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ABSTRACT

The purpose of this project was to develop and field test supplementary mathematics curriculum materials that could be used in a typical school setting to introduce elementary school children to calculators and computers in the process of solving everyday mathematical problems. The materials were designed to help teachers: (1) familiarize children with the technology and promote its spontaneous and competent utilization; (2) foster the appropriate applications of technology; (3) encourage and instill positive attitudes toward technology on the part of children; and (4) teach traditional and non-traditional mathematical topics more effectively. Part 1 is the final report from the project director and includes the purpose, the outline of the procedures, the results, the end products, and conclusive recommendations. Part 2 contains the final evaluation reports from four different sites in the United States that participated in this project: New Rochelle, Brooklyn, and Newburgh, New York; and Tucson, Arizona. Each final evaluation report contains an introduction, a pre-service workshop description, notes on the supplementary lessons, calculator lessons, and computer lessons, a synopsis of student growth in terms of achievement gains and attitude changes, and the impediments to implementation that were encounter. Part 3 consists of appendices which include a workshop evaluation form, a lesson evaluation form, a teacher interview encountered. Part 3 consists of appendices which include a workshop computer and calculator applications tests, and student attitude surveys about the technology utilized. (JJK)

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NATIONAL SCIENCE FOUNDATION
1800 G STREET, NW
WASHINGTON, DC 20550

PI/PD Name and Address

Dr. Stephen Willoughby
Department of Mathematics
University of Arizona
Tucson, AZ 85721

NATIONAL SCIENCE FOUNDATION FINAL PROJECT REPORT

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K-6 SUPPLEMENTARY MATHEMATICS MATERIALS

FOR A TECHNOLOGICAL SOCIETY

FINAL REPORT

(Project Number: MDR-8896131)

Stephen S. Willoughby, Project Director

PURPOSE

The purpose of this project was to develop and field test supplementary mathematics curriculum materials that could be used in a typical school setting to introduce elementary school children to two forms of technology (calculators and computers) that impact heavily on the way ordinary people solve mathematical problems in their everyday lives.

More specifically, the materials were to help teachers: (1) familiarize children with the technology and make them comfortable and competent using the technology; (2) teach children to use technology INTELLIGENTLY (that is, use technology only when appropriate and continue thinking even when technology is appropriate); (3) encourage positive attitudes towards technology on the part of children; and (4) teach mathematics (including both traditional and non-traditional topics) more effectively.

PROCEDURES

During the 1986-87 academic year the staff* for the project was recruited, the advisory and evaluation boards** were created and consulted, available research and curriculum materials were reviewed and used to help direct our thoughts and activities, tentative activities were developed and tried with children in local schools, and negotiations were begun with local school systems to locate appropriate field test sites.

On the basis of the informal trials, we decided not to try to develop materials for kindergarten. However, on the basis of work subsequently done by one member of the Advisory Board (Marilyn Wright) with her kindergarten class, we believe that with the right teacher some of the materials developed for grade one would be useful in kindergarten late in the school year.

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*Kenneth P. Goldberg and Sharon L. Weinberg were principle investigators along with Stephen S. Willoughby. Graduate assistants were Richard Sgroi, Bernadette Russek, and Louise Pate.

**Members of the Advisory Board were: Peter Hilton (Chair), Carl Bereiter, Donald Chambers, Howard Johnson, Judy Johnson, Magdalene Lampert, Marsha Lilly, Henry O. Pollak, Joseph H. Rubinstein, Dorothy Maharam Stone, and Marilyn Wright. Members of the Evaluation Board were: Jeremy Kilpatrick (Chair), Martin Herbert, and Jane O. Swafford.

During 1987-88 field test materials for grades one through five were written, tried by staff members with small numbers of children, and circulated to Advisory Board members and others for comments. On the basis of those experiences and comments the materials were rewritten. The rewritten materials were printed in field test form and distributed to field test sites by Open Court Publishing Company.

The two field test sites used in 1987-88 were: the New Rochelle New York public schools and the Tucson (Arizona) Hebrew Academy. In both sites, the Real Math textbook series was being used. That series is a pioneer of the present reform movement in mathematics education and requires the use of calculators in fifth grade and above.

During 1988-89 brief in-service workshops were provided for the field test teachers, and some project staff support was available during the year for teachers. However, because this was a curriculum development project with a goal of producing materials that could be used in ordinary classrooms, and also because of limited budget, both the workshops and the project staff support were kept to a minimum. In the New Rochelle schools, however, there was a very strong system mathematics coordinator (Charlotte Stadler) and in the Tucson Hebrew Academy, two of the teachers (Marney Welmers and Karen Gabino) were particularly enthusiastic and well-informed supporters of the project (as were all three of the people who served as principal during the course of the project).

On the basis of information collected by the project staff from pupils and teachers during the year, the materials for grades one through five were completely rewritten and sixth grade materials were prepared for trial in the following year. Because of questions raised by teachers about the appositeness of the assigned grade levels of the materials, and the fact that many teachers did not complete all the calculator activities the first year, the last half of the activities for each grade were repeated in the next grade (for example, the last half of the third grade calculator lessons were made available in the fourth grade books so the fourth grade teacher could choose to teach some of those).

The computer materials were changed on the assumption that classroom teachers would have the assistance of a computer specialist or that a computer lab with a specialist would be available. Two additional field test sites were selected for the 1989-90 test: Brooklyn New York and Newburgh New York. Both of those schools systems use traditional mathematics textbook series.

During 1989-90, there were brief in-service programs for teachers in all field test schools, and a small amount of staff support for field test teachers. Interviews, forms, observations, and other procedures were used to collect information for the summative evaluation.

On the basis of data collected from this extensive field test, and at the recommendation of the Evaluation and Advisory Boards, the materials have now been completely reorganized and rewritten so that one pamphlet will contain calculator activities for all grades and a second will contain all the computer activities.

RESULTS

The complete evaluation is attached. There are, however, several results that should be mentioned here.

First, and perhaps most important, the children loved the calculators.[4,13,20,26]* They also loved the computers when they actually used them. Probably the best indicator of their responses were their facial expressions and their comments while they were using calculators and computers.

Children did learn to use calculators intelligently and efficiently, and their attitudes changed in the directions we had predicted and hoped for.[8,9,15,16,22]

Teachers and pupils were more positive the second year they used the materials, and the children remembered what they had learned the previous year.[3,5,22,27]

Second, the teacher's attitude and preparation substantially influenced whether the material was successful in the classroom.[9,10,13,17,18,20,21,22,22,23,24,26] Previous research reports, and the experience of Willoughby et al in the development of Real Math, predicted this effect, but we hoped to create materials that would work well in typical classrooms in which teachers are not necessarily highly prepared and motivated. We

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* Numbers in brackets refer to pages in "An Evaluation of the SMMTS Project: Final Report (attached).

appear to have been only partially successful in this endeavor, but expect that the newly revised version will more nearly approximate the goal.

On the basis of our experience it appears that some of the calculator materials can be picked up and used by teachers who are only moderately motivated, while the computer activities and some of the rest of the calculator activities require more teacher motivation and preparation.

The need for highly prepared teachers seemed to be mitigated somewhat when there was a computer specialist and/or a computer laboratory available in the school, and was even somewhat moderated by simply having a second adult in the classroom to help handle questions and classroom control.[9,13,16,20,21,24]

Teachers became more confident and more competent as they had more experience. In particular, teachers who completed a substantial amount of the material in the first year of the field test were more comfortable and effective with the material the second year than teachers who had either not been involved the first year or had not completed many of the lessons the first year.

Third, there are many factors in typical schools that make innovations of this sort difficult to institute. These include:

a) Textbooks, curriculum guides and other requirements such as standardized tests, that teachers believe should take precedence over any supplementary activities, no matter how educational the supplementary activities might be.[4,5,16, 24]

b) Lack of continuity in the possible mathematics education of children. In one school system (New Rochelle), for example it was a rare event when all children assigned to a class were present for a continuous 45 minutes or more of mathematics. Children entered and left during the class for special events, for special instruction in other subjects, for activities for gifted and talented, and so on. Because of the sequential nature of mathematics and its need for continuity in instruction, this hampers any attempt to teach mathematics, but is particularly destructive to a program that is not constantly repetitive.

c) Teachers' resistance to reading teachers' manuals, instructions, or other materials.[17,18,24] Such resistance to reading teachers guides makes educational innovation through improved curriculum materials difficult at best.

d) Variable support for innovation among academic administrators in the schools. In schools where there was substantial support for this activity among at least some of the administrators and teacher leaders the project went much more smoothly, and was more effective than in schools where such support was perceived by the teachers to be lacking.[17, 22,23,24,26] Administrative changes that occurred in some of the schools during the project made this particularly clear. When a new administrator understood and supported the project teachers worked hard at it and tended to be quite effective. When a new administrator failed to support the project teachers followed that lead.

END PRODUCTS

(1) Open Court Publishing Company will publish two pamphlets, one with computer activities, the other with calculator activities. These are expected to be available in August 1991. Open Court will send two copies of each pamphlet to the Instructional Materials Development Center at the National Science Foundation.

The pamphlets have been written for teachers with black line masters of pupils' materials so teachers can make as many copies of that material as needed.

Included with each activity is an indication of necessary prerequisite knowledge and grade levels at which the material has been successfully taught. On the basis of teacher comments about levels for which the activities were appropriate, the two Boards and the project staff agreed that this format would provide teachers with sufficient flexibility to use each activity at a time when it would be most appropriate for their pupils.

(2) An article based on project activities was written by Kenneth Goldberg and was published in the August/September 1990 issue of The Computing Teacher. Two copies of that article are attached.

(3) Kenneth Goldberg made presentations relating to the project at the Spring 1989 NCTM Annual Convention in Orlando, the Fall 1989 Annual Meeting of the Association of Mathematics Teachers of New York State, and the Spring 1990 New York State Ten County Math Conference at SUNY, New Paltz. Stephen Willoughby has made presentations relating to the project at the NCTM Regional Conference in Madison Wisconsin and the Northwest Mathematics

Conference in Portland Oregon (both in October 1990) and is scheduled to make further presentations relating to the project at the Regional NCTM Conference in Sacramento California in February 1991 and at the Long Island Mathematics Conference in March 1991.

We expect to make more presentations based on this material in the future and will also write several articles based on the project. If those are published, copies will be forwarded to NSF.

There have also been two newspaper articles (attached) about the project and one television newscast (WABC in New York) that discussed it.

RECOMMENDATIONS

The following recommendations are based partially on information obtained in this project and partially on the preconceived prejudices of the project director, where those prejudices do not conflict with the information obtained in the project.

(1) Calculators and computers can be, and should be, used more extensively in elementary schools. They should be used in conjunction with activities that encourage mathematical thinking, but should ultimately be simply another widely available tool for helping in the study of mathematics.

(2) Teachers and teacher leaders need much stronger preparation than is commonly now the case. Inservice institutes for teachers, for specialists, and for other academic leaders

ought to be supported at an even higher level than they are now. Excellent curriculum materials for all levels of pre-college mathematics are available but are not widely used, and when they are adopted in schools, they are often not well used. The success of new and better curricular material in classrooms seems to be principally dependent on the competence and attitudes of teachers and other school personnel. Programs that would help educators choose and use the best available materials effectively would have a positive effect.

(3) The inefficiencies of developing curriculum material through government grants are well known. Perhaps a more effective procedure would be to spend a reasonable amount of money to evaluate what is now available and all new material as it is produced. Then, identify good materials and reward those curriculum developers who produce particularly good materials.

(4) Standardized tests, curriculum guides, and other materials, as well as textbooks, have a monopoly on the attention of teachers (and therefore of pupils). Reducing the emphasis on such materials by society at large, and therefore by teachers and children, is probably at least as important as improving those materials.

AN EVALUATION OF THE SMMTS PROJECT: FINAL REPORT

by

Sharon L. Weinberg

This is the final evaluation report on the effectiveness of Supplementary Mathematics Materials for a Technological Society (SMMTS) in its second pilot year, 1989-1990.

Based on a one year field-based design, this program evaluation was structured to inform decision-making regarding future implementations of the SMMTS program. Accordingly, the evaluation focused on the variety of components that define and constitute this curriculum effort: pre-service workshops, supplementary lessons, students, teachers, administrators, and overall school context.

In broad terms, the evaluation was process-oriented as it was concerned with the quality and quantity of program inputs and activities, and with the socio-political context in which the program operated. It was also outcome-oriented in its concern with measuring changes in student knowledge and attitudes. To attempt to rule out alternative explanations of observed changes, an experimental-control group design was employed in two of the four sites tested. Key questions addressed were:

-- What were the reactions of teachers to the one-day pre-service workshops, conducted to introduce them to project materials?

-- Were the workshops sufficient to prepare teachers for participation in the program?

-- What prior experiences and knowledge did teachers have in the area of technology?

-- What were teacher reactions to the supplementary lessons?

-- What were student reactions to the supplementary lessons?

-- How many supplementary lessons were taught? Did extent of coverage vary as a function of instructional device (calculator, computer)?

-- Did students exhibit positive growth in knowledge and attitudes?

-- Did such growth vary as a function of program implementation?

-- What were key impediments to implementation?

-- What features need to be in place in order for the SMMTS program to be implemented successfully in the future?

Design Overview

A sample of children and teachers in grades 1 through 6 from four different sites in the United States participated in the project during the academic year, 1989-1990. Three sites were in New York State (Brooklyn, New Rochelle, and Newburgh) and one was in Arizona (Tucson). In Brooklyn and in New Rochelle, the study was conducted within the context of an experimental-control group design. In Arizona and in Newburgh, however, the study was limited, by necessity, to an experimental group only design. Because of the diversity that existed across sites in terms of demographic and other school related variables, each site is described and discussed separately in this report.

NEW ROCHELLE

The students who participated in the SMMTS program from New Rochelle were from lower middle to middle class neighborhoods of mixed ethnic backgrounds. Although a total of 29 classes from eight different schools participated (see Table 1 for a breakdown of classes by grade and school), because of limited funds and resources, only 22 classes were monitored. They were selected from two elementary schools (grades K - 5) that served similar neighborhoods and the only two middle schools (grades 6 - 8) in the district. Of the 22 classes, nine were in the control group and thirteen were in the experimental group. Table 2 indicates the breakdown of classes by grade, school, and experimental/control group designation for New Rochelle.

The textbook in use for grades one through five was from Open Court (Real Math) and from Harcourt Brace for grade six. Although not all children and teachers who participated in this non-pilot year had previously used the supplementary materials, 1989-1990 was the second year that this program was in place in New Rochelle.

The district has a math coordinator, who was an active advocate of the program, and each school had its own computer lab specialist and computer lab. Sharon Weinberg had primary responsibility for the coordination of evaluation activities at this site.

Pre-Service Workshops

One-day calculator and computer workshops were presented to all participating New Rochelle teachers in early September, 1989. All participating teachers completed a workshop evaluation form at the conclusion of each workshop. Sample copies of the workshop evaluation forms are attached in Appendix A.

Based on the responses of the fifteen teachers who returned completed copies of the workshop evaluation forms, New Rochelle teachers appeared, in general, to be satisfied with the workshops.

With respect to the calculator workshop, in response to question 2, "To what extent has the workshop met your anticipated needs?", ten teachers responded, "most of my needs have been met," one teacher responded, "almost all of my needs have been met," and four teachers responded, "only a few of my needs have been met." A similar pattern of response was noted with respect to question 3, "Did you get the kind of training you wanted?". Twelve teachers responded, "yes, generally," and three teachers responded, "No, not really." With respect to the computer workshop, the same pattern of response was noted relative to these two questions.

Additional comments that were made on the forms echoed those of other sites. In particular, teachers wanted information presented by grade level; they did not believe the calculator workshop was appropriate for grades 1 and 2. They also asked for more hands-on work with the computer.

During subsequent interviews (see Appendix A for a sample copy of the teacher interview guide), conducted after the teachers had a chance to work with the project materials, two teachers at the sixth grade noted that although the workshops provided basic, or fundamental knowledge, what was needed was a workshop devoted to pedagogical practice, and, in particular, to "teaching techniques that are tailored to the specific textbook series in use in the classroom."

Several other teachers noted on the exit questionnaire (see Appendix A for a sample copy of this questionnaire) that a workshop during the year (e.g., January) might have helped solve some problems that teachers faced while using the materials in the classroom.

In summary, although teachers were generally satisfied with the workshops at their immediate conclusion, some of the comments suggest that the workshops should have been tailored more closely to the textbook series and to particular grade levels. Moreover, teachers requested more hands-on experience with the computer and additional workshops, scheduled during the academic year after they had had the chance to teach from the materials in the classroom.

Supplementary Lessons

The number of completed calculator and computer lesson evaluation forms (see Appendix A for a sample copy of this form) are presented in Table 3 by class within grade for New Rochelle.

According to Table 3, teachers varied in the number of calculator lessons they taught. The fewest number were taught in the sixth grade. (Note: sixth grade teachers had not taught from this material previously.) In general, teachers in New Rochelle did not attend to the computer aspect of the project.

Calculator Lessons. With the exception of one sixth grade teacher, teachers appeared to be quite happy with the calculator lessons they covered. Of the nine experimental group teachers who returned the exit questionnaires, the following pattern of response to question 37, "Overall, how would you evaluate the calculator lessons you have taught thus far?" was: 2 Excellent; 5 Very Good; 1 Good; 1 Poor. The one rating of Poor was from a sixth grade teacher.

Some more descriptive comments made by teachers in response to question 28 of the exit questionnaire ("How do your students react to the calculator activities?") were:

Grade 1: "They enjoy using them."
Grade 1: "Excited and motivated -- they ask to use them and are at ease with them."

Grade 2: "The children are enthusiastic and eager to work with the calculator."

Grade 3: "They were excited at first, but towards the end when they got to exponents they got frustrated. Easier pages were fun."

Grade 4: "They cannot wait to get their hands on the calculator."
Grade 4: "The very good math students were quite excited and engaged by the activities. The students who have more difficulty with math liked the idea of using the calculator, but were sometimes frustrated. For example, the lesson involving time frustrated them."

Grade 5: "The students are motivated and challenged because all activities are in a cooperative learning setting."

Grade 6: "Students are motivated and excited. They enjoyed these activities."
Grade 6: "Frustrated. Their work was teacher directed or in groups."

The more negative sixth grade teacher commented at one interview during the year that lesson one was "difficult to present" because the knowledge required by this lesson had not yet been covered in class. In general, the problem, in her view, was that the supplementary lessons did "not fit the sequence of topics in the HBJ textbook."

On the matter of experience, a fifth grade TAG teacher wrote, "For the first time, every student had a positive attitude towards use of calculators. This class piloted the program in fourth grade also. Perhaps it needs continuity and repeated exposure for ease and comfort of use!" She added that the success of the calculator lesson on percents was also likely to be due to the fact that it was a direct outgrowth of the lesson on percents in the Real Math textbook. In general, she noted that "if a lesson can be well-integrated into the math curriculum, it will work out better." One teacher reported receiving positive feedback from parents on the use of calculators in the classroom, and at holiday time, many children requested calculators from their parents as gifts.

One fourth grade teacher reported the following. "Many of the children in my class had used calculators in third grade, as part of your program. I was impressed that they remembered some games and particularly, that they were very familiar with negative numbers. I was also excited to see how the children played with numbers. They seemed much more free to experiment with numbers than I've ever noticed them feeling when they use just paper and pencil. I had not fully anticipated that this could be one of the especially beneficial aspects of using calculators! I particularly enjoyed the games suggested. One child figured out the square root key and what it does with some guided practice from me. He was very excited and then articulated his discovery beautifully."

Computer Lessons. With so few computer lessons taught, it is difficult to assess the computer component of the project in New Rochelle. Moreover, teachers only taught lessons from the spreadsheet and database programs to the exclusion of the graphing program. An explanation for why teachers did not cover the graphing program is offered by K. Goldberg. "The graphing activities, which might have been expected to have the largest frequency of implemenation because they so clearly fit the mathematics curriculum, were used the least. This was probably because the graphing activities made use of charts completed in the database activities. Consequently, teachers who did not complete the database activity could not go on to the graphing activity. The final version of the teacher's guide indicates that the graphing activities can be used independently of the database activities by simply providing the students with the appropriate charts and tables from which to work."

Of the three teachers who did implement computer activities, one evaluated the lessons overall as excellent, one as good, and the third wrote, "I was not impressed with the computer aspect of this program." Two teachers noted that the computer activities needed to relate more directly to what was taught, and that in its current form the activities form too much of a "stand-alone package." To exemplify the lack of linkage between the supplementary computer materials and the mathematics curriculum, one teacher noted that "the New York State curriculum guide does not list the statistics that are required by the graphing program." Another teacher wrote that the "children enjoyed the lessons, but they were too long to hold their attention." Finally, one middle school computer specialist noted that, in her view, "the readability index of the computer workbook was well above the sixth grade level."

Student Growth

Typical to studies conducted in the school setting, intact classes, as opposed to individuals, were assigned to experimental and control groups. Because classes are not tracked within New Rochelle, but are composed of students of mixed abilities, and because the activities of the SMMTS program are carried out by students on an individual basis, the unit of analysis for this aspect of the evaluation was considered to be the student rather than the class as a whole. To confirm that experimental and control groups were comparable on related abilities, and to rule out the possibility that initially the experimental group, for example, was more advanced academically than the control group, national percentiles on the reading and math (concepts, problems, computation, and total) Iowa tests, taken during the Spring, 1989, were obtained from school records for each participating student in grades 2 through 6. Table 4 contains means and standard deviations and t-tests on each of the five Iowa tests by group and grade, as well as overall. According to Table 4, with the possible exception of the reading scores in grade five, all larger differences between groups favor the control group. Accordingly, any observed group differences in growth between groups which favor the experimental group are unlikely to be due to an initial academic advantage of the experimental group over the control group.

To assess student growth in both computer and calculator knowledge and attitude, tests were developed by the evaluation staff and the principal investigator.

Calculator knowledge pretests were administered to all students by class in September by S. Weinberg after she gave a ten-minute introduction to the calculator. The same knowledge and attitude tests were administered in June as posttests. In addition, at the request of the Evaluation Board, a twenty-one item test, designed specifically to tap those fourth grade mathematical concepts covered by the fourth grade SMMTS curriculum, was developed by S. Willoughby in April. This test was administered to all fourth grade classes in June as a posttest. In the interest of fairness, care was taken to explain, on this test itself, concepts which some children might not have been exposed to previously through the regular mathematics curriculum. Moreover, for fairness to the control group, this test was designed to be completed without the aid of a calculator.

The computer knowledge test was administered twice, in September and in June. Knowledge of three different computer programs is assessed on the computer knowledge test: a data base program (items 1 - 5), a spreadsheet program (items 6 - 10), and a graphing program (items 11 - 17). Scoring and data entry were carried out by S. Weinberg. Sample copies of all tests are provided in Appendix B.

Knowledge Growth. Table 5 contains means and standard deviations for the experimental and control groups by grade for the calculator and computer knowledge pretests and posttests, respectively.

Pretest-Posttest Gains: E Group Only. It was reasoned that unless the experimental group demonstrated positive growth with respect to the SMMTS materials, there would be little justification to ask whether experimental group performance surpassed that of the control group. Hence, preliminary to comparing the performance of experimental and control groups, a series of paired group t-tests was carried out on the experimental group only to compare September (pretest) with June (posttest) knowledge with respect to both calculators and computers, by grade.

According to Table 5, in all cases where data were available, experimental students demonstrated positive learning with respect to the calculator component of the SMMTS curriculum. Although not shown in Table 5, all increases in calculator knowledge were highly statistically significant ($p < .0001$).

For the computer, pretest and posttest means were virtually identical, suggesting, not unexpectedly given the low computer implementation at New Rochelle, no growth in this area for New Rochelle.

Pretest-Posttest Gains: E vs C group. To determine whether the observed experimental group gains in calculator knowledge were greater than the corresponding gains of the control group, a series of t-tests on difference scores (posttest - pretest) was carried out on the available data, for grades 1, 3, 4, and 6 (see Table 6). (In addition to the fact that posttest data were not available for the experimental fifth grade, posttest data were also not available for the control second grade.)

According to Table 6, at least for grades 3, 4, and 6, the noted experimental group pretest to posttest mean gains were also statistically significantly higher ($p < .10$) than those of the control group, providing even stronger evidence that students gained positively as a result of their exposure to these materials.

Because the special fourth grade test was given only as a posttest, and pretest scores were not available, the more simple and straightforward difference scores could not be computed. Accordingly, for this fourth grade test, gains were computed as "regressed gains" via a series of analyses of covariance with the total math score on the IOWA test, administered during the Spring of the previous year (1989) as the covariate.

Moreover, because the fourth grade test addressed five discrete areas of study, five separate analyses of covariance were carried out, one for each area of study. The first area of study (items 1 through 4) assessed whether students understand making inference from patterns; the second area (items 5 through 10) assessed whether students understood arithmetic operations with negative numbers; the third area (items 11 through 15) assessed whether students understood exponentiation; the fourth area (items 16 through 18) assessed whether students understood approximation; and the fifth area (items 19 through 21) assessed whether students understood an assortment of techniques including exponentiation, approximation, and working with time.

Results of these five separate analyses of covariance suggest a significant difference between groups on only the three-item approximation subscale ($p < .02$). In this case the adjusted mean for the experimental group was 1.98, and for the control group, it was 1.55. No other statistically significant differences were observed to exist between groups. It should be noted, too, that the assumption of homogeneity of regression that underlies the analysis of covariance procedure was met for these data.

Attitude Change. Based on separate factor analyses of the calculator and computer attitude tests, two different factors emerged for each test. Because the factors of the calculator test were quite similar in content to those of the computer test, these factors were labelled more generally, "technology as an adjunct to learning" and "trusting answers derived from technology."

For the calculator test the first factor consisted of items 4, 6, 8, 10, 11, and 13 and the second factor consisted of items 3, 9, and 12. For the computer attitude test the first factor consisted of items 3, 4, 7, and 8 and the second factor consisted of items 1, 6, 9, 12, and 13.

A higher score on factor one suggests that a student believes that calculators (or computers) are useful learning tools and a higher score on factor two suggests that a student does not view calculators (or computers) as tools that necessarily provide the correct answer at all times.

Table 7 contains means and standard deviations for the experimental and control groups, calculated across all grades, for subscales one and two of the calculator and computer attitude pretests and posttests, respectively.

Pretest-Posttest Gains: E Group Only. Following the same pattern of testing as employed in assessing knowledge growth, a series of paired t-tests was carried out on the experimental group only to determine whether the attitudes of experimental students in June (posttests) were more positive than their attitudes in September (pretests).

According to Table 7, results of these tests suggest that for the calculator, students were significantly more positive in their attitude at the end of the year than at the beginning with respect to both subscales one and two ($p < .001$). With respect to the computer, however, positive attitude change was not evident ($p > .05$), reflecting the limited degree of implementation of the computer in New Rochelle.

Pretest-Posttest Gains: E vs C Group. Because positive attitude change from September to June was noted for the calculator only, experimental-control group comparisons in attitude change were carried out with respect to the calculator only. According to two-group t-tests, a statistically significant difference emerged only on calculator subscale two ($p < .03$). The mean gain for the experimental group on this three-item subscale is .512 ($n = 207$), and .103 for the control group ($n = 145$). As a result of participating in the program, students appear to understand that calculators cannot be expected to produce the correct answer at all times, and that human interface is an important component to calculator use. As the demystification of the calculator as a panacea to solving math problems was a key goal of this program, this finding is an important one.

Impediments to Implementation

According to Table 3, and as noted earlier, many more calculator lessons were covered than computer lessons, and only one teacher covered all calculator lessons provided. Based on this evaluation, the less than complete coverage appears to be due to several factors mentioned below.

1. Classroom management.
One teacher commented in an interview, "I must remember to use the calculator at times when a second person is in the room since the children become restless when I circulate around the room to help them individually." Others reported similar problems.

2. Link with curriculum.
Several teachers noted that to be more effective, the lessons needed to be tied more closely into the specific math content being taught. Although this was true for the calculator, it appeared to be especially the case for the computer where lessons were taught not by a math teacher, but by a computer specialist, outside the classroom, and where teachers viewed the computer activities as not math skill-enhancing, but solely as computer skill-enhancing.

3. Teacher beliefs.
One teacher believed that computers for data base, graphing, and spreadsheet activities were not appropriate at the elementary level. In her view, activities were needed instead, in logo, etc. which encouraged critical thinking in math.

4. Time demands.
Several teachers noted that an unrealistic amount of time was

required for both sets of activities, but especially for computer activities. Many reported that individual lessons took far longer than anticipated.

5. Teacher training.
Most teachers had very limited experience with the calculator in the classroom; and no experience with the computer. Although the project staff did provide an introduction to the technology in the form of one-day workshops, this introduction was clearly inadequate, especially for the computer. Training and practice in technology and related materials need to be long-term and ongoing.

6. Support personnel.
In the face of a variety of demands on teaching time, administrators needed to support teachers more with aides and other classroom assistance. In the case of the computer, the availability and support of a computer specialist appears critical. Administrators also are needed to help teachers set priorities for which of the many competing programs should get taught in the classroom.

BROOKLYN

The Brooklyn students in this project were from lower middle class neighborhoods of mixed ethnic backgrounds. The textbooks in use were published by Houghton Mifflin, Scott Foresman, and Holt, Rhinehart & Winston. This was the first time these students were exposed to these supplementary activities.

A total of 33 classes from six schools (three schools at the elementary level, K-5, and three schools at the intermediate level, 6-8) of a single school district in Brooklyn participated in this field test. Table 8 contains a breakdown of all classes by grade, school, and experimental/control group designation for this site. Because of limited funds and resources, only twelve classes in the experimental group and six classes in the control group were monitored. Because the sixth grade control group teacher was uncooperative, only limited data were available from this class for analysis.

The district has its own math coordinator and grant writer, and each school has its own computer specialist. The math coordinator and grant writer were instrumental in securing their district as a test site for the field study. Project staff members, Kenneth Goldberg and Bernadette Russek, had primary responsibility for coordination of evaluation activities at this site.

Pre-Service Workshops

Calculator and computer workshops were presented in Brooklyn in early September, 1989. Thirty-four teachers participated in the calculator workshop and twenty-one teachers participated in the computer workshop. As in New Rochelle, all participating teachers completed a workshop evaluation form at the conclusion of each workshop.

With respect to the evaluation of the calculator workshop, responses to question 2, "To what extent has the workshop met your anticipated needs?", were fairly evenly split between alternative two, "only a few of my needs have been met," and alternative three, "most of my needs have been met." Alternative 2 received 14 responses; alternative 3 received 15 responses. With respect to question 3, "Did you get the kind of training you wanted?", 13 responds were negative and 21 were positive.

A sampling of salient comments written on the evaluation form included the following:

"Would like more information for primary grade children."

"There is a need to understand how this program is to be implemented in conjunction with the required math program."

"More time should have been spent on individual grades to show grade appropriate work."

"Workshop was too advanced for lower grades."

"Would have liked workshop to go over examples that the children will be doing and to demonstrate methods of solution."

With respect to the evaluation of the computer workshop, results also were evenly split between positive and negative responses. For question 2, 11 responses were negative and 10 were positive; for question 3, 10 were negative and 11 were positive. The workshop was held in a computer lab, but without hands-on activities. Teachers were frustrated by this as evidenced by the following comments.

"Teachers, as well as students, need hands-on workshops. The computer screen [at the front of the room] was difficult to see -- the printed material helped, but the boredom factor set in. If you had any computer experience with Appleworks, the material presented was too basic to be useful -- if you had no experience, the material presented was overwhelming."

In subsequent interviews conducted by B. Russek during the Fall semester, teachers reported that the workshops did not prepare them for teaching the supplementary lessons. In response to these complaints, K. Goldberg conducted follow-up workshops at each school which were primarily of the "hands-on" variety. However, in teacher written exit questionnaires submitted in June, most teachers continued to report that neither the preservice nor the inservice workshop prepared them to teach the activities in the program.

Teachers made suggestions on the exit questionnaire for how to improve the workshop. These agree strongly with the earlier suggestions reported for New Rochelle. They are listed here for completeness.

"Doing examples of the type of problems the workbook contained would have helped."

"Role playing with one or two lessons would have been helpful."

"Advice on problems that were the hard parts and what needed to be included."

"A better introduction to calculators might have been helpful."

"Workshops ought to be designed for specific grades."

Supplementary Lessons

The number of completed calculator and computer lesson evaluation forms are presented in Table 9 by class within grade for Brooklyn.

According to Table 9, with the exception of teachers in grades 2 and 6, teachers completed few calculator lessons. As in New Rochelle, the teachers in Brooklyn did not implement, even modestly, the computer activities. Moreover, only lessons on the spreadsheet program were completed. The graphing and database programs were not taught at all. K. Goldberg offers the following explanations as to why the spreadsheet activities were relatively more popular. "Although the teachers were instructed to teach the activities in any order they chose, the spreadsheet activity was likely to be chosen because it appeared first in each booklet. In addition, unlike the other activities, the spreadsheet activity did not require the manipulation of data or the use of cumbersome menus. Moreover, the spreadsheet activity did not require the student to switch among two or more display screens; all the information needed to work on a problem was in clear view at all times. In short, the spreadsheet activity was the least complicated of the three activities."

Calculator Lessons. Based on the collection of calculator lesson evaluation forms received, the vast majority of teacher ratings of lessons (approximately 40) were "good," five were "excellent," nine were "fair," and four were "poor."

Based, in addition, on classroom observations, informal interviews, and teacher written exit interviews, it seems clear that for various reasons, calculator lessons were modified extensively. Teachers presented lessons in a way they thought best for their students, and most compatible with their own beliefs and interests.

In general, the teachers liked the calculator activities because they were "highly motivating," and provided "reinforcement of ideas." The teachers also believed, however, that "many lessons assumed too much" and "were too difficult." Accordingly, teachers noted a need to "alter and water down" many of the lessons.

Some teachers also reported a need for an aide in the classroom during the lesson to help with classroom management problems that arose, and a need for more examples "for success."

Observations of two teachers by B. Russek, one at grade 2 and one at grade 4, revealed two highly competent teachers who adapted the materials to low-achieving classes. Both teachers felt confident to modify the materials according to what they felt was appropriate for their students. In particular, each teacher was concerned with students having successful experiences and 'having fun' rather than learning new concepts. Both teachers were comfortable and capable using the calculator. They understood the lesson objectives and developed them accordingly. Both teachers had excellent classroom management skills. Presentations were considered excellent.

A sixth grade teacher was also observed by B. Russek. This teacher liked the "project" approach of many of the lessons and the teacher tried to carry over what they learned from other lessons -- calculator and non-calculator. Students participated enthusiastically, were facile with the calculators and appreciated using them as a tool. They were able to handle 'what if' questions comfortably with the calculator. Moreover, students appeared to be focused on the notions of the lessons rather than the calculator itself -- they used the calculator as a serious tool to solve problems. This teacher made the comment that she felt that her students learned a lot more than what they displayed on the posstests and that she felt badly about this. (It should be noted that this teacher's posttests were lost in transit.)

<u>Computer Lessons.</u> As noted earlier, only the spreadsheet program was taught by one computer specialist in grades three, four, and five. The classroom teachers did not involve themselves at all in the teaching of computer lessons in Brooklyn; they assigned the task of teaching the computer activities, in their entirety, to the computer lab specialist within the school. Classroom teachers did not even teach the material that was deemed prerequisite to the computer lesson itself, nor did they communicate with lab personnel about ways to integrate the material into the math curriculum.

Structural problems interfered with the teaching of the computer lessons. One computer lab specialist, who did assume responsibility for the computer component in her school, complained that because the computers in her lab were not networked she had to load Appleworks individually on each computer before students arrived. Given the short space of time between classes, this was a near-impossible task, one that left no time to go over the materials, even briefly, before the lesson began.

This same computer specialist reported during an interview that at the third grade, there were problems with respect to the reading level of the Children's Workbook and the length of the lessons. She said that,"the lessons in the workbook are too long. They do not focus on one activity. They expect too much prior knowledge on the part of both the teacher and the third grade student. The vocabulary in the workbook is difficult (entries, original, maximum, automatically, etc.) for an average or below average class."

B. Russek observed this computer specialist teach a lesson in the lab with a lab assistant present. A summary of this observation follows.

The computer teacher was quite facile with loading the software, explaining the menu, and using the operating system. She lectured or gave directions all period. Few concepts were developed. There was little build-up or discussion of what the lesson was all about. The lesson appeared to be bits of isolated information, stepping through the mine-field of the software, nothing else. The students were moderately well behaved, not very interested, and exhibited little initiative. They needed a lot of help to use the software. They did not appear to understand the objectives of the lessons. The need to 'boot-up' the machines as noted above, was not only time consuming, but also very wearing on the teacher.

Student Growth

Following the same procedure as in New Rochelle, but with B. Russek in charge, pretests were administered in September and posttests were administered in June to all 18 classes in Brooklyn. In addition, assessments made during the Spring, 1989, of students' initial reading (via the Developmental Reading Profile) and mathematics abilities (via the Metropolitan Achievement Test) were obtained from school records. Table 10 contains means and standard deviations on these measures for the experimental and control groups in grades 1 through 6. Overall, the two groups were comparable in both reading and math ($p > .55$). By grade, there were no statistically significant differences between groups in mathematics ($p > .45$), but there were differences however, in reading ($p < .05$). In grades 3 and 6, the experimental group exceeded the control group; in grade 4, the control group exceeded the experimental group.

Knowledge Growth. Table 11 contains means and standard deviations by grade for the calculator and computer knowledge pretests and posttests for experimental and control groups. The one control group teacher at grade 6 was uncooperative, and so only experimental group results are presented for this grade. Moreover, with such wide variation in cell sizes, especially for the control group from pretest to posttest, a comparison of growth must be interpreted with extreme caution for this site.

Pretest-Posttest Gains: E Group Only. Following earlier practice, experimental group pretest and posttest means were compared initially to determine whether those exposed to the materials demonstrated any growth at all over the academic year. Although all experimental classes showed increases in calculator knowledge from pretest to posttest, a series of paired t-tests suggests that increases were statistically significant only for grades 1, 2, and 3 ($p < .001$). As expected, based on the limited computer implementation in Brooklyn, no increases in computer knowledge were observed from pretest to posttest for any of the grades 3, 4, or 5.

Pretest-Posttest Gains: E vs C Group. To compare the noted experimental group gains in grades 1, 2, and 3 to those of the control group, a series of independent groups t-tests were carried out on posttest-pretest difference scores (see Table 12). Unfortunately, few cases had complete sets of data on both pretests and posttests. Accordingly, the t-tests of Table 12 must be interpreted with much caution. For grade 1, results were in the predicted direction ($p < .001$), but not so for grade 2. Grade 3 could not be tested because there was only one score in the control group.

Despite the small cell sizes, an assessment of gains for both the experimental and control groups in terms of the special fourth grade posttests, was also carried out in Brooklyn. Because of the observed initial differences in reading between the experimental and control group fourth grades, and in the absence of special fourth grade pretests, a series of analyses of covariance was carried out with the developmental reading test as covariate and the individual subtests as separate dependent variables. As in New Rochelle, the assumption of homogeneity of regression was met for these data. According to this series of analyses of covariance, the experimental fourth grade (with adjusted mean 2.73) surpassed the control group (with adjusted mean 1.44) in area two only, concerning the understanding of negative numbers ($p < .001$). In all other areas, there were no statistically significant differences between the two groups.

To reiterate, the presence of only few observations per cell for these data, suggests that, for Brooklyn, this statistical comparison of gains must be interpreted with extreme caution. One finding that does appear to emerge from these analyses, however, is, as one would expect, where implementation is greater (i.e., in New Rochelle as opposed to in Brooklyn), student growth is greater as well.

Attitude Change. Table 13 contains the means and standard deviations of pretest and posttest scores (subscales 1 and 2) for both the calculator and computer. Recall that subscale one measures the extent to which calculators are viewed as useful learning tools and subscale two measures the extent to which calculators do not necessarily provide the correct answer at all times.

Pretest-Posttest Changes: E Group Only. According to a series of paired t-tests, students in the experimental group showed positive change on calculator subscale two ($p < .001$), but not on calculator subscale one ($p > .50$).

With respect to computer attitude, as in New Rochelle, there was no evidence of positive growth in attitude on either subscale.

Pretest-Posttest Changes: E vs C Group. According to an independent groups t-test on pretest-posttest difference scores in terms of calculator attitude, the experimental group demonstrated a statistically greater change in computer attitude than the control group on subscale two ($p < .013$). As in New Rochelle, then, the students in Brooklyn exposed to the SMMTS materials learned that calculators do not necessarily provide the correct answer at all times.

Impediments to Implementation

The impediments to implementation listed earlier were not unique to New Rochelle; they were present in varying degrees in Brooklyn as well. Some comments particular to Brooklyn are listed under each of the six factors enumerated earlier. An additional, seventh, factor is listed here as well.

1. Classroom management.
One fourth grade teacher commented in an interview, "I have a large class of 27 students who are average to below average ability. It is a difficult class, there is no teacher's aide to help, the lessons need the teacher to monitor student responses, but I can't be everywhere at once."

2. Link with the mathematics curriculum.
The Open Court series is not in use in Brooklyn. As a result, the link of the SMMTS materials with the textbook is more tenuous here than in New Rochelle, and may account, in part, for the lower implementation here. Teachers reported that some of the lessons were too advanced or difficult, given what was being taught under the regular mathematics curriculum. For example, one fourth grade teacher reported that students were intimidated by the decimal point in the early lessons and so she skipped those lessons. Also, the mixed sign notation (e.g., -7) confused them. Finally, this teacher did not think that her students would be able to do exponents because "they are not that sharp." Several teachers reported that lessons took too long ot complete. To be more

consistent with the presentation of the regular math curriculum, teachers requested that lessons be broken up into smaller units.

3. Teacher beliefs.
As in New Rochelle, some teachers questioned the appropriateness of using calculators in the classroom. One teacher noted that she did not believe in using calculators for this age level for basic skills and given the option, she would not use them. She was concerned that students would begin to use the calculators as a "crutch."

4. Time demands.
As in New Rochelle, teachers complained about the inordinate amount of time they were having to spend on the project; time they believed they could not justify in some cases. In part, the extra time was spent modifying the lessons to meet the needs and abilities of their own classes.

5. Teacher training.
As in New Rochelle, teachers had limited prior classroom experience with the technology, especially the computer, and the one-day workshops were inadequate to fill the knowledge gaps. Only one "exceptional" teacher implemented the computer activities on her own, with only some support form the computer specialist. This teacher was computer knowledgeable. A more detailed description of her reactions to the project is given in a succeeding section, "Additional Observations." In one other school, computer activities were carried out by the computer specialist in the computer lab. The participating SMMTS teachers did not assist her, or give preparation lessons, or even observe what was happening in the computer lab. The specialist reported that she was putting an "inordinate amount of time" into the project, and although she liked the whole idea, she would not recommend it to any other schools unless the materials were revised. She believed that the Teacher Guide assumed computer knowledge and software knowledge that the ordinary teacher does not have and that even she finds difficult. Furthermore, she believed that "the lessons needed to be broken down into more digestible units, in time, concepts, and in level of difficulty."

6. Support personnel.
Although all principals, assistant principals, and the math coordinator were all cooperative and helpful, the project might have run more smoothly had these administrators known more about the project and what it entailed for teachers. For example, there was confusion about who was to carry out the computer activities (the teacher and/or the computer specialist) and about what material the teachers were supposed to receive. Leaving these concerns up to the teachers created problems in Brooklyn.

7. Resistance to reading the Teachers' Guide
Teachers resisted reading the Teachers' Guide, instructions, or

other materials. In one school a teacher suggested to a project staff member several activities that "ought to be added to the program." Since the activities were already included as suggestions in the Teachers' Guide, the staff member asked the teacher whether she had read the Teachers' Guide. The teacher replied that she never reads teachers' guides. Several other teachers in the same school admitted happily that they too never read teachers' guides.

Additional Observations

As mentioned earlier, there was one "exceptional" teacher in Brooklyn who was computer knowledgeable and who taught the computer lessons by herself. The reactions of this well-trained teacher are provided to suggest and underscore the importance of teacher training to the success of such a project.

This teacher liked the activities very much and said that the children were motivated and were learning "a lot." She used the computer specialist as a resource person only, and carried out all the 'hands-on' activities without assistance in the computer lab. The class was brought to the computer lab and two children worked at each computer. The teacher was very enthusiastic about the "project approach" of the activities. She noted that the "children can really get into it. There is enough of it so if they don't understand it at the beginning, by the end, they were getting there." She said that the first unit took five class days and she had to do a lot of background preparation for the activity, such as re-teaching decimals and percent. But, she said, it was time well spent. She expected, at the time of the interview, to modify all lessons to suit her low achieving class.

In addition to underscoring the need for properly trained teachers, this vignette underscores the importance of the teacher's own motivation level in participating in the project. From this situation, and others, it appears clear, that unless a teacher is motivated and excited about the project herself, it will not be implemented in the classroom.

TUCSON

The Tucson Hebrew Academy is a small private institution which serves a Jewish upper middle class community. Admission to the school is on a selective basis; therefore, the student body tends to be homogeneous and of above average ability. One class per grade 1 - 6, representing a total of 134 students, participated in the project. The textbook series in use was Real Math.

In general, this was the second year that these students and teachers used the supplementary materials. Although a fifth grade teacher was designated as the math coordinator/computer specialist for the school, she had her own classroom teacher responsibilities, as well, and therefore, could not be responsible for teaching the computer activities to all students in the project. Accordingly, each classroom teacher was responsible for teaching the supplementary computer lessons to her own class. The computer specialist was viewed as a resource person, someone to whom the teachers could turn for help.

There was a computer lab in the school, which was highly accessible. Teachers were able to sign up for the lab as late as only one hour before they wished to use it. Project staff member, Louise Pate had primary responsibility for coordinating the evaluation activities at this site.

Pre-Service Workshops

Workshops were conducted in August, before workshop evaluation forms had been printed. All teachers participated, and according to informal evaluations of workshops conducted by Stephen Willoughby and Louise Pate, teachers were satisfied with the workshops at the time they were given. Some later comments about the workshops in subsequent interviews during the year and on the exit teacher questionnaire emphasized the difference that existed in teacher satisfaction between the calculator and computer workshops.

With respect to the calculator workshop, teachers, in general, appeared to be satisfied. Although one teacher reported that "the workshop needed to be more specific for each grade level," two other comments were perhaps more representative of other comments in Tucson. One teacher noted that the calculator workshop provided a "very good introduction, especially regarding the scope and sequence of activities to be covered;" and another teacher noted that she didn't "really feel the calculator requires much more than what was given." She added that "the review was helpful at the beginning of the year just to refresh us."

Teachers felt less satisfied with the computer workshop, most likely because initially, they lacked the familiarity and expertise with the computer that they enjoyed with the calculator. One teacher noted that "it would have been better to have more training in how to do actual lessons on the computer." Another teacher wrote that she "would like to have had a week or so of intense computer instruction -- hands on (my hands). 'I do and I learn'." These two responses appeared to be representative of those in the Tucson group.

Supplementary Lessons

Table 14 contains the number of calculator and computer lessons completed by teachers at this site. Implementation for both calculator and computer was high in Tucson.

Calculator Lessons. Six teachers participated in the calculator component of the project in Tucson, one per grade level. Of these six, four gave responses of "excellent" and two gave responses of "very good" to question #37, "Overall, how would you rate the calculator lessons you have taught thus far?" Clearly, the teachers at Tucson were extremely satisfied with these supplementary calculator lessons.

The following responses to the question "How do your students react to the calculator activities?" provide additional evidence of the high degree of enthusiasm that existed in Tucson for the calculator component of this project.

Grade 1: "With enthusiasm, excitement and interest to meet a new challenge."

Grade 2: "All the children look forward to calculator time."

Grade 3: "Excited, yet frustrated at times...Everyone enjoys them."

Grade 4: "Excited -- they love the challenge -- I look at this as excellent enrichment."

Grade 5: "Motivated, excited. They enjoy the lessons -- an extra enrichment with new or 'different' media."

Grade 6: "They enjoy them. As a matter of fact the calculator is a part of our everyday math. Very often they'll get out their calculators to double check problems, or verify answers. At times, they'll whip out their calculators if we're working with 'bigger' numbers in social studies or other subjects."

Computer Lessons. In sharp contrast to the responses of the teachers at the other sites, three of the four teachers who participated in the computer component in Tucson rated the lessons as excellent; the fourth rated them as very good. Yet, all teachers but the computer specialist, described the extent of their experience with the computer as "minimal," and were "not confident" about their computer abilities.

An explanation for these apparently contradictory comments is that Louise Pate or Ken Goldberg taught all the computer lessons for all teachers in the school except for the computer specialist. She taught her own lessons. As articulated by one teacher, "I took my class into the computer room and either Louise or Ken taught the lessons and I helped. Also, I did the preliminary work in the workbooks and the follow up in my classroom by myself."

One teacher who rated the lessons as excellent, qualified her rating with the following comment: "But teaching the lessons shouldn't be such a struggle. Hours and hours are required for preparation and help is needed from a specialist."

All Tucson teachers agreed that if others wished to implement the computer part of the project in their own schools that help would be needed in the form of a full-time, trained computer specialist. Clearly, the teachers' own lack of confidence in computer skills factored greatly into their evaluations of the computer component for future implementations.

In sum, one teacher wrote, "Learning to operate a computer takes time and practice. Because of my lack of experience, I had to rely on others and when they could be at school for my class. Therefore, the lessons were a pain to an extent. For the computer component to be effective in the future you would need (1) a teacher who knows how to run computers well, (2) time to schedule the lessons close enough together, and (3) at least one computer per two children" (as was the case in Tucson).

Student Growth

Calculator and computer knowledge and attitude pretests were administered to all participating students in September, 1989, and corresponding posttests were administered in May, 1990. The special fourth grade calculator posttest was administered to students of the fourth grade in May. The fourth grade teacher did not also administer, as she was supposed to, the calculator posttest corresponding to the fourth grade calculator pretest. As a result, student growth in calculator knowledge at the fourth grade could not be assessed at this site.

Knowledge Growth. Table 15 contains means and standard deviations of all knowledge pretests and posttests by grade, and where appropriate, overall.

Pretest-Posttest Gains: E Group Only. According to a series of paired t-tests on the data of Table 15, students in grades 1, 2, and 6 gained significantly ($p < .001$) in calculator knowledge over the course of the academic year. In grade 3, there was a decrease in scores from pretest to posttest, in grade 5, scores remained exactly the same on average from pretest to posttest, and as mentioned earlier, because only the special fourth grade test was administered to the fourth grade, calculator knowledge growth could not be assessed in grade 4.

With respect to computer knowledge, Tucson Academy is the one site at which there was a statistically significant overall increase in computer knowledge ($p < .001$). Analyzed by grade, we find that the observed increase in computer knowledge is due primarily to the increase at the fourth grade ($p < .001$). The precipitous jump from a pretest mean of 1.23 to a posttest mean of 10.00 at the fourth grade is difficult to understand. Interestingly, the fourth grade pretest mean is not unlike the third grade pretest mean, and the fourth grade posttest mean is not unlike the fifth grade posttest mean. Statistically significant increases were also observed at the fifth grade ($p < .05$), but not at the third grade ($p > .75$) nor at the sixth grade ($p > .06$).

Attitude Change. Table 16 contains means and standard deviations for the experimental group, calculated across all grades, for subscales one and two of the calculator and computer attitude pretests and posstests.

Pretest to Posttest Changes: E Group Only. Changes in attitude, in the expected direction, were statistically significant for the calculator, both overall ($p < .001$) and for subscale one ($p < .001$) and subscale two ($p < .05$). As in other sites, computer attitude did not shift from pretest to posttest. As mentioned earlier, although computer lessons were taught at this site, they were taught by members of the project staff, rather than by teachers within the school. Perhaps, it was this fact, that classroom teachers did not involve themselves directly with the computer component, and that, therefore, were not in a position to reinforce ideas in the classroom that were covered in the computer lab, that accounted for the absence of observed change in computer attitude in Tucson.

Impediments to Implementation

Because both components of the project were implemented to a high degree in Tucson, whatever impediments to implementation there were, were overcome. The following factors appeared to be most salient in contributing to the success of the project in Tucson.

1. Collegial support

The teachers received "a lot of support" not only from the people who designed it, but also from Louise Pate, the computer lab specialist and the principal. According to one teacher, the principal "herself is well versed and comfortable with the computer and so it is natural that she would encourage and support the use of computers by others." Most importantly, perhaps, for the smooth operation of the computer component, is the fact that Louise Pate and Ken Goldberg shouldered the responsibility for teaching the computer programming.

2. Previous experience with project materials

One teacher observed that with respect to the calculator, "having one year under my belt makes it infinitely easier. The first year I concentrated on method, but this year I have gone beyond that, and can deal with rationale."

3. Teacher enthusiasm

When asked, what are the important factors that need to be in place if the project is to be effective, one teacher replied, "open communication between project designers and implementers. Where there is resistance on the part of the teachers, the project cannot succeed." Another teacher echoed these sentiments when she replied, "teachers need to be convinced that the project is worthwhile. Without teacher enthusiasm about the project, the project cannot succeed."

4. Compatibility with the curriculum

A major benefit of the calculator component was that the project provided "a gentle, easy way to introduce technology that children will be expected to use." Since the calculator activities were seen as reinforcing concepts in Real Math, the project was perceived to be worthwhile on another level, simply because, "the more ways information is presented, the better it is."

NEWBURGH

The students in the project from Newburgh were from lower middle to middle class neighborhoods of mixed ethnic backgrounds. The textbook in use was published by Addison-Wesley. This was the first time Newburgh students and teachers used these supplementary activities.

A total of 18 classes from three K - 6 elementary schools participated in this field test. Table 17 provides a breakdown of participating classes by grade and school for this site. Table 18 contains the number of calculator and computer lessons completed by class within grade in Newburgh. Because of the generally negative reception of the Newburgh staff to the project, the low implementation, and the lack of a control group, student growth data were not analyzed for this site. Rather, a discussion of the factors that appear to have contributed to the negative reception of the project at Newburgh follows. It is based on information provided by R. Sgroi, member of the project staff with primary responsibility for this site.

Impediments to Implementation

The following factors appear to have been particularly salient in contributing to the negative impact of the project in Newburgh. For the most part, these factors parallel those in other schools.

1. Administrative support.

The mathematics director, who was instrumental in having Newburgh selected as a test site, left his job to become principal of the middle school. The new director, who was hired in November, 1989, did not appear to share the same enthusiasm for the project, and because of other responsibilities, did not give the project the attention it required.

2. Preservice workshops

Teachers were not satisfied with the workshops held in early

September because they lacked sufficient hands-on activities, and were not focused on the individual grade levels.

3. Link with the curriculum
The Addison-Wesley textbook series, being computation driven, is quite different from the philosophy underlying Real Math and the supplementary materials. Although the teachers were comfortable with giving skill/drill instruction, they appeared to be intimidated by the mathematics background assumed by the project materials, based largely on the Real Math approach.

4. Student ability to handle material
According to the teachers at Newburgh, the materials were written at a level far above their students' abilities. In addition, they were not comfortable with the teacher's guide, which they believed was not very clear, or the amount of time required to prepare and conduct a lesson, which they believed was extreme. Finally, they believed that the work required by the project was too difficult and demanding for the students who, in general, were accustomed to a skill/drill approach and were not independent workers. According to completed lesson evaluation forms from grades four and five, the feelings of discontent among teachers and students appeared to surface by the second calculator lesson. Before that, teachers and students appeared to be more satisfied with the activities of the project.

5. Collegial support
The computer specialist at one of the Newburgh schools resigned in early September. Her position was not filled until December. The computer specialist at another school showed no interest in being involved in the project. He did not attend the initial summer workshop, nor did he respond to any of the letters and phone calls. The computer specialist at the third school, expressed interest in the program, but never sent in any evaluation forms. Accordingly, for the most part, the teachers (as opposed to the computer specialists) had the responsibility for covering the computer materials by themselves. Every effort was made to give support where needed by the project staff. For example, R. Sgroi made up overhead transparencies of student materials for many teachers. One school was given a PC Viewer in March with the hope that it would encourage the teachers to do some computer lessons. However, the viewer remained locked in the vault for the remainder of the year. Despite the efforts made, the teachers at Newburgh did not, in general, implement the computer component of this project.

At a final evaluation meeting held at one of the Newburgh schools, and attended by all project teachers from that school, teachers reiterated many of the concerns expressed in their evaluations and noted above. However, they all agreed that the project was extremely worthwhile and that calculators and computers should be an integral part of the mathematics curriculum. Moreover, they all said that they would make an attempt to use some of the project materials next year. They were most concerned about teachers attempting to use materials without proper inservice training. They felt that it was imperative to have administrative involvement, preservice, and inservice workshops, and frequent "round table" discussions. The participants all agreed that the training received in August of 1989 was inadequate, especially the computer portion.

Based on nine teacher exit questionnaires received on the calculator component, four teachers gave an overall rating of "fair" to the calculator lessons they taught, four gave a rating of "very good," and one gave a rating of "excellent."

From the perspective of these teachers, the following factors need to be in place in order for the calculator component to be effective. These statements reinforce earlier teacher comments about the program in Newburgh and elsewhere.

"I would start the program in first grade and have that group work with them throughout the grades. Often programs that are started in midstream don't do as well."

"There needs to be ample time to do the activities."

"Teacher enthusiasm, availability of calculators, necessary time and willingness of class to participate."

"Teachers must be made aware that the calculator component can be coordinated into regular class activities."

"A great deal of support from administrator and resource people."

"Be sure you have calculators available and read the whole program before you start."

"Cooperative attitudes."

"Teachers should be comfortable using it -- support system should be in place."

"All the calculators need to be the same, that each student has one, that the calculators perform operations in the same manner as the book describes. Important for teachers to understand scope and sequence of project."

CONCLUSIONS

The large variation in project implementation across, and in some cases, within sites by class, leads to some interesting conclusions regarding the key ingredients necessary for supplementing effectively the elementary mathematics curriculum with calculator and computer exercises.

In general, this evaluation makes clear that

(a) strong administrative support, the availability of a highly competent computer lab specialist, and a far higher level of teacher confidence than can be expected of today's teachers are key ingredients of a successful implementation of the computer component of this project.

(b) teacher support, motivation and training, and the use of a well-coordinated mathematics text are key ingredients of a successful implementation of the calculator component of this project.

(c) the barriers to successful implementation of computers "into the classroom" are substantially greater than those of the calculator.

Several other evaluation findings are worthy of mention.

(1) Most teachers saw the need to introduce supplementary technological materials, especially as they relate to the calculator, into today's mathematics classroom. As one teacher noted, "Twenty years ago I would have washed my mouth out with soap for saying this, but I can see calculator lessons in first grade and defend their advantages wholeheartedly."

(2) Although teachers were quite willing and interested to learn about technology and its place in the mathematics curriculum so that they could pass on to students what they believe "is now expected of them," one-day pre-service workshops were not sufficient to prepare these teachers, who had little or no prior experience with technology, to handle this technologically-oriented curriculum innovation. For the present, long-term, in-service training would be a minimum requirement. For the future, plans need to be made to institute technological training at both the undergraduate and graduate levels.

(3) The children reacted with enthusiasm to the calculator lessons, and when implemented, to the computer lessons as well. They also demonstrated evidence of growth in calculator knowledge and attitudes as a result of being exposed to these materials. At one site only were computer materials implemented fully enough to foster growth in knowledge from pretest to posttest.

(4) Teachers were somewhat less enthusiastic about the materials than their students. They believed that many lessons were too difficult and too long. To be more consistent with the presentation of the regular math curriculum, teachers requested that lessons be broken down into smaller, "more digestible" units. They also believed that for the success of the program it was

imperative for lessons to be well-integrated by topic into the regular math curriculum.

(5) Teachers who had experience with the materials during the prior year were more enthusiastic about the program, at least the calculator component. One teacher noted that with experience came "ease and comfort" of implementation. Another teacher noted that she was impressed by how much her students retained from their first year in the program to the second.

The materials have been rewritten and reorganized to reflect the many valuable comments and criticisms raised by teachers in this pilot year. Two pamphlets will be available, one that contains calculator activities and another that contains computer activities. Each pamphlet will contain information regarding necessary prerequisite student knowledge, and ability levels for which the activities are appropriate.

With these revised materials and our knowledge about critical implementation factors gleaned from this field-based study, a full-scale implementation of both calculator and computer components in the classroom may indeed be possible.

Table 1

Breakdown of All Classes by Grade and School:

New Rochelle

	Columbus	Webster	Trinity	Davis	Jefferson	Ward	Albert Leonard	Isaac Young	Total
Grade 1	0	1	2	0	0	0	0	0	3
Grade 2	0	1	2	0	0	0	0	0	3
Grade 3	0	2	1	0	0	1	0	0	4
Grade 4	1	3	2	1	1	0	0	0	8
Grade 5	1	1	1	1	1	0	0	0	5
Grade 6	0	0	0	0	0	0	2	4	6
Total	2	8	8	2	2	1	2	4	29

Table 2

Experimental and Control Group Designations:

New Rochelle

	Experimental Group		Control Group	
	Webster	Trinity	Webster	Trinity
Grade 1	1	1	0	1
Grade 2	1	1	0	1
Grade 3	1	1	1	0
Grade 4 (reg)	1	1	1	0
Grade 4 (tag)	1	0	0	1
Grade 5 (tag)	1	0	0	1
	Albert Leonard	Isaac Young	Albert Leonard	Isaac Young
Grade 6	1	2	1	2

Table 3

A breakdown of number of calculator and computer lessons completed by class within grade: New Rochelle

	Lesson Type	
	Calculator	Computer
Grade 1: Total no. possible	11	--
class 1	7	--
class 2	8	--
Grade 2: Total no. possible	12	--
class 1	12	--
class 2	3	--
Grade 3: Total no. possible	12	4
class 1	12	0
Grade 4: Total no. possible	10	3
class 1	7	0
class 2	10	1
class 3	3	0
Grade 5: Total no. possible	11	4
class 1	5	0
Grade 6: Total no. possible	9	4
class 1	3	2
class 2	2	1

Table 4

Means and Standard Deviations of Iowa Tests: Administered 5/89 in New Rochelle

	Control			Experimental				
	N	Mean	SD	N	Mean	SD	t-value	p
Grade 2								
Reading	14	61.2	22.9	39	69.5	24.6	- 1.10	.278
Concepts	13	69.4	29.0	39	72.9	25.2	- .42	.679
Problems	14	70.6	25.4	39	67.0	25.2	.46	.743
Compute	14	77.4	25.0	39	79.7	20.9	- .33	.743
Total	13	75.5	27.8	39	76.3	22.8	- .10	.918
Grade 3								
Reading	21	46.1	33.7	40	53.3	30.5	- .84	.405
Concepts	21	64.9	29.0	39	62.0	27.7	.38	.704
Problems	21	60.9	26.3	41	60.4	26.6	.07	.943
Compute	21	59.8	28.0	41	60.7	30.1	- .12	.907
Total	21	63.1	27.3	39	62.9	26.6	.02	.981
Grade 4								
Reading	28	74.1	21.1	53	61.0	29.2	2.09	.040
Concepts	28	81.7	18.8	53	73.5	25.4	1.51	.093
Problems	28	80.7	17.1	53	66.7	28.3	2.40	.019
Compute	28	85.4	15.1	52	76.9	24.9	1.67	.100
Total	28	84.4	16.4	51	75.0	24.7	1.81	.075
Grade 5								
Reading	21	79.8	12.0	16	86.4	9.2	- 1.85	.072
Concepts	21	90.9	9.7	16	92.5	6.4	- .57	.571
Problems	21	91.8	7.7	16	88.6	10.8	1.05	.301
Compute	21	85.3	15.7	16	91.1	6.8	- 1.39	.174
Total	20	92.6	7.9	16	93.1	6.3	- .22	.830
Grade 6								
Reading	39	44.2	24.2	33	49.0	32.3	- .71	.477
Concepts	39	64.2	18.0	33	62.7	32.7	.24	.809
Problems	39	53.6	17.1	33	56.4	35.1	- .44	.663
Compute	39	56.8	22.6	33	55.2	36.7	.22	.823
Total	39	59.7	14.5	33	58.0	36.2	.20	.793
TOTAL								
Reading	152	64.2	27.6	210	63.3	28.5	.30	.765
Concepts	151	77.5	22.4	209	72.7	26.5	1.80	.073
Problems	152	73.8	23.1	211	67.4	27.6	2.33	.021
Compute	152	75.7	24.5	210	73.8	28.0	.70	.487
Total	150	77.5	22.2	207	73.3	26.8	1.56	.119

Table 5

Means and Standard Deviations of Knowledge Pretests

And Posttests for C and E Groups By Grade: New Rochelle

Calculator Knowledge Tests

	Maximum Possible Score	Pretest N	Pretest Mean	Pretest S.D.	Posttest N	Posttest Mean	Posttest S.D.
Grade 1	16						
Control		15	10.53	2.67	17	12.47	1.23
Exptl		37	7.92	4.41	33	11.45	3.44
Total		52	8.67	4.13	50	11.82	2.91
Grade 2	15						
Control		18	8.17	1.69	0	---	--
Exptl		39	8.82	2.45	36	13.36	2.27
Total		57	8.61	2.23	36	13.36	2.27
Grade 3	22						
Control		12	10.17	1.59	18	7.28	2.59
Exptl		42	8.62	2.51	40	14.83	4.80
Total		54	8.96	2.41	58	12.48	5.49
Grade 4	14						
Control		28	4.32	1.39	18	7.17	1.79
Exptl		50	4.48	1.73	51	7.63	2.79
Total		78	4.42	1.61	69	7.51	2.57
Grade 5	7						
Control		19	4.47	.96	18	4.56	1.04
Exptl		16	4.38	1.09	0	--	--
Total		35	4.43	1.01	18	4.56	1.04
Grade 6	7						
Control		67	1.87	1.34	70	2.29	2.04
Exptl		65	1.57	1.09	69	2.52	1.37
Total		132	1.72	1.23	139	2.40	1.74

Table 5 (Continued)

Means and Standard Deviations of Knowledge Pretests

And Posttests for C and E Groups By Grade: New Rochelle

	Maximum Possible Score	Computer Knowledge Tests Pretest N	Mean	S.D.	Posttest N	Mean	S.D.
Grade 3	21						
Control		20	8.10	1.97	0	---	--
Exptl		41	6.46	2.67	0	---	--
Total		61	7.00	2.56	0	---	--
Grade 4	21						
Control		26	7.19	2.80	0	---	--
Exptl		50	5.68	2.66	0	---	--
Total		76	6.20	2.79	0	---	--
Grade 5	22						
Control		20	5.85	2.23	0	---	--
Exptl		17	8.71	3.31	0	---	--
Total		37	7.16	3.11	0	---	--
Grade 6	20						
Control		69	8.25	3.68	65	9.15	2.91
Exptl		68	8.78	3.29	60	8.78	3.28
Total		137	8.51	3.49	125	8.98	3.09

Table 6

t-Tests on Experimental and Control Group
Gains in Calculator Knowledge By Grade:
New Rochelle

	Experimental Group			Control Group			t		p
	N	Mean	S.D.	N	Mean	S.D.	value	df	value
Grade 1	26	3.14	3.87	13	1.92	2.25	-1.05	38	.150
Grade 3	37	6.41	5.78	10	-3.40	3.06	-5.14	45	.000
Grade 4	47	3.26	2.26	16	2.31	2.41	-1.42	61	.081
Grade 6	62	.87	1.29	63	.48	1.41	-1.63	123	.051

Note: p-values are one-tailed.

Table 7

Means and Standard Deviations for Pretest and Posttest Calculator and Computer Attitude Subscales: New Rochelle E and C Groups

Experimental Group

	Pretest			Posttest			t		p
	N	Mean	S.D.	N	Mean	S.D.	value	df	value
Calculator Scale One	193	13.35	2.48	193	14.34	2.30	4.97	192	.000
Calculator Scale Two	207	5.58	1.82	207	6.10	1.77	3.70	206	.000
Computer Scale One	55	9.27	2.48	55	8.85	2.35	-1.47	54	.074*
Computer Scale Two	54	8.85	1.49	54	9.04	1.75	.75	53	.228

Control Group

	Pretest			Posttest		
	N	Mean	S.D.	N	Mean	S.D.
Calculator Scale One	135	12.98	2.59	135	13.74	2.62
Calculator Scale Two	145	6.38	1.68	145	6.48	1.82
Computer Scale One	58	10.10	2.48	58	9.41	2.41
Computer Scale Two	61	8.89	1.62	61	8.87	1.69

* Note: This difference is in a direction opposite from expected.

Table 8

Breakdown of All Classes by Grade and School:

Brooklyn -- District # 18

	P.S. 114	P.S. 208	P.S. 233	I.S. 68	I.S. 252	I.S. 285	Total
Grade 1	2	3	1[a]	0	0	0	6
Grade 2	4	3	1[a]	0	0	0	8
Grade 3	2	2	1[a]	0	0	0	5
Grade 4	2	2	1[a]	0	0	0	5
Grade 5	2	2	1[a]	0	0	0	5
Grade 6	0	0	0	2[b]	1	1	4
Total	12	12	5	2	1	1	33

[a] These are the control group classes in grades 1 - 5.

[b] One of these classes is in the control group; the other is in the experimental group.

Table 9

A breakdown of number of calculator and computer lessons completed by class within grade: Brooklyn

	Lesson Type	
	Calculator	Computer
Grade 1: Total no. possible	11	--
class 1	3	--
class 2	2	--
Grade 2: Total no. possible	12	--
class 1	10	--
class 2	12	--
class 3	8	--
class 4	7	--
Grade 3: Total no. possible	12	4
class 1	1	1
class 2	1	1
class 3	3	0
Grade 4: Total no. possible	10	3
class 1	1	1
Grade 5: Total no. possible	11	4
class 1	3	1
Grade 6: Total no. possible	9	4
class 1	7	0

Table 10

Means and Standard Deviations of the DRP and MAT tests:

Administered 5/89 in Brooklyn

	Control			Experimental				
	N	Mean	SD	N	Mean	SD	t-value	p
Grade 1								
DRP	0	--	--	34	48.8	40.5	--	--
MAT-M	0	--	--	32	47.1	39.7	--	--
Grade 2								
DRP	0	--	--	43	47.5	30.5	--	--
MAT-M	21	50.3	22.5	40	52.9	36.9	- .30	.766
Grade 3								
DRP	24	72.9	13.4	47	80.6	14.2	- 2.20	.031
MAT-M	24	72.7	13.3	48	75.3	15.5	- .69	.494
Grade 4								
DRP	26	61.6	22.0	42	49.4	23.0	2.15	.035
MAT-M	0	--	--	0	--	--	--	--
Grade 5								
DRP	23	84.2	11.4	56	81.5	17.7	.68	.496
MAT-M	0	--	--	0	--	--	--	--
Grade 6								
DRP	21	45.0	24.0	50	67.7	31.4	- 2.97	.004
MAT-M	0	--	--	0	--	--	--	--
TOTAL								
DRP	94	66.3	23.0	272	64.4	30.3	.56	.577
MAT	45	62.3	21.2	120	60.3	33.3	.37	.715

Table 11

Means and Standard Deviations of Knowledge Pretests And Posttests for C and E Groups By Grade: Brooklyn

Calculator Knowledge Tests

	Maximum Possible Score	Pretest N	Pretest Mean	Pretest S.D.	Posttest N	Posttest Mean	Posttest S.D.
Grade 1	16						
Control		19	11.89	1.15	9	9.44	1.67
Exptl		31	13.55	1.77	42	14.43	1.70
Total		50	12.92	1.75	51	13.55	2.55
Grade 2	15						
Control		5	6.80	.84	24	12.58	2.13
Exptl		16	8.19	2.20	42	10.81	2.16
Total		21	7.86	2.03	66	11.46	2.30
Grade 3	22						
Control		2	9.00	1.41	8	6.00	3.02
Exptl		20	9.45	1.40	37	14.59	4.18
Total		22	9.41	1.37	45	13.07	5.18
Grade 4	14						
Control		0	--	--	6	5.33	.52
Exptl		5	4.80	1.30	35	5.34	1.57
Total		5	4.80	1.30	41	5.34	1.46
Grade 5	7						
Control		9	4.11	.60	4	.50	.58
Exptl		44	3.70	.95	51	4.00	.85
Total		53	3.77	.91	55	3.75	1.24
Grade 6	7						
Control		6	1.50	.55	0	--	--
Exptl		34	1.47	.79	28	3.32	.30
Total		40	1.48	.75	28	3.32	.30

Table 11 (Continued)

Means and Standard Deviations of Knowledge Pretests And Posttests for C and E Groups By Grade: Brooklyn

Computer Knowledge Tests

	Maximum Possible Score	Pretest N	Pretest Mean	Pretest S.D.	Posttest N	Posttest Mean	Posttest S.D.
Grade 3	21						
Control		5	8.80	2.49	14	11.29	1.86
Exptl		41	9.44	2.57	31	7.87	1.86
Total		46	9.37	2.54	45	8.93	2.44
Grade 4	21						
Control		8	8.75	2.82	14	7.86	1.79
Exptl		13	8.38	2.54	32	7.78	2.18
Total		21	8.52	2.58	46	7.80	2.05
Grade 5	22						
Control		23	8.57	2.00	7	6.29	1.38
Exptl		32	10.13	1.88	27	9.93	3.01
Total		55	9.49	2.06	34	9.18	3.12
Grade 6	20						
Control		0	--	--	0	--	--
Exptl		17	7.47	2.13	0	--	--
Total		17	7.47	2.13	0	--	--

Table 12

t-Tests on Experimental and Control Group Gains in Calculator Knowledge By Grade: Brooklyn

	Experimental Group			Control Group			t		p
	N	Mean	S.D.	N	Mean	S.D.	value	df	value
Grade 1	27	1.30	1.20	5	-2.40	2.07	-5.62	30	.000
Grade 2	13	3.15	2.23	4	5.25	1.50	1.74	15	.102
Grade 3	16	6.38	4.00	1	-1.00	--	--	--	--

Note: p-values are two-tailed.

Table 13

Means and Standard Deviations for Pretest and Posttest Calculator and Computer Attitude Subscales: Brooklyn E and C Groups

Experimental Group

	Pretest			Posttest			t		p
	N	Mean	S.D.	N	Mean	S.D.	value	df	value
Calculator Scale One	211	14.08	2.38	211	13.96	2.29	- .64	210	.262
Calculator Scale Two	235	5.47	1.87	235	6.36	1.82	5.67	234	.000
Computer Scale One	108	9.62	2.22	108	9.79	2.30	.64	107	.262
Computer Scale Two	109	7.82	1.48	109	7.49	1.54	-1.83	108	.035*

Control Group

	Pretest			Posttest		
	N	Mean	S.D.	N	Mean	S.D.
Calculator Scale One	47	13.94	2.24	47	13.47	1.83
Calculator Scale Two	49	4.88	1.32	49	4.90	1.70
Computer Scale One	57	9.07	2.39	57	9.89	2.14
Computer Scale Two	58	7.31	1.70	58	7.86	1.64

*Note: The result is in a direction opposite from expected.

Table 14

A breakdown of number of calculator and computer lessons completed by grade: Tuscon

	Lesson Type	
	Calculator	Computer
Grade 1: Total no. possible	11	--
class 1	11	--
Grade 2: Total no. possible	12	--
class 1	12	--
Grade 3: Total no. possible	12	4
class 1	5	2
Grade 4: Total no. possible	10	3
class 1	9	3
Grade 5: Total no. possible	11	4
class 1	10	3
Grade 6: Total no. possible	9	4
class 1	8	2

Table 15

Means and Standard Deviations of Knowledge Pretests

And Posttests By Grade: Tucson

	Calculator Pretest				Calculator Posttest			
	Maximum Score	N	Mean	S.D.	Maximum Score	N	Mean	S.D.
Grade 1	16	18	11.28	2.45	16	18	13.72	2.05
Grade 2	15	13	11.00	2.12	15	13	13.31	1.49
Grade 3	22	15	11.27	4.86	22	15	8.93	2.19
Grade 4	14	15	5.51	1.42	14	0	--	--
Grade 5	7	10	4.52	.85	7	10	4.52	1.08
Grade 6	7	15	2.07	1.44	7	15	5.00	1.65

	Computer Pretest				Computer Posttest			
	Maximum Score	N	Mean	S.D.	Maximum Score	N	Mean	S.D.
Grade 3	21	15	1.73	2.66	21	15	1.53	1.85
Grade 4	21	13	1.23	1.69	21	13	10.00	2.31
Grade 5	21	10	8.10	3.04	21	10	9.80	3.58
Grade 6	21	13	11.08	3.20	21	13	12.69	3.82
Total	21	51	5.24	5.01	21	51	8.16	5.29

Table 16

Means and Standard Deviations for Pretest and Posttest Calculator and Computer Attitude Subscales: Tucson

	Pretest			Posttest			t		p
	N	Mean	S.D.	N	Mean	S.D.	value	df	value
Calculator Scale One	83	13.98	2.35	83	15.06	1.97	-3.75	82	.000
Calculator Scale Two	87	5.82	1.53	87	6.17	1.45	-1.72	86	.045
Computer Scale One	47	10.15	1.95	47	10.21	2.01	- .17	46	.434
Computer Scale Two	48	8.50	1.50	48	8.67	1.43	-.68	47	.249

Table 17

Breakdown of Classes by Grade and School:

Newburgh

	Horizons	New Windsor	Temple Hill	Total
Grade 1	1	1	2	4
Grade 2	1	1	0	2
Grade 3	2	1	1	4
Grade 4	1	1	1	3
Grade 5	1	1	1	3
Grade 6	0	1	1	2
Total	6	6	6	18

Table 18

A breakdown of number of calculator and computer lessons completed by grade: Newburgh

	Lesson Type	
	Calculator	Computer
Grade 1: Total no. possible	11	--
class 1	3	--
class 2	8	--
class 3	0	--
class 4	0	--
Grade 2: Total no. possible	12	--
class 1	1	--
class 2	0	--
Grade 3: Total no. possible	12	4
class 1	5	1
class 2	5	1
class 3	2	0
class 4	5	0
Grade 4: Total no. possible	10	3
class 1	0	0
class 2	0	0
class 3	0	0
Grade 5: Total no. possible	11	4
class 1	1	0
class 2	7	0
class 3	7	0
Grade 6: Total no. possible	9	4
class 1	1	0
class 2	4	0

Appendix A

Workshop Evaluation Form

Lesson Evaluation Form

Teacher Interview Guide

Teacher Exit Questionnaire

SUPPLEMENTARY MATHEMATICS MATERIALS FOR A TECHNOLOGICAL SOCIETY

Workshop Evaluation Form

Please return this questionnaire following the completion of the workshop. If you want your responses to be anonymous, simply leave off your name and the name of your school.

Name ______________________ School ________________

PART I. CIRCLE YOUR ANSWERS

1. How would you rate the quality of training you received?

4	3	2	1
Excellent	Good	Fair	Poor

2. To what extent has the workshop met your anticipated needs?

4	3	2	1
Almost all of my needs have been met	Most of my needs have been met	Only a few of my needs have been met	None of my needs have been met

3. Did you get the kind of training you wanted?

1	2	3	4
No, definitely not	No, not really	Yes, generally	Yes, generally

4. If a colleague were going to participate in the SMMTS project, would you recommend this workshop to him/her?

1	2	3	4
No, definitely not	No, I don't think so	Yes, I think so	Yes, definitely

5. How satisfied are you with the amount of information you received?

1	2	3	4
Quite dissatisfied	Indifferent or mildly dissatisfied	Mostly satisfied	Very satisfied

6. Do you anticipate that the training you have received in the workshop will help you to deal more effectively with the SMMTS materials in the classroom?

4	3	2	1
Yes, will help a great deal	Yes, will help somewhat	No, really won't won't help at all	No, seemed to make it worse

7. In an overall, general sense, how satisfied are you with the training you received?

4	3	2	1
Very satisfied	Mostly satisfied	Indifferent or mildly dissatisfied	Quite dis-satisfied

PART II. EXCEPT FOR QUESTION 5, CIRCLE YOUR ANSWERS.

1. How would you evaluate the pacing of the workshop?

1	2	3
Too slow	Adequate	Too fast

2. How would you evaluate the level of the presentation?

1	2	3
Too elementary	Adequate	Too advanced

3. How would you evaluate the amount of time devoted to this workshop?

1	2	3
Too short	Adequate	Too long

4. How would you evaluate the amount of time devoted to "hands on" practice with the materials?

1	2	3
Too short	Adequate	Too long

5. If you have any comments regarding the workshop, please indicate them here or on the back of this sheet.

SMMTS
Lesson Evaluation Form

Name ____________________ School ______________ Grade ____

Supplementary Lesson No. ____ for Calculator/Computer Date ____

PLEASE RESPOND BY CIRCLING THE APPROPRIATE NUMBER

1. How would you rate the clarity of the Teacher's Guide for this lesson?

4	3	2	1
Excellent	Good	Fair	Poor

2. Did you have a hard time understanding the Teacher's Guide for this lesson?

4	3	2	1
No, definitely not	No, not really	Yes, generally	Yes, definitely.

3. How would you rate the clarity of the Children's Work~~shop~~ book for this lesson?

4	3	2	1
Excellent	Good	Fair	Poor

4. Did the children have a hard time understanding the Children's Workbook for this lesson?

4	3	2	1
No, definitely not	No, not really	Yes, generally	Yes, definitely

5. Were the learning objectives for this lesson clearly stated?

1	2	3	4
No, definitely not	No, not really	Yes, generally	Yes definitely

6. Were the suggested activities appropriate for teaching the learning objectives for this lesson to your students?

4	3	2	1
Yes, definitely	Yes, generally	No, not really	No, definitely not

7. Were the suggested activities for this lesson too difficult for the children in your class?

4	3	2	1
No, definitely not	No, I don't think so	Yes, generally	Yes, definitely

8. Were the suggested activities for this lesson too easy for the children in your class?

4	3	2	1
No, definitely not	No, I don't think so	Yes, generally	Yes, definitely

9. Are additional activities needed to supplement the ones suggested in order to teach more effectively the learning objectives for this lesson?

4	3	2	1
No, definitely not	No, I don't think so	Yes, generally	Yes, definitely

10. Are the suggested activities complete in their coverage of the learning objectives for this lesson?

1	2	3	4
No, definitely not	No, not really	Yes, generally	Yes, definitely

11. In an overall, general sense, how would you rate the usefulness of the Children's Workbook for this lesson?

4	3	2	1
Excellent	Good	Fair	Poor

12. In an overall, general sense, how would you rate the usefulness of the Teacher's Guide for this lesson?

4	3	2	1
Excellent	Good	Fair	Poor

13. How would you describe the degree of relatedness between the lesson and the textbook material on this topic?

4	3	2	1
Excellent	Good	Fair	Poor

14. How would you describe the children's interest during this lesson?

4	3	2	1
Excellent	Good	Fair	Poor

15. How would you describe the degree of your overall satisfaction with the lesson?

4	3	2	1
Excellent	Good	Fair	Poor

16. How long did it take you to complete this lesson?

__________ minutes

FOR QUESTIONS 17-20, USE THE REVERSE SIDE OF THIS PAPER AS NEEDED.

17. Please describe any indications of student frustration during this lesson.

18. Please describe any difficulties you experienced that were not addressed in the Teacher's Guide.

19. Please indicate whether you taught the lesson as presented in the Guide or modified it in any way. If you did modify it, please describe the modifications you made.

20. Use the remaining space for any strong negative or possitive comments you would like to make at this time.

Interview Guide for Teachers in SMMTS Program

Introduction: Thank you for agreeing to talk with me today about your experience with the SMMTS project. We are hoping to obtain information about how it's going so far and what might make it better. I want to assure you that this interview is completely confidential. Would it be all right with you if I tape our conversation?

I. Nature of the Innovation:

a. Technological Component:

1. Familiarity:

For first interview only:

How many years have you been teaching? How many years have you been teaching in this particular school?
What previous experience have you had working with the calculator inside the classroom? outside the classroom?
Repeat previous question for computer.

For first and subsequent interviews:

How many calculator lessons have you taught so far?
How do you feel about working with the calculator?
What factors would you say contribute to your feeling this way?
Repeat above three questions for computer.
Do you feel any differently working with the calculator than the computer? Why or why not?

2. Complexity:

Tell me about a lesson you taught with the calculator that went well. What contributed to its going well?
Tell me about a lesson you taught with the calculator that did not go well. What contributed to its not going well?
How typical are these lessons?
Repeat above questions for computer.
What do you need to know to be able to use these tools effectively? Did you know this information before you joined the project?
What kinds of support do you have at the school for helping you to sort out these difficulties?
From where have you sought support? (e.g., math coordinator, math committee, computer lab instructor, other teachers)
Would you say these people have been supportive and helpful? In what ways? In what ways not?
What about the principal? What is his/her role in the project? Would you say that he/she has a great interest

in it? Why or why not? Can you give me some examples?
How might the support you currently receive be improved upon?

3. Accessibility:

I wonder if you might comment on the degree to which the calculator/computer is accessible within the school.
Where do the computer lessons take place? In the classroom? In a lab?
How well does that work out from your point of view? From the children's point of view?
How easy i it to set up for the computer lesson and get the compi er equipment out into the classrrom setting?
Is the physical layout of the classroom a problem in setting up? (in terms of outlets and desks, for example)
Is it a problem for the calculator? In what way?
Has security been a problem? Why or why not?

4. Time Block Demands:

How do you fit using the computer into the school day?
Is scheduling within the school compatible with the time demands of the computer?
Repeat previous two questions for calculator.
Do other subjects impose the same kinds of time demands, or, are these innovations unique in this way? Why or why not?

b. Written Materials

I know you have been filling out evaluation forms about the written materials. I just want to give you another chance to say anything you care to about the written materials (that is, about the teacher's guide and children's workbook) -- e.g., about their clarity, completeness, or appropriateness.

What textbook series are you using?
How compatible are the written materials with the textbook?
Do you feel the ideas in the supplementary materials reinforce ideas in the textbook, or are they rather separate?

II. Workshop

Earlier we spoke about existing support within the school for helping you sort out difficulties along the way. I would now like to ask you some things about the workshop.

Do you feel that the workshop helped prepare you for what you are now doing with the computer and calculator?
What was especially useful about the workshop?
Was was especially lacking?

With the advantage of hindsight, how might it have been structured to help you more? Would something other than a workshop be more helpful in preparing you to teach these lessons?

III. Selected Teacher Characteristics

a. Compatibility with Philosophies and Beliefs

In your view, what are the overall learning objectives for this project?
Do you think they are appropriate for your students? In what ways?
Do you think they can be achieved by the activities of the project? Why or why not?

How did you get involved with this project?
Given your experience with it so far, would you agree to participate if you had the opportunity again?

b. Compatibility with Pedagogical Practice

How much curriculum preparation is involved? Have you been able to follow the Teacher Guides closely, or have you needed to make modifications? Can you give me some examples.
How much class time is taken up by the project?
Are you concerned about not being able to cover the core math curriculum in a timely manner? Why or why not?

IV. Teacher's Perception of Impact

How do your students react to the activities? Give me some examples.
Would you say they are frustrated, motivated, content, excited, bored, easily distracted, etc.?
Are they learning the intended objectives?
What seems to make a difference in how different students react? Do the project activities appeal to some students more than others? If so, which ones?
Do you notice any differences this year over last, for example, in the way your students are approaching math?
Can you give me some examples of difference, if it exists?

Given what you know at this point about the project, and what is involved in its implementation, do you think it is a worthwhile endeavo

What would you say are its main drawbacks?
What would you say are its main benefits?
Would you recommend it to others? Why or why not?
If others wished to implement the project in their own schools, what would you tell them?
In your view, what are the important factors that need to be in place if the project is to be effective?

Questionnaire for Teachers using SMMTS

Thank you for taking the time to complete this short questionnaire on the CALCULATOR COMPONENT of SMMTS. Your responses will help us to obtain information about how the program is going thus far, and what might make it better. Please feel free to use the reverse sides of these pages to elaborate upon your answers if you wish.

Name________________________ School____________________

1. How many years have you been teaching? ____________
2. How many years have you been teaching in this school? ________
3. What previous experience have you had working with the calculator inside the classroom? ____________________

4. What previous experience have you had working with the calculator outside the classroom? ____________________

5. How many, and which, calculator lessons have you taught thus far?

6. How do you feel about working with the calculator? ________

7. What factors would you say contribute to your feeling this way?

8. Do you have support at the school for helping you to sort out any difficulties with the calculator lessons? ________
9. From whom have you sought support? (circle as many as apply) math coordinator; other teachers; other personnel. Please describe:

10. Would you say these people have been supportive and helpful? How so?

11. Has the principal of your school been involved in the project?

12. If so, in what ways? ____________________

13. How might the support you receive currently be improved upon? __

14. How accessible is the calculator to the children in your class? Please describe. ________________________________

15. Has security been a problem? Why or why not? ________________________________

16. Does using the calculator impose special time demands on your math class? Please describe. ________________________________

17. What textbook series are you using? ________________________________

18. How compatible are the calculator materials with this textbook? ________________________________

19. Do you believe that the ideas in the calculator materials reinforce ideas in this textbook, or are they rather separate? Please give examples. ________________________________

20. Do you believe the workshop helped prepare you for what you are now doing with the calculator? Please describe. ________________________________

21. With the advantage of hindsight, how might the workshop have been structured to be more helpful? ________________________________

22. Do you think the calculator activities are appropriate for your students? In what ways? In what ways not? ________________________________

23. How did you get involved with this project? Please describe. ________________________________

24. Given your experience with the calculator materials thus far, would you agree to participate again if you had the opportunity? ______

25. How much curriculum preparation is involved? ________________________________

26. Have you been able to follow the Teacher Guides closely, or have you needed to make modifications? Please explain. ________________________________

27. Are you concerned about not being able to cover the core math curriculum in a timely manner because of the calculator activities? Why or why not? ________________________________

28. How do your students react to the calculator activities? E.g., would you say they are frustrated, motivated, content, excited, bored, easily distracted, etc.? Please give examples. ____________

29. Do you believe they are learning the intended objectives? ______

30. Do the calculator materials appeal to some students more than others? Please explain. ____________

31. Given what you know at this point about the calculator activities, and what is involved in their implementation, do you think they are worthwhile? ____________

32. What are their main drawbacks? ____________

33. What are their main benefits? ____________

34. Would you recommend them to others? Please explain. ____________

35. If others wished to implement the calculator component of the project in their own schools, what would you tell them? ____________

36. In your view, what are the important factors that need to be in place if the calculator component of the project is to be effective?

37. Overall, how would you evaluate the calculator lessons you have taught thus far? (circle one) excellent; very good; good; fair; poor

THANK YOU VERY MUCH.

EVALUATION STAFF,
SMMTS PROJECT

Questionnaire for Teachers using SMMTS

Thank you for taking the time to complete this short questionnaire on the COMPUTER COMPONENT of SMMTS. Your responses will help us to obtain information about how the program is going thus far, and what might make it better. Please feel free to use the reverse sides of these pages to elaborate upon your answers if you wish.

Name________________________School________________________

1. Who teaches the computer lessons? ________________
2. Where are the computer lessons taught? ________________
3. If you do not teach the computer lessons, do you sit in on the lessons when they are taught? Please describe the situation. ____
4. What previous experience have you had working with the computer?
5. How many, and which, computer lessons have been taught thus far?
6. How do you feel about working with the computer? ________
7. What factors would you say contribute to your feeling this way?
8. Do you have support at the school for helping you to sort out any difficulties with the computer lessons? ________
9. From whom have you sought support? (circle as many as apply) math coordinator; other teachers; other personnel. Please describe:
10. Would you say these people have been supportive and helpful? How so?
11. Has the principal of your school been involved in the project?
12. If so, in what ways? ________
13. How might the support you receive currently be improved upon? ____

14. How accessible is the computer to the children in your class? Please describe. ______

15. Has scheduling been a problem? Why or why not? ______

16. Does using the computer impose special time demands on your math class? Please describe. ______

17. What textbook series are you using? ______

18. How compatible are the computer materials with this textbook? ______

19. Do you believe that the ideas in the computer materials reinforce ideas in this textbook, or are they rather separate? Please give examples. ______

20. Do you believe the workshop helped prepare you for what you are now doing with the computer? Please explain. ______

21. With the advantage of hindsight, how might the workshop have been structured to be more helpful? ______

22. Do you think the computer activities are appropriate for your students? In what ways? In what ways not? ______

23. How did you get involved with this project? Please describe. ______

24. Given your experience with the computer materials thus far, would you agree to participate again if you had the opportunity? ______

25. How much curriculum preparation is involved? ______

26. Have you been able to follow the Teacher Guides closely, or have you needed to make modifications? Please explain. ______

27. Are you concerned about not being able to cover the core math curriculum in a timely manner because of the computer activities? Why or why not? ______

28. How do your students react to the computer activities? For example, would you say they are frustrated, motivated, content, excited, bored, easily distracted, etc.? Please give examples. ________

29. Do you believe they are learning the intended objectives? ________

30. Do the computer materials appeal to some students more than others? Please explain. ________

31. Given what you know at this point about the computer activities, and what is involved in their implementation, do you think they are worthwhile? ________

32. What are their main drawbacks? ________

33. What are their main benefits? ________

34. Would you recommend them to others? Please explain. ________

35. If others wished to implement the computer component of the project in their own schools, what would you tell them? ________

36. In your view, what are the important factors that need to be in place if the computer component of the project is to be effective? ________

37. Overall, how would you evaluate the computer lessons taught thus far? (circle one) excellent; very goo-; good; fair; poor

THANK YOU VERY MUCH.

EVALUATION STAFF,
SMMTS PROJECT

Appendix B

Student Growth Measures

GRADE 1 TEST (Use Calculator) **Name** ______________
TIME LIMIT: 15 MINUTES

Do the following problems. Write your answers in the blanks.

1) 9 + 8 = __________ 2) 9 - 8 = __________

3) 15 - 9 = __________ 4) 4 + 6 = __________

5) 4 + 1 = __________ 6) 4 - 1 = __________

7) 40 + 10 = __________ 8) 40 - 10 = __________

9) 60 + 10 = __________ 10) 60 - 10 = __________

11) 60 + 1 = __________ 12) 60 - 1 = __________

Guess the rule. Write the missing numbers.

1) 1, 2, 3, _____, _____, _____, _____, _____

2) 3, 6, 9, _____, _____, _____, _____, _____

3) 75, 72, 69, _____, _____, _____, _____, _____

4) 0, 10, 20, _____, _____, _____, _____, _____

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GRADE 2 TEST (Use Calculator) **Name** ________________
TIME LIMIT: 15 MINUTES

Do the following problems. Write your answers in the blanks.

1) 42 + 27 = __________

2) 42 - 27 = __________

3) 39 + 1 = __________

4) 39 - 1 = __________

5) 39 + 10 = __________

6) 39 - 10 = __________

7) 5 + 5 + 5 + 5 = __________

8) 5 + 5 + 5 + 5 + 5 + 5 = __________

9) 10 - 2 - 2 - 2 - 2 = __________

10) 10 - 2 - 2 - 2 - 2 - 2 = __________

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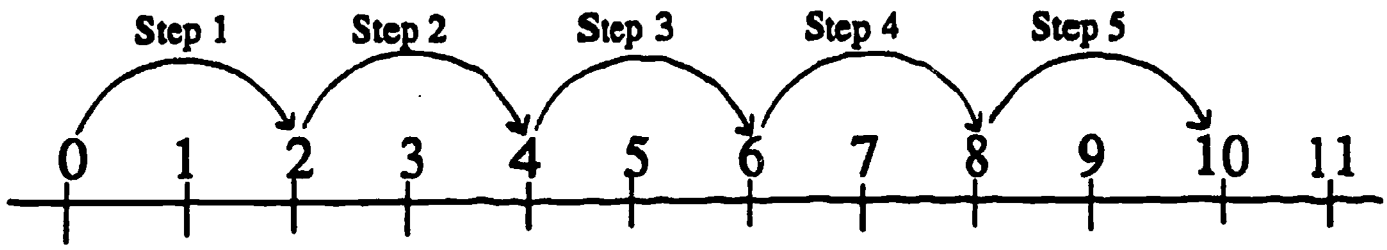
GRADE 2 TEST - Page 2

Name ______________



In each problem, write the number of steps to reach the goal. If you will MISS the goal, write M.

First 2 Steps	Goal	Number of Steps
0, 2, 4	10	5
0, 5, 10	17	M
0, 5, 10	50	________
0, 5, 10	55	________
0, 5, 10	56	________
0, 5 10	100	________
0, 5 10	101	________

Stephen S. Willoughby, MDR-8896131

GRADE 3 TEST (Use Calculator) **Name** ______________
TIME LIMIT: 15 MINUTES

Do the following problems. Write your answers in the blanks.

1) 73 + 48 = __________ 2) 73 - 48 = __________

3) 730 + 480 = __________ 4) 730 - 480 = __________

5) 7300 + 4800 = __________ 6) 7300 - 4800 = __________

7) 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = __________

8) 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 = __________

9) 10 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 = __________

10) 20 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 = __________

3^4 means 3 x 3 x 3 x 3 = 81. 2^5 means 2 x 2 x 2 x 2 x 2 = 32 (the small number up to the right of the first number tells how many times the first number is to be used as a factor). 81 and 32 are the standard forms of 3^4 and 2^5.

Write the following in standard form:

1) 3^5 = _____ 2) 3^{10} = _____ 3) 5^3 = _____

4) 10^3 = _____ 5) 2^{10} = _____ 6) 2^{11} = _____

7) 2^{20} = _____ 8) 2^{26} = _____ 9) 2^{27} = _____

10) 27^2 = _____ 11) 7^7 = _____ 12) 8^8 = _____

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GRADE 4 TEST (Use Calculator) **Name ________________**
TIME LIMIT: 15 MINUTES

Do the following problems. Write your answers in the blanks.

1) 8,346 + 5,792 = ______ 2) 37,504 - 21,418 = ______

3) 8,346 x 5,792 = ______ 4) 48,340,032 ÷ 5,792 = ____

5) How many seconds are there in one day? _________ seconds

6) How many seconds are there in two days?_________ seconds

7) How many seconds are there in 1 year (365 days)?

__________ seconds

8) How many seconds are there in 10 years if two of those years are leap years (366 days)?

__________ seconds

9) 634,910,527 + 23,456,789 = __________

10) 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 x 9 x 10 x 11 = __________

 Name ____________

3^4 means 3 x 3 x 3 x 3 = 81. 2^5 means 2 x 2 x 2 x 2 x 2 = 32 (the small number up to the right of the first number tells how many times the first number is to be used as a factor). 81 and 32 are the standard forms of 3^4 and 2^5.

Write the following in standard form:

1. 3^5= __________

2. 10^{10}= __________

3. 9^7= __________

4. 1^{73} = __________

ALLOW 15 MINUTES FOR THIS THIS -
DO NOT HAVE CHILDREN USE CALCULATORS.

SMMTS
GRADE 4 TEST

DIRECTIONS TO BE READ TO CLASS

Once cricket starts, he always hops in the same direction and always hops the same distance each time. At the top of the page, in example A, cricket started at 0 and hopped to 5. Where will cricket land after his second hop? (That's right, on 10.) Where will he land on his third hop? (Right, on 15.) Will cricket land on 20? If so, how many hops will he take? That's right, he WILL land on 20, and it will take him 4 hops. So write "Yes" and 4 in the spaces.

In example B, cricket started at 4 and landed on 7. How far did he hop? That's right, he hopped a distance of 3. Where will he land after the second hop? That's right, he will land on 10. Where will he land after the third hop? (13). Will cricket land on 20? If so, how many hops will he take? That's right, he will miss 20. He will land on 19 and 22, but he won't land on 20. So write "no" in the first space and leave the second space blank.

For problems 1 through 4, figure out how far cricket hops each time. Then decide whether the cricket will land on the given number. If your answer to that question is yes, decide how many hops it will take him to land on the given number.

Before continuing, turn to the second page of your test booklet. Notice the cricket is jumping in the other direction there. The cricket started at 2 in the picture and is jumping to the left, a distance of 5. Will the cricket pass 0? We call the numbers to the left of zero "negative numbers" or numbers below zero, and we write them with little dashes in front of them. Where will cricket land if he jumps to the left five places from 2? That's right, he will land on negative three, or three below zero. So, write a three with a little dash in front of it for example C on your paper (proctor should walk around the room to see everybody has this right while continuing with the instructions).

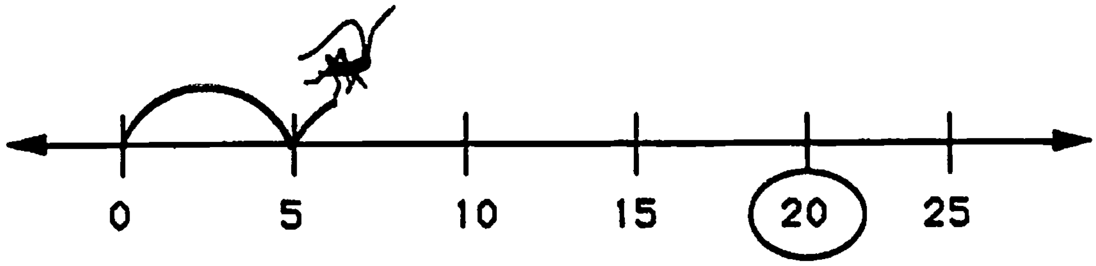
If cricket started at one below zero or negative one, and jumped 8 places to the right, where would he land? Then, what is negative one plus eight? Seven is correct. Write seven as your answer for example D.

If cricket started at zero and jumped to the right a distance of two, and then kept on jumping until he had jumped three times, where would he end up? Then, what is three times two? Six is right. Write a six as your answer to example E.

Now, do the ten problems on pages 1 and 2 of your test booklet. When you are finished with those, continue on to the other questions. If you have any doubt about what any of the questions means, or what is expected, please ask.

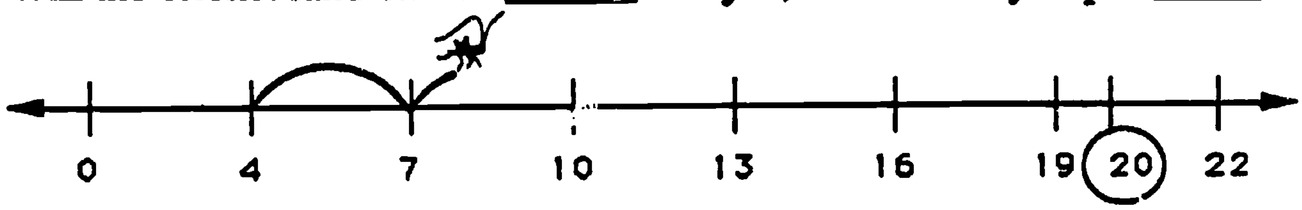
PAGE 1

A.



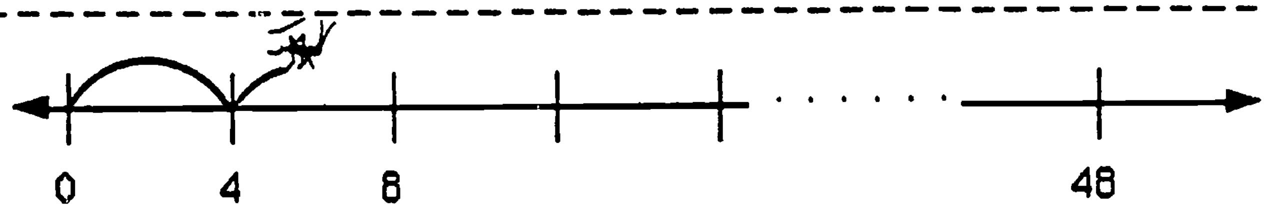
Will the cricket land on 20? ______ If yes, in how many hops? _____

B.



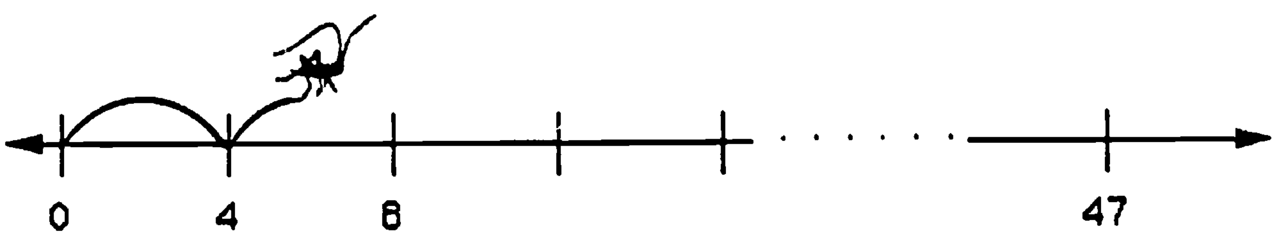
Will the cricket land on 20? ______ If yes, in how many hops? _____

1.



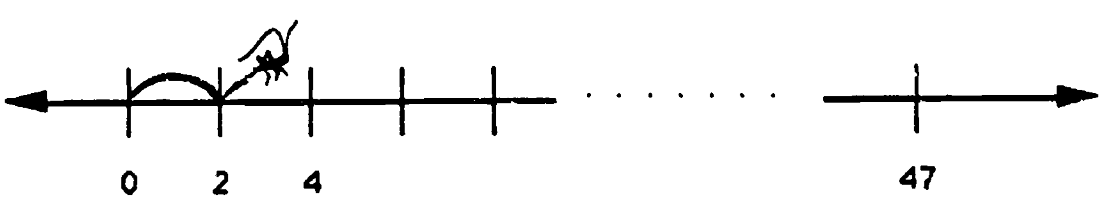
Will the cricket land on 48? ______ If yes, in how many hops? _____

2.



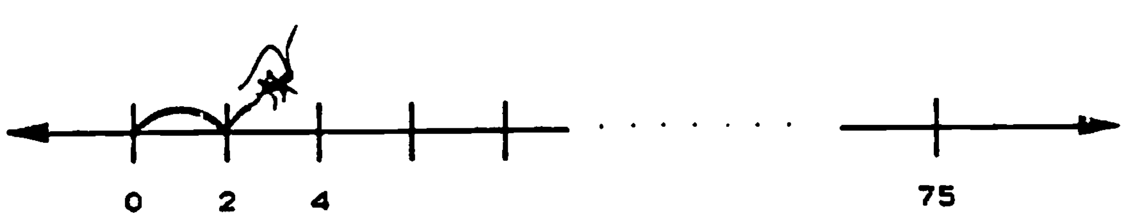
Will the cricket land on 47? _____ If yes, in how many hops? _____

3.



Will the cricket land on 47? _____ If yes, in how many hops? _____

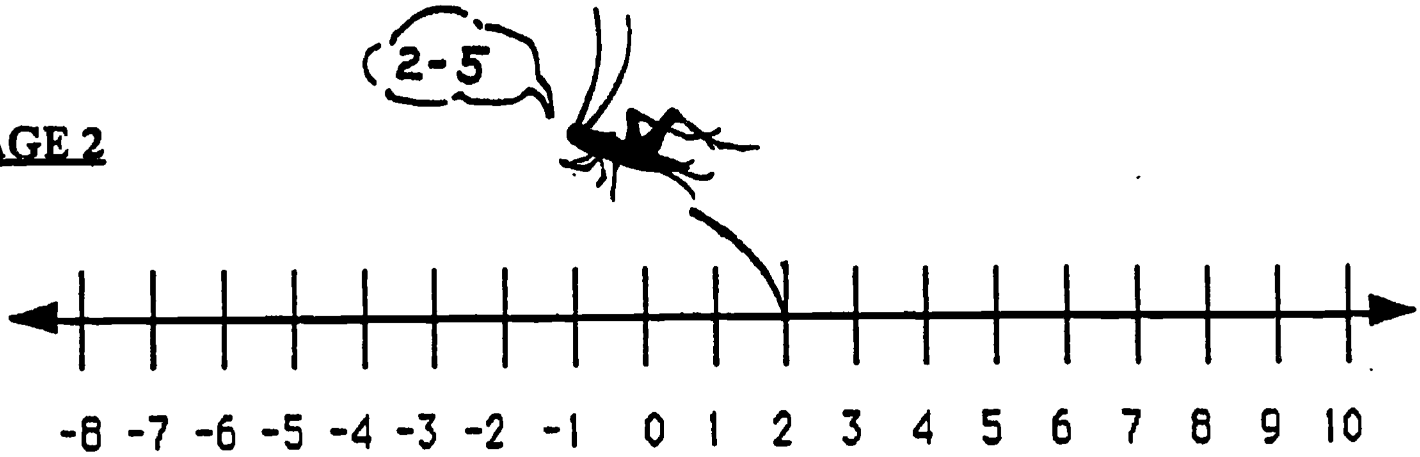
4.



Will the cricket lar.d on 75? _____ If yes, in how many hops? _____

NAME ____

PAGE 2



C. 2 - 5 = ________

D. -1 + 8 = ________

E. 3 x 2 = ________

---

5. 4 - 5 = ________

6. -1 + 5 = ________

7. -3 - 7 = ________

8. 0 + 8 = ________

9. 0 - 8 = ________

10. 5 x (-3) = ________

NAME ____________________________

Stephen S. Willoughby, MDR-8896131

F. 2^5 means 2 multiplied together 5 times, so $2^5 = 2x2x2x2x2 = 32$

G. 3^4 means 3 multiplied together 4 times, so $3^4 = 3x3x3x3 = 81$

---

11. What is 2^3? ________

12. What is 2^4? ________

13. Would a calculator help more in finding (circle one):

    2^7 OR 7^2 ?

14. Would a calculator help more in finding (circle one):

    3^{10} OR 10^3 ?

15. Using this new way of writing numbers, how would you write

    2×2^5 ? ________

In each of problems 16 through 18 there are two calculators. They give different answers to problems. One of them is broken Circle the one that gives correct answers. Look at sample problem H before you begin to answer problems 16 through 18.

H.	73 x 56	Calculator 1: 129	Calculator 2: 4088
16.	3 x 348	Calculator 1: 1044	Calculator 2: 1025
17.	23 x 15	Calculator 1: 139	Calculator 2: 345
18.	8^7	Calculator 1: 20,487,174	Calculator 2: 2,097,152

NAME ____________________________________

19. You can use a calculator to help find 4^9 by pushing these keys:
4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 x 4 =
Suppose the 4 key on your calculator doesn't work, but everything else does.
What keys could you push to find 4^9?

____

20. Juan worked 3 hours and 40 minutes Monday morning.
He worked 4 hours and 20 minutes Monday afternoon.
He worked 2 hours and 40 minutes Monday evening.
Altogether, how long did Juan work on Monday?

____

21. Approximately what is 24,433 x 186,282? (Circle One)

A. 73

B. 5,000,000

C. 4,500,000,000

D. 4,700,000,000,000

E. 60,000,000,000,000,000

GRADE 5 TEST (Use Calculator) **Name** ________________
TIME LIMIT: 15 MINUTES

Do the following problems. Write your answers in the blanks.

1) 73,456 + 840,951 = ________

2) 1,000,000 - 734,599 = ________

3) 42,674,196 ÷ 9,876 = ________

4) 1,234 x 5,678 = ________

5) 12,345 x 12,340 = ________

6) 123,456,789 + 987,654 = ________

7) The First National Bank of Sand pays 10 percent interest compounded annually. That means that at the end of each year they add to your account 10% of the money you had in the bank all year. So, the second year they give you 10% of the original money plus 10% of the interest, and so on.

   If I deposit $1000 now, how much will the bank owe me in 10 years at this rate?

   ____

Stephen S. Willoughby, MDR-8896131

GRADE 6 TEST (Use Calculator) **Name** ________________
TIME LIMIT: 15 MINUTES

Do the following problems. Write your answers in the blanks.

1) A classroom has a length of 47 feet, a width of 26 feet, and a height of 13 feet.

   a) What is the perimeter of the floor of the classroom?

   ____

   b) What is the area of the floor of the classroom?

   ____

   c) What is the volume of the classroom?

   ____

2) 9753 x 2468 = ____________

3) 97,531 x 2468 = ____________

4) 59,628,354 ÷ 3487 = ____________ (to the nearest hundredth)

5) 123,456,789 ÷ 58 = ____________ (to the nearest hundedth)

Stephen S. Willoughby, MDR-8896131

SUPPLEMENTARY MATHEMATICS MATERIALS FOR A TECHNOLOGICAL SOCIETY

Test on Computer Application Software

Please Print The Following Information

STUDENT NAME ________________ SCHOOL ______________

TEACHER NAME ____________ GRADE ___ BOY OR GIRL _____

A friend of yours has a large collection of music tapes. To keep track of them, he has set up a database containing information about them with the following five fields:

1. Singer's Name
2. Singer's Sex
3. Title of Tape
4. Price Of Tape
5. Year When The Tape Was Bought

Which feature of the database, SORT or SELECT, would you choose to obtain the following information. Please check one feature only for each item.

	SORT	SELECT
1. The most expensive tape in the collection.	____	____
2. Titles of all tapes in the collection that cost exactly $8.00	____	____
3. Titles of all Michael Jackson tapes in the collection.	____	____
4. Number of different singers in the collection.	____	____
5. Which tape was bought first.	____	____

Fred has been picked by his teacher, Ms. Jones, to be in charge of buying food for the class picnic this year. To help keep track of how much of each item he needs, and how much everything will cost, he has created the following picnic spreadsheet on his computer. Use this spreadsheet to answer the questions that follow.

	A	B	C	D
1		Unit		Total
2	Item	Price	Number	Price
3				
4	Hot Dogs	0.40	0	0.00
5	Hamburgers	0.50	0	0.00
6	Soda	0.35	0	0.00
7	Ice Cream	0.25	0	0.00
8				
9				Total: 0.00

6. If Ms. Jones tells Fred they will need 10 hot dogs for the picnic, in which cell should he enter this number?

   Answer: ______________________

7. If Fred enters the number 15 into cell C6, what is he ordering for the picnic?

   Answer: ______________________

8. If Fred puts the number 5 into cell C5, what other cells in the spreadsheet would automatically change?

   Answer: ______________________

9. If the store where Fred was buying the food had a sale and all the food prices changed, which column of the spreadsheet would Fred have to change?

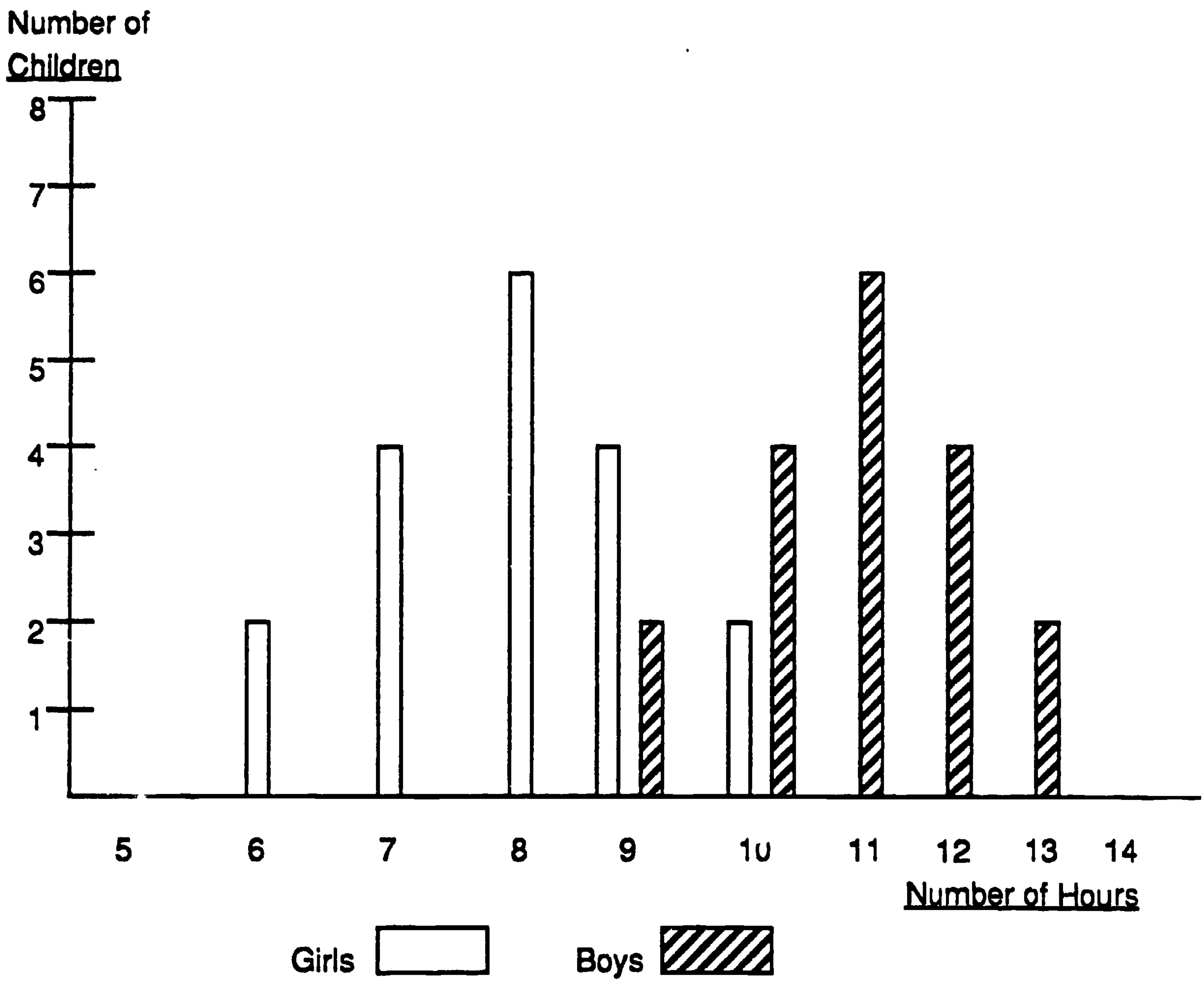
Answer: ____________________

10. Check whether the information in each of the following cells is defined as a constant, or as a function of the numbers in other cells.

	CONSTANT	FUNCTION
Cell D4	________	________
Cell C7	________	________
Cell B4	________	________
Cell D9	________	________

Angela has been collecting information on the number of hours per week her friends watch television as part of a class project. She has used a computer graphing program to display this information, and the display is shown below. Use this graph to answer the questions that follow.

NUMBER OF HOURS PER WEEK SPENT WATCHING TELEVISION



11. Draw a picture of the type of bar that is used in this graph to represent the information about the girls.

Answer: ______________________________

12. What is the fewest number of hours the girls watched television? ____________

13. What is the greatest number of hours the girls watched television? ____________

14. Did any of the girls watch more television than one or more of the boys? Check the answer you think is correct.

Answer: Yes __________ No __________

15. In general, who do you think watched more television, the girls or the boys? Check the answer you think is correct.

Answer: Girls ____ Boys ____ The Same ____

16. If you had to estimate the average number of hours the girls watched television, which number would you choose? Check one number.

Answer:	5 Hours	8 Hours	11 Hours	14 Hours
	_____	_____	_____	_____

17. If you had to estimate the average number of hours the boys watched television, which number would you choose? Check one number.

Answer:	5 Hours	8 Hours	11 Hours	14 Hours
	_____	_____	_____	_____

SMMTS – CALCULATOR
STUDENT ATTITUDE QUESTIONNAIRE

PLEASE PRINT YOUR:

Name ______________________ School ____________________

Teacher ______________ Grade _______ Boy or Girl _________

Here are 13 statements. There are no correct answers to these statements. They have been set up in a way which permits you to let us know how you feel about each statement by circling one of the following choices:

Yes Not Sure No

Be sure to circle an answer next to every statement. Remember, the best answer is the one that is <u>true for you</u>.

1.	If you use a calculator, there is no need to learn addition, subtraction, multiplication, or division.	Yes	Not Sure	No
2.	Learning how to use a calculator is worthwhile and useful.	Yes	Not Sure	No
3.	I would trust an answer to any math problem gotten by using a calculator more than I would an answer gotten by using paper and pencil.	Yes	Not Sure	No
4.	Using a calculator in math class is cheating.	Yes	Not Sure	No
5.	It is always better to use a calculator than not to use one in solving math problems.	Yes	Not Sure	No
6.	It is more fun to learn math if you use a calculator than if you do not.	Yes	Not Sure	No

Stephen S. Willoughby, MDR-8896131

7. People should try to estimate answers to problems when they use a calculator. Yes Not Sure No

8. A calculator should not be used in math class. Yes Not Sure No

9. An answer found by using a calculator will always be correct. Yes Not Sure No

10. Learning how to use a calculator in math class is a waste of time. Yes Not Sure No

11. A calculator is a good learning tool. Yes Not Sure No

12. I would worry less about the answer to any math problem if I used a calculator than if I did not use a calculator. Yes Not Sure No

13. Calculators can be used to discover facts about numbers. Yes Not Sure No

In 50 words or less, discuss when the use of a calculator is appropriate and when it is not appropriate.

____

____

____

____

____

____

____

____

SMMTS – COMPUTER
STUDENT ATTITUDE QUESTIONNAIRE

PLEASE PRINT YOUR:

Name ____________________ School ____________________

Teacher ______________ Grade ______ Boy or Girl __________

Here are 13 statements. There are nc correct answers to these statements. They have been set up in a way which permits you to let us know how you feel about each statement by circling one of the following choices.

Yes Not Sure No

Be sure to circle an answer next to every statement. Remember, the best answer is the one that is true for you.

1.	A computer should be used to solve all types of math problems.	Yes	Not Sure	No
2.	Learning how to use a computer is worthwhile and useful.	Yes	Not Sure	No
3.	Using a computer to solve a math problem sometimes lets you discover things that you would not discover without a computer.	Yes	Not Sure	No
4.	Using a computer in math class is cheating.	Yes	Not Sure	No
5.	You have to be an expert to use a computer for solving math problems.	Yes	Not Sure	No
6.	It is more fun to learn math if you use a computer than if you do not.	Yes	Not Sure	No
7.	Doing math with a computer is harder than doing it without a computer.	Yes	Not Sure	No

8. If you use a computer to solve math problems, then you are not really learning math. Yes Not Sure No

9. An answer found by using a computer will always be correct. Yes Not Sure No

10. Learning how to use a computer in math class is a waste of time. Yes Not Sure No

11. A computer is a good learning tool. Yes Not Sure No

12. I would trust an answer to a math problem that I got from a computer more than I would trust an answer I got by myself. Yes Not Sure No

13. Using the computer allows you to solve math problems in ways that you would not try without the computer. Yes Not Sure No

In 50 words or less, discuss when the use of a computer is appropriate and when it is not appropriate.

END

U.S. Dept. of Education

Office of Educational
Research and Improvement (OERI)

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