC2	171	.478	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	VAL1 How convinced of value of hands-on sci instruction - VAL2	-.32	.72	5.48E-02	-.43	-.21	-5.869	170	.000
Pair 2	PRAC1 How convinced of practicality hands-on sci instruction - PRAC2	-.44	.85	6.48E-02	-.57	-.31	-6.767	170	.000

T-Test: Familiarity with National Science Standards (#11 Pre Survey)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PDPRE11 How familiar with National Science Standards	2.63	168	1.12	8.67E-02
	PDPOST11	3.07	168	1.25	9.61E-02

Paired Samples Correlations

		N	Correlation	Sig
Pair 1	PDPRE11 How familiar with National Science Standards & PDPOST11	168	.647	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	PDPRE11 How familiar with National Science Standards - PDPOST11	-.44	1.00	7.72E-02	-.59	-.29	-5.702	167	.000

Appendix F

Statistical Results for Kit Evaluations (ANOVAs)

Oneway ANOVA-Publisher (All Grades Combined)

Descriptives

			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Q1-TEACH GUIDE BACKGROUND INFO RE:UNIT	PUBLISHER	CHOL	109	4.34	0.77	7.40E-.02	4.19	4.49	2	5
		FOSS	87	4.43	0.88	9.48E-.02	4.24	4.61	1	5
		Insights	100	3.88	0.95	9.46E-.02	3.69	4.07	1	5
		STC	105	4.30	0.85	8.33E-.02	4.13	4.46	1	5
		Total	401	4.23	0.89	4.42E-.02	4.15	4.32	1	5
Q2-TEACH GUIDE IDEAS CLASS MANAGMENT TECH	PUBLISHER	CHOL	109	3.87	0.92	8.85E-.02	3.70	4.05	1	5
		FOSS	88	4.06	0.93	9.88E-.02	3.86	4.25	1	5
		Insights	98	3.69	0.94	9.45E-.02	3.51	3.88	1	5
		STC	104	4.01	0.88	8.59E-.02	3.84	4.18	1	5
		Total	399	3.90	0.92	4.62E-.02	3.81	4.00	1	5
Q3-TEACH GUIDE IDEAS FOR STU ASSESS	PUBLISHER	CHOL	109	3.69	1.03	9.90E-.02	3.49	3.88	1	5
		FOSS	88	4.03	0.94	0.10	3.83	4.23	1	5
		Insights	99	3.75	1.05	0.11	3.54	3.96	1	5
		STC	104	1.09	0.86	8.44E-.02	3.92	4.25	1	5
		Total	400	3.88	0.99	4.94E-.02	3.79	3.98	1	5
Q4-EACH GUIDE IDEAS EXTENDING KIT	PUBLISHER	CHOL	109	3.76	1.00	9.57E-.02	3.57	3.95	1	5
		FOSS	88	3.86	0.97	.10	3.66	4.07	1	5
		Insights	99	3.61	0.93	9.40E-.02	3.42	3.79	1	5
		STC	104	3.89	0.85	8.30E-.02	3.73	4.06	1	5
		Total	400	3.78	0.94	4.71E-.02	3.69	3.87	1	5
Q5-TEACH GUIDE WAS CLEAR & EASY TO USE	PUBLISHER	CHOL	109	4.34	0.84	8.06E-.02	4.18	4.50	1	5
		FOSS	87	4.23	0.94	.10	4.03	4.43	1	5
		Insights	100	3.78	1.12	.11	3.56	4.00	1	5
		STC	105	4.11	0.98	9.60E-.02	3.92	4.30	1	5
		Total	401	4.12	0.99	4.95E-.02	4.02	4.21	1	5
Q6-SPENT LOT OF TIME DUPLICATING MATERIALS	PUBLISHER	CHOL	109	1.46	0.88	8.40E-.02	1.29	1.63	1	5
		FOSS	87	23.34	1.25	.13	2.08	2.61	1	5
		Insights	98	2.88	1.39	.14	2.60	3.16	1	5
		STC	104	2.57	1.18	.12	2.34	2.80	1	5
		Total	398	2.29	1.29	6.48E-.02	2.16	2.42	1	5
Q7-HAD TO PURCHASE MATERIALS NOT PROVIDED	PUBLISHER	CHOL	109	1.14	0.50	4.78E-.02	1.04	1.23	1	4
		FOSS	88	1.91	1.28	.14	1.64	2.18	1	5
		Insights	99	1.61	1.00	.10	1.41	1.81	1	5
		STC	105	1.40	0.93	9.40E-.02	1.22	1.58	1	5
		Total	401	1.49	0.99	4.92-.02	1.39	1.59	1	5
Q8-HAD TO GATHER MATERIALS NOT PROVIDED	PUBLISHER	CHOL	108	1.19	0.57	5.50E-.02	1.09	1.30	1	4
		FOSS	87	1.85	1.15	.12	1.61	2.09	1	5
		Insights	99	1.91	1.25	.13	1.66	2.16	1	5
		STC	105	1.45	0.92	8.98E-.02	1.27	1.63	1	5
		Total	399	1.58	1.03	5.17E-.02	1.48	1.68	1	5
Q9-HAD TO PREPARE MANY MATERIALS TO DO ACTIVITIES	PUBLISHER	CHOL	109	1.44	0.87	8.29E-.02	1.28	1.60	1	5
		FOSS	87	2.47	1.31	.14	2.19	2.75	1	5
		Insights	99	2.56	1.51	.15	2.25	2.86	1	5
		STC	104	2.11	1.34	.13	1.84	2.37	1	5
		Total	399	2.12	1.34	6.73E-.02	1.98	2.25	1	5
QIO-OVERALL BENEFITS MADE TIME INVESTED WORTHWHILE	PUBLISHER	CHOL	109	4.36	0.86	8.19E-.02	4.20	4.52	1	5
		FOSS	87	4.29	0.98	.10	4.08	4.50	1	5
		Insights	100	3.66	1.10	.11	3.44	3.88	1	5
		STC	105	4.43	0.96	9.36E-.02	4.24	4.61	1	5
		Total	401	4.19	1.02	5.09E-.02	4.09	4.29	1	5
Q11-CONTENT OF KIT WAS APPROPRIATE FOR STUS	PUBLISHER	CHOL	109	4.30	0.95	9.08E-.02	4.12	4.48	1	5
		FOSS	88	4.35	0.88	9.43E-.02	4.16	4.54	1	5
		Insights	99	3.71	1.15	.12	3.48	3.94	1	5
		STC	106	4.35	0.93	9.00E-.02	4.17	4.53	1	5
		Total	402	4.18	1.02	5.07E-.02	4.08	4.28	1	5

Descriptives

			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
							Lower Bound	Upper Bound		
Q12-KIT	PUBLISHER	CHOL	100	3.83	1.08	.11	3.62	4.04	1	5
APPROPRIATE		FOSS	79	4.00	1.00	.11	3.78	4.22	2	5
FOR LEP STUS		Insights	91	3.56	1.13	.12	3.33	3.80	1	5
		STC	101	3.92	1.02	.10	3.72	4.12	1	5
		Total	371	3.82	1.07	5.54E-02	3.72	3.93	1	5
Q-13 MY STUS	PUBLISHER	CHOL	109	4.54	.80	7.66E-02	4.39	4.69	1	5
ENJOYED USING		FOSS	87	4.52	.82	8.78E-02	4.34	4.69	1	5
THE KIT		Insights	97	4.05	1.04	.11	3.84	4.26	1	5
		STC	105	4.58	.78	7.63E-02	4.43	4.73	1	5
		Total	398	4.43	.89	4.45E-02	4.34	4.51	1	5
Q14-KIT CONTRIB	PUBLISHER	CHOL	109	4.25	.90	8.66E-02	4.08	4.42	1	5
TO STU		FOSS	87	4.33	.82	8.75E-02	4.16	4.51	1	5
UNDERSTANDING		Insights	98	3.89	.90	9.04E-02	3.71	4.07	1	5
SCI CONCEPTS		STC	105	4.46	.78	7.66E-02	4.31	4.61	1	5
		Total	399	4.23	.88	4.38E-02	4.15	4.32	1	5
Q15-KIT MORE	PUBLISHER	CHOL	104	3.91	.99	9.67E-02	3.72	4.11	1	5
EFFECTIVE		FOSS	84	3.87	1.03	.11	3.65	4.09	1	5
THAN OTHER		Insights	94	3.30	1.18	.12	3.06	3.54	1	5
KITS HAVE USED		STC	105	4.02	.93	9.08E-02	3.84	4.20	1	5
		Total	387	3.78	1.06	5.41E-02	3.68	3.89	1	5
Q16-KIT MORE	PUBLISHER	CHOL	106	4.52	.75	7.25E-02	4.38	4.66	1	5
EFFECTIVE		FOSS	87	4.61	.75	8.07E-02	4.45	4.77	2	5
THAN		Insights	100	4.14	1.03	.10	3.94	4.34	1	5
TEXTBOOK		STC	102	4.66	.71	7.04E-02	4.52	4.80	1	5
INSTRUCTION		Total	395	4.48	.84	4.23E-02	4.40	4.56	1	5
Q17-MATERIALS	PUBLISHER	CHOL	107	4.26	.92	8.94E-02	4.08	4.44	1	5
IN KIT WERE		FOSS	88	4.31	.98	.10	4.10	4.51	1	5
DURABLE		Insights	97	1.14	1.01	.10	3.94	4.35	1	5
		STC	103	4.46	.71	7.01E-02	4.32	4.60	2	5
		Total	395	4.29	.97	4.59E-02	4.20	4.38	1	5
Q18-ABLE TO USE	PUBLISHER	CHOL	106	4.49	.83	8.07E-02	4.33	4.65	1	5
THIS KIT		FOSS	87	4.43	.98	.11	4.22	4.63	1	5
WITHOUT HELP		Insights	97	4.07	1.06	.11	3.86	4.29	1	5
		STC	103	4.45	.85	8.36E-02	4.28	4.61	1	5
		Total	393	4.36	.94	4.76E-02	4.27	4.45	1	5
Q19-IMPORTANT	PUBLISHER	CHOL	107	1.92	1.13	.11	1.70	2.13	1	5
TO HAVE		FOSS	88	2.17	1.28	.14	1.90	2.44	1	5
INSERVICE TRAIN		Insights	96	2.21	1.20	.12	1.97	2.45	1	5
TO USE KIT		STC	102	2.07	1.15	.11	1.84	2.29	1	5
		Total	393	2.08	1.18	5.98E-02	1.97	2.20	1	5
Q20-SHARED	PUBLISHER	CHOL	107	3.63	1.14	.11	3.41	3.84	1	5
SOME IDEAS-ACTI		FOSS	87	3.69	1.16	.12	3.44	3.94	1	5
IN KIT W OTHER		Insights	99	3.13	1.15	.12	2.90	3.36	1	5
TEACHERS		STC	103	3.67	1.08	.11	3.46	3.88	1	5
		Total	396	3.53	1.15	5.78E-02	3.41	3.64	1	5
Q21-WOULD	PUBLISHER	CHOL	107	4.41	.92	8.90E-02	4.23	4.59	1	5
RECOMMEND		FOSS	88	4.33	1.01	.11	4.11	4.54	1	5
KIT TO		Insights	99	3.58	1.39	.14	3.30	3.85	1	5
ANOTHER		STC	103	4.50	.88	8.71E-02	4.33	4.68	1	5
TEACHER		Total	397	4.21	1.13	5.66E-02	4.10	4.32	1	5
Q22-WOULD	PUBLISHER	CHOL	107	4.31	.97	9.33E-02	4.12	4.49	1	5
RECOMMEND		FOSS	88	4.24	1.07	.11	4.01	4.47	1	5
KIT FOR SCH		Insights	99	3.54	1.43	.14	3.25	3.82	1	5
ADOPTION		STC	103	4.50	.84	8.26E-02	4.33	4.66	1	5
		Total	397	4.15	1.15	5.77E-02	4.04	4.26	1	5

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Q1-TEACH GUIDE BACKGROUND INFO RE:UNIT	.485	3	397	.693
Q2-TEACH GUIDE IDEAS CLASS MANAGMENT TECH	.623	3	395	.601
Q3-TEACH GUIDE IDEAS FOR STU ASSESS	2.965	3	396	.032
Q4-EACH GUIDE IDEAS EXTENDING KIT	2.799	3	396	.040
Q5-TEACH GUIDE WAS CLEAR & EASY TO USE	1.963	3	397	.119
Q6-SPENT LOT OF TIME DUPLICATING MATERIALS	13.447	3	394	.000
Q7-HAD TO PURCHASE MATERIALS NOT PROVIDED	20.614	3	397	.000
Q8-HAD TO GATHER MATERIALS NOT PROVIDED	18.013	3	395	.000
Q9-HAD TO PREPARE MANY MATERIALS TO DO ACTIVITIES	19.028	3	395	.000
QIO-OVERALL BENEFITS MADE TIME INVESTED WORTHWHILE -	3.335	3	397	.019
Q11-CONTENT OF KIT WAS APPROPRIATE FOR STUS	2.466	3	398	.062
Q12-KIT APPROPRIATE FOR LEP STUS	.644	3	367	.587
Q-13 MY STUS ENJOYED USING THE KIT	2.268	3	394	.080

Q14-KIT CONTRIB TO STU UNDERSTANDING SCI CONCEPTS	.407	3	395	.748
Q15-KIT MORE EFFECTIVE THAN OTHER KITS HAVE USED	4.092	3	383	.007
Q16-KIT MORE EFFECTIVE THAN TEXTBOOK INSTRUCTION	6.129	3	391	.000
Q17-MATERIALS IN KIT WERE DURABLE	1.978	3	391	.117
Q18-ABLE TO USE THIS KIT WITHOUT HELP	1.260	3	389	.288
Q19-IMPORTANT TO HAVE INSERVICE TRAIN TO USE KIT	.990	3	389	.397
Q20-SHARED SOME IDEAS-ACTI IN KIT W OTHER TEACHERS	.681	3	392	.564
Q21-WOULD RECOMMEND KIT TO ANOTHER TEACHER	13.785	3	393	.000
Q22-WOULD RECOMMEND KIT FOR SCH ADOPTION	16.015	3	393	.000

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Q1-TEACH GUIDE BACKGROUND INFO RE:UNIT	Between Groups	17.319	3	5.773	7.740	.000
	Within Groups	296.112	397	.746		
	Total	313.431	400			
Q2-TEACH GUIDE IDEAS CLASS MANAGMENT TECH	Between Groups	7.656	3	2.552	3.048	.029
	Within Groups	330.724	395	.837		
	Total	338.381	398			
Q3-TEACH GUIDE IDEAS FOR STU ASSESS	Between Groups	12.277	3	4.092	4.296	.005
	Within Groups	377.200	396	.953		
	Total	389.478	399			
Q4-EACH GUIDE IDEAS EXTENDING KIT	Between Groups	5.005	3	1.668	1.890	.131
	Within Groups	349.635	396	.883		
	Total	354.640	399			
Q5-TEACH GUIDE WAS CLEAR & EASY TO USE	Between Groups	17.860	3	5.953	6.292	.000
	Within Groups	375.631	397	.946		
	Total	393.491	400			
Q6-SPENT LOT OF TIME DUPLICATING MATERIALS	Between Groups	117.412	3	39.137	28.202	.000
	Within Groups	546.779	394	1.388		
	Total	664.191	397			
Q7-HAD TO PURCHASE MATERIALS NOT PROVIDED	Between Groups	31.175	3	10.392	11.554	.000
	Within Groups	357.045	397	.899		
	Total	388.219	400			
Q8-HAD TO GATHER MATERIALS NOT PROVIDED	Between Groups	34.985	3	11.662	11.808	.000
	Within Groups	390.118	395	.988		
	Total	425.103	398			
Q9-HAD TO PREPARE MANY MATERIALS TO DO ACTIVITIES	Between Groups	79.875	3	26.625	16.463	.000
	Within Groups	638.822	395	1.617		
	Total	718.697	398			
QIO-OVERALL BENEFITS MADE TIME INVESTED WORTHWHILE	Between Groups	37.956	3	12.652	13.323	.000
	Within Groups	377.016	397	.950		
	Total	414.973	400			

Q11-CONTENT OF KIT WAS APPROPRIATE FOR STUS	Between Groups	29.426	3	9.809	10.122	.000
	Within Groups	385.679	398	.969		
	Total	415.104	401			
Q12-KIT APPROPRIATE FOR LEP STUS	Between Groups	9.718	3	3.239	2.886	.036
	Within Groups	411.894	367	1.122		
	Total	421.612	370			
Q-13 MY STUS ENJOYED USING THE KIT	Between Groups	18.294	3	6.098	8.142	.000
	Within Groups	295.093	394	.749		
	Total	313.387	397			
Q14-KIT CONTRIB TO STU UNDERSTANDING SCI CONCEPTS	Between Groups	17.856	3	5.952	8.178	.000
	Within Groups	287.468	395	.728		
	Total	305.323	398			
Q15-KIT MORE EFFECTIVE THAN OTHER KITS HAVE USED	Between Groups	30.365	3	10.122	9.515	.000
	Within Groups	407.402	383	1.064		
	Total	437.767	386			
Q16-KIT MORE EFFECTIVE THAN TEXTBOOK INSTRUCTION	Between Groups	16.362	3	5.454	8.133	.000
	Within Groups	262.205	391	.671		
	Total	278.567	394			
Q17-MATERIALS IN KIT WERE DURABLE	Between Groups	5.013	3	1.671	2.023	.110
	Within Groups	322.922	391	.826		
	Total	327.934	394			
Q18-ABLE TO USE THIS KIT WITHOUT HELP	Between Groups	10.986	3	3.662	4.218	.006
	Within Groups	337.706	389	.868		
	Total	348.692	392			
Q19-IMPORTANT TO HAVE INSERVICE TRAIN TO USE KIT	Between Groups	5.190	3	1.730	1.235	.297
	Within Groups	545.039	389	1.401		
	Total	550.229	392			
Q20-SHARED SOME IDEAS-ACTI IN KIT W OTHER TEACHERS	Between Groups	20.957	3	6.986	5.458	.001
	Within Groups	501.737	392	1.280		
	Total	522.694	395			
Q21-WOULD RECOMMEND KIT TO ANOTHER TEACHER	Between Groups	54.368	3	18.123	15.853	.000
	Within Groups	449.279	393	1.143		
	Total	503.647	396			
Q22-WOULD RECOMMEND KIT FOR SCH ADOPTION	Between Groups	53.047	3	17.682	14.748	.000
	Within Groups	471.185	393	1.199		
	Total	524.232	396			

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Publisher	(J) Publisher	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Level Lower Bound	95% Confidence Level Upper Bound
Q1-TEACH GUIDE BACKGROUND INFOR RE:UNIT	CHOL	FOSS	-8.58E-02	.124	.900	-.40	.23
		Insights	.46*	.120	.001	.15	.77
		STC	4.42E-02	.118	.982	-.26	.35
	FOSS	CHOL	8.58E-02	.124	.900	-.23	.40
		Insights	.55*	.127	.000	.22	.87
		STC	.13	.125	.727	-.19	.45
	Insights	CHOL	-.46*	.120	.001	-.77	-.15
		FOSS	-.55*	.127	.000	-.87	-.22
		STC	-.42*	.121	.003	-.73	-.11
	STC	CHOL	-4.42E-02	.118	.982	-.35	.26
		FOSS	-.13	.125	.727	-.45	.19
		Insights	.42*	.121	.003	.11	.73
Q5-TEACH GUIDE WAS CLEAR & EASY TO USE	CHOL	FOSS	.11	.140	.862	-.25	.47
		Insights	.56*	.135	.000	.21	.91
		STC	.23	.133	.327	-.12	.57
	FOSS	CHOL	-.11	.140	.862	-.47	.25
		Insights	.45*	.143	.009	8.35E-02	.82
		STC	.12	.141	.845	-.25	.48
	Insights	CHOL	-.56*	.135	.000	-.91	-.21
		FOSS	-.45*	.143	.009	-.82	-8.35E-02
		STC	-.33	.136	.066	-.68	1.49E-02
	STC	CHOL	-.23	.133	.327	-.57	.12
		FOSS	-.12	.141	.845	-.48	.25
		Insights	.33	.136	.066	-1.49E-02	.68
Q11-CONTENT OF KIT WAS APPROPRIATE FOR STUDENTS	CHOL	FOSS	-4.95E-02	.141	.985	-.41	.31
		Insights	.60*	.137	.000	.24	.95
		STC	-4.63E-02	.134	.986	-.39	.30
	FOSS	CHOL	4.95E-02	.141	.985	-.31	.41
		Insights	.65*	.144	.000	.27	1.02
		STC	3.22E-03	.142	1.000	-.36	.37
	Insights	CHOL	-.60*	.137	.000	-.95	-.24
		FOSS	-.65*	.144	.000	-1.02	-.27
		STC	-.64*	.138	.000	-1.00	-.29
	STC	CHOL	4.63E-02	.134	.986	-.30	.39
		FOSS	-3.22E-02	.142	1.000	-.37	.36
		Insights	.64*	.138	.000	.29	1.00

Q13-MY STUS ENJOYED USING THE KIT	CHOL	FOSS	2.40E-02	1.24	.997	-.30	.34
		Insights	.49*	.121	.000	.18	.80
		STC	-3.97E-02	.118	.987	-.34	.26
	FOSS	CHOL	-2.40E-02	.124	.997	-.34	.30
		Insights	.47*	.128	.002	.14	.79
		STC	-6.37E-02	.125	.957	-.39	.26
	Insights	CHOL	-.49*	.121	.000	-.80	-.18
		FOSS	-.47*	.128	.002	-.79	-.14
		STC	-.53*	.122	.000	-.84	-.22
	STC	CHOL	3.97E-02	.118	.987	-.26	.34
		FOSS	6.37E-02	.125	.957	-.26	.39
		Insights	.53*	.122	.000	.22	.84
Q14-KIT CONTRIB TO STU UNDERSTANDING SCI CONCEPTS	CHOL	FOSS	-8.56E-02	.123	.898	-.40	.23
		Insights	.36*	.119	.013	5.49E-02	.67
		STC	-.21	.117	.275	-.51	9.02E-02
	FOSS	CHOL	8.56E-02	.123	.898	-.23	.40
		Insights	.45*	.126	.002	.12	.77
		STC	-.12	.124	.749	-.44	.19
	Insights	CHOL	-.36*	.119	.013	-.67	-5.49E-02
		FOSS	-.45*	.126	.002	-.77	-.12
		STC	-.57*	.120	.000	-.88	-.26
	STC	CHOL	.21	.117	.275	-9.02E-02	.51
		FOSS	.12	.124	.749	-.19	.44
		Insights	.57*	.120	.000	.26	.88
Q20-SHARED SOME IDEAS-ACTI IN KIT W OTHER TEACHS	CHOL	FOSS	-6.35E-02	.163	.980	-.48	.36
		Insights	.49*	.158	.009	8.95E-02	.90
		STC	-4.37E-02	.156	.992	-.44	.36
	FOSS	CHOL	6.35E-02	.163	.980	-.36	.48
		Insights	.49*	.166	.004	.13	.99
		STC	-4.37E-02	.165	.999	-.40	.44
	Insights	CHOL	-.49*	.158	.009	-.90	-8.59E-02
		FOSS	-.56*	.166	.004	-.99	-.13
		STC	-.54*	.159	.004	-.95	-.13
	STC	CHOL	4.37E-02	.156	.992	-.36	.44
		FOSS	-1.98E-02	.165	.999	-.44	.40
		Insights	.54*	.159	.004	.13	.95

* The mean difference is significant at the .05 level.

Post Hoc Tests

Multiple Comparison

Dunnet T3

Dependent Variable	(I) Publisher	(J) Publisher	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Level	
						Lower Bound	Upper Bound
Q6-SPENT LOT OF TIME DUPLICATING MATERIALS	CHOL	FOSS	-.89*	.169	.000	-1.31	-.47
		Insights	-1.42*	.164	.000	-1.85	-.98
		STC	-1.11*	.161	.000	-1.49	-.73
	FOSS	CHOL	.89*	.169	.000	.47	1.31
		Insights	-.53*	.174	.038	-1.05	-1.80E-02
		STC	-.22	.171	.753	-.69	.25
	Insights	CHOL	1.42*	.164	.000	.98	1.85
		FOSS	.53*	.174	.038	1.80E-02	1.05
		STC	.31	.166	.427	-.17	.79
	STC	CHOL	1.11*	.161	.000	.73	1.49
		FOSS	.22	.171	.753	-.25	.69
		Insights	-.31	.166	.427	-.79	.17
Q7-HAD TO PURCHASE MATERIALS NOT PROVIDED	CHOL	FOSS	-.77*	.136	.000	-1.16	-.38
		Insights	-.47*	.132	.000	-.76	-.17
		STC	-.26	.130	.065	-.53	9.92E-03
	FOSS	CHOL	.77*	.136	.000	.38	1.16
		Insights	.30	.139	.374	-.15	.75
		STC	.51*	.137	.013	7.24E-02	.95
	Insights	CHOL	.47*	.132	.000	.17	.76
		FOSS	-.30	.139	.374	-.75	.15
		STC	.21	.133	.559	-.15	.56
	STC	CHOL	.26	.130	.065	-6.62E-03	.53
		FOSS	-.51*	.137	.013	-.95	-7.24E-02
		Insights	-.21	.133	.559	-.56	.15
Q8-HAD TO GATHER MATERIALS NOT PROVIDED	CHOL	FOSS	-.66*	.143	.000	-1.02	-.30
		Insights	-.71*	.138	.000	-1.08	-.35
		STC	-.25	.136	.098	-.53	2.68E-02
	FOSS	CHOL	.66*	.143	.000	.30	1.02
		Insights	-5.85E-02	.146	1.000	-.53	.41
		STC	.40	.144	.052	-2.16E-03	.81
	Insights	CHOL	.71*	.138	.000	.35	1.08
		FOSS	5.85E-02	.146	1.000	-.41	.53
		STC	.46*	.139	.019	5.00E-02	.87
	STC	CHOL	.25	.136	.098	-2.68E-02	.53
		FOSS	-.40	.144	.052	-.81	2.16E-03
		Insights	-.46*	.139	.019	-.87	-5.00E-02

Q9-HAD TO PREPARE MANY MATERIALS TO DO ACTIVITIES	CHOL	FOSS	-1.03*	.183	.000	-1.47	-.60
		Insights	-1.12*	.177	.000	-1.58	-.65
		STC	-.67*	.174	.000	-1.08	-.25
	FOSS	CHOL	1.03*	.183	.000	.60	1.47
		Insights	-8.43E-02	.187	.999	-.63	.47
		STC	.37	.185	.305	-.15	.88
	Insights	CHOL	1.12*	.177	.000	.65	1.58
		FOSS	8.43E-02	.187	.999	-.47	.63
		STC	.45	.179	.148	-8.48E-02	.98
	STC	CHOL	.67*	.174	.000	.25	1.08
		FOSS	-.37	.185	.305	-.88	.15
		Insights	-.45	.179	.148	-.98	8.48E-02
Q10-OVERALL BENEFITS MADE TIME INVESTED WORTHWHILE	CHOL	FOSS	7.04E-02	.140	.996	-.28	.42
		Insights	.70*	.135	.000	.33	1.06
		STC	-7.08E-02	.133	.994	-.40	.26
	FOSS	CHOL	-7.04E-02	.140	.996	-.42	.28
		Insights	.63*	.143	.000	.22	1.03
		STC	-.14	.141	.895	-.51	.23
	Insights	CHOL	-.70*	.135	.000	-1.06	-.33
		FOSS	-.63*	.143	.000	-1.03	-.22
		STC	-.77*	.136	.000	-1.15	-.38
	STC	CHOL	7.08E-02	.133	.994	-.26	.40
		FOSS	.14	.141	.895	-.23	.51
		Insights	.77*	.136	.000	.38	1.15
Q15-KIT MORE EFFECTIVE THAN OTHER KITS HAVE USED	CHOL	FOSS	4.44E-02	.151	1.000	-.35	.44
		Insights	.62*	.147	.001	.20	1.03
		STC	-.11	.143	.964	-.46	.25
	FOSS	CHOL	-4.44E-02	.151	1.000	-.44	.35
		Insights	.57*	.155	.004	.13	1.01
		STC	-.15	.151	.880	-.53	.23
	Insights	CHOL	-.62*	.147	.001	-1.03	-.20
		FOSS	-.57*	.155	.004	-1.01	-.13
		STC	-.72*	.146	.000	-1.13	-.32
	STC	CHOL	.11	.143	.964	-.25	.46
		FOSS	.15	.151	.880	-.23	.53
		Insights	.72*	.146	.000	.32	1.13
Q16-KIT MORE EFFECTIVE THAN TEXTBOOK INSTRUCTION	CHOL	FOSS	-9.03E-02	.118	.955	-.38	.20
		Insights	.38*	.114	.017	4.50E-02	.71
		STC	-.14	.114	.678	-.41	.13
	FOSS	CHOL	9.03E-02	.118	.955	-.20	.38
		Insights	.47*	.120	.002	.12	.82
		STC	-4.77E-02	.120	.998	-.33	.24
	Insights	CHOL	-.38*	.114	.017	-.71	-4.50E-02
		FOSS	-.47*	.120	.002	-.82	-.12
		STC	-.52*	.115	.000	-.85	-.19
	STC	CHOL	.14	.114	.678	-.13	.41
		FOSS	4.77E-02	.120	.998	-.24	.33
		Insights	.52*	.115	.000	.19	.85

Q21-WOULD RECOMMEND KIT TO ANOTHER TEACHER	CHOL	FOSS	8.17E-02	.154	.993	-.29	.45
		Insights	.84*	.149	.000	.39	1.28
		STC	-9.36E-02	.148	.973	-.42	.24
	FOSS	CHOL	-8.17E-02	.154	.993	-.45	.29
		Insights	.75*	.157	.000	.28	1.22
		STC	-.18	.155	.973	-.54	.19
	Insights	CHOL	-.84*	.149	.000	-1.28	-.39
		FOSS	-.75*	.157	.000	-1.22	-.28
		STC	-.93*	.150	.000	-1.37	-.49
	STC	CHOL	9.36E-02	.148	.973	-.24	.42
		FOSS	.18	.155	.750	-.19	.54
		Insights	.93*	.150	.000	.49	1.37
Q22-WOULD RECOMMEND KIT FOR SCH ADOPTION	CHOL	FOSS	6.98E-02	.158	.998	-.32	.46
		Insights	.77*	.153	.000	.32	1.23
		STC	-.19	.151	.580	-.52	.14
	FOSS	CHOL	-6.98E-02	.158	.998	-.46	.32
		Insights	.70*	.160	.001	.21	1.19
		STC	-.26	.159	.353	-.63	.12
	Insights	CHOL	-.77*	.153	.000	-1.23	-.32
		FOSS	-.70*	.160	.001	-1.19	-.21
		STC	-.96*	.154	.000	-1.40	-.52
	STC	CHOL	.19	.151	.580	-.14	.52
		FOSS	.26	.159	.353	-.12	.63
		Insights	.96*	.154	.000	.52	1.40

* The mean difference is significant at the .050 level.

Appendix G

Statistical Results for Paired Comparisons (t-tests)

T-Test: CHOL and FOSS

	N	Mean	Std. Deviation	Std. Error Mean
Q15A TG-BACKGROUND INFO	18	3.39	1.24	0.29
Q15B TG-TEACHER INSTRUCTIONS	18	3.17	1.42	0.34
Q15C TG-CLEAR LEARNING OBJ	18	3.44	1.04	0.25
Q15D TG-CLASS MANAGEMENT IDEAS	18	3.22	1	0.24
Q15E TG-STU ASSESSMENT IDEAS	18	3.44	0.98	0.23
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	18	3.28	1.18	0.28
Q15G TG-OVERALL QUALITY	18	3.44	1.15	0.27
Q15H MATERIALS-COMPLETE	18	2.67	0.97	0.23
Q15I MATERIALS-DURABILITY	18	3	0.97	0.23
Q15J MATERIALS-QUALITY	18	3.28	1.02	0.24
Q15K MATERIALS-EASE OF USE	18	3.06	1.11	0.26
Q15L MATERIALS-OVERALL RATING	18	3.22	1.06	0.25
Q15M INST ACT-DEV LOGICAL THINKING	18	3.44	0.98	0.23
Q15N INST ACT-DEV SOCIAL SKILLS	18	3.33	1.03	0.24
Q15O INST ACT-DEV COMMUNICATION SKILLS	18	3.22	0.81	0.19
Q15P INST ACT-DEV PROB SOLVING SKILLS	18	3.28	1.07	0.25
Q15Q INST ACT-STU INTEREST	18	3.5	1.25	0.29
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	18	3.44	1.15	0.27
Q15S INST ACT-GRADE LEV APPROP	18	3.28	0.96	0.23
Q15T INST ACT-APPROP FOR LEP STU	18	3.33	0.97	0.23
Q15U INST ACT-OVERALL EFFECTIVENESS	17	3.76	1.03	0.25

T-Test: CHOL and FOSS

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q15A TG-BACKGROUND INFO	1.327	17	0.202	0.39	-0.23	1.01
Q15B TG-TEACHER INSTRUCTIONS	0.496	17	0.626	0.17	-0.54	0.88
Q15C TG-CLEAR LEARNING OBJ	1.81	17	0.088	0.44	-0.0735	0.96
Q15D TG-CLASS MANAGEMENT IDEAS	0.94	17	0.361	0.22	-0.28	0.72
Q15E TG-STU ASSESSMENT IDEAS	1.917	17	0.072	0.44	-0.0447	0.93
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	1	17	0.331	0.28	-0.31	0.86
Q15G TG-OVERALL QUALITY	1.641	17	0.119	0.44	-0.13	1.02
Q15H MATERIALS-COMPLETE	-1.458	17	0.163	-0.33	-0.82	0.15
Q15I MATERIALS-DURABILITY	0	17	1	0	-0.48	0.48
Q15J MATERIALS-QUALITY	1.158	17	0.263	0.28	-0.23	0.78
Q15K MATERIALS-EASE OF USE	0.212	17	0.834	0.0556	-0.5	0.61
Q15L MATERIALS-OVERALL RATING	0.889	17	0.386	0.22	-0.31	0.75
Q15M INST ACT-DEV LOGICAL THINKING	1.917	17	0.072	0.44	-0.0447	0.93
Q15N INST ACT-DEV SOCIAL SKILLS	1.374	17	0.187	0.33	-0.18	0.85
Q15O INST ACT-DEV COMMUNICATION SKILLS	1.166	17	0.26	0.22	-0.18	0.62
Q15P INST ACT-DEV PROB SOLVING SKILLS	1.097	17	0.288	0.28	-0.26	0.81
Q15Q INST ACT-STU INTEREST	1.699	17	0.108	0.5	-0.12	1.12
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	1.641	17	0.119	0.44	-0.13	1.02
Q15S INST ACT-GRADE LEV APPROP	1.23	17	0.236	0.28	-0.2	0.75
Q15T INST ACT-APPROP FOR LEP STU	1.458	17	0.163	0.33	-0.15	0.82
Q15U INST ACT-OVERALL EFFECTIVENESS	3.054	16	0.008	0.76	0.23	1.3

T-Test: CHOL and Insights

	N	Mean	Std. Deviation	Std. Error Mean
Q15A TG-BACKGROUND INFO	32	2.41	0.95	0.17
Q15B TG-TEACHER INSTRUCTIONS	32	2.47	0.84	0.15
Q15C TG-CLEAR LEARNING OBJ	32	2.75	0.67	0.12
Q15D TG-CLASS MANAGEMENT IDEAS	32	2.91	0.69	0.12
Q15E TG-STU ASSESSMENT IDEAS	32	3.16	0.57	0.1
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	32	3	0.72	0.13
Q15G TG-OVERALL QUALITY	31	2.68	0.91	0.16
Q15H MATERIALS-COMPLETE	32	2.59	0.67	0.12
Q15I MATERIALS-DURABILITY	32	2.84	0.68	0.12
Q15J MATERIALS-QUALITY	32	2.66	0.7	0.12
Q15K MATERIALS-EASE OF USE	32	2.28	0.89	0.16
Q15L MATERIALS-OVERALL RATING	32	2.56	0.84	0.15
Q15M INST ACT-DEV LOGICAL THINKING	32	2.88	0.79	0.14
Q15N INST ACT-DEV SOCIAL SKILLS	32	2.81	0.86	0.15
Q15O INST ACT-DEV COMMUNICATION SKILLS	32	2.72	0.58	0.1
Q15P INST ACT-DEV PROB SOLVING SKILLS	31	2.94	0.85	0.15
Q15Q INST ACT-STU INTEREST	32	2.72	1.11	0.2
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	32	2.75	0.67	0.12
Q15S INST ACT-GRADE LEV APPROP	31	2.81	0.87	0.16
Q15T INST ACT-APPROP FOR LEP STU	27	2.81	0.62	0.12
Q15U INST ACT-OVERALL EFFECTIVENESS	30	2.8	0.85	0.15

T-Test: CHOL and Insights

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q15A TG-BACKGROUND INFO	-3.552	31	0.001	-0.59	-0.93	-0.25
Q15B TG-TEACHER INSTRUCTIONS	-3.57	31	0.001	-0.53	-0.83	-0.23
Q15C TG-CLEAR LEARNING OBJ	-2.104	31	0.044	-0.25	-0.49	-0.00771
Q15D TG-CLASS MANAGEMENT IDEAS	-0.77	31	0.447	-0.0938	-0.34	0.15
Q15E TG-STU ASSESSMENT IDEAS	1.539	31	0.134	0.16	-0.0507	0.36
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	0	31	1	0	-0.26	0.26
Q15G TG-OVERALL QUALITY	-1.976	30	0.057	-0.32	-0.66	0.0107
Q15H MATERIALS-COMPLETE	-3.455	31	0.002	-0.41	-0.65	-0.17
Q15I MATERIALS-DURABILITY	-1.305	31	0.201	-0.16	-0.4	0.0879
Q15J MATERIALS-QUALITY	-2.775	31	0.009	-0.34	-0.6	-0.0911
Q15K MATERIALS-EASE OF USE	-4.576	31	0	-0.72	-1.04	-0.4
Q15L MATERIALS-OVERALL RATING	-2.946	31	0.006	-0.44	-0.74	-0.13
Q15M INST ACT-DEV LOGICAL THINKING	-0.892	31	0.379	-0.13	-0.41	0.16
Q15N INST ACT-DEV SOCIAL SKILLS	-1.235	31	0.226	-0.19	-0.5	0.12
Q15O INST ACT-DEV COMMUNICATION SKILLS	-2.738	31	0.01	-0.28	-0.49	-0.0717
Q15P INST ACT-DEV PROB SOLVING SKILLS	-0.421	30	0.677	-0.0645	-0.38	0.25
Q15Q INST ACT-STU INTEREST	-1.428	31	0.163	-0.28	-0.68	0.12
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	-2.104	31	0.044	-0.25	-0.49	-0.00771
Q15S INST ACT-GRADE LEV APPROP	-1.235	30	0.226	-0.19	-0.51	0.13
Q15T INST ACT-APPROP FOR LEP STU	-1.546	26	0.134	-0.19	-0.43	0.0611
Q15U INST ACT-OVERALL EFFECTIVENESS	-1.293	29	0.206	-0.2	-0.52	0.12

T-Test: CHOL and STC

	N	Mean	Std. Deviation	Std. Error Mean
Q15A TG-BACKGROUND INFO	26	3.04	0.66	0.13
Q15B TG-TEACHER INSTRUCTIONS	26	2.96	1	0.2
Q15C TG-CLEAR LEARNING OBJ	25	3.2	0.65	0.13
Q15D TG-CLASS MANAGEMENT IDEAS	26	2.92	0.93	0.18
Q15E TG-STU ASSESSMENT IDEAS	26	3	0.57	0.11
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	26	3.08	0.74	0.15
Q15G TG-OVERALL QUALITY	26	3	1.02	0.2
Q15H MATERIALS-COMPLETE	26	2.77	0.71	0.14
Q15I MATERIALS-DURABILITY	26	2.96	0.72	0.14
Q15J MATERIALS-QUALITY	26	3.15	0.61	0.12
Q15K MATERIALS-EASE OF USE	26	2.77	0.76	0.15
Q15L MATERIALS-OVERALL RATING	26	3.15	0.73	0.14
Q15M INST ACT-DEV LOGICAL THINKING	26	3.15	0.61	0.12
Q15N INST ACT-DEV SOCIAL SKILLS	26	3.19	0.75	0.15
Q15O INST ACT-DEV COMMUNICATION SKILLS	26	3.15	0.61	0.12
Q15P INST ACT-DEV PROB SOLVING SKILLS	26	3.08	0.56	0.11
Q15Q INST ACT-STU INTEREST	26	3.23	1.03	0.2
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	26	3	0.57	0.11
Q15S INST ACT-GRADE LEV APPROP	26	3.12	0.59	0.12
Q15T INST ACT-APPROP FOR LEP STU	26	3	0.4	0.0784
Q15U INST ACT-OVERALL EFFECTIVENESS	26	3.08	0.63	0.12

T-Test: CHOL and STC

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q15A TG-BACKGROUND INFO	0.296	25	0.77	0.0385	-0.23	0.31
Q15B TG-TEACHER INSTRUCTIONS	-0.196	25	0.846	-0.0385	-0.44	0.37
Q15C TG-CLEAR LEARNING OBJ	1.549	24	0.134	0.2	-0.0664	0.47
Q15D TG-CLASS MANAGEMENT IDEAS	-0.42	25	0.678	-0.0769	-0.45	0.3
Q15E TG-STU ASSESSMENT IDEAS	0	25	1	0	-0.23	0.23
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	0.527	25	0.603	0.0769	-0.22	0.38
Q15G TG-OVERALL QUALITY	0	25	1	0	-0.41	0.41
Q15H MATERIALS-COMPLETE	-1.656	25	0.11	-0.23	-0.52	0.0562
Q15I MATERIALS-DURABILITY	-0.272	25	0.788	-0.0385	-0.33	0.25
Q15J MATERIALS-QUALITY	1.28	25	0.212	0.15	-0.0936	0.4
Q15K MATERIALS-EASE OF USE	-1.539	25	0.136	-0.23	-0.54	0.0781
Q15L MATERIALS-OVERALL RATING	1.072	25	0.294	0.15	-0.14	0.45
Q15M INST ACT-DEV LOGICAL THINKING	1.28	25	0.212	0.15	-0.0936	0.4
Q15N INST ACT-DEV SOCIAL SKILLS	1.309	25	0.203	0.19	-0.11	0.49
Q15O INST ACT-DEV COMMUNICATION SKILLS	1.28	25	0.212	0.15	-0.0936	0.4
Q15P INST ACT-DEV PROB SOLVING SKILLS	0.7	25	0.49	0.0769	-0.15	0.3
Q15Q INST ACT-STU INTEREST	1.14	25	0.265	0.23	-0.19	0.65
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	0	25	1	0	-0.23	0.23
Q15S INST ACT-GRADE LEV APPROP	1	25	0.327	0.12	-0.12	0.35
Q15T INST ACT-APPROP FOR LEP STU	0	25	1	0	-0.16	0.16
Q15U INST ACT-OVERALL EFFECTIVENESS	0.625	25	0.538	0.0769	-0.18	0.33

T-Test: FOSS and Insights

	N	Mean	Std. Deviation	Std. Error Mean
Q15A TG-BACKGROUND INFO	19	2.42	1.07	0.25
Q15B TG-TEACHER INSTRUCTIONS	18	2.56	1.1	0.26
Q15C TG-CLEAR LEARNING OBJ	18	2.67	0.91	0.21
Q15D TG-CLASS MANAGEMENT IDEAS	19	2.47	0.9	0.21
Q15E TG-STU ASSESSMENT IDEAS	19	2.63	1.01	0.23
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	19	2.58	0.9	0.21
Q15G TG-OVERALL QUALITY	19	2.58	1.17	0.27
Q15H MATERIALS-COMPLETE	19	2.53	1.22	0.28
Q15I MATERIALS-DURABILITY	19	2.84	0.83	0.19
Q15J MATERIALS-QUALITY	19	2.74	0.99	0.23
Q15K MATERIALS-EASE OF USE	19	2.84	1.21	0.28
Q15L MATERIALS-OVERALL RATING	19	2.53	1.02	0.23
Q15M INST ACT-DEV LOGICAL THINKING	19	2.74	0.99	0.23
Q15N INST ACT-DEV SOCIAL SKILLS	19	2.63	0.83	0.19
Q15O INST ACT-DEV COMMUNICATION SKILLS	19	2.68	0.89	0.2
Q15P INST ACT-DEV PROB SOLVING SKILLS	19	2.58	0.9	0.21
Q15Q INST ACT-STU INTEREST	19	2.47	1.26	0.29
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	19	2.68	1.06	0.24
Q15S INST ACT-GRADE LEV APPROP	19	2.79	0.79	0.18
Q15T INST ACT-APPROP FOR LEP STU	17	2.76	0.75	0.18
Q15U INST ACT-OVERALL EFFECTIVENESS	18	2.61	0.92	0.22

T-Test: FOSS and Insights

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q15A TG-BACKGROUND INFO	-2.357	18	0.03	-0.58	-1.09	-0.0629
Q15B TG-TEACHER INSTRUCTIONS	-1.719	17	0.104	-0.44	-0.99	0.1
Q15C TG-CLEAR LEARNING OBJ	-1.558	17	0.138	-0.33	-0.78	0.12
Q15D TG-CLASS MANAGEMENT IDEAS	-2.535	18	0.021	-0.53	-0.96	-0.0902
Q15E TG-STU ASSESSMENT IDEAS	-1.587	18	0.13	-0.37	-0.86	0.12
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	-2.036	18	0.057	-0.42	-0.86	0.0135
Q15G TG-OVERALL QUALITY	-1.569	18	0.134	-0.42	-0.98	0.14
Q15H MATERIALS-COMPLETE	-1.694	18	0.107	-0.47	-1.06	0.11
Q15I MATERIALS-DURABILITY	-0.825	18	0.42	-0.16	-0.56	0.24
Q15J MATERIALS-QUALITY	-1.157	18	0.262	-0.26	-0.74	0.21
Q15K MATERIALS-EASE OF USE	-0.567	18	0.578	-0.16	-0.74	0.43
Q15L MATERIALS-OVERALL RATING	-2.024	18	0.058	-0.47	-0.97	0.0181
Q15M INST ACT-DEV LOGICAL THINKING	-1.157	18	0.262	-0.26	-0.74	0.21
Q15N INST ACT-DEV SOCIAL SKILLS	-1.933	18	0.069	-0.37	-0.77	0.032
Q15O INST ACT-DEV COMMUNICATION SKILLS	-1.555	18	0.137	-0.32	-0.74	0.11
Q15P INST ACT-DEV PROB SOLVING SKILLS	-2.036	18	0.057	-0.42	-0.86	0.0135
Q15Q INST ACT-STU INTEREST	-1.816	18	0.086	-0.53	-1.14	0.0827
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	-1.302	18	0.209	-0.32	-0.83	0.19
Q15S INST ACT-GRADE LEV APPROP	-1.166	18	0.259	-0.21	-0.59	0.17
Q15T INST ACT-APPROP FOR LEP STU	-1.289	16	0.216	-0.24	-0.62	0.15
Q15U INST ACT-OVERALL EFFECTIVENESS	-1.8	17	0.09	-0.39	-0.84	0.0668

T-Test: FOSS and STC

	N	Mean	Std. Deviation	Std. Error Mean
Q15A TG-BACKGROUND INFO	26	2.62	1.06	0.21
Q15B TG-TEACHER INSTRUCTIONS	25	2.6	1.19	0.24
Q15C TG-CLEAR LEARNING OBJ	26	2.88	0.99	0.19
Q15D TG-CLASS MANAGEMENT IDEAS	26	2.81	0.85	0.17
Q15E TG-STU ASSESSMENT IDEAS	26	2.92	0.8	0.16
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	26	2.88	0.95	0.19
Q15G TG-OVERALL QUALITY	26	2.54	1.07	0.21
Q15H MATERIALS-COMPLETE	26	3.04	1.11	0.22
Q15I MATERIALS-DURABILITY	26	2.77	0.91	0.18
Q15J MATERIALS-QUALITY	26	2.81	1.02	0.2
Q15K MATERIALS-EASE OF USE	26	2.81	1.2	0.24
Q15L MATERIALS-OVERALL RATING	26	2.88	1.07	0.21
Q15M INST ACT-DEV LOGICAL THINKING	25	3	0.96	0.19
Q15N INST ACT-DEV SOCIAL SKILLS	25	2.84	0.99	0.2
Q15O INST ACT-DEV COMMUNICATION SKILLS	25	2.92	0.91	0.18
Q15P INST ACT-DEV PROB SOLVING SKILLS	25	2.96	1.06	0.21
Q15Q INST ACT-STU INTEREST	25	2.88	1.17	0.23
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	25	2.72	0.94	0.19
Q15S INST ACT-GRADE LEV APPROP	25	2.92	1	0.2
Q15T INST ACT-APPROP FOR LEP STU	25	2.76	0.88	0.18
Q15U INST ACT-OVERALL EFFECTIVENESS	25	2.96	1.06	0.21

T-Test: FOSS and STC

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q15A TG-BACKGROUND INFO	-1.848	25	0.076	-0.38	-0.81	0.044
Q15B TG-TEACHER INSTRUCTIONS	-1.68	24	0.106	-0.4	-0.89	0.0913
Q15C TG-CLEAR LEARNING OBJ	-0.592	25	0.559	-0.12	-0.52	0.29
Q15D TG-CLASS MANAGEMENT IDEAS	-1.154	25	0.259	-0.19	-0.54	0.15
Q15E TG-STU ASSESSMENT IDEAS	-0.493	25	0.627	-0.0769	-0.4	0.24
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	-0.618	25	0.542	-0.12	-0.5	0.27
Q15G TG-OVERALL QUALITY	-2.206	25	0.037	-0.46	-0.89	-0.0306
Q15H MATERIALS-COMPLETE	0.176	25	0.862	0.0385	-0.41	0.49
Q15I MATERIALS-DURABILITY	-1.296	25	0.207	-0.23	-0.6	0.14
Q15J MATERIALS-QUALITY	-0.961	25	0.346	-0.19	-0.6	0.22
Q15K MATERIALS-EASE OF USE	-0.817	25	0.422	-0.19	-0.68	0.29
Q15L MATERIALS-OVERALL RATING	-0.55	25	0.587	-0.12	-0.55	0.32
Q15M INST ACT-DEV LOGICAL THINKING	0	24	1	0	-0.4	0.4
Q15N INST ACT-DEV SOCIAL SKILLS	-0.811	24	0.425	-0.16	-0.57	0.25
Q15O INST ACT-DEV COMMUNICATION SKILLS	-0.44	24	0.664	-0.08	-0.46	0.3
Q15P INST ACT-DEV PROB SOLVING SKILLS	-0.189	24	0.852	-0.04	-0.48	0.4
Q15Q INST ACT-STU INTEREST	-0.514	24	0.612	-0.12	-0.6	0.36
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	-1.495	24	0.148	-0.28	-0.67	0.11
Q15S INST ACT-GRADE LEV APPROP	-0.401	24	0.692	-0.08	-0.49	0.33
Q15T INST ACT-APPROP FOR LEP STU	-1.365	24	0.185	-0.24	-0.6	0.12
Q15U INST ACT-OVERALL EFFECTIVENESS	-0.189	24	0.852	-0.04	-0.48	0.4

T-Test: Insights and STC

	N	Mean	Std. Deviation	Std. Error Mean
Q15A TG-BACKGROUND INFO	22	3.64	1.22	0.26
Q15B TG-TEACHER INSTRUCTIONS	22	3.32	1.09	0.23
Q15C TG-CLEAR LEARNING OBJ	22	3.27	1.03	0.22
Q15D TG-CLASS MANAGEMENT IDEAS	22	3	1.02	0.22
Q15E TG-STU ASSESSMENT IDEAS	22	3	0.93	0.2
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	22	3.14	0.94	0.2
Q15G TG-OVERALL QUALITY	22	3.32	1.13	0.24
Q15H MATERIALS-COMPLETE	22	3.55	1.22	0.26
Q15I MATERIALS-DURABILITY	22	3.32	1.17	0.25
Q15J MATERIALS-QUALITY	22	3.41	1.1	0.23
Q15K MATERIALS-EASE OF USE	22	3.36	1.36	0.29
Q15L MATERIALS-OVERALL RATING	22	3.41	1.33	0.28
Q15M INST ACT-DEV LOGICAL THINKING	22	3.32	0.99	0.21
Q15N INST ACT-DEV SOCIAL SKILLS	22	3.14	0.94	0.2
Q15O INST ACT-DEV COMMUNICATION SKILLS	22	3.18	0.91	0.19
Q15P INST ACT-DEV PROB SOLVING SKILLS	22	3.14	1.08	0.23
Q15Q INST ACT-STU INTEREST	22	3.59	1.3	0.28
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	22	3.45	1.06	0.23
Q15S INST ACT-GRADE LEV APPROP	22	3.45	1.26	0.27
Q15T INST ACT-APPROP FOR LEP STU	21	3.24	1.04	0.23
Q15U INST ACT-OVERALL EFFECTIVENESS	22	3.45	1.34	0.28

T-Test: FOSS and STC

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Q15A TG-BACKGROUND INFO	-1.848	25	0.076	-0.38	-0.81	0.044
Q15B TG-TEACHER INSTRUCTIONS	-1.68	24	0.106	-0.4	-0.89	0.0913
Q15C TG-CLEAR LEARNING OBJ	-0.592	25	0.559	-0.12	-0.52	0.29
Q15D TG-CLASS MANAGEMENT IDEAS	-1.154	25	0.259	-0.19	-0.54	0.15
Q15E TG-STU ASSESSMENT IDEAS	-0.493	25	0.627	-0.0769	-0.4	0.24
Q15F TG-IDEAS FOR CURRIC EXTENSIONS	-0.618	25	0.542	-0.12	-0.5	0.27
Q15G TG-OVERALL QUALITY	-2.206	25	0.037	-0.46	-0.89	-0.0306
Q15H MATERIALS-COMPLETE	0.176	25	0.862	0.0385	-0.41	0.49
Q15I MATERIALS-DURABILITY	-1.296	25	0.207	-0.23	-0.6	0.14
Q15J MATERIALS-QUALITY	-0.961	25	0.346	-0.19	-0.6	0.22
Q15K MATERIALS-EASE OF USE	-0.817	25	0.422	-0.19	-0.68	0.29
Q15L MATERIALS-OVERALL RATING	-0.55	25	0.587	-0.12	-0.55	0.32
Q15M INST ACT-DEV LOGICAL THINKING	0	24	1	0	-0.4	0.4
Q15N INST ACT-DEV SOCIAL SKILLS	-0.811	24	0.425	-0.16	-0.57	0.25
Q15O INST ACT-DEV COMMUNICATION SKILLS	-0.44	24	0.664	-0.08	-0.46	0.3
Q15P INST ACT-DEV PROB SOLVING SKILLS	-0.189	24	0.852	-0.04	-0.48	0.4
Q15Q INST ACT-STU INTEREST	-0.514	24	0.612	-0.12	-0.6	0.36
Q15R INST ACT-STU UNDERSTANDING SCI CONCEPTS	-1.495	24	0.148	-0.28	-0.67	0.11
Q15S INST ACT-GRADE LEV APPROP	-0.401	24	0.692	-0.08	-0.49	0.33
Q15T INST ACT-APPROP FOR LEP STU	-1.365	24	0.185	-0.24	-0.6	0.12
Q15U INST ACT-OVERALL EFFECTIVENESS	-0.189	24	0.852	-0.04	-0.48	0.4