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ABSTRACT

Appalachia Educational Laboratory's Rural Excel program collaborated with the Tennessee Center of Excellence for Science and Mathematics Education and with faculty at 21 local education agencies in rural Tennessee to evaluate implementation of the Tennessee Mathematics Activities Manuals for grades 5-8. The manuals each contain 54-67 activities organized into 8 curriculum strands, such as numeration, fractions, and geometry. Project activities involving 21 teachers and 1,655 students took place during the 1991-92 school year. With collaboration of participants, project staff gathered information about: (1) pre-implementation inservice training; (2) teachers' concerns during implementation (using the Concerns-Based Adoption Model); (3) teachers' actual use of activities; and (4) students' pre-project and post-project affect and achievement. Post-project telephone interviews gathered additional information about teachers' views and background. Results show that teachers used 80-90 percent of available activities; they rated the effectiveness of activities as "very good"; and the most frequently used activities were not always the ones teachers rated most highly for effectiveness. Overall changes in student affect and achievement were slight. Affective outcomes differed significantly by grade-placement (favoring students not in grade 7), while achievement outcomes were significantly related to average number of activities used per class and to gender (favoring males). Appendices contain sample activities, evaluation instruments, responses to items on affect scales, and a completed evaluation standards checklist. (KS)

Mathematics Activities Manuals: Final Evaluation Report

by

Robert Childers
and
Craig Howley

November 1993

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Appalachia Educational Laboratory

Rural Excel Program ♦ P. O. Box 1348 ♦ Charleston, WV 25325

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AEL
Post Office Box 1348
Charleston, West Virginia 25325-1348
304/347-0400
800/624-9120 (toll-free)
304/347-0487 (FAX)

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Mathematics Activities Manuals: Final Evaluation Report

Rural Excel Program

Appalachia Educational Laboratory

Charleston, WV 25325

Robert Childers, Director
Craig Howley, Senior Research and Development Specialist

November 1993

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Robert Childers

Craig Howley

EXECUTIVE SUMMARY

AEL's Rural Excel program collaborated with the Tennessee Center of Excellence for Science and Mathematics Education and with faculty at 21 local education agencies in rural Tennessee to conduct a research and development project. Its purpose was to evaluate implementation of the Tennessee Mathematics Activities Manuals for grades 5-8. These manuals each contained between 54 and 67 activities organized into eight curriculum strands (e.g., numeration, fractions, geometry). The Center of Excellence had developed, pilot tested, and revised the manuals in 1988-1990, but had not evaluated an implementation.

Rural Excel staff developed a project plan for the proposed work in August 1991. Project activities took place during the 1991-1992 school year. Twenty-one teachers and 1,655 students were involved. With the collaboration of participants, project staff gathered information about (1) pre-implementation inservice training; (2) teachers' concerns during implementation (using the Concerns-Based Adoption Model); (3) teachers' actual use of activities; and (4) students' pre-project and post-project affect and achievement. Information about students' backgrounds, including sex and risk status, was also available. Post-project telephone interviews gathered additional information about teachers' views and backgrounds.

Evaluation data suggest that the collaborating parties worked well together during this project. Effective procedures were developed and implemented to ensure timely completion of tasks and progress toward each objective of the plan. Substantive findings include the following:

- Teachers used between 80 and 90 percent of available activities.
- Teachers rated the effectiveness of activities as very good.

- The most frequently used activities were not always the ones teachers rated most highly for effectiveness.
- In grades 5-7, activities from the graphing strand were used less frequently than activities in other strands.
- Overall changes in student affect and achievement were slight.
- Differences in affective gain scores between grade-placement groups were significant.
- Differences in student achievement gain scores between gender groups were significant.
- Usage variables related positively to affective and achievement gain scores in correlational and regression analyses.
- Differences in student achievement gain scores between high- and low-usage groups were very significant.

This evaluation confirms the existence of a positive relationship between activity usage and student gain scores, but cannot confirm any causal relationship. Within-classroom circumstances certainly mediate the probable effects of any usage, and effective usage in one context may differ from effective usage in another context.

This report recommends the use of <u>one or two carefully chosen activities per week, especially to introduce a topic</u>, as a reasonable practice for improving both student mathematics achievement and affect. Whatever the usage, however, teachers should <u>actively engage the activities</u> as important, useful, and productive for students. Correlational and regression results illustrate this case with respect to females' concept gains. But because classroom contexts are so varied--in terms both of student and of teacher characteristics--effective usage requires ongoing cultivation, perhaps through <u>peer coaching or mentoring</u>. Finally, this report recommends that future revisions of the manuals investigate features of the most frequently used as compared to the least frequently used activities.

INTRODUCTION

This project of the Rural Excel program of the Appalachia Educational Laboratory (AEL), in collaboration with the Center of Excellence for Science and Mathematics Education (CESME) at the University of Tennessee at Martin (UTM), evaluated implementation of a large-scale effort to infuse supplementary activities into the instructional routines of middle-grade (grades 5-8) teachers in 21 principally rural schools throughout Tennessee.

The purpose of this evaluation report is twofold: (1) to document the process and procedures utilized in conducting the project; and (2) to report the effects that use of the mathematics activities had on student affect and achievement.

The evaluation report has two primary audiences: (1) AEL's administration and the program monitor from the Office of Educational Research and Improvement (OERI); and (2) the staff at the Center of Excellence for Science and Mathematics Education. Mathematics educators, evaluators interested in assessment, and researchers interested in measuring students' attitudes and opinions regarding mathematics make up a secondary audience.

Background

In the 1985-1986 school year, a statewide committee of Tennessee mathematics educators developed the Mathematics Curriculum Frameworks for Grades K-8 and state curriculum guides for each grade. The guides include instructional objectives, associated content synopses, skills, and sample activities to facilitate the implementation of the Frameworks at the local level. The Frameworks in K-8 apportioned the curriculum to eight strands:

- numeration;
- operations on whole numbers and integers;

- fractions and decimals;
- graphing, probability, and statistics;
- problem-solving and applications;
- measurement;
- geometry; and
- ratio, proportion, and percent (beginning in grade 6).

Each guide contains the following statement:

> The final "critical factor" is the use of concrete experiences as students learn a new skill at any level. Without the understanding that comes from concrete experiences, the rote learning of skills has little meaning. The transition from concrete to abstract should be a slow, deliberate process, and at all levels, new concepts should be introduced through concrete experiences (Tennessee Department of Education, 1986, p. vi).

Inclusion of this statement reflected an emerging consensus in the field of mathematics education. According to numerous studies, mathematics teaching has remained closely bound to the use of textbooks throughout recent decades (e.g., National Council of Teachers of Mathematics [NCTM], 1991; Porter, 1988). The instructional routines that accompany this usage, moreover, fail to nurture mathematical understanding among students (e.g., Lochead & Mestre, 1988; Mathematical Association of America, 1991; NCTM, 1991). According to contemporary notions of best practice in mathematics education, students need frequent opportunities to think about mathematical ideas, to explore alternative problem-solving strategies, and to discourse productively with each other and with their teachers about mathematical concepts. Finally, organizations such as the Mathematical Sciences Education Board (1990) recommend that students should use real objects and real data in the classroom as they learn mathematics.

In the Tennessee Frameworks, concrete experiences figured prominently as a recommended means to nurture mathematical learning and understanding. Because of space limitations in the curriculum guides, however, activities were described very briefly (one or two paragraphs). The elementary committee suggested that a separate activities manual be developed for each grade, but funding for this work was not available. In the 1986-1987 school year, as the guides were distributed throughout the state, a key question from teachers was: "How do we use activities and manipulatives in the classroom?"

Development of Activities Manuals

The Tennessee Frameworks, the emerging professional consensus nationally, and the evident need of Tennessee teachers led to the development of the Activities Manuals. In the fall of 1988, CESME staff wrote a proposal for unallocated Eisenhower funds from the State Department of Education. This grant provided for the development of the activities manuals, keyed to the curriculum as presented in the Frameworks. Under the auspices of CESME, 24 teachers (17 elementary and 7 secondary) developed the initial draft of the manuals from January to June 1989.

Draft versions of the manuals were mailed to teachers across the state who had agreed to pilot test the Activities Manuals during the 1989-1990 school year. By May 30, 1990, 113 teachers from 40 school systems (including one private school) had completed all parts of the pilot test.

The Manuals were revised following the pilot test. At the end of February 1990, descriptions and applications for the revision project were mailed to the original writers and the pilot teachers, and to others (e.g., local education agency supervisors). The program was also announced in March in CESME's Mathematical Moments. Revisions were completed during the summer of 1990.

All 139 local educational agencies in Tennessee received order forms for the manuals in the fall of 1990. To date, approximately 115 local education agencies have purchased the manuals in large quantities. Some systems purchased the manuals with Eisenhower funds and provided inservice training. AEL's involvement with implementation activities began with the provision of such training in the summer of 1991.

Rural Excel's Involvement

Rural Excel's goal is to provide rural educators with tested materials and practices that show promise of improving student performance in classrooms. Development of the manuals was prompted by concerns at the state and national level. Whether or not the manuals would show promise of improving student performance in _rural_ classrooms was unclear. Staff of AEL's Rural Excel program and CESME agreed to collaborate in evaluating the implementation in grades 5-8 in rural schools serving rural areas.

METHODOLOGY

This section describes in more detail the subjects, materials, and instrumentation of this study. It also describes the procedures (implementation activities as well as data collected) and the research questions that guided AEL's evaluation activities.

Subjects

This subsection of the report provides descriptive background data about students, teachers, and schools involved in the implementation. Teacher data were gathered in telephone interviews following the 1991-1992 academic year and include years of experience, highest education level, views on use of calculators, and preferences for kinds of students (low, average, or high-achieving students), and males versus females. Student data were reported by teachers and include risk status (did or did not receive free or reduced-price meals) and gender, two key background variables in subsequent analyses. School data came from the U. S. Department of Education's Common Core of Data and include type of locale, enrollment, and grade span served.

Teachers

All 21 teachers in project classrooms were females. At the end of the project year, the number of years spent in teaching among this group ranged from 2 to 25 (mean = 14.3, median = 16). Approximately one-quarter had taught less than 10 years; about one-quarter had taught between 10 and 14 years; about one-quarter between 15 and 19 years; and the remaining quarter had taught 20 or more years. On average, then, teachers in project classrooms were very experienced.

As might be expected from the data about the teachers' experience, they were also well qualified in terms of highest level of educational attainment.

Approximately 85 percent had earned a Master's degree; about 50 percent possessed at least 15 additional credit hours above the Master's level. More than 25 percent possessed at least 30 additional credit hours above the Master's level. Two-thirds of this latter group (five teachers) possessed a Master's plus 45 credit hours.

Students

Following data cleaning, there were records for 1,655 students. Of these, 49.7 percent were female (n = 823) and 45.9 percent (n = 759) were male. Seventy-three cases (4.4 percent) had missing data on gender.

With respect to risk status (receiving versus not receiving free or reduced-price meals), 55.5 percent (n = 919) did not receive free or reduced-price meals, versus 15.9 percent (n = 263) who did. Missing cases comprised 28.6 percent of the sample (n = 473).

With respect to grade placement, 8.1 percent (n = 134) were grade 5 students, 34.3 percent (n = 567) were grade 6 students, 28.9 percent (n = 478) were grade 7 students, and 28.6 percent (n = 473) were grade 8 students. Three cases had missing data on grade placement.

Schools

Data on schools are drawn from the 1990-1991 Common Core of Data, which gathers from each public school in the nation limited data about enrollment, grade spans, and type of locale in which schools are located. Comparable data were available from this source for 20 of the 21 project schools.

Enrollment in project schools varied from a low of 265 to a high of 1,345 (mean = 605, median = 626). Approximately half the schools were middle or junior high schools, and the remainder served the elementary grades, beginning with grade

K or PK. At the time of the survey, 30 percent of project schools enrolled fewer than 475 students, 30 percent enrolled between 475 and 645 students, and 30 percent enrolled between 645 and 950 students. Two schools enrolled more than 1,000 students. Type-of-locale data confirm the rural character of these schools, with 70 percent located in the NCES-assigned locale types 6 and 7 (see Johnson, 1988).[1] Enrollment size varied by type of locale and by type of organization (elementary versus middle level), with the most rural schools (Johnson code 7) being smallest. Middle-level schools (middle or junior high schools) had a mean enrollment of 723 students, versus 607 for elementary schools.

Materials

Each grade, K-8, has its own Activities Manual, and each manual consists of a set of activities, together with instructions for making the required materials, instructions for conducting the activity, and ancillary material (references, appendices, and so forth). Each manual contains an introduction that lists instructional strategies recommended in the NCTM Standards and provides general hints for making activity materials.

The seventh- and eighth-grade manuals may be used with both Arithmetic 9 and pre-Algebra. The Algebra Manual covers two years of instruction (i.e., Algebra I and II). The Unified Geometry Manual covers geometry only, and the Advanced Topics Manual covers selected topics beyond Algebra and Geometry.

Table 1 describes the content of each Activities Manual for grades 5-8.

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[1]Locale type 6 (30 percent of project schools) refers to small towns (outside standard metropolitan statistical areas, with population less than 25,000). Locale type 7 (30 percent of project schools) refers to places with population under 2,500 or having a zip code designated as "rural" by the Census Bureau.

Table 1

Content of Mathematics Activities Manuals:
Number of Activities by Strand and Grade Level

Strand	Grade Level 5th	6th	7th	8th
NUM	12	10	6	6
OPS	7	4	4	6
FRA	15	10	8	5
GRA	6	6	6	5
PRB	12	8	11	9
MEA	9	8	6	9
GEO	6	7	9	5
RAT	n/a	6	4	5
TOTAL ACTIVITIES	67	59	54	50

Key to Strands

NUM = numeration
OPS = operations on whole numbers and integers
FRA = fractions and decimals
GRA = graphing, probability, and statistics
PRB = problem-solving and applications
MEA = measurement
GEO = geometry
RAT = ratio, proportion, and percent (beginning in grade 6)

The description of each activity in the manuals follows a standard form, developed by CESME staff, with input from t acher/writers. This form records the following information:

- activity name
- Tennessee curriculum strand
- objectives
- prerequisites
- materials needed
- instructions to teachers for making the activity
- instructions to teachers for conducting the activity
- students' directions (if applicable)
- variations
- extensions
- references
- blackline masters

Activities were written so that a beginning teacher in the first week of school could use them. See Appendix A for sample activities, reproduced from the Activities Manuals.

Instrumentation

Several instruments were used to gather data about teachers and students during implementation in the 1991-1992 school year. These instruments are described next.

Teachers

Four instruments were used to gather data from teachers. First, AEL's standard Workshop Evaluation Form was used to assess teachers' ratings of CESME inservice training. This instrument asks teachers to rate quality of training events by indicating the degree to which they affirm or reject eight statements. The rating scale is continuous, varying from 0 to 50, with subjects free to mark any point along this continuum. Depending on sample sizes, alpha reliabilities vary between .70 and .90. A copy of this instrument appears as Appendix B.

Second, the Stages of Concern (SoC) Questionnaire (Hall, George, and Rutherford, 1979) was used to gather information about teachers' concerns as implementation progressed. This instrument is part of the Concerns-Based Adoption Model (Hall, Wallace, and Dossert, 1973). The Questionnaire measures seven different stages of concern (see Table 2 for a description of these stages), with each item soliciting subjects' degree of concern about the stimulus item on a seven-point Likert scale. Test-retest study results proved stage score correlations ranging from .64 to .84 with six of the coefficients being above .70. Appendix C provides a copy of the SoC Questionnaire as used in this study.

Third, information from teachers about the actual use of activities was gathered through the use of a specially designed Mathematics Activities Class Log. The log sheets were designed to elicit the following information (in addition to teacher's name, grade, and period):

- date activity used;
- name of activity;
- purpose of use (introduce, teach, review);
- effectiveness (excellent, good, fair, poor); and
- comments.

A copy of the Mathematics Activities Class Log is included as Appendix D.

Table 2

Stages of Concern: Typical Expressions of Concern About the Innovation*

Stage No.	Stages of Concern	Expressions of Concern
0	Awareness	I'm not concerned about the innovation.
1	Information	I would like to learn more about it.
2	Personal	How will using it affect me?
3	Management	I seem to be spending all my time getting material ready.
4	Consequence	How is my use affecting students?
5	Collaboration	I am concerned about relating what I am doing with what other instructors are doing.
6	Refocusing	I have some ideas about something that would work even better.

*Hord, S. (1987). Evaluating educational innovation. London: Croom Helm.

Finally, staff conducted structured telephone interviews with teachers at the end of the implementation year. These questions elicited background information about teachers: educational level, years taught, views of calculator use, and so forth. Appendix E is a list of the questions asked.

Students

Three instruments were used to gather pre- and post-implementation data from students. Information gathered concerned both affect and achievement.

First, an extensive review of the literature revealed no suitable research instruments with which to gather data about students' affective responses to mathematics. Therefore, project staff worked with staff at CESME to develop suitable instruments. This process resulted in instruments intended to measure two distinct factors: (1) students' views of mathematics in a personal frame of reference (attitude instrument) and (2) students' views of mathematics in a social and cultural frame of reference (opinion instrument). The "Mathematics Attitude Scale" of 25 items and the "Mathematics Opinionnaire" of 23 items appear as Appendix F. These instruments were administered both as pretest and as posttest measures. Alpha reliabilities in both pre- and posttest administration were .90 or higher.

Second, achievement was measured with the Comprehensive Test of Basic Skills, Fourth Edition (Macmillan/McGraw-Hill, 1989). The CTBS/4 was administered to project students as part of the regular Tennessee Comprehensive Assessment Program testing schedule, as both a pre- and posttest measure.

Procedures

Consonant with the Rural Excel goal, this project sought to test the use of the CESME Mathematics Activities Manuals in grades 5-8 in schools serving a predominantly rural area. Procedures included (1) teacher training prior to implementation (in collaboration with CESME staff), (2) agreements between AEL and participating teachers (n = 21), and (3) the collection of evaluation data for subsequent analysis.

Teacher Training

The provision of inservice training, which included the construction of materials necessary to conduct activities described in the manuals, was provided to all participating teachers during the summer of 1991. Training was provided through an Eisenhower grant funded through the Tennessee Higher Education Commission, which provided training for three-teacher teams from each of 21 school districts. Each team consisted of a K-4, 5-8, and 9-12 teacher.

The week-long training began with a general session that provided an overview of the planned inservice activities. During that session, the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) and its implications for the project were discussed. Generally, Tennessee teachers--like others in the AEL Region--had looked unfavorably upon the use of calculators in mathematics instruction. Since the Standards required that "appropriate calculators should be available to all students at all times," and since the manuals did not address calculator usage per se, the workshop leaders decided to include training in calculator use. Appropriate calculators and activities were specified by grade level. The K-4 group used a four-function calculator; the 5-8 group used the Texas Instruments TI-12 "Explorer" calculator; and the 9-12 used both a scientific calculator and the Texas Instruments TI-81 graphing calculator. Calculator training sessions were held the first evening, and calculators were available to all teachers throughout the following week.

Workshops about the Activities Manuals were led by teachers who had written or revised the manuals; each leader had more than 10 years of successful teaching experience. The leaders directed activities and modeled lessons that incorporated activities from the manuals as the teaching strategy. Participants were subsequently required to present an activity to their workshop group. Participants also constructed materials to use themselves in activities with their students during the 1991-1992 school year. Each participant left the workshop with materials for approximately 12 activities.

These would be used not only for instruction, but for demonstrations with other teachers in the districts where participants taught. The workshops thus included a training-for-trainers component. The three-person teams from each district were required to develop outlines for six-hour inservice sessions at each grade-range level. Teams developed plans for presentation to (and the approval of) their system contact person (i.e., authoritative colleague in their home district). CESME staff encouraged participating systems to continue to use their trained teams as resource people for implementing activity-based mathematics.[2]

Agreements Between AEL and Participating Teachers

In order to provide a framework for the collection of data in project classrooms, AEL developed an agreement form specifying the responsibilities of both AEL and participating teachers. All participating teachers (grades 5-8) signed the form as did their principals. Forms were completed prior to the start of the 1991-1992 school year.

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[2]Between the time they finished inservice training and January 1993, participating teachers had provided inservice training to more than 4,000 individuals. Presentations have included regional and national mathematics meetings. In addition, manuals have been shipped to 16 states, the District of Columbia, and Canada.

The substance of the agreement was that AEL would provide each participating teacher with a stipend of $250.00 for the purchase of additional manipulatives for mathematics classes and with copies of all protocols and instruments required for data collection. AEL also agreed to reimburse teachers' postage and freight expenses.

The 21 participating teachers agreed to use one activity per week from the appropriate Activities Manual in each class taught and to complete the teacher log (under "Implementation," page 9). Teachers also agreed to report pre- and post-project achievement data about students and to administer the two affective instruments described above to students. Teachers stipulated that they would spend their stipends on manipulatives, and they also provided information about grade levels and projected enrollments of the classes they would be teaching. Appendix G is a copy of this form.

Evaluation Data Collected

Data collection instruments described in a previous section were used to collect information about

- teachers' views of the initial inservice training;
- teachers' stages of concern with the implementation;
- student achievement and affect prior to and following implementation;
- teachers' use of activities, purposes of such use, and subjective assessment of effectiveness; and
- teachers' post-project views and their teaching backgrounds.

Each of these data collection efforts is described sequentially in the paragraphs that follow.

AEL staff who attended the inservice sessions collected teachers' views of the initial inservice training on the previously described instrument. Evaluation instruments were administered in June 1991 to 66 inservice participants (i.e., not only to teachers in grades 5-8, who would subsequently participate in the AEL/CESME project). The Rural Excel secretary entered data, and AEL's senior research and evaluation specialist completed the data analysis.

Teachers' stages of concern with the implementation were measured at three separate times during the project. The Stages of Concern (SoC) Questionnaire was administered by project staff to participating teachers (grades 5-8) at (1) the end of training, (2) the second month of implementation, and (3) the eighth month of implementation. The Rural Excel secretary entered the raw data into a computer database. AEL's senior research and evaluation expert conducted the subsequent analyses, and also developed a separate report synthesizing information across all three SoC administrations.

Teachers provided student achievement data from results of the CTBS/4 administrations in the spring of 1991 (pretest) and the spring of 1992 (posttest). Teachers recorded achievement data on forms provided by AEL ("Class Roster: Mathematics Activities Manuals Project"). The forms included space to record student names, student sex, grade, period, and teacher name. Achievement data were gathered for the following CTBS/4 categories: (1) mathematics computation subtest score, (2) mathematics concepts and applications subtest score, (3) total mathematics composite score, and (4) total CTBS/4 battery composite score. Teachers recorded both scaled scores and scores in Normal Curve Equivalent (NCE) units (with NCE units used in subsequent analyses). The Rural Excel secretary entered data as received and reminded teachers when data were due. Data analysis was provided by AEL's senior research and development specialist, who developed a preliminary report late in the summer following implementation.

Student affect was measured with the attitude and opinion instruments described previously. Teachers administered these instruments near the beginning and near the end of the implementation. Data from these administrations were used to construct a 12-item instrument related in exploratory analyses to achievement, but retaining the two separate factors of attitude and opinion. Factor 1, attitude, consists of six items about students' personal views of their engagement with mathematics instruction. Factor 2, opinions, consists of six items about the usefulness and meaning of mathematics in the world. See Appendix H for a list of the 12 questions that comprise the data used in subsequent analyses.

Teachers recorded their use of activities in the log provided by AEL. The form included space to record the date each activity was implemented; the title of each activity; its purpose (introduce, teach, review); its effectiveness (excellent, good, fair, poor); and narrative comments for the activity. Narrative comments were not required, but a separate space to record such comments was provided for each activity. Teachers submitted their completed class logs at the end of the 1991-1992 school year. The Rural Excel secretary entered data; the project director aggregated data and derived several variables used in subsequent analyses conducted by the research and evaluation specialist.

Following preliminary analyses of achievement and affective data, in fall 1992, the Rural Excel secretary interviewed teachers to obtain their post-project views and their teaching backgrounds.

Analysis

This evaluation study asks three research questions in support of the project's objectives:

(1) Can a procedure be developed whereby an institution of higher education, a Regional Educational Laboratory, and local education agencies collaborate to conduct an R & D project?

(2) How well did the activities in the grade 5-8 Mathematics Activities Manuals work when used in rural classrooms in Tennessee during the 1991-1992 school year?

(3) What effects did the use of activities in the grade 5-8 Mathematics Activities Manuals have on students' mathematics affect and achievement when used in rural classrooms in Tennessee during the 1991-1992 school year?

Evidence to answer the second and third research questions is presented in the next section of this report, FINDINGS. Principal methods of analysis for these two questions include descriptive statistics, analysis of variance, and correlational and regression analysis. All three questions, however, are considered in the DISCUSSION section of the report, which follows presentation of the study findings.

FINDINGS

Instrumentation for this study focused on the collection of data about teachers and students. Teacher data included evaluations of the inservice conducted prior to use of the manuals in the 1991-1992 school year, teachers' stages of concern, and data gathered in the activity logs. Student data are concerned principally with mathematics affect and achievement, but also include such background data as sex, free or reduced-price-meal status, grade level, and period of the day taught. Exploratory data analysis attempted, moreover, to link activities usage to observed patterns of student affect and achievement.

Teacher Findings

This section describes data pertinent to teachers' views of the pre-project inservice training, presents the results of the SoC administrations, and analyzes data supplied in teachers' activity logs. Each subsection ends with conclusions drawn from the findings.

Inservice Training

Sixty-six participants in the inservice training completed the evaluation form on June 15, 1991. All subjects were employed as teachers by local education agencies. The alpha reliability of this administration was .75.

Text of stems, means, and standard deviations for each item are reported below:

(1) Did UTM carry out planned activities at the times scheduled?

Mean: 46.97 SD: 5.5

(2) How responsive were UTM staff and/or consultants to your requests for service and/or assistance during this event?

Mean: 47.58 SD: 5.5

(3) In this event, how skilled were UTM staff and/or consultants in completing their tasks?

<u>Mean</u>: 48.48 <u>SD</u>: 3.6

(4) How convenient was this UTM event to your location?

<u>Mean</u>: 30.00 <u>SD</u>: 16.5

(5) During this event how clear were staff's and/or consultants' explanations?

<u>Mean</u>: 45.00 <u>SD</u>: 6.6

(6) Did this event enhance UTM's credibility as an R&D service provider?

<u>Mean</u>: 46.77 <u>SD</u>: 5.0

(7) How well did UTM staff and/or consultants understand your professional needs during this event?

<u>Mean</u>: 46.52 <u>SD</u>: 5.9

(8) How useful were the materials provided to you during this UTM event?

<u>Mean</u>: 47.54 <u>SD</u>: 4.7

The only item on which participants' ratings fell below 45 was the item referring to convenient location. The single location could hardly have been convenient for all participants, since they came from all parts of the state. The mean of 30 is equivalent to "somewhat convenient." The highest mean (48.48) was for item 3 dealing with the skill of inservice trainers; this item also produced the smallest standard deviation (3.6).

The evaluation form also solicited narrative comments for features of the workshop respondents (a) really liked and (b) would change in subsequent sessions. Sixty-four respondents listed features they really liked; 59 provided suggestions for changes. Positive comments concerned the organization of the sessions, the enthusiasm and skill of UTM staff, usefulness of materials and activities, and the camaraderie of participants and UTM staff. Suggestions for change focused on improvements in the distribution of supplies (for making materials) and access to copiers. Another suggestion repeated by several participants was that night sessions be eliminated.

Participants clearly appreciated the inservice training, found it useful and well organized, and believed it enhanced UTM's reputation. The problems perceived by participants concerned logistics, but were not of sufficient concern to compromise participants' overall assessment as reflected in ratings. One participant, who noted that the location was not convenient for her, nonetheless wrote that she would "drive a thousand miles" for such an experience.

SoC Results

SoC data can be interpreted at several different levels of detail and abstraction, but profile interpretation is perhaps the most useful type. Figure 1 displays the three SoC profiles (end of training, second month, and eighth month) for participating teachers. The number of teachers varies slightly from administration to administration, but this variability does not affect interpretation. Figure 1 displays the SoC stage numbers (bottom) and names (top) on the horizontal axis. The relative intensity of the concern stages is displayed on the vertical axis in percentile ranks.

At the macro level, looking at the intensity of all the stages for all the administrations, Figure 1 shows that participating teachers were moderately concerned about their involvement with the project. Across all stages of the

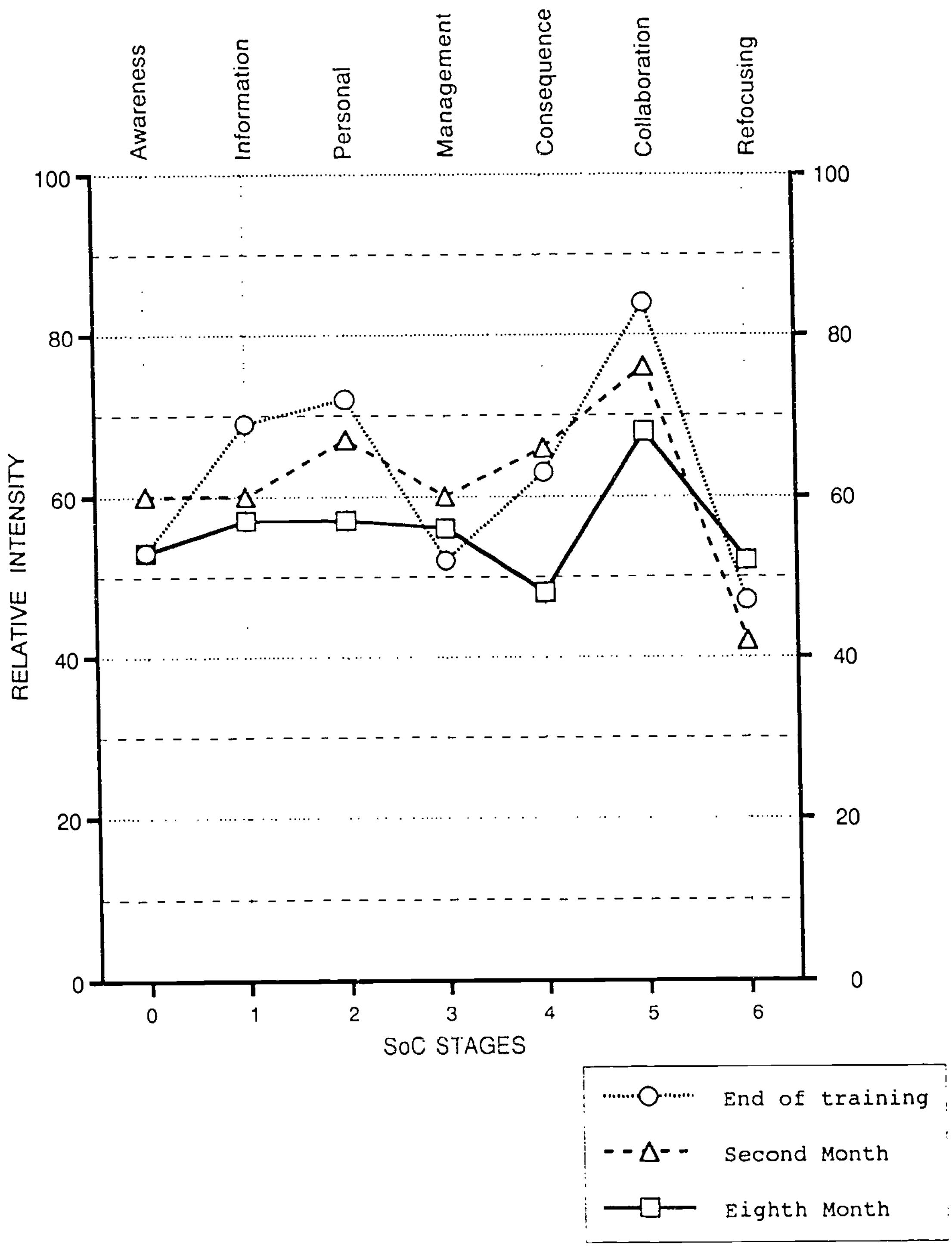

Figure 1. Group SoC Profiles

three administrations, scores (in percentile ranks) ranged from a low of 42 percentile to a high of 84. Individual teachers were neither too concerned nor too unconcerned about the project.

The SoC model is developmental. That is, as individuals move from unawareness and nonuse of an innovation into beginning use then more sophisticated use, it is hypothesized that intensity of concern declines from the self-oriented stages (Stages 0, 1, and 2), through the task stage (Stage 3), and into the impact stages (Stages 4, 5, and 6). Individuals or groups in this "growth" sequence can be assessed best through an analysis of the complete profile. This analysis is presented next.

Figure 1 displays the three SoC profiles for participating teachers. The intensity of the SoC profiles for Stages 0-2 declines steadily in percentile rank points from the end of training, through the second month, and then through the eighth-month administration. This is the pattern typically observed as innovations are implemented.

The shape of the SoC profile for the first two administrations also merits discussion. The intensity of the Personal Stage (#2) is higher than the intensity of the Information Stage (#1). This is called a "one/two split." This pattern means that the personal concerns of the teachers dominated over all other stage concerns--at those two SoC administrations. However, by the third administration, the Personal stage score was exactly the same as the Information stage score. This indicates that teachers' initial personal concerns were reduced by the eighth month of the school year; they no longer superseded all other concerns.

The task-oriented stage, Management (#3), showed less intense concerns than the Information and Personal stage scores across all three SoC administrations. However, Management concerns rose in intensity from the end-of-training administration to the eighth-month administration. This rise in concerns at the Management stage (#3) shows that the project teachers were more concerned about task-oriented aspects of the project as the school year progressed. This is expected.

One of the more interesting aspects of the SoC profiles in Figure 1 revolves around the impact-oriented Stages of Concern. The impact-oriented stages are: Consequence (#4), Collaboration (#5), and Refocusing (#6). Figure 1 shows that the grades 5-8 teachers were most intense at the Collaboration Stage (#5) across all three administrations of the SoC instrument. This result is somewhat unusual; collaboration ordinarily is not the highest stage score for teachers at the beginning or during the middle of an innovation. A high collaboration score characterizes respondents who are most concerned about working with others to coordinate use of an innovation and is typical of administrators or team leaders. Figure 1 nonetheless does show a steady decline in the groups' collaboration scores, from a high of 84 at the first administration to a low of 68 at the third administration.

Last, the shape of the SoC profiles for the impact stages merits discussion. For all three administrations of the SoC, the direction and magnitude of the profile line from Stage #5 to Stage #6 is both downward and steep. At each SoC administration, the profile dropped steeply from the Collaboration stage to the Refocusing stage. In fact, the range between the two stages was 32, 29, and 16 points from the first to the third administration. This drop in SoC scores between the last two stages in the model means that the project teachers were not thinking of different or alternative innovations to replace the Mathematics Activities Manuals. Their concerns were focused on the target innovation, not on possible replacements for it.

In summary of the profiles in Figure 1, it can be said that project teachers' concerns were appropriately focused on the target innovation; they were committed to implementing the Mathematics Activities Manuals. At the beginning, they had many personal concerns about the innovation; these concerns were attenuated by the eighth month of the project (April). By April, concerns focused on the time, materials, resources, and management of the Mathematics Activities Manual project (Management Stage, #3). Throughout the entire school year, project teachers had relatively intense concerns about working with others in implementing this project (Collaboration Stage, #5). Interestingly, those collaboration concerns decreased at the same time that the management scores increased.

These data warrant two conclusions. First, project teachers became more concerned about using the Mathematics Activities Manuals. The steady decline in the intensity of scores on the self-oriented stages (#0-#2), together with increases in intensity on the task-oriented stage (#3) score, warrants this conclusion. Second, project teachers were sufficiently comfortable with use of the Mathematics Activities Manuals that they were not considering alternatives. The steep drop in observed scores between the collaboration and refocusing stage warrants this conclusion.

Activity Logs

Teachers were asked to keep activity logs primarily to reveal which activities in the various manuals in grades 5-8 were used, their effectiveness ratings, which were used most frequently, and which were not used at all. Use is reported by grade level in the paragraphs that follow. Data for the activities in the manuals for each grade level are displayed in four pairs of two tables, one pair for each grade level (Tables 3a and b through Tables 6a and b).

The first table in each pair lists the 10 most frequently used activities (ties are included) by title, teachers' average effectiveness ratings (on a four-point scale, with four the highest rating), and the Mathematics Activities Manual page number on which the activity is described. The first table in each pair also reports the number of separate instances of activity use among the 10 most frequently used activities, as well as the grand average rating of activities (weighted by frequency of use). This latter statistic provides an overall indicator of teachers' views of the effectiveness of each instance of activity use. The second table in each pair lists the activities unused in each manual.

Table 3a shows the 10 most frequently used activities from the grade 5 manual. Activities are listed by frequency of use. The most frequently used activity (Map Trivia) on this list was used 22 times by teachers in all grades 5-8, and the least frequently used activity was used six times (three different activities). Ratings generally follow usage ranks, but the activity titled "Round It," though used only seven times, was rated excellent for effectiveness in all seven cases. In all, these activities were used on 121 occasions, with an average weighted rating of 3.63. Ten activities in the grade 5 manual (15 percent) were not used by any teachers (Table 3b).

Table 4a shows that "I Have...Who Has?" from the grade 6 manual was used 43 times by grade 6 teachers only, whereas the least frequently used activities among the top 10 were used 14 times (by project teachers in all grade levels, 5-8 teachers). These data represent 243 separate instances of use, with an average weighted rating of 3.53. Table 4b identifies eight activities in the grade 6 manuals (14 percent) as unused by any project teacher.

Table 3a

Most Often Used Activities in 5th Grade Manual and Their Average Ratings

Activity	*Number of Times	Average Rating	Page Number
Map Trivia	22	4.00	188
Banana Splits	18	3.83	87
What's My Name?	15	3.27	17
Diviso	14	3.67	72
GCF Game	11	3.40	30
Metric Concentration	8	3.25	205
I Have...Who Has?	**8	3.88	51, 225
Round It!	7	4.00	2
Division Lotto	6	3.50	92
Angle Concentration	6	3.17	253
Multiplying Fractions	6	3.33	105

Total instances of use = 121

Weighted average rating = 3.63

*Number of times used by Grade 5-8 teachers.
**Number of times used by Grade 5 teachers.

Table 3b

Activities in 5th Grade Manual Not Used

Activity	Page No.
Bar Graph Estimation	138
Collect-A-Graph	136
Crazy Congruent Shapes	252
Fractional Cut-Up	98
Make A Graph	140
Number Names	56
Rods and Area	210
Solve It!	161
The Line-Up	119
What Shape is Your Garden?	187

Table 4a

Most Often Used Activities in 6th Grade Manual and Their Average Ratings

Activity	*Number of Times	Average Rating	Page Number
I Have...Who Has?	**43	3.62	34, 87
Decimal Concentration	32	3.89	48
Prime Factor Family Trees	32	3.23	16
What is Your Value?	28	4.00	47
Sieve of Eratosthenes	24	3.54	20
Place Value Roundup	21	3.40	3
M & M Activity	18	3.61	119
Rest in Peace with Roman Numerals	17	2.94	10
Artistic Doubles	14	3.36	115
Exponent/Factor/Product	14	3.14	24

Total instances of use = 243

Weighted average rating = 3.53

*Number of times used by Grade 5-8 teachers.
**Number of times used by Grade 6 teachers.

Table 4b

Activities in 6th Grade Manual Not Used

Activity	Page No.
Circle the Percent	60
Find the Volume	98
Let the Sun Shine	93
Pick a Pair	58
Quad Collage	102
Spin, Write, Read	7
What Are Your Chances?	62
What Makes Absurd Possible?	74

Table 5a shows that "I Have...Who Has?" from the grade 7 manual was used 71 times by grade 7 teachers; "Integer Concentration" was another activity frequently used (20 times) by grade 7 teachers only. The other activities listed in Table 5a were used by project teachers at all four grade levels. The least frequently used activities among the top 10 were used 14 times (by grade 5-8 teachers). These activities were used on 229 separate occasions, with an average weighted rating of 3.62. Table 5b identifies eight activities (13 percent) in the grade 7 manuals not used by any project teacher.

Table 6a shows that "I Have...Who Has?" from the grade 8 manual was used 47 times by grade 8 teachers; "Integer Concentration" from this manual, as with the grade 7 manual, was also frequently used (19 times) by grade 8 teachers only. The other activities listed in Table 6a were used by project teachers at all four grade levels, 5-8. The least frequently used activities among the top 10 were used 12 times each (by teachers in all grades, 5-8). The data indicate 185 separate instances of use, with a weighted average effectiveness rating of 3.31. Table 6b identifies just four activities (8 percent) in the grade 8 manuals as unused by any project teacher.

The data in Tables 3a through 6b do not address the issue of the pattern of use among curriculum strands (see Table 1 for a listing of these strands). Table 7 provides this information, listing the percentage of available activities that were actually used, by strand, by manual level. (Table 1 reports the actual number of activities in each strand at each grade level.)

Table 5a

Most Often Used Activities in 7th Grade Manual and Their Average Ratings

Activity	*Number of Times	Average Rating	Page Number
% I Have...Who Has?	*71	3.49	151
Fraction Concentration	35	3.63	50
Integer Concentration	**20	3.63	20
Candy and Fractions	17	4.00	45
Divisibility Switch	15	3.53	6
Triangle Words	15	3.27	120
Decimal Shuffle	14	3.71	42
Poker Chip Probability	14	4.00	62
Riddles	14	3.86	78
Rolling Icosahedra	14	3.46	7

Total instances of use = 229

Weighted average rating = 3.62

*Number of times used by Grade 5-8 teachers.
**Number of times used by Grade 7 teachers.

Table 5b

Activities in 7th Grade Manual Not Used

Activity	Page No.
Combo Constructions	133
Go Fish for Opposites	12
Lawn Division	80
Oatmeal Surface	104
Pictures and Diagrams Needed	83
Thumbtack Toss	67
Triangle Trade	119
Volume Conservation	102

Table 6a

Most Often Used Activities in 8th Grade Manual and Their Average Ratings

Activity	*Number of Times	Average Rating	Page Number
I Have...Who Has?	**47	1.93	54
Unit Price	24	3.70	163
Integer Concentration	**19	3.63	34
Exponent Bingo	18	3.72	9
Let's Play Ball	14	3.43	75
Fraction Rummy	13	2.23	45
Geometric Remembrance	13	3.77	141
Two-Step Relay	13	3.69	87
Connect the Dots	12	2.92	139
Most Mode It	12	3.50	68

Total instances of use = 185

Weighted average rating = 3.31

*Number of times used by Grade 5-8 teachers.
**Number of times used by Grade 8 teachers.

Table 6b

Activities in 8th Grade Manual Not Used

Activity	Page No.
Double Zero #2	30
Feed the People	89
If You Had Five Wishes	97
Let's Play A-Round	120

Table 7

Percentage of Activities Used From Each Manual,
By Strand and Grade Level

Strand	5th	6th	7th	8th
NUM	83	90	67	100
OPS	86	100	75	83
FRA	87	100	100	100
GRA	50	50	67	100
PRB	83	75	82	78
MEA	89	75	67	89
GEO	83	87	78	100
RAT	n/a	83	100	100
PERCENTAGE OF TOTAL ACTIVITIES	82	83	83	92

Key to Strands

NUM = numeration
OPS = operations on whole numbers and integers
FRA = fractions and decimals
GRA = graphing, probability, and statistics
PRB = problem-solving and applications
MEA = measurement
GEO = geometry
RAT = ratio, proportion, and percent (beginning in grade 6)

Overall, at each level, teachers used between 82 and 92 percent of available activities. Percentage of use increases with grade level, but this tendency may be an artifact of the fact that the grade 5 manual featured the most activities (67) and the grade 8 manual the fewest (50). Because the grade 8 manual featured fewer activities, teachers may have found it necessary to use a greater percentage of the activities.

Use of activities varies somewhat by strand, between 67 and 100 percent. The exception to this rule is use of activities in the graphing, probability, and statistics strand. Just 50 percent of the activities on this topic in the grades 5 and 6 manuals were used. For this strand, the grade 5-7 manuals each contained six activities; the grade 8 manual contained five activities. Use of activities in the fractions strand was high at all grade levels.

The data in Tables 3a through 6a suggest that teachers' evaluations of an activity's effectiveness and the frequency with which an activity is used are not perfectly correlated. Teachers who use an activity may perceive it to be effective, yet the activity may not be used so frequently as other activities. Table 8 lists the five most highly rated activities by manual level. It also provides information about the strand to which these highly rated activities relate.

Table 8 shows that, in the case of the grade 6-8 manuals, the activity rated most effective by teachers is not the one most frequently used by teachers. This becomes apparent when data are compared with those in Tables 3a through 6a. In the grade 5 manual an infrequently used activity (used seven times) is rated as highly (4.00) as the most frequently (and most highly rated) activity. Data on the strands to which these activities belong also show a change in focus by manual

Table 8

The Five Most Highly Rated Activities at Each Level

Grade 5 Manual

Title	Usage	Rating	Strand
Round It!	7	4.00	NUMERATION
Map Trivia	22	4.00	PROBLEM SOLVING AND APPLICATIONS
I Have...Who Has?	8	3.88	NUMERATION/MEASUREMENT
Banana Splits	18	3.83	OPERATIONS
Diviso	14	3.67	OPERATIONS

Grade 6 Manual

Title	Usage	Rating	Strand
What is Your Value?	28	4.00	FRACTIONS AND DECIMALS
Decimal Concentration	32	3.89	FRACTIONS AND DECIMALS
I Have...Who Has?	43	3.62	FRACTIONS AND DECIMALS/MEASUREMENT
M & M Activity	18	3.61	RATIO, PROPORTION, PERCENT
Sieve of Eratosthenes	24	3.54	NUMERATION

Grade 7 Manual

Title	Usage	Rating	Strand
Candy and Fraction	17	4.00	FRACTIONS AND DECIMALS
Poker Chip Problem	14	4.00	GRAPHING, PROBABILITY, STATISTICS
Riddles	14	3.86	PROBLEM SOLVING AND APPLICATIONS
Decimal Shuffle	14	3.71	FRACTIONS AND DECIMALS
Fraction Concentration	35	3.63	FRACTIONS AND DECIMALS

Grade 8 Manual

Title	Usage	Rating	Strand
Geometric Remembrance	13	3.77	GEOMETRY
Exponent Bingo	18	3.72	NUMERATION
Unit Price	24	3.70	RATION, PROPORTION, PERCENT
Two-Step Relay	13	3.69	PROBLEM SOLVING AND APPLICATIONS
Integer Concentration	19	3.63	OPERATIONS

level. Activities rated highest by project teachers at grade 5 concern numeration and operations; in grades 6 and 7 this shifts to fractions and decimals; and in grade 8 the most highly rated activities represent a variety of topics.

The data presented warrant two principal conclusions about project teachers' extent of use of manuals activities:

- First, teachers used most of the activities provided in the manuals, across all curriculum strands and at all grade levels, though with considerable variance in frequency of use by activity. The percentage of activities used was lowest in the graphing, statistics, and probability strands in grades 5 and 6.
- Second, summary data indicate that, on average, teachers regarded the effectiveness (with ratings weighted by frequency of an activity's use) of activities as very good, with average ratings between 3 ("good") and 4 ("excellent"). Ratings for activities in the grade 8 manual were marginally lower (i.e., 3.31) than ratings for activities in the other manuals.

Interestingly, the activity logs indicate that teachers at all grade levels drew activities from all four manuals for instructional purposes. It is also apparent from the data in Table 8 and in Tables 3a through 6a that the most highly rated activities are not always judged to be the most effective activities. Some of the most frequently used activities, in fact, received average ratings slightly below 3.00 ("good").

As noted previously, teachers also provided information about the purposes for which they used activities and optional narrative comments. Data provided by teachers pertinent to purposes, commentary, and effectiveness were also used to draw inferences about the connection between use of the Mathematics Activities Manuals and changes in student affect and achievement, as reported in the next section.

Student Findings

This section focuses particularly on the affect and achievement of students in the classrooms of participating teachers. Some attempt is made to relate teachers' reported use of mathematics activities to changes in student affect and achievement, as well as to relate changes in affect and achievement to one another. Comparison of the use of activities manuals with other methods was not an objective of the project, however, and the available data permit only exploratory analyses of such issues.

Student Affect

Student affect was assessed originally by a pair of instruments, one having 25 items (mathematics attitude) and one, 23 items (mathematics opinionnaire). Student responses to both instruments were combined into one database and a factor analysis was conducted.[3] The result was a 12-item student affect instrument, composed of six items from each of the original instruments. The two six-item factor scores and the 12-item scores, hereafter called Scale 12, were used in subsequent analysis.

Analyses of variance and t-tests were used to compare group means on the 12-item, two-factor affective instrument; exploratory regression analyses were performed to investigate which variables might influence changes in attitudes and opinions, and to what degree.

To determine if the difference in pre- to posttest raw scores for the entire group (n = 1125) was significant, t-test analysis was used. For total score and for opinion (factor 2), the observed changes (a decrease in total scores, an

[3]Appendix I is a table that reports pre- and post-project performance on each item of the two original 25- and 23-item instruments.

increase in opinion scores) from pre- to posttest were not statistically significant. The observed decline in attitude (factor 1) scores was statistically significant, with $p<.05$. This decline, however, is equal to just 1/20th of a standard deviation. Table 9 summarizes these results.

Table 9

Comparison of Means on Student Affective Measures

		Pretest		Posttest		t	Sig.
Measure	N	Mean	SD	Mean	SD	Value	Level
Scale 12 (12-Item) Score	1125	46.32	7.12	46.13	7.52	1.00	NS
Attitude (Factor 1) Score	1247	22.24	4.84	21.95	4.96	2.29	.05
Opinion (Factor 2) Score	1236	24.08	3.55	24.19	3.68	1.02	NS

Note: This analysis employed paired-samples t-tests, with listwise deletion of cases with missing data. The sample size (n = 1125) is larger than that given in Appendix I due to the use here of 12 selected items rather than the 48 items for which data are presented in Appendix I (where listwise deletion yields complete information for just 954 students).

To investigate possible influences obscured in analysis of the total group scores, staff employed one-way analysis of variance to determine if certain background variables about which information had been gathered might be influential: sex, risk status, teacher, grade, and period of the day in which instruction occurred. The dependent variable in these analyses was affective-gain score, computed by subtracting pretest raw scores from posttest raw scores for the Scale 12 and the two factor scales (attitude and opinionnaire).

Analysis of variance techniques assume equal variances in comparison groups. For these samples, homogeneity of variance tests permitted the following one-way analysis of variance comparisons on this basis:

- gender (Scale 12 gain scores, math attitude gain scores),

- risk status (none),
- teacher (nor.),
- grade placement (math opinion gain score), and
- period (Scale 12 gain score).

One-way analysis of variance indicated the following results for these comparisons:

- gender (no statistically significant differences on either measure),
- grade placement (statistically significant differences [p=.01] on math opinion gain scores), and
- period (no statistically significant differences).

Multiple range tests (least squares differences) on mathematics opinion gain scores by grade placement indicated probable significant differences between grade 7 students and those in grades 6 and 5. Two-tailed t-tests (pooled variance estimates) confirmed the existence of these differences. Table 10 summarizes the relevant comparisons.

Table 10

Comparison of Means on Mathematics Opinion Gain Scores by Grade Placement

Grades	N	Gain Score Mean	SD	t Value	df	Probability Level
Comparison 1						
grade 5	104	.7981	3.756	2.87	464	.004
grade 7	362	-.3398	3.504			
Comparison 2						
grade 6	408	.3064	3.740	2.46	768	.014
grade 7	362	-.3398	3.504			

An external reviewer suggested that analysis of variance be completed by risk status, since risk status so frequently exerts an effect on school performance. A caveat precedes this analysis. Risk data were missing for 473 students in the total sample; other missing data further restricts the number of cases available for particular analyses by risk-status groups.

Comparisons within risk-status groups were made for affective gain scores by gender, grade level, and period. Analysis by teacher groups was not pursued due to previously observed lack of homogeneity of variance. For at-risk students (i.e., those receiving free or reduced-price lunches), the following comparisons were available after assessment of homogeneity of variance:

- gender (Scale 12, attitude, and opinion gain scores) and
- grade placement (attitude and opinion gain scores).

ANOVA results were non-significant in all cases, though multiple range tests indicated a probable significant difference between grade 7 and 8 students on attitude gain scores.

Within the not-at-risk group, homogeneity of variance test results permitted the following comparisons:

- gender (Scale 12, attitude, and opinion gain scores),
- grade (Scale 12, attitude, and opinion gain scores), and
- period (Scale 12 gain scores).

ANOVA results were non-significant for gender and period comparisons. Among the not-at-risk group, however, differences on opinion gain scores were highly significant by grade level ($p=.0002$). Multiple range tests suggested the existence of significant differences between grade 7 students and students in each of the other grades, as well as a significant difference between grade 8 and grade 6 students. Tables 11 and 12 report the relevant t-test results for the at-risk and not-at-risk groups, respectively.

Table 11

Comparison of Means on Mathematics Attitude Gain Scores
For At-Risk Students

Grades	N	Gain Score Mean	SD	t Value	df	Probability Level
Comparison 1						
grade 7	39	-1.6667	4.538	-2.37	82	.020
grade 8	45	.6444	4.401			

Table 12

Comparison of Means on Mathematics Opinion Gain Scores
For Not-At-Risk Students

Grades	N	Gain Score Mean	SD	t Value	df	Probability Level
Comparison 1						
grade 5	63	.8095	3.454	2.57	300	.011
grade 7	239	-.4477	3.453			
Comparison 2						
grade 6	189	.9577	3.513	4.15	426	.000
grade 7	239	-.4477	3.453			
Comparison 3						
grade 8	232	.1940	3.291	2.06	469	.040
grade 7	239	-.4477	3.453			
Comparison 4						
grade 6	189	.9577	3.513	2.30	419	.022
grade 8	232	.1940	3.291			

Comparison of group means on affective gains strongly suggests the existence of differences by grade placement, but not by gender or period of the day in which instruction occurred. Differences between groups categorized by risk status and teacher were not possible, due to lack of homogeneity of variance. Within risk groups, however, differences by grade level were evident among not-at-risk students.

Opinion gain scores, rather than Scale 12 or attitude scores, exhibit the most notable differences among groups by grade level, with students in grades 5 and 6 (especially) exhibiting aggregate gains on this, and students in grade 7 exhibiting pre- to posttest losses.

While comparison of group means is useful for discovering patterns in any set of data, the technique is less useful for examining which combination of independent variables contributes to changes in a related (i.e., dependent) variable. Of critical interest in the evaluation of this project is the possible influence of teachers' use of activities from the Mathematics Activities Manuals on students' achievement, especially with respect to the influence of pretest measures (affective and achievement) and such ascribed measures as sex and risk status. Correlational analysis was used to explore possible relationships.

Data from logs kept by each teacher on the use of the mathematics activities were coded for regression analysis. Five measures were derived from this source for use in regression analyses:

- average number of activities used per class (total instances of use/number of classes taught) as a proxy measure of the extent of individual students' exposure to activities;

- percentage of activities with comments (number of activities with comments/total number of activities used) as a proxy measure of the engagement of an individual students' teacher; and

- three measures of teachers' purposes in using mathematics activities were created: (1) percentage of activities used to <u>introduce</u> topics to students; (2) to <u>teach</u> topics to students; and (3) to <u>review</u> topics previously taught.

Each value thus computed was added to each student's record as a teacher-level variable. Univariate and multivariate analyses were applied to determine the possible relationship of these teacher-level variables to achievement gains. These five variables represent an instructional context encountered by students and specifically related to the use of the mathematics activities manuals that were the focus of this project.

Analysis calculated zero-order correlations for the whole sample among the derived variables and the three affective gain scores. Since positive correlations were expected, one-tailed tests of significance were employed.

The analysis was repeated for risk, gender, and grade-placement groups. Two grade-placement groups were constructed: grade 7 students and others. The negative gain scores among grade seven students, as compared to the positive gain scores among other students, provide some warrant for this division. Tables 13 through 19 provide the relevant correlation matrices (the key to variable names appears only on Table 13).

Table 13

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: Full Sample, N = 1125

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	.0749*	.0746*	.0422
ACTCLASS	.0126	.0047	.0167
ACTPUR1	.1295**	.0716*	.1435**
ACTPUR2	-.0276	-.0324	-.0095
ACTPUR3	-.0581	-.0140	-.0866*

Note: Key to Variables:

ACT_COM Percentage of activities on which student's teacher recorded comments
ACTCLASS Average number of activities used by student's teacher per class
ACTPUR1 Percentage of activities used by student's teacher to introduce topics
ACTPUR2 Percentage of activities used by student's teacher to teach topics
ACTPUR3 Percentage of activities used by student's teacher to review topics
SC12_GN Gain score on full 12-item, 2-factor instrument
MA6_GN Gain score on attitude items
MO6_GN Gain score on opinion items

* = significant at p<.01
** = significant at p<.001

Table 14

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: At-Risk Group, N = 179

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	.0533	.0870	-.0168
ACTCLASS	-.0301	-.0627	.0281
ACTPUR1	.1618	.0945	.1825*
ACTPUR2	-.0849	-.1345	.0210
ACTPUR3	-.0138	.0768	-.1323

* = significant at p<.01

Table 15

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: Not-At-Risk Group, N = 670

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	.0588	.0414	.0524
ACTCLASS	.0110	.0141	.0023
ACTPUR1	.1291**	.0588	.1531**
ACTPUR2	.0054	.0139	-.0072
ACTPUR3	-.0851	-.0518	-.0854

** = significant at p<.001

Table 16

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: Males, N = 528

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	.1009	.0911	.0672
ACTCLASS	.0009	-.0341	.0415
ACTPUR1	.1665**	.0978	.1725**
ACTPUR2	.0084	.0279	-.0183
ACTPUR3	-.1102*	-.0824	-.0934

* = significant at p<.01
** = significant at p<.001

Table 17

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: Females, N = 573

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	.0370	.0529	.0003
ACTCLASS	.0207	.0381	-.0107
ACTPUR1	.0939	.0510	.1081*
ACTPUR2	-.0654	-.0924	-.0020
ACTPUR3	.0003	.0555	-.0709

* = significant at p<.01

Table 18

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: Grade 7 Students, N = 327

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	-.0132	.0170	-.0449
ACTCLASS	.1620*	.1587*	.0954
ACTPUR1	.0955	.1106	.0351
ACTPUR2	.0095	-.0208	.0429
ACTPUR3	-.0985	-.0771	-.0820

* = significant at p<.01

Table 19

Correlation of Mathematics Activity Usage Variables and Affective Gain Scores: Students Not in Grade 7, N = 798

	SC12_GN	MA6_GN	MO6_GN
ACT_COM	.0926*	.0923*	.0518
ACTCLASS	.0076	-.0083	.0236
ACTPUR1	.1225**	.0468	.1607**
ACTPUR2	-.0236	-.0291	-.0064
ACTPUR3	-.0501	.0022	-.0919*

* = significant at p<.01
** = significant at p<.001

A number of trends are observable in the correlational analysis:

- Zero-order correlations, as expected but with one exception (noted below), were generally positive or nonsignificant across all groups.

- In all results, except for grade 7 students, the percentage of activities used to introduce a topic showed a statistically significant positive correlation with the mathematics opinion gain scores (varying from .18 for the at-risk group to .10 for females).

- Among the full sample and among students not in grade 7, the percentage of activities with comments showed statistically significant positive correlations with Scale 12 gain scores and mathematics attitude gain scores.

- Among grade 7 students, a different pattern was evident. Here, neither percentage of activities with comments nor the percentage of activities used to introduce topics showed a statistically significant relationship with gain scores. Rather, the average number of activities used per class correlated significantly and positively with Scale 12 gain score and with mathematics attitude gain scores.

- Finally, only the percentage of activities used to review topics showed statistically significant negative correlations with gain scores. Among the full sample, this measure correlated negatively (-.09) with mathematics opinion gain scores; among males, with Scale 12 gain scores (-.11); and among students not in grade 7, with mathematics opinion scores (-.09).

The patterns of correlational analysis suggest a positive association of mathematics activity usage with improvement in gain scores, particularly with mathematics opinion gain scores. However, these data do not permit the conclusion that activity usage mathematics causes gains.

The correlational analysis raises the question of whether or not activity usage would continue to exert a statistically significant influence on affective gain scores if controls were imposed for other variables, particularly the powerful background variables of affective pretest and cognitive scores and the intervening variables of gender and risk status. Regression analysis can provide such information, provided that the data are appropriate. Of particular concern in such analyses is the question of multicollinearity. That is, when strong correlations exist among independent variables (multicollinearity), it becomes more difficult to disentangle their separate contributions.

Since the previous analyses of data for the full sample indicated that the percentage of activities used to introduce a mathematics topic was most strongly associated with affective gain scores, particularly with opinion gain scores, an exploratory regression analysis pertaining to this relationship seemed most clearly warranted.

Prior to conducting this analysis, the magnitude of zero-order correlations among variables of interest was examined. These variables included the pretest score (opinion) related to the dependent variable, a general measure of cognitive level (CTBS/4 composite pretest score), the context variables of gender and risk (dummy variables), the usage variable with the strongest zero-order correlations with affective gain scores (percentage of activities used to introduce topics), and the dependent variable of interest (opinion gain scores). Table 20 reports the zero-order correlations among these variables.

Table 20

Zero-Order Correlations Among Regression Equation Variables, N = 847

	GENDUMMY	RISK	COMP_NCE	MO6_GN	ACTPUR1	MOSCAL6
GENDUMMY	1.0000	-.0091	-.1409**	-.0101	-.0121	-.0643
RISK	------	1.0000	-.2150**	-.0629	.0206	-.0518
COMP_NCE	------	------	1.0000	.0136	.1290**	.1807**
MO6_GN	------	------	------	1.0000	.1498**	-.4687**
ACTPUR1	------	------	------	------	1.0000	-.0292
MOSCAL6	------	------	------	------	------	1.0000

Note: Key to variables:

GENDUMMY Dummy variable for gender (1=male)
RISK Dummy variable for risk status (1=receives free or reduced lunch)
COMP_NCE Pretest CTBS/4 composite in NCE units
MO6_GN Opinion gain score
ACTPUR1 Percentage of activities student's teacher used to introduce topic
MOSCAL6 Pretest opinion gain score

** = p<.001

The matrix in Table 20 shows that correlations among independent variables are quite weak. Among the independent variables the strongest relationship is the negative correlation of risk status (r = -.2150) with the composite achievement pretest score. This is a low moderate correlation. It is concluded that, for these variables, the threat of multicollinearity is low and that regression analysis is warranted. As expected, the strongest correlation among the independent variables and the dependent variable (MO6_GN) is the opinion pretest score.

Regression analysis introduced the relevant variables in three blocks. The first block introduced pretest scores, in this case opinion pretest score and the CTBS/4 (achievement) composite score, conceived as a proxy of overall academic aptitude; the second block introduced intervening ascribed variables, in this case gender and risk status; and the third block introduced the usage variable of interest, percentage of activities used to introduce a topic. Variables that did not enter the equation at a significant level were subsequently removed. Table 21 reports the regression results.

Table 21

Regression of Mathematics Opinion Gain Score on Background Variables

Variable	Slope & Intercept Value (B)	Standard Error of B	Standardized Regression Coefficient	t Value	Significance of t	R^2 (Adjusted)
Block 1						
MOSCAL6	.484003	.030566	-.481093	-15.835	.0000	.21876
COMP_NCE	.011213	.005199	.067619	2.157	.0313	.22874
Block 2						
RISK	-.659178	.265748	.075880	-2.480	.0133	.23154
Block 3						
ACTPUR1	6.953289	1.631876	.128546	4.261	.0000	.24687
(Constant)	10.301169	.781401		13.183	.0000	

$F = 70.32655$, $p<.0001$

As shown in Table 21, the influence of the pretest score, as expected, clearly exerts the strongest influence on opinion gain scores. The addition of other variables, however, produces statistically significant increments in explained variance. Moreover, the usage variable (ACTPUR1) enters the equation in the last block at a highly significant level. The equation itself is highly significant ($p<.0001$) and residuals were normally distributed. Gender was not entered into the equation because it did not reach the level of statistical significance.

This regression analysis indicates the persistence of a relationship between the percentage of mathematics activities a student's teacher uses to introduce topics and positive gains in a student's mathematics opinion score, even when levels of pre-existing performance and the effect of ascribed variables are statistically controlled. Once again, however, readers are cautioned that causality cannot be inferred from this analysis.

Similar regressions for this model, not reported, were run for cases selected by two grade-level groupings (students not in grade 7 and students in grade 7) to determine if the pattern observed in the above analysis persisted. Results among students not in grade 7 were nearly identical to those reported above. With grade 7 students, risk, gender, and pretest achievement (COMP_NCE) did not enter the equation at statistically significant levels. Among independent variables, only pretest opinion scores exhibited a statistically significant (negative) relationship with the dependent variable (MO6_GN). That is, once pretest scores were controlled for this group, the percentage of activities used by a student's teacher to introduce topics became statistically significant (it was not statistically significant in zero-order correlational analysis). Apparently, among grade 7 students, the higher the pretest score, the lower the gain score, a relationship that the use of activities to introduce a topic appears to mitigate.

Student Achievement

Although the project plan did not call for a comparison group, normal curve equivalent (NCE) scores provide an implicit comparison group for determining significant gains in achievement with respect to average scores for the standardization group. NCE scores are essentially transformed z-scores, with a mean of 50 and a standard deviation of approximately 21. They resemble percentile ranks, in that the NCE scale extends from 0 to 100, with a mean of 50. Unlike percentile ranks, however, NCE scores represent equal-interval units (as do z-scores). This feature permits more precise statistical manipulation, as mathematical operations can be performed on NCE scores without the distortion that percentile ranks introduce.

On this basis, a statistically significant change in group NCE scores warrants the conclusion that the group's relative performance has improved with respect to the standardization sample. For example, groups of students who maintain any particular average NCE score from year to year continue to perform at a certain level of achievement with respect to others their age in the norming sample. Groups of students, however, who increase their NCE scores from one year to the next can be said to have made "unexpected" or "unusual" gains with respect to others their age.

Pre- and posttest achievement scores for mathematics computation and for mathematics concepts were compared in t-test analysis to determine the extent to which the subjects' achievement (measured in NCE units) improved. Since improvement was anticipated, one-tailed tests of significance were employed. Observed differences were in the expected direction, but they were nonsignificant. Table 22 provides the results of the t-test analysis.

Table 22

T-Test Analysis of NCE Score Changes
in Pre- to Posttest Mathematics Achievement

Math Achievement Subscale	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	df	t Value	Sig. Level[a]
Computation	1326	61.10	21.139	61.86	20.66	1325	1.52	NS
Concepts	1326	58.35	19.790	58.47	19.75	1325	0.26	NS

[a]One-tailed test used.

As with affective scores, one-way analysis of variance of gain scores was used to investigate possible differences in means by potentially influential grouping variables. Grouping was done by the following variables: gender, risk status, teacher, grade placement, and period. Dependent variables were (1) CTBS/4 computation gain score and (2) CTBS/4 concepts gain score. Homogeneity of variance tests permitted the following one-way analysis of variance comparisons among the full sample on this basis:

- gender (concept gain score),
- risk status (computation gain score and concept gain score),
- teacher (none),
- grade placement (none), and
- period (none).

One-way analysis of variance indicated the following results for these comparisons:

- gender (statistically significant differences on concept gain score) and
- risk status (no significant difference on either measure).

A t-test analysis was performed on the concept gain scores by gender; results are provided in Table 23.

Table 23

T-Test Analysis of Mathematics Concept Gain Scores by Gender

Females			Males				t	Probability
N	Mean	SD	N	Mean	SD	df	Value	Level
679	-1.0751	15.68	631	1.4913	16.20	1308	2.91	.004

In addition to one-way analyses of variance for the full group, similar analyses were computed for risk status, grade-placement, and gender groups in order to discover possible within-group differences. Because grade-level effects were observed in the analysis of affective outcomes, grade-placement groups for this analysis consisted of those in grade 7 and those not in grade 7.

For the most part, homogeneity of variance tests would not permit valid comparisons, and detailed results will not be reported here. Of the nine valid comparisons, however, three proved statistically significant, and two of these concerned gender comparisons (concept gain scores within the not-at-risk group and within the not-in-grade-7 group). These ancillary analyses provide additional support for the importance of gender effects with respect to achievement gains, especially concepts.

As with the analysis of affective gains, zero-order correlations were computed between the derived usage variables and the two focal achievement gain scores (dependent variables) to determine if significant relationships existed between them. Table 24 reports the correlations for the sample as a whole.

Table 24

Correlations Between Focal Achievement Gain Scores and Derived Usage Variables, N = 1325

	COMP_NGN	CON_NGN
ACT_COM	-.0785*	.1145**
ACTCLASS	.2150**	.0950**
ACTPUR1	-.0475	.0445
ACTPUR2	-.0751*	.0113
ACTPUR3	.0505	-.0523

Note: Key for variables:

ACT_COM Percentage of activities on which student's teacher recorded comments
ACTCLASS Average number of activities used by student's teacher per class
ACTPUR1 Percentage of activities used by student's teacher to introduce topics
ACTPUR2 Percentage of activities used by student's teacher to teach topics
ACTPUR3 Percentage of activities used by student's teacher to review topics
COMP_NGN CTBS/4 computation gain score
CON_NGN CTBS/4 concepts gain score

* = p<.01, one-tailed.
** = p<.001, one-tailed.

Among the sample as a whole, Table 24 shows that both the percentage of activities on which a student's teacher recorded comments (ACT_COM) and the average number of activities used by a student's teacher per class (ACTCLASS) were significantly related to the mathematics achievement outcome variables.

Since gender appears to be associated significantly with achievement gains among this sample, the correlations were also computed by gender group to determine if the association observed for the sample as a whole would still pertain to single-gender groups. Table 25 reports correlations by gender group.

Inspection of the zero-order correlations for males as compared to females indicates a somewhat different pattern of influence within the two groups. Significant associations of both ACT_COM and ACTCLASS persist. In both groups ACTCLASS is positively associated with computation gain scores. Among males, ACTCLASS is also positively associated with concept gain scores, but the

Table 25

Correlations Between F cal Achievement Gain Scores
and Derived Usage Variables

Derived Variables	Achievement Gain Scores	
	Males N = 630	
	COMP_NGN	CON_NGN
ACT_COM	-.1146*	.0496
ACTCLASS	.2058**	.1238**
ACTPUR1	-.0438	.0052
ACTPUR2	-.0414	.0200
ACTPUR3	.0095	-.0450
	Females N = 679	
	COMP_NGN	CON_NGN
ACT_COM	-.0627	.1669**
ACTCLASS	.2390**	.0687
ACTPUR1	-.0548	.0849
ACTPUR2	-.1087*	.0044
ACTPUR3	.0925*	-.0627

Note: Key for variables:

ACT_COM Percentage of activities on which student's teacher recorded comments
ACTCLASS Average number of activities used by student's teacher per class
ACTPUR1 Percentage of activities used by student's teacher to introduce topics
ACTPUR2 Percentage of activities used by student's teacher to teach topics
ACTPUR3 Percentage of activities used by student's teacher to review topics
COMP_NGN CTBS/4 computation gain score
CON_NGN CTBS/4 concepts gain score

* = p<.01
** = p<.001

association, though positive among females, does not reach a level of statistical significance. On the other hand, ACT_COM (percentage of activities on which a student's teacher wrote comments) displays among females a comparatively strong positive association with concept gain scores. Among males the association is also positive, but it does not reach statistical significance. Less statistically significant correlations also appear to differentiate males and females, even though they do not appear as statistically significant in Table 25, perhaps due to the evident within-group gender differences.

In order to determine if these relationships between usage variables and achievement gain scores persist once background variables are controlled, multiple regression analysis by gender group seemed warranted. As in the similar analysis for affective outcomes, variables of interest were correlated to assess the threat of multicollinearity. Independent variables of interest include computation and concept pretest scores, the Scale 12 pretest score (as a global measure of pre-existing affect), risk status, and the usage variables of activities with comments (ACT_COM) and average number of activities used per class (ACTCLASS). Table 26 reports the zero-order correlations among these variables, for the full sample and for gender groups (listwise deletion of missing data yields reduced sample sizes for regression analyses, largely as the result of missing data for risk status).

In all cases in Table 26, relationships among relevant independent variables are low to moderate, minimizing the threat of multicollinearity to the regression analyses. The strongest correlation among independent variables is between the computation and concept pretest scores (r approximately .60), but in no model will both variables be used. The only pretest achievement measure to be employed will

Table 26

Zero-Order Correlations for Independent Variables in Regression Analyses for Full Sample, Females, and Males

Full Sample, N = 923

	COMP_NCE	CON_NCE	SCALE 12	RISK	ACT_COM	ACTCLASS
COMP_NCE	1.0000	.5839**	.2986**	-.2004**	.0815*	-.1908**
CON_NCE	------	1.0000	.3120**	-.2036**	.0029	-.0541
SCALE 12	------	------	1.0000	-.0861*	.0516	.0274
RISK	------	------	------	1.0000	-.0545	-.0019
ACT_COM	------	------	------	------	1.0000	-.1025**
ACTCLASS	------	------	------	------	------	1.0000

Females, N = 478

	COMP_NCE	CON_NCE	SCALE 12	RISK	ACT_COM	ACTCLASS
COMP_NCE	1.0000	.5793**	.2682**	-.1992**	.1025	-.1775**
CON_NCE	------	1.0000	.3169**	-.2189**	-.0275	-.0004
SCALE 12	------	------	1.0000	-.0274	.1100*	.0551
RISK	------	------	------	1.0000	-.0834	-.1117*
ACT_COM	------	------	------	------	1.0000	-.0659
ACTCLASS	------	------	------	------	------	1.0000

Males, N = 438

	COMP_NCE	CON_NCE	SCALE 12	RISK	ACT_COM	ACTCLASS
COMP_NCE	1.0000	.6120**	.3302**	-.2036**	.0742	-.1854**
CON_NCE	------	1.0000	.3032**	-.1890**	.0272	-.0913
SCALE 12	------	------	1.0000	-.1447*	-.0082	.0066
RISK	------	------	------	1.0000	-.0171	.1061
ACT_COM	------	------	------	------	1.0000	-.1417*
ACTCLASS	------	------	------	------	------	1.0000

* = p<.01, one-tailed.
** = p<.001, one-tailed.

be that associated with the relevant gain score (e.g., the computation pretest, COMP_NCE, when the computation gain score, COMP_NGN, is the dependent variable). Otherwise, correlations among independent variables do not exceed a moderate r = .3302. It is concluded that regression analyses would provide reliable insight to the association of usage variables and achievement gain scores once controls for background variables were imposed.

Six regression equations were constructed using the two dependent variables (COMP_NGN and CON_NGN) for three groups: full sample, females only, and males only. Independent variables were entered in three blocks, which requested entry of (1) the relevant achievement pretest score (i.e., either COMP_NCE, when COMP_NGN was the dependent variable, or CON_NCE, when CON_NGN was the dependent variable) and the 12-item affective pretest measure (SCALE 12); (2) risk status and gender (the latter for the full sample only); and (3) the two usage variables.

In all regression analyses, reported in Tables 27-28 and 29-30, the equations were significant at $p<.0001$ and the residuals were normally distributed. The six regression equations accounted for between 19 percent and 29 percent of variance in the two achievement gain scores, depending on group and dependent variable.

Results were very similar across groups, with some exceptions among females (described below). With the two blocks of background variables controlled, ACTCLASS continued to be associated with the dependent variables at a statistically significant level. Tables 27 and 28 present the results for the full sample.

Results for the gender groups were similar, with ACTCLASS continuing to exhibit a statistically significant association with dependent variables in both groups. In addition, in the female group, the percentage of activities on which a student's teacher recorded comments (ACT_COM), rather than ACTCLASS, appeared

Table 27

Regression of Achievement Gain Score on Background Variables for Full Sample: Computation Gain Score

Variable	Slope and Intercept Value (B)	Standard Error of B	Standard Regression Coefficient	t Value	Significance of t	R^2 (Adjusted)
Block 1						
COMP_NCE	-.411061	.026070	-.498911	-15.767	.0000	.21262
SCALE 12	.388941	.077148	.153952	5.041	.0000	.23699
Block 2						
RISK	-2.805210	1.309933	-.063553	-2.141	.0325	.24069
Block 3						
ACTCLASS	.168504	.045870	.109326	3.673	.0003	.25127
(Constant)	3.512453	3.788298		.927	.3541	

$F = 94.72021$, $p<.0001$

Table 28

Regression of Achievement Gain Score on Background Variables for Full Sample: Concept Gain Score

Variable	Slope and Intercept Value (B)	Standard Error of B	Standard Regression Coefficient	t Value	Significance of t	R^2 (Adjusted)
Block 1						
CON_NCE	-.365056	.025869	-.455223	-14.112	.0000	.16270
SCALE 12	.176546	.071526	.078155	2.468	.0138	.16840
Block 2						
RISK	-5.828865	1.217309	-.147547	-4.788	.0000	.18877
Block 3						
ACTCLASS	.100923	.041675	.073153	2.422	.0156	.19321
(Constant)	12.590625	3.480013		3.618	.0003	

$F = 54.16287$, $p<.0001$

Table 29

Regression of Achievement Gain Scores on Background Variables Among Females

Variable	Slope and Intercept Value (B)	Standard Error of B	Standard Regression Coefficient	t Value	Significance of t
Equation 1: Computation					
COMP_NCE	-.375457	.037877	-.429885	-9.913	.0000
SCALE 12	.351679	.108272	.138545	3.248	.0012
ACTCLASS	.237908	.065046	.153336	3.658	.0003
(Constant)	.970369	5.301625		.183	.8549

Dependent variable: computation gain score (COMP_NGN)
Adjusted R^2 = .21826
F = 44.36835, p<.0001

Variable	Slope and Intercept Value (B)	Standard Error of B	Standard Regression Coefficient	t Value	Significance of t
Equation 2: Concepts					
CON_NCE	-.361364	.033628	-.454053	-10.746	.0000
RISK	-4.813704	1.641606	-.124365	-2.932	.0035
ACT_COM	6.504428	2.125979	.126412	3.059	.0023
(Constant)	17.585990	2.672772		6.580	.0000

Dependent variable: concept gain score (CON_NGN)
Adjusted R^2 = .21258
F = 42.93645, p<.0001

as statistically significant in the regression of concept gain scores on background variables. Among the female group, moreover, some background variables that entered equations for the full sample and for the male group were not statistically significant. In the regression of computation gain score on background variables among females, risk did not enter the equation at a statistically significant level in Block 2, nor, in the regression of concept gain scores on background variables, did the 12-item affective measure enter the equation at a statistically significant level. Tables 29 and 30 summarize regression results for single-gender groups.

Table 30

Regression of Achievement Gain Scores on Background Variables Among Males

Variable	Slope and Intercept Value (B)	Standard Error of B	Standard Regression Coefficient	t Value	Significance of t
Equation 1: Computation					
COMP_NCE	-.445543	.035577	-.561490	-12.523	.0000
SCALE 12	.415431	.109924	.165323	3.779	.0002
RISK	-5.725299	1.920354	-.125501	-2.981	.0030
ACTCLASS	.132128	.064565	.085994	2.046	.0413
(Constant)	5.307288	5.307072		1.000	.3179

Dependent variable: computation gain score (COMP_NGN)
Adjusted R^2 = .29178
F = 44.26005, p<.0001

Variable	Slope and Intercept Value (B)	Standard Error of B	Standard Regression Coefficient	t Value	Significance of t
Equation 2: Concepts					
CON_NCE	-.351953	.037620	-.437065	-9.355	.0000
SCALE 12	.211313	.102064	.095677	2.070	.0390
RISK	-6.782916	1.810213	-.168848	-3.747	.0002
ACTCLASS	.121255	.060070	.089603	2.019	.0442
(Constant)	11.167963	5.060286		2.207	.0279

Dependent variable: concept gain score (CON_NGN)
Adjusted R^2 = .18628
F = 25.09416, p<.0001

The results of correlational and regression analysis of achievement gain scores led the researchers to ask if student achievement could be distinguished more clearly by mathematics activity usage variables. The method adopted to investigate this possibility was to divide students into groups by activity usage variables. The three usage variables of interest were ACTCLASS (average number of activities used per class by a student's teacher), ACTPUR1 (percentage of activities used by a student's teacher to introduce a topic), and ACT_COM (percentage of activities for which a student's teacher recorded comments).

Students were divided into three pairs of groups by the median of the three activity usage variables, i.e., median splits. This technique results in groups of roughly equal size, for which t-test analysis can be applied without regard for homogeneity of variance because division at the median produces groups of equal size (see Glass & Hopkins, 1984, p. 238 for the relevant discussion). The median for ACTCLASS, for instance, was 30. This figure reflects the fact that teachers were advised to implement one activity per week; some used fewer activities and some used more (the range was 8 to 58). Dividing students at the median for ACTCLASS produced two comparison groups of students, one whose teachers used fewer than the recommended number of activities, and one whose teachers used more. A similar situation pertained in the case of the other two variables used to group students.

The dependent variables for these comparisons, as in the preceding analyses, were computation and concept gain scores. Of the six possible comparisons (computation and concepts in three pairs of groups), four proved statistically significant (three at $p<.001$.) Table 31 reports these results.

In all cases, the statistically significant difference favored the groups classified by usage above the median. As effect sizes, these differences are not inconsequential.[1] The above-median ACTCLASS group (the students whose teachers used more than the median number of activities per class), for instance, improved its computation scores by approximately .42 standard deviations with respect to the below-median group (i.e., taking the below-median group as a *de facto* control group). On this basis, effect sizes for concepts by ACTPUR1 (purpose of the activity) and ACT_COM (percentage of activities on which a student's teacher recorded comments) groups would be .24 and .21.

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[1]Effect size is the difference in means between an experimental and control group, measured in standardized units (e.g., NCE scores) divided by the standard deviation of the control group.

Table 31

Achievement Score t-Test Results: Students Grouped[a] by Three Activity Usage Variables

Measure	Group 1		Group 2		t		Probability
	Mean	SD	Mean	SD	Value	df	Level
			Average Activities/Class Groups[b]				
COMP_NGN	-3.0063	17.043	4.1962	18.580	7.33	1323	.000
CON_NGN	-1.0964	15.172	1.2193	16.709	2.63	1324	.008
			Percentage of Activities to Introduce Topics Groups[c]				
COMP_NGN	.7818	18.309	.7378	18.128	.04	1323	.965
CON_NGN	-1.6061	15.102	1.9968	16.799	4.11	1324	.000
			Percentage of Activities with Teacher Comments Groups[d]				
COMP_NGN	1.7492	19.887	-.2144	16.358	1.96	1323	.050
CON_NGN	-1.6216	16.391	1.8234	15.489	3.93	1324	.000

[a]Group 1 = below median, Group 2 = above median.
[b]Median of ACTCLASS = 30.0
[c]Median of ACTPUR1 = .104
[d]Median of ACT_COM = .800

DISCUSSION

The organization of this section parallels that of the previous section (FINDINGS). The discussion of teacher findings concerns the summer institutes, teachers' stages of concern, and activity logs. The discussion of student findings concerns affective and achievement findings.

Teacher Findings

Inservice Training

Teachers provided high ratings on the AEL evaluation instrument and included many positive comments about the workshop content and organization. Opinion about the convenience of location was divided; in fact, the distribution of ratings was bimodal, with one mode centered around the mean (30) and the other at the extreme right end of the scale. One can infer from the data that the minority of participating teachers who lived near the inservice site would regard that location as very convenient and that others would tend to rate this item more negatively the further away they lived from the inservice site. Negative comments about the inservice focused almost exclusively on the mechanics of producing materials, such as access to copiers and distribution of supplies. Producing materials was a key activity in the inservice week, one that teachers' positive comments indicated they valued highly. This circumstance may well have led inservice participants to give unusual emphasis to production snafus.

Stages of Concern

The results from the Stages of Concern study suggest that teachers' concerns showed the pattern of concerns typical of those in their first year of adoptions of innovations. Personal concerns dominated early in the adoption. Later concerns focused on tasks associated with the adoption. Concerns in the refocusing stage were low, indicating that participants were not considering abandoning the innovation or looking for an alternative. Across all stages of concern, participants exhibited intensities of concern that were consistent with profiles of adopters of innovations in their first year: concerned enough to ensure attention to relevant issues. One finding deserves special comment. Participating teachers exhibited comparatively high levels of concern about collaboration. This finding may concern the teachers' commitment to training other teachers about use of the Activities Manuals. Indeed, as noted previously, participating teachers were part of a group of teachers across Tennessee who did train more than 4,000 colleagues in the use of the manuals. The observed levels of concern about collaboration may reflect the fact that this training function actually placed teachers in a (possibly unaccustomed) supervisory role. As noted previously, the observed levels of concern with collaboration at this point in an innovation are characteristic of administrative or supervisory staff.

Activity Logs

Teachers used between 80 and 90 percent of mathematics activities in the various manuals, though usage varied somewhat by grade level of the manuals and by curriculum strand. The most frequently used activities were by no means the ones most likely to elicit the highest effectiveness ratings from participating teachers. Some seldomly used activities received high effectiveness ratings, and some frequently used activities received comparatively low ratings on effectiveness. In general, teachers rated the effectiveness of the 10 most frequently used activities in each manual as at least "good." Because the number of available activities declined with manual grade level, teachers at higher grade levels had fewer grade-level activities on which to draw. At the same time, all activities were available to all teachers, and the teacher logs show that teachers at all grade levels did employ at least some activities from all manuals. Activities in one curriculum strand (i.e., graphing, probability, and statistics) seemed to elicit less frequent use than other strands (grades 5-7 manuals only). Some evidence also suggests that the curricular focus of the most highly rated activities varied by manual grade level. Activities concerning numeration and operations in the grade 5 manual were most highly rated, whereas activities concerning fractions and decimals in the grades 6 and 7 manuals were most highly rated. This result may reflect (1) the traditional progression of instructional focus in grades 5-7, (2) teachers' and students' instructional expectations, and (3) an interaction between these two conditions. Data gathered, however, do not permit examination of these alternative explanations.

Student Findings

Student Affect and Achievement

The analyses of student mathematics affect and achievement found differences in affective outcomes by grade level and differences in achievement outcomes by gender. Influences within the grade 7 group seem to be producing negative affective gain scores, with respect to both mathematics attitude and opinion. The cause of this difference cannot be determined from the data collected, but it is clear that even among grade 7 students, the percentage of activities a teacher uses to introduce a topic (ACTPUR1) is positively associated with opinion gain scores, but only when controls for background variables are imposed.

Differences in mathematics achievement outcomes revealed a statistically significant difference between females' (negative) concept gain scores and males' (positive) concept gain scores. Further, the derived usage variables showed a markedly different pattern of zero-order correlations with achievement gain scores among females. In regression analysis for the full sample and for males, the average number of activities used per class by a student's teacher (ACTCLASS) remained significantly associated with achievement gain scores when background variables were controlled. Among females only, another usage variable (percentage of activities with teacher comments, ACT_COM) showed this persistent association, and not ACTCLASS. This result is consistent with the correlational analysis, where ACT_COM, but not ACTCLASS, was significantly associated with concept gain scores.

When student groups were divided at the median according to the influential usage variables (ACTCLASS, ACTPUR1, and ACT_COM), highly significant differences were discovered. The accumulated evidence suggests a strong association between activity usage, especially high levels of usage (e.g., more than that required by the terms of participation), and improved student achievement.

A Cautionary Note

The correlational and regression analyses conducted for this report found that usage of the activity manuals was significantly and positively related to changes in student affect and achievement gain scores. But the analyses do not suggest that usage caused gains, merely that the relationship remained significant when background variables were controlled.

Although the data set did not support statistical comparison of means by teacher group due to unequal variances, the wide variation of observed gain scores on both affective and achievement measures between teacher groups is intriguing. Table 32 reports aggregate gain scores by teacher group and also provides a breakout by risk status of students in these 21 groups.

Table 32

Key Student Variables by Teacher Group

Teacher Group Number	Gain Scores				Risk Status	
	computation	concepts	attitude	opinion	% at risk	% not at risk
1	-4.67	-3.26	-1.52	-.96	28.1%	71.9%
2	+14.00	-7.43	-.63	+.62	0.0%	100.0%
3	-.84	+1.80	-1.83	+.09	28.0%	72.0%
4	+4.00	+9.14	+.62	+.95	8.7%	91.3%
5	+5.08	-.42	+1.76	+1.84	(MISSING)	(MISSING)
6	-.92	+4.31	-.03	+.40	5.5%	94.5%
7	-1.50	+1.65	+.04	-.10	3.1%	96.9%
8	+2.60	-3.74	-.60	+.13	32.3%	67.7%
9	-7.43	-5.05	-1.64	-.53	(MISSING)	(MISSING)
10	+13.87	+3.91	+.48	+1.44	50.0%	50.0%
11	+7.08	+6.60	+1.67	+4.00	15.7%	84.3%
12	-6.75	+1.90	+1.05	-.28	(MISSING)	(MISSING)
13	+16.90	-3.01	-.01	+.48	(MISSING)	(MISSING)
14	-3.35	+1.79	+.13	+.35	33.7%	66.3%
15	-9.76	-6.99	-.45	+1.54	27.7%	72.3%
16	+4.48	+.98	+.15	-.81	57.3%	42.7%
17	-2.05	-2.14	-.87	-.39	16.8%	83.2%
18	-3.83	-2.69	+2.03	-.18	48.6%	51.4%
19	+6.58	-.70	-1.[illegible]9	-.62	17.7%	82.3%
20	+4.24	+8.82	-.19	+.12	0.0%	100.0%
21	+17.37	+19.58	+.25	+.39	59.1%	40.9%
grand means	+.76	+.11	-.31	+.09	22.3%	77.7%

Note: CTBS/4 computation and concept gain scores are in NCE units (standard deviation = 21). Attitude (standard deviation = 4.43) and opinion scores (standard deviation = 3.57) are in raw score units.

Readers are cautioned against interpreting the data in Table 32 literally: comparisons among these groups are <u>not</u> warranted statistically. The point of Table 32, rather, is cautionary; it is provided to suggest the complexity of influences that lie behind the statistical analyses permitted by the characteristics of the data analyzed for this report.

Many interactions take place in classrooms; the precise relationship of each to improved outcomes is obscure; and maybe they cannot be or should not be studied in isolation from one another, since it is their total effect that "produces" outcomes. An important theoretical question is whether or not particular applications of any instructional methodology can actually "cause" positive effects. Too mechanistic an analysis can convey the misleading impression that students do not have ultimate charge of their own learning and that all learning is "supplied" by educational institutions.

In any case, participating teachers in the project evaluated here were instructed to use one activity per week per class. Some teachers used more activities than this, some fewer; some used activities for a greater variety of instructional purposes than others; some were motivated to record more extensive reactions to usage than others; and some doubtless brought to their instructional duties characteristics (e.g., more mathematical training, greater facility with mathematical ideas, greater sensitivity to students' needs, and so forth) that other teachers did not. Much more is happening here than any dataset can capture.

But it should be recognized that this project provided all participating teachers a viable opportunity to move instructional practice incrementally further away from the sort of textbook-based mathematics instruction with which critics and national associations have found fault. It seems likely that in some cases this opportunity reinforced teachers' already productive instructional routines.

In other cases, this opportunity may have introduced teachers to alternative ways of approaching mathematics instruction that they had not previously been able to consider. In these cases, the beneficiaries could be classes of students taught by these teachers in the future. The data in Table 32 probably reflect many circumstances and dilemmas not adequately captured in the data collection efforts.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The research questions that guided this study serve as the organizational structure for this section. Conclusions pertinent to each question are considered below.

(1) Can a procedure be developed whereby an institution of higher education, a Regional Educational Laboratory, and local education agencies collaborate in conducting an R & D project?

Staff of the Rural Excel program worked closely with staff of the University of Tennessee at Martin on the Mathematics Activities Manual project to evaluate the inservice provided to teachers in the summer of 1991, and to design procedures for providing useful evaluative data about the implementation. University staff assisted AEL in the development of an instrument that proved capable of measuring changes in students' attitudes toward and opinions about mathematics. University staff and AEL staff presented results of the program at a national professional conference of rural educators (the ACRES National Rural Education Symposium, Savannah, GA) in March 1993.

AEL staff collaborated with local education agencies to study participating teachers' stages of concern as implementation took place during the 1991-1992 academic year; to obtain student data (on affect and achievement) for pre-project and post-project analysis; to obtain data about teachers' use of mathematics activities; and to provide support for teachers' purchase of mathematics manipulatives for their classrooms. Teachers did provide the information agreed upon in the agreements cosigned by them and the principals of the schools in which they taught, and AEL did provide the agreed-upon stipends for the purchase of manipulatives.

Project implementation included:

- formation of a program advisory group;
- development of a project plan--reviewed by the advisory group--that stated needs, objectives, plan of action, and evaluation plan;
- meetings with university staff, participating teachers, and LEA officials to discuss the project;
- followup letter and telephone contact with participating teachers;
- development of project materials and protocols for collecting and analyzing data;
- documentation of all correspondence and activities in project files; and
- fulfillment of commitments agreed to by all parties.

These features enabled AEL to carry out the Mathematics Activities Manuals project successfully in collaboration with the university and local education agencies. So, the answer to question one is a resounding Yes.

(2) How well did the activities in the grade 5-8 Mathematics Activities Manuals work when used in rural classrooms in Tennessee during the 1991-1992 school year?

Teachers used between 80 and 90 percent of available mathematics activities from the grade 5-8 manuals. The most frequently used mathematics activities received average ratings (averages weighted for frequency of use) of between approximately 3.30 and 3.60 on a 4-point Likert scale, with 4.00 referring to "excellent" effectiveness and 3.00 referring to "good" effectiveness. In the view of teachers in this project, then, the effectiveness of the activities in the manuals was very good. In actual practice, teachers appeared to use activities from any level if they thought such activities appropriate to the needs of their students. The most frequently used activities in each manual, with few exceptions, appear to have been used at all grade levels.

(3) What effects did the use of activities in the grade 5-8 Mathematics Activities Manuals have on students' mathematics affect and achievement when used in rural classrooms in Tennessee during the 1991-1992 school year?

For the group of nearly 1,600 students as a whole, observed changes were not, in general, statistically significant. This study hypothesized that affective changes would not show a directional tendency, but that achievement changes would show a directional tendency.

For the whole group, opinion scores were observed to increase (nonsignificantly), whereas attitude scores were observed to decline (significantly, but of small magnitude). Both mathematics computation and mathematics concept scores increased, neither at a statistically significant level. However, achievement gain scores differed very significantly between high- and low-usage groups.

Affective outcomes also differed significantly by grade-placement (favoring students not in grade 7), while achievement outcomes differed significantly by gender (favoring males). In regression analysis, several mathematics activity usage variables were observed to relate significantly to affective and achievement outcomes. These significant associations, moreover, persisted even when background variables (risk-status and gender) were controlled.

Recommendations

In view of the Rural Excel goal of providing rural educators with tested materials and practices that show promise of improving student performance in classrooms, the recommendations presented in this section focus on actions that might help other educators realize the promise evident in the Tennessee Activities Manuals. Recommendations regarding the revision of these materials by UTM staff or others, further use of the mathematics scale, and further research studies conclude this section.

Analyses presented in this report show that teachers found the mathematics activities very effective and that they successfully incorporated these activities into their instructional routines. At the same time, observed improvement in affect and achievement did not accrue to all students, but principally to students in the classrooms of some teachers. Regression analyses, however, suggest that the way teachers use the activities may help explain the differences.

On the basis of this evaluation effort, tentative recommendations are ventured, as follows:

- The use of one or two carefully chosen mathematics activities per week--principally to introduce topics--seems to offer the best chance of helping students improve their performance in mathematics, insofar as it is possible to judge from the data gathered and the analyses conducted.

- Teachers should be prepared to "engage" the mathematics activities. That is, they should view them as important, useful, and productive for their students. They should reflect on the experience of using activities and take a hand in developing and elaborating them.

- Some teachers who want to use activities could apparently benefit from peer coaching or other sorts of consistent mentoring from teachers who are successfully "engaging" the activities. Such arrangements obviously require trust, commitment, and release time (at least for mentors or coaches, and ideally for mentees as well).

- Training should more actively encourage teachers of grades 5-7 to use activities in the graphing, probability, and statistics curriculum strand.

The various activities in the Tennessee Activities Manuals appear to work very well in rural classrooms. This study has identified both the most highly rated and the most frequently used activities. It also identified the few activities <u>never</u> used during the project year. This latter group of activities should be compared to those most highly rated or most frequently used, to see if further revision is warranted or if specific training activities in their use is required.

The 12-item mathematics attitude scale, developed by factor analysis of two longer instruments, has both the reliability and validity to warrant its use with students, especially in grades 5 through 8. The shorter, 12-item math scale will improve its usability to others. This new mathematics attitude scale should be used by others in followup research or math instructional improvement efforts. Too, it may be applicable to other grade levels (8 through 12) and perhaps to adults, either in college or in adult education classes.

Finally, this evaluation study raises a few issues worthy of further investigation. The number of mathematics activities tried, the purposes to which teachers applied the activities, and the extent to which the teachers became engaged with the mathematics activities could be varied and studied in followup efforts. More research is needed to determine the optimal implementation level for each of these issues.

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APPENDIX A:

Sample Activities

SAMPLE ACTIVITIES

TAKEN FROM: MATHEMATICS ACTIVITIES MANUAL FOR GRADE FIVE

ACTIVITY: Map Trivia **STRAND:** Problem Solving and Applications

OBJECTIVE:
51507 To solve problems using data from charts, tables, graphs and maps

PREREQUISITES:
To read a simple map
To add, subtract and multiply 2 and 3 digit numbers

MATERIALS NEEDED:
Construction paper: yellow, green, pink and blue
Large manila envelope
One number cube
Two game markers
Game board

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Mount the game board, which has been colored as directed on the front of the manila envelope.

2. Mount the game cards on the proper color of construction paper.

   (Since the game is stored in the manila envelope the following will make it more durable.)

3. Remove the metal brad.

4. Laminate the envelope.

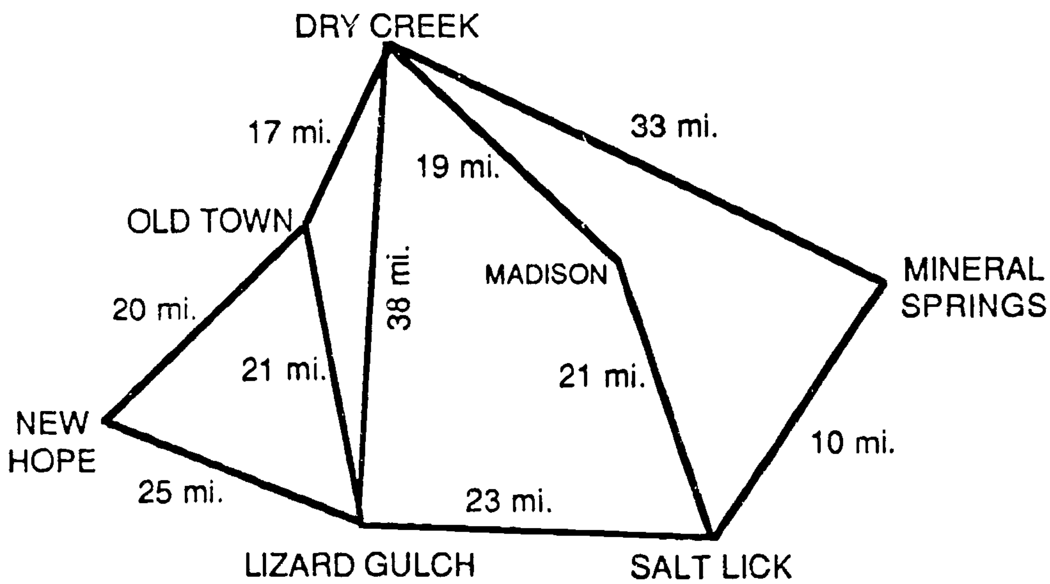
5. Use an X-acto® knife to cut the opening.

6. Glue small pieces of VELCRO® on the envelope to make a fastener.

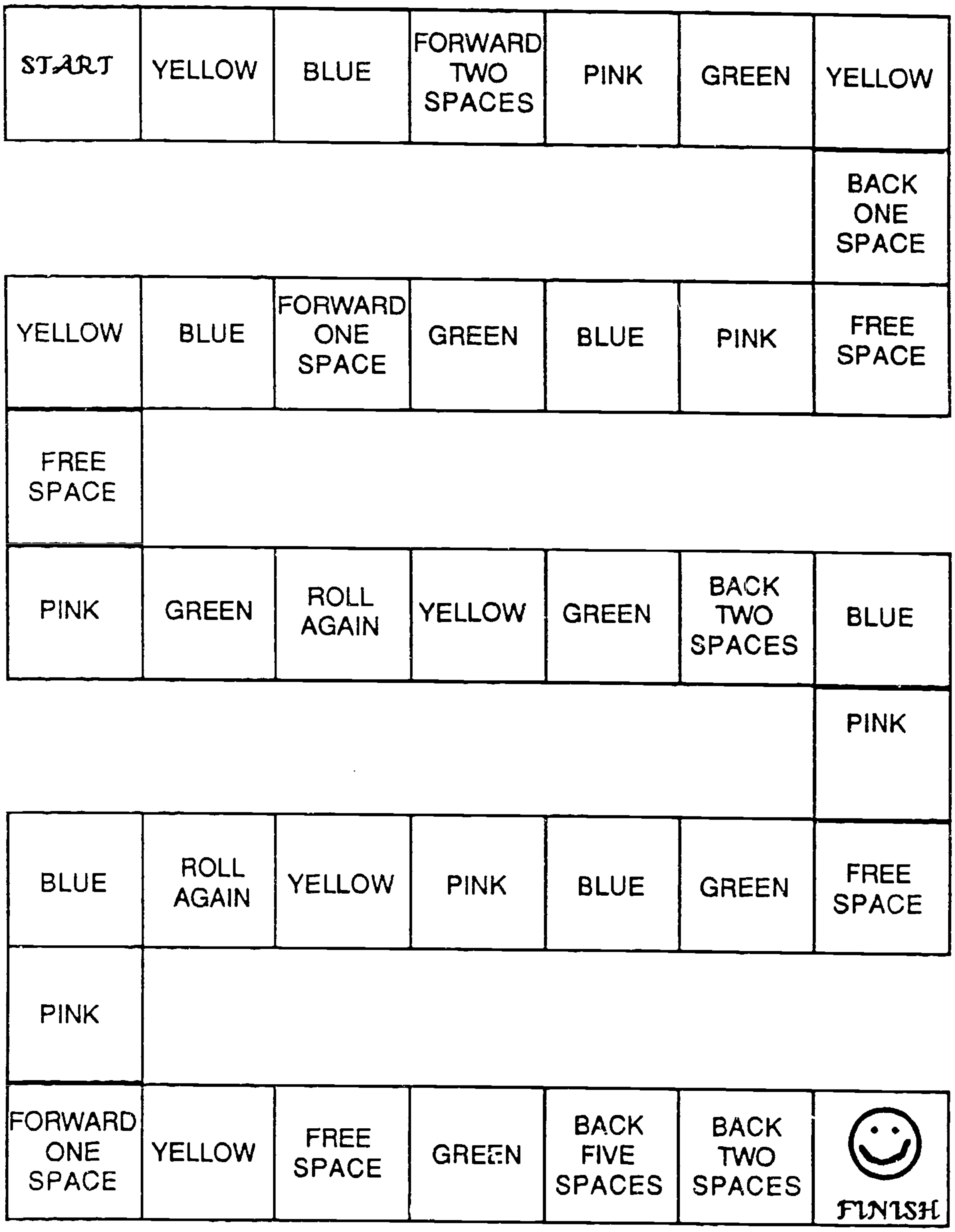
DIRECTIONS TO THE STUDENT:

This is a version of the popular Trivia® game to be played by two students.

1. The students will move their game pieces around the board as they roll the number cube and answer questions.
2. You may move to a colored space only if you answer the question correctly from the stack of cards of the matching color.
3. Have the cards stacked in four stacks according to color. Markers are placed on start.
4. Player A rolls the die and determines where his/her marker will land.
5. If Player A lands on a color, Player B asks Player A the first question from the stack of the matching color.
6. If Player A answers the question correctly, he/she may move to that space. If the player gives an incorrect answer, his/her marker must remain where it was before the die was rolled.
7. Player B rolls the die and play proceeds.
8. The player to reach the happy face first wins.



Game Board


START
YELLOW
BLUE
FORWARD TWO SPACES
PINK
GREEN
YELLOW
BACK ONE SPACE
YELLOW
BLUE
FORWARD ONE SPACE
GREEN
BLUE
PINK
FREE SPACE
FREE SPACE
PINK
GREEN
ROLL AGAIN
YELLOW
GREEN
BACK TWO SPACES
BLUE
PINK
BLUE
ROLL AGAIN
YELLOW
PINK
BLUE
GREEN
FREE SPACE
PINK
FORWARD ONE SPACE
YELLOW
FREE SPACE
GREEN
BACK FIVE SPACES
BACK TWO SPACES
FINISH

Mount these on green construction paper.

How far is it from Madison to Old Town? Answer: 36 miles	How far is it from Dry Creek to New Hope? Answer: 37 miles
What is the shortest way from Salt Lick to Dry Creek? Answer: Through Madison	How far is it from Salt Lick to Old Town going through Dry Creek? Answer: 57 miles
If you leave New Hope and travel to Dry Creek and return to New Hope, how far will you travel? Answer: 74 miles	What is the shortest way to go from Mineral Springs to Old Town? Answer: Through Dry Creek
How far is it from Dry Creek to Old Town if you must go through Lizard Gulch? Answer: 59 miles	What is the shortest way from Madison to New Hope? Answer: Through Dry Creek and Old Town

Mount these on yellow construction paper.

How far is it from Dry Creek to Salt Lick? Answer: 40 miles	How far is Mineral Springs from Lizard Gulch if you go through Salt Lick? Answer: 33 miles
If you travel to New Hope from Lizard Gulch and return the same day, how far did you travel? Answer: 50 miles	If you go to Lizard Gulch from Dry Creek and on to Old Town, how far did you go? Answer: 59 miles
How far is it from New Hope to Salt Lick? Answer: 48 miles	What is the shortest way to Salt Lick from Old Town? Answer: Through Lizard Gulch
How far is it to New Hope from Dry Creek if you go through Lizard Gulch? Answer: 63 miles	What is the shortest way to go to Madison from Mineral Springs? Answer: Through Salt Lick

Mount these on blue construction paper.

Which towns are more than 50 miles from New Hope? Answer: Madison and Mineral Springs	Which towns are less than 40 miles from Mineral Springs? Answer: Dry Creek, Salt Lick, Madison, and Lizard Gulch
How far is it from Salt Lick to Dry Creek? Answer: 40 miles	If you went from New Hope to Lizard Gulch to Salt Lick to Madison, how far will you go? Answer: 69 miles
How far is a round trip from Mineral Springs to Salt Lick? Answer: 20 miles	How far is it from Madison to Salt Lick to Mineral Springs to Dry Creek? Answer: 64 miles
How far is it from New Hope to Old Town to Lizard Gulch? Answer: 41 miles	How far is it from Lizard Gulch to Dry Creek to Mineral Springs? Answer: 71 miles

Mount these on pink construction paper.

What is the shortest distance from Lizard Gulch to Madison? Answer: 44 miles	How much closer is Old Town to Dry Creek than to Lizard Gulch? Answer: 4 miles
If you lived in Mineral Springs, would Lizard Gulch be closer than Dry Creek? Answer: No, they are the the same distance.	Which towns are less than 20 miles from Dry Creek? Answer: Old Town and Madison.
You live in Old Town, your mom says you can drive to the towns less than 25 miles away, where can you go? Answer: Dry Creek, New Hope, and Lizard Gulch	How far is it from New Hope to Madison if you go through Dry Creek and Old Town? Answer: 56 miles
How far is it from Madison to New Hope if you go through Dry Creek and Lizard Gulch? Answer: 82 miles	A delivery truck must leave Mineral Springs and stop at every town, returning to Madison each day. Can this be done without going through any town twice? Answer: No

ACTIVITY: Banana Splits **STRAND:** Operations

OBJECTIVE:
51209 To divide two 2-digit numbers with a remainder

PREREQUISITE:
To divide a 2-digit number by a multiple of ten with a remainder

MATERIALS NEEDED:
Banana sheets (See sample pages.)
Yellow construction paper

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:
1. Duplicate enough banana sheets on yellow construction paper for four groups. Each group should have twenty bananas.

2. Cut out bananas. Cut bananas apart.

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:
1. Divide class into four teams.

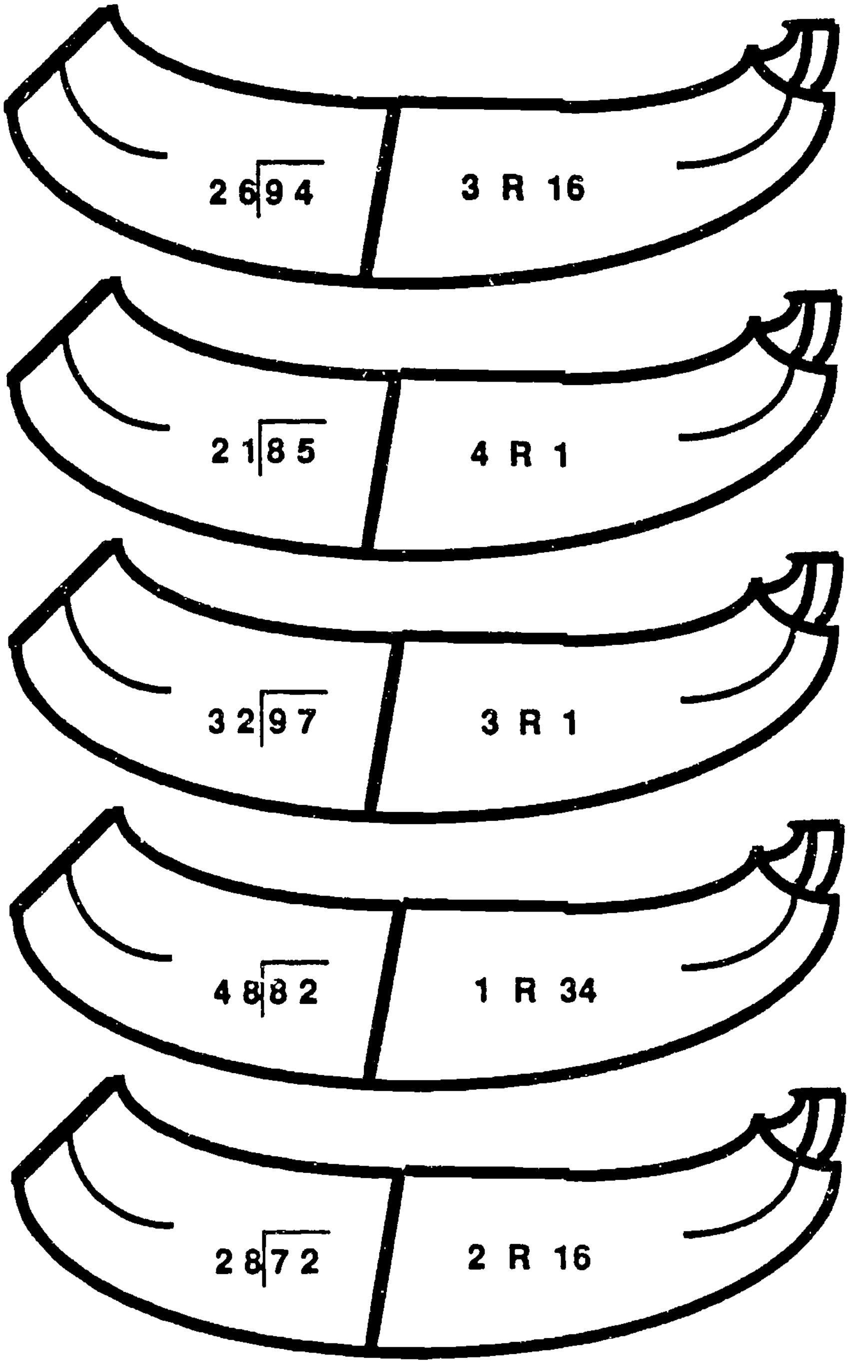
2. Give each team a set of bananas.

DIRECTIONS TO THE STUDENT:
1. Put the halves of the bananas together. Match the problem with the answer.

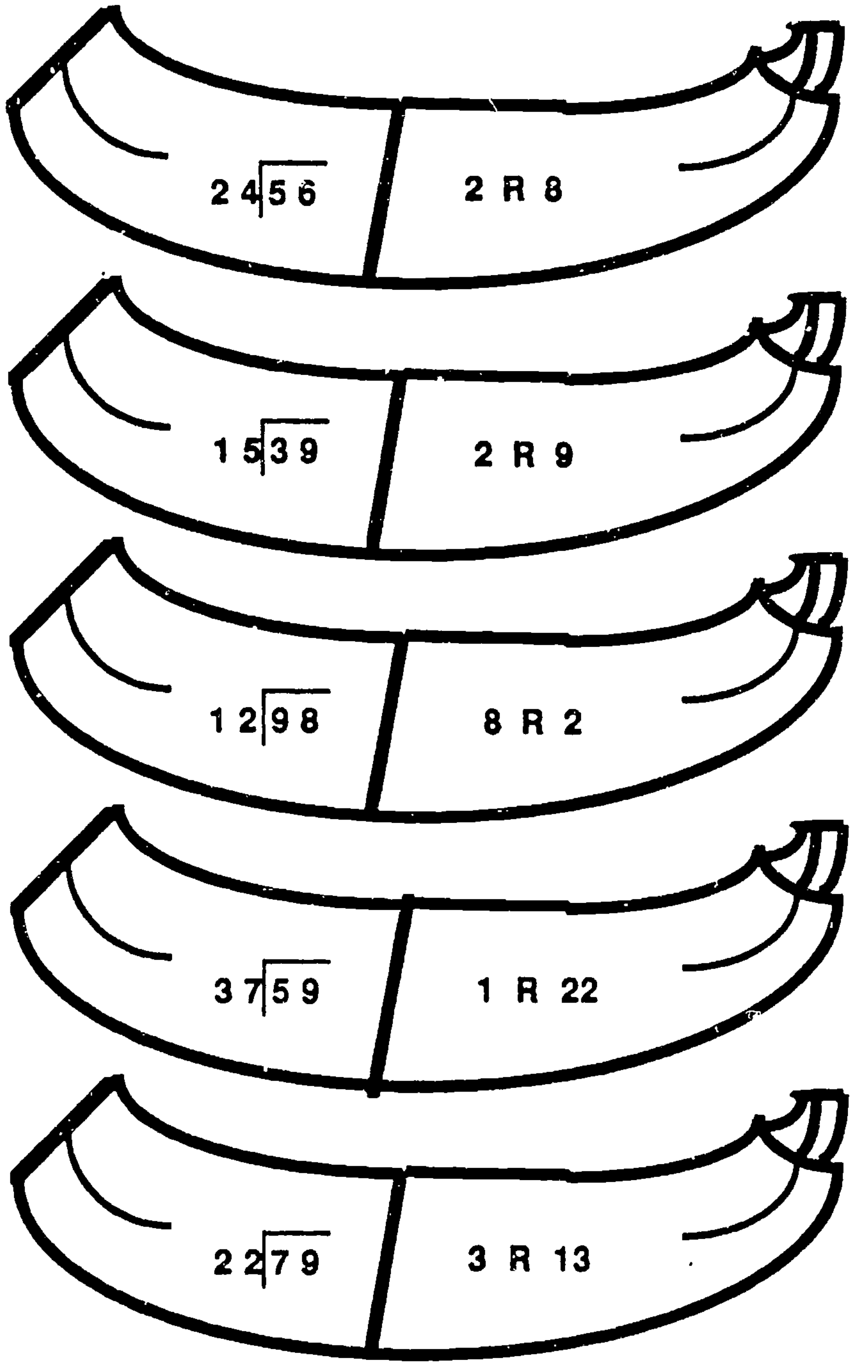
2. You may use paper and pencil if needed.

3. The team that puts all of the bananas together correctly first is the winner.

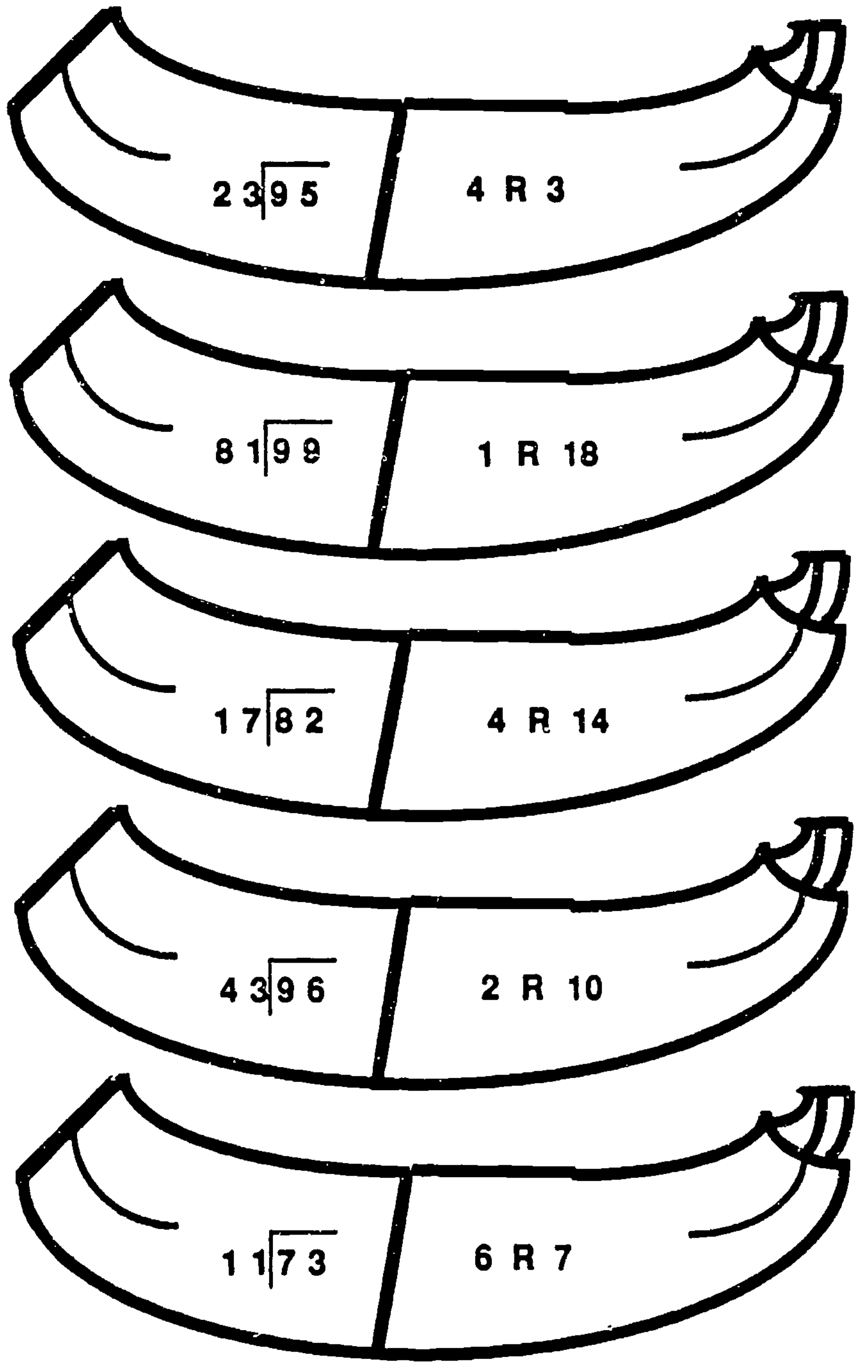
Bananas



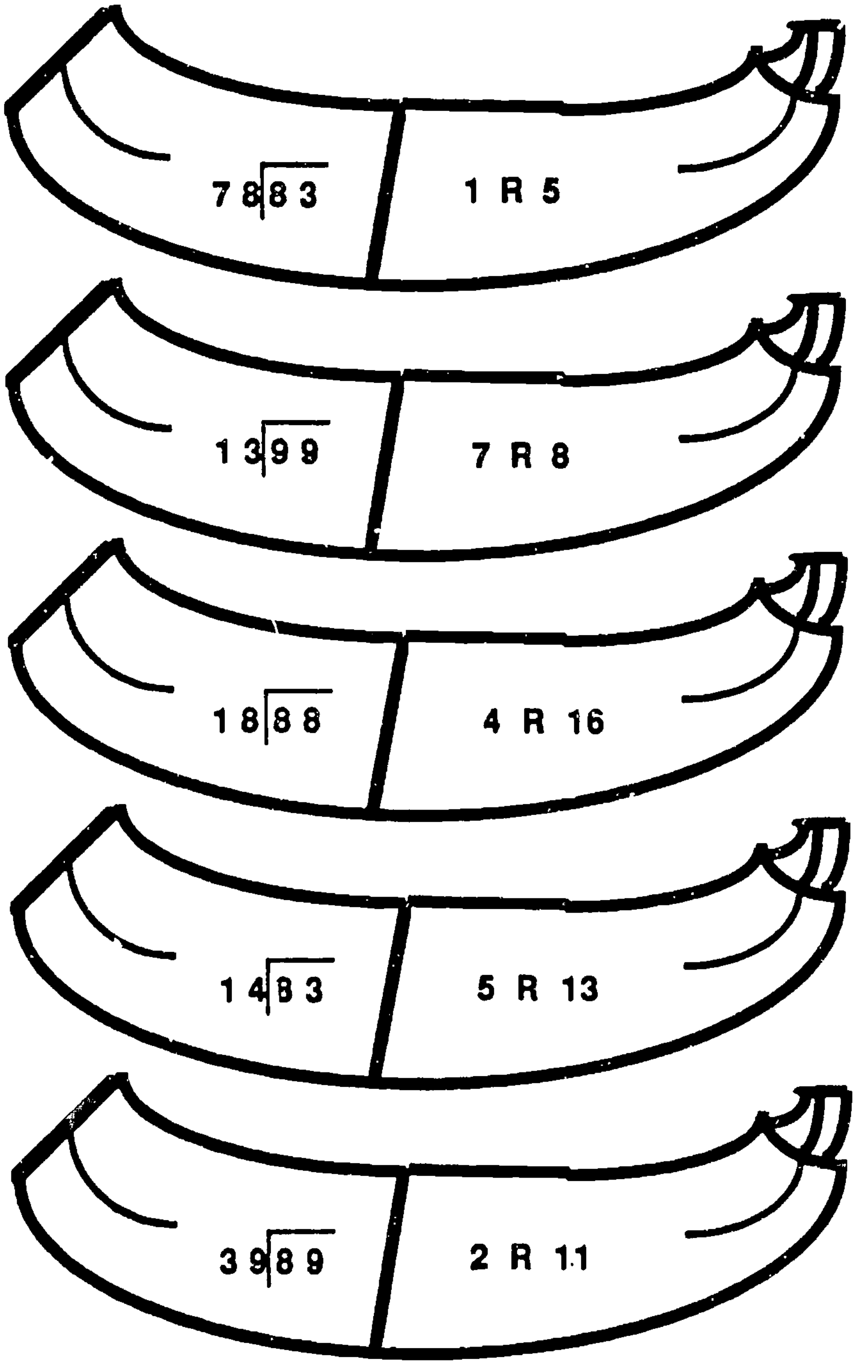
Bananas



Bananas



Bananas



ACTIVITY: What's My Name? **STRAND:** Numeration

OBJECTIVE:
51107 To read and write word names for numbers through 9,999,999

PREREQUISITE:
To read and write word names for numbers through 999,999

MATERIALS NEEDED:
Number cards (See sample pages.)
Score sheet (See sample page.)
Pencils

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Duplicate enough number cards and score sheets for every two students.
2. Laminate.
3. Cut number cards apart.

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

1. Divide class into groups of two-student teams.
2. Give each team a set of number cards and a score sheet.

DIRECTIONS TO THE STUDENT:

1. Place deck of cards face down.
2. The first player draws a card and reads the number to his/her partner.
3. The partner writes the number in words on first space on score sheet.
4. The players check the answer by looking at the card. A point is scored for a correct answer.
5. The team with the most points is the winner.

five million four hundred thirty-six thousand seven hundred twelve	three million four thousand seven hundred seventy-eight
eight million six hundred two thousand one hundred thirteen	one million three hundred fifty thousand sixty-one
nine million five hundred thousand forty-eight	four million five thousand two
two million fifty-six thousand four hundred twenty	six million three hundred eighty-five thousand

seven million four hundred	three million five thousand four hundred seventeen
nine million six hundred ninety-one thousand four hundred eleven	eight million six hundred ninety-five thousand
two million fifteen thousand two hundred eighteen	five million nineteen thousand seven hundred eleven
six million two hundred seventy-four thousand fourteen	one million three hundred thirty-six thousand five hundred forty-four

What's My Name Score Sheet

Score____	Score____
Score____	Score____
Score____	Score____
Score____	Score____

Total Score ______

SAMPLE ACTIVITIES

TAKEN FROM: MATHEMATICS ACTIVITIES MANUAL FOR GRADE SIX

ACTIVITY: I Have . . . Who Has . . . ?

STRAND: Fraction and Decimals

OBJECTIVE:
61301 To write the lowest common denominator for three mixed numbers

PREREQUISITES:
To state the definition of least common multiple
To list several multiples of a whole number
To list some common multiples of two whole numbers

MATERIALS NEEDED:
Set of *I have... Who has...?* cards (See sample cards.)
Construction Paper

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Run off *I have... Who has...?* cards on construction paper.
2. Laminate and cut apart.
3. See Appendix 2 for alternate instructions and blank cards.

DIRECTIONS TO THE STUDENT:

1. Pass the cards out to the students. Every card must be passed out. Some students may have more than one card.
2. The student who has the card *I have* 24 starts the play by standing and reading the *Who has...* part of the card.
3. The student who has the answer stands and reads it and then reads his/her question.
4. The play continues until all the cards have been read.

I Have . . . Who Has . . . ? Cards

I have 20. Who has the least common multiple of 12 and 9?	I have 36. Who has the least common multiple of 48 and 8?
I have 48. Who has the least common multiple of 10 and 15?	I have 30. Who has the least common multiple of 10 and 8?
I have 40. Who has the least common multiple of 7 and 4?	I have 28. Who has the least common multiple of 3 and 7?
I have 21. Who has the least common multiple of 12 and 21?	I have 84. Who has the least common multiple of 7 and 9?

I Have . . . Who Has . . . ? Cards

I have 63. Who has the least common multiple of 4 and 8?	I have 8. Who has the least common multiple of 21 and 6?
I have 42. Who has the least common multiple of 7 and 5?	I have 35. Who has the least common multiple of 12 and 8?
I have 24. Who has the least common multiple of 6 and 9?	I have 18. Who has the least common multiple of 7 and 8?
I have 56. Who has the least common multiple of 4 and 12?	I have 12. Who has the least common multiple of 3 and 2?

I Have . . . Who Has . . . ? Cards

I have 6. Who has the least common multiple of 12 and 15?	I have 60. Who has the least common multiple of 11 and 2?
I have 22. Who has the least common multiple of 5 and 9?	I have 45. Who has the least common multiple of 13 and 14?
I have 52. Who has the least common multiple of 27 and 6?	I have 54. Who has the least common multiple of 2 and 33?
I have 66. Who has the least common multiple of 4 and 17?	I have 68. Who has the least common multiple of 10 and 35?

I Have . . . Who Has . . . ? Cards

I have 70. Who has the least common multiple of 15 and 25?	I have 75. Who has the least common multiple of 4 and 19?
I have 76. Who has the least common multiple of 9 and 30?	I have 90. Who has the least common multiple of 13 and 3?
I have 39. Who has the least common multiple of 5 and 13?	I have 65. Who has the least common multiple of 2 and 23?
I have 46. Who has the least common multiple of 4 and 50?	I have 100. Who has the least common multiple of 5 and 4?

ACTIVITY: I Have . . . Who Has . . . ? **STRAND:** Measurement

OBJECTIVE:
To review conversions between units of time

PREREQUISITES:
To tell time
To convert minutes to hours
To add minutes and hours

MATERIALS NEEDED:
Construction paper
Set of *I have...Who has...?* cards

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Run off *I have...Who has...?* cards on construction paper.
2. Laminate and cut apart.
3. See Appendix for alternate instructions and blank cards.

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

1. Pass the cards out to the students. Every card must be passed out. Some students may have more than one card.
2. Have a student stand and read the question from his/her card.
3. The student who has the answer stands and reads it and then reads his/her question.
4. The play continues until all the cards have been read.

I Have . . . Who Has . . . ? Cards

I have 12:05 p.m. Who has 25 minutes later?	I have 1:15 p.m. Who has 5 hours later?
I have 12:30 p.m. Who has 1 hour earlier?	I have 6:15 p.m. Who has 12 hours earlier?
I have 11:30 a.m. Who has 45 minutes later?	I have 6:15 a.m. Who has 3 hours earlier?
I have 12:15 p.m. Who has 60 minutes later?	I have 3:15 a.m. Who has 30 minutes later?

I Have . . . Who Has . . . ? Cards

I have 3:45 a.m. Who has 12 hours later?	I have 8:30 p.m. Who has 2 hours and 15 minutes later?
I have 3:45 p.m. Who has 30 minutes later?	I have 10:45 p.m. Who has 2 hours later?
I have 4:15 p.m. Who has 15 minutes later?	I have 12:45 a.m. Who has 30 minutes later?
I have 4:30 p.m. Who has 4 hours later?	I have 1:15 a.m. Who has 2 hours earlier?

I Have . . . Who Has . . . ? Cards

I have 11:15 p.m. Who has 30 minutes later?	I have 2:45 a.m. Who has 5 hours later?
I have 11:45 p.m. Who has 1 hour and 15 minutes later?	I have 7:45 a.m. Who has 10 minutes later?
I have 1:00 a.m. Who has 1 hour and 30 minutes later?	I have 7:55 a.m. Who has 12 hours and 5 minutes later?
I have 2:30 a.m. Who has 15 minutes later?	I have 8:00 p.m. Who has 45 minutes later?

I Have . . . Who Has . . . ? Cards

I have 8:45 p.m. Who has 30 minutes later?	I have 10:15 p.m. Who has 12 hours earlier?
I have 9:15 p.m. Who has 1 hour 15 minutes later?	I have 10:15 a.m. Who has 45 minutes later?
I have 10:30 p.m. Who has 45 minutes earlier?	I have 11:00 a.m. Who has 25 minutes later?
I have 9:45 p.m. Who has 30 minutes later?	I have 11:25 a.m. Who has 40 minutes later?

ACTIVITY: Decimal Concentration **STRAND.** Fractions and Decimals

OBJECTIVE:
61317 To read and write decimal numbers to ten thousandths

PREREQUISITE:
To identify decimal numbers to thousandths

MATERIALS NEEDED:
Folder
Glue
Two copies of concentration board
Envelope
Construction paper
Decimal and word name cards

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Make two copies of Concentration gameboard. See Appendix 1. Glue one copy to the left inside of a folder and one to the right inside.

2. Glue a set of student instructions on the back of the folder. Also, glue an envelope for the cards on the back of the folder.

3. The cards need to be copied on construction paper. Photocopying directly on construction paper is possible on some copiers. The alternative is making a thermal master and running the copies on construction paper.

4. Laminate cards and folder.

DIRECTIONS TO THE STUDENT:

1. Shuffle the cards.

2. Lay the cards face down on the game board, one card per rectangle.

3. Each person turns over two cards, one at a time, trying to get a match.

4. When two cards that match are turned over in one turn, the person who turned them over gets to keep them.

5. At the end of the game, the person who has the most matching pairs wins.

CONCENTRATION

5 and 524 thousandths	5.524
234 ten thousandths	0.0234
59 and 104 thousandths	59.104
3 and 412 ten-thousandths	3.0412

6 tenths 4 hundredths 5 thousandths 3 ten-thousandths	0.6453
2 tenths 2 thousandths 2 hundred-thousandths	0.20202
twenty-seven ten-thousandths	0.0027
six thousand four and six hundred ninety-four thousandths	6004.694

621 ten-thousandths	0.0621
89 and 28 thousandths	89.028
471 and 47 ten-thousandths	471.0047
6214 and 8 hundredths	6214.08

two hundred two and two hundredths	202.02
twenty-seven and twenty-seven hundredths	27.27
seventy and seven thousandths	70.007
eight hundred and eighteen hundredths	800.18

ACTIVITY: Prime Factor Family Trees **STRAND:** Numeration

OBJECTIVE:	
61111	To list prime numbers less than one hundred

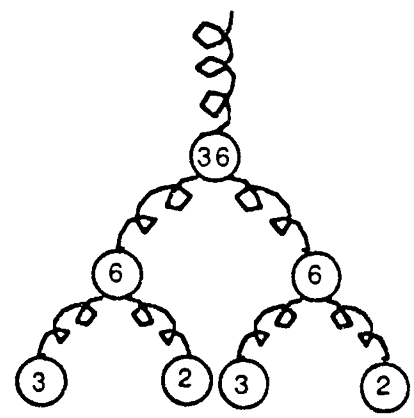
MATERIALS NEEDED:

Shoe box
Pipe cleaners
Number discs (Master is included.)
Glue
Yarn
Large discs
Pencils

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Show the students how to find prime factors of a number by making a bulletin board using yarn and large circles.

2. Make a factor "tree" similar to this one: You will use this when you conduct the activity.



INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

1. Fix a shoe box from which students draw a number.

2. Each circle has a number on it and a hole near the top of each circle.

3. Give students pipe cleaners and blank paper discs.

4. Have students make their own factor trees for the numbers they draw by gluing pipe cleaners and circles together.

REFERENCE

Frank, Marjorie. *Kids' Stuff Math.* Incentive Publications, Inc. Cost: $10.95

DIRECTIONS TO THE STUDENT:

1. Draw a nu· ·ered circle from the shoe box.

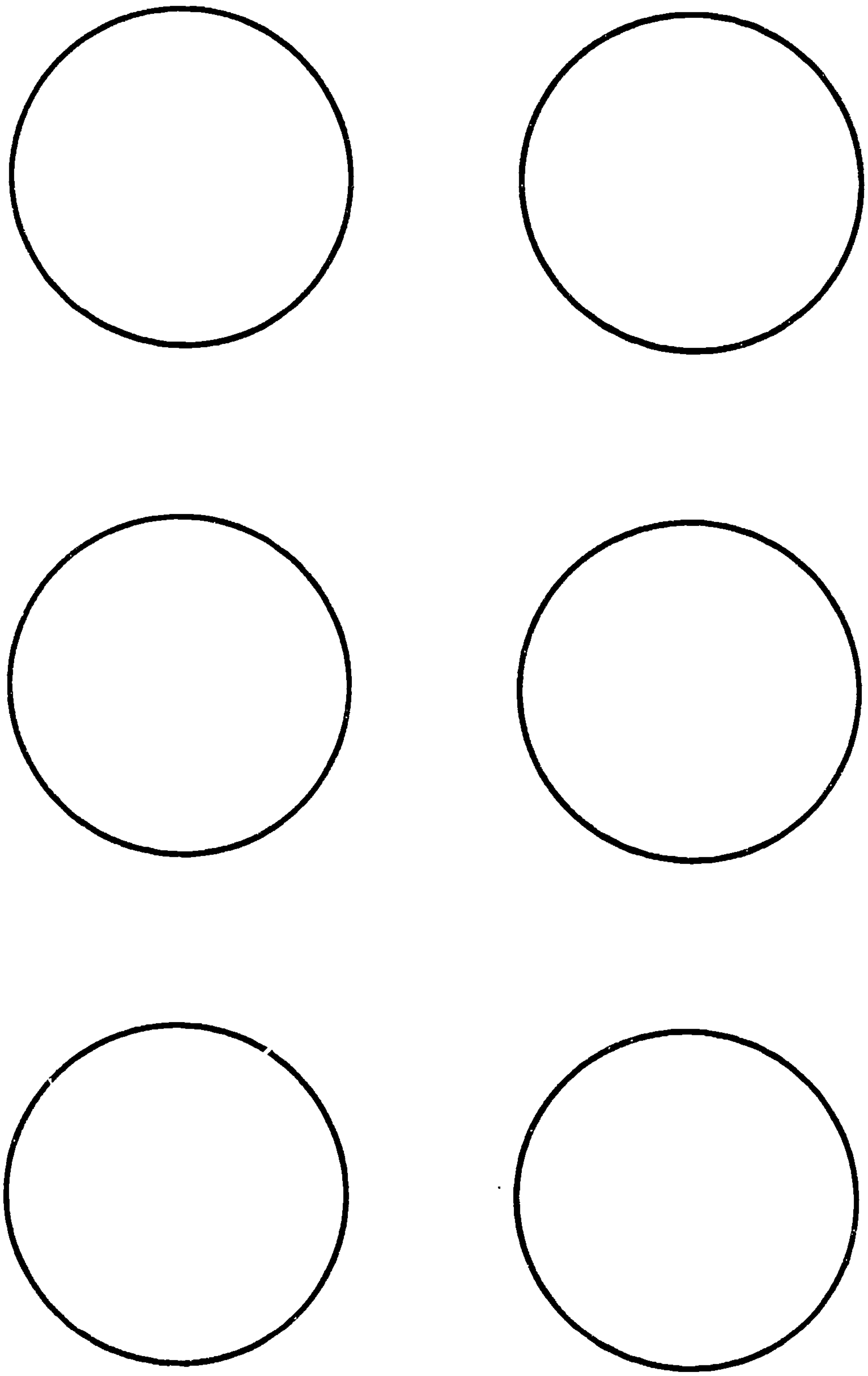
2. Use the pipe cleaners and plain paper discs to make a number tree similar to the one the teacher has constructed.

3. Write the factors for the number you have chosen on the blank discs.

Number Discs

21	48
12	54
36	64

Number Discs



SAMPLE ACTIVITIES

TAKEN FROM: MATHEMATICS ACTIVITIES MANUAL FOR GRADE SEVEN

ACTIVITY: % I Have . . . Who Has . . .? **STRAND:** Ratio, Proportion and Percent

OBJECTIVES:
71803 To write using proportion the percent equivalent of a fraction
71804 To write using division the percent equivalent of a fraction

PREREQUISITES:
To divide the numerator by the denominator to find the decimal equivalent of a fraction
To find the percent equivalent of a fraction using proportion

MATERIALS NEEDED:

Index cards (sufficient number to insure that each student gets two or three cards)

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

For alternate instructions, see Appendix 2.

1. Make a key of your *"I have... Who has... ?"* questions first (See sample.)
2. Make the questions cyclic (the answer to the last question is on the first card.)
3. Use your key to make your deck of cards.

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

For alternate instructions, see Appendix 2.

1. Shuffle the cards.
2. Give each student at least two cards.
3. See directions to the student.

DIRECTIONS TO THE STUDENT:

1. Listen to the questions as they are read.
2. Write down the information given.
3. Try to mentally solve the question and write it down. (If you have difficulty solving mentally, work the problem on your paper.)
4. If one of your cards has the answer to the *Who has* question, read the *I have* response and *Who has* question on that card aloud.
5. Play continues in this manner until the answer to the last question read is on the first card or until the teacher calls time.

SAMPLE KEY

1. I have $\frac{1}{3}$. Who has this fraction as a percent?
2. I have $33\frac{1}{3}$%. Who has $\frac{3}{4}$ as a percent?
3. I have 75%. Who has 1 ÷ 6 as a percent?
4. I have $16\frac{2}{3}$%. Who has 7 ÷ 5 as a percent?
5. I have 140%. Who has $12\frac{1}{2}$% as a fraction?
6. I have $\frac{1}{8}$. Who has $\frac{1}{4}$ as a decimal?
7. I have 0.25. Who has this as a percent?
8. I have 25%. Who has $\frac{2}{3}$ as a percent?
9. I have $66\frac{2}{3}$%. Who has $\frac{16}{25}$ as a decimal?
10. I have 0.64. Who has this as a percent?
11. I have 64%. Who has 36 ÷ 9 as a decimal?
12. I have 4. Who has this as a percent?
13. I have 400%. Who has $\frac{1}{2}$ as a percent?
14. I have 50%. Who has its decimal equivalent?
15. I have 0.5. Who has $\frac{7}{8}$ as a percent?
16. I have $87\frac{1}{2}$%. Who has its decimal equivalent?
17. I have 0.875. Who has the decimal equivalent of $\frac{12}{15}$?
18. I have 80%. Who has this as a decimal?
19. I have 0.800. Who has 65% as a fraction?
20. I have $\frac{13}{20}$. Who has its decimal equivalent?
21. I have 0.65. Who has the fraction equivalent of 0.0925?
22. I have $\frac{925}{10\ 000}$. Who has this as a percent?
23. I have 9.25%. Who has 30% as a fraction?
24. I have $\frac{3}{10}$. Who has the fraction equivalent of 20%?

25. I have $\frac{1}{5}$. Who has 0.75 as a fraction?

26. I have $\frac{3}{4}$. Who has the decimal equivalent of $\frac{3}{8}$?

27. I have 0.375. Who has 0.375 as a percent?

28. I have $37\frac{1}{2}$%. Who has the decimal equivalent of 40%?

29. I have 0.4. Who has 0.4 as a fraction?

30. I have $\frac{2}{5}$. Who has $\frac{3}{5}$ as a decimal?

31. I have 0.6. Who has 0.6 as a percent?

32. I have 60%. Who has 0.625 as a fraction?

33. I have $\frac{5}{8}$. Who has $\frac{5}{8}$ as a percent?

34. I have $62\frac{1}{2}$%. Who has 525% as a fraction?

35. I have $5\frac{1}{4}$. Who has the decimal equivalent of $5\frac{1}{4}$?

36. I have 5.25. Who has the decimal equivalent of $\frac{1}{20}$?

37. I have 0.05. Who has 0.05 as a percent?

38. I have 5%. Who has 2% as a fraction?

39. I have $\frac{1}{50}$. Who has the decimal equivalent of $\frac{1}{50}$?

40. I have 0.02. Who has 6% as a fraction?

41. I have $\frac{3}{50}$. Who as the decimal equivalent of $\frac{3}{50}$?

42. I have 0.06. Who as 34% as a fraction?

43. I have $\frac{17}{50}$. Who has $\frac{7}{20}$ as a percent?

44. I have 35%. Who has 45% as a fraction?

45. I have $\frac{9}{20}$. Who has the decimal equivalent of $\frac{9}{20}$?

46. I have 0.45. Who has 7 as a percent?

47. I have 700%. Who has 86% as a decimal?

48. I have 0.86. Who has 0.86 as a fraction?

49. I have $\frac{43}{50}$. Who has 0.3125 as a fraction?

50. I have $\frac{5}{16}$. Who has $\frac{5}{16}$ as a percent?

51. I have $31\frac{1}{4}$%. Who as 0.9 as a percent?

52. I have 90%. Who has 90% as a fraction?

53. I have $\frac{9}{10}$. Who has 95% as a fraction?

54. I have $\frac{19}{20}$. Who has the decimal equivalent of $\frac{19}{20}$?

55. I have 0.95. Who has 85% as a fraction?

56. I have $\frac{17}{20}$. Who has $\frac{17}{20}$ as a decimal?

57. I have 0.85. Who has $7\frac{1}{4}$ as a decimal?

58. I have 7.25. Who has 7.25 as a percent?

59. I have 725%. Who has 0.56 as a percent?

60. I have 56%. Who has 56% as a fraction?

61. I have $\frac{14}{25}$. Who has 0.7 as a fraction?

62. I have $\frac{7}{10}$. Who has $\frac{7}{10}$ as a percent?

63. I have 70%. Who has the fraction equivalent $66\frac{2}{3}$%?

64. I have $\frac{2}{3}$. Who has the fraction equivalent $33\frac{1}{3}$%?

This leads back to the first question.

I Have . . . Who Has . . . ? Cards

I have $\frac{1}{3}$. Who has this fraction as a percent?	I have $33\frac{1}{3}$%. Who has $\frac{3}{4}$ as a percent?
I have 75%. Who has 1 ÷ 6 as a percent?	I have $16\frac{2}{3}$%. Who has 7 ÷ 5 as a percent?
I have 140%. Who has $12\frac{1}{2}$%?	I have $\frac{1}{8}$. Who has $\frac{1}{4}$ as a decimal?
I have 0.25. Who has this as a percent?	I have 25%. Who has $\frac{2}{3}$ as a percent?

I Have . . . Who Has . . . ? Cards

I have $66\frac{2}{3}$%. Who has $\frac{16}{25}$ as a decimal?	I have 0.64. Who has this as a percent?
I have 64%. Who has 36 ÷ 9 as a decimal?	I have 4. Who has this as a percent?
I have 400%. Who has $\frac{1}{2}$ as a percent?	I have 50%. Who has its decimal equivalent?
I have 0.5. Who has $\frac{7}{8}$ as a percent?	I have $87\frac{1}{2}$%. Who has its decimal equivalent?

I Have . . . Who Has . . . ? Cards

I have 0.875. Who has the decimal equivalent of $\frac{12}{15}$?	I have 80%. Who has this as a decimal?
I have 0.800. Who has 65% as a fraction?	I have $\frac{13}{20}$. Who has its decimal equivalent?
I have 0.65. Who has the fraction equivalent of 0.0925?	I have $\frac{925}{10\ 000}$. Who has this as a percent?
I have 9.25%. Who has 30% as a fraction?	I have $\frac{3}{10}$. Who has the fraction equivalent of 20%?

I Have . . . Who Has . . . ? Cards

I have $\frac{1}{5}$. Who has 0.75 as a fraction?	I have $\frac{3}{4}$. Who has the decimal equivalent of $\frac{3}{8}$?
I have 0.375. Who has 0.375 as a percent?	I have $37\frac{1}{2}$%. Who has the equivalent of 40%?
I have 0.4. Who has 0.4 as a fraction?	I have $\frac{2}{5}$. Who has $\frac{3}{5}$ as a decimal?
I have 0.6. Who has 0.6 as a percent?	I have 60%. Who has 0.625 as a fraction?

I Have . . . Who Has . . . ? Cards

I have $\frac{5}{8}$. Who has $\frac{5}{8}$ as a percent?	I have $62\frac{1}{2}$%. Who has 525% as a fraction?
I have $5\frac{1}{4}$. Who has the decimal equivalent of $5\frac{1}{4}$?	I have 5.25. Who has the decimal equivalent of $\frac{1}{20}$?
I have 0.05. Who has 0.05 as a percent?	I have 5%. Who has 2% as a fraction?
I have $\frac{1}{50}$. Who has the decimal equivalent of $\frac{1}{50}$?	I have 0.02. Who has 6% as a fraction?

I Have . . . Who Has . . . ? Cards

I have $\frac{3}{50}$. Who has the decimal equivalent of $\frac{3}{50}$?	I have 0.06. Who has 34% as a fraction?
I have $\frac{17}{50}$. Who has $\frac{7}{20}$ as a percent?	I have 35%. Who has 45% as a fraction?
I have $\frac{9}{20}$. Who has the decimal equivalent of $\frac{9}{20}$?	I have 0.45. Who has 7 as a percent?
I have 700%. Who has 86% as a decimal?	I have 0.86. Who has 0.86 as a fraction?

I Have . . . Who Has . . . ? Cards

I have $\frac{43}{50}$. Who has 0.3125 as a fraction?	I have $\frac{5}{16}$. Who has $\frac{5}{16}$ as a percent?
I have $31\frac{1}{4}$%. Who has 0.9 as a percent?	I have 90%. Who has 90% as a fraction?
I have $\frac{9}{10}$. Who has 95% as a fraction?	I have $\frac{19}{20}$. Who has the decimal equivalent of $\frac{19}{20}$?
I have 0.95. Who has 85% as a fraction?	I have $\frac{17}{20}$. Who has $\frac{17}{20}$ as a decimal?

I Have . . . Who Has . . . ? Cards

I have 0.85. Who has $7\frac{1}{4}$ as a decimal?	I have 7.25. Who has 7.25 as a percent?
I have 725%. Who has 0.56 as a percent?	I have 56%. Who has 56% as a fraction?
I have $\frac{14}{25}$. Who has 0.7 as a fraction?	I have $\frac{7}{10}$. Who has $\frac{7}{10}$ as a percent?
I have 70%. Who has the fraction equivalent of $66\frac{2}{3}$%?	I have $\frac{2}{3}$. Who has the fraction equivalent of $33\frac{1}{3}$%?

ACTIVITY: Fraction Concentration **STRAND:** Fractions and Decimals

OBJECTIVES:	
71301	To multiply three factors in any combination of fractions, mixed fractional numbers and whole numbers
71312	To divide two mixed fractional numbers

PREREQUISITES:

To be able to multiply factors in any combination of fractions, mixed fractional numbers and whole numbers

To divide two mixed fractional numbers

MATERIALS NEEDED:

Construction paper
Master sheet
Coin or numbered cube
Paper and pencils

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Copy enough master sheets for each team to have a set of 40 cards.
2. See Appendix 1 for additional instructions.

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

Separate class into teams of two.

DIRECTIONS TO THE STUDENT:

1. Place the cards with problems face down and the answer cards face up in six rows of seven cards each.
2. Turn over one problem card.
3. The first student to work the problem and pick up the correct answer card will keep the match.
4. Play is over when all matches have been made.
5. The player with the most matched pairs wins the game.

$\frac{4}{15} \times \frac{5}{8} \times \frac{2}{3}$	$\frac{1}{9}$
$2\frac{1}{13} \times 2\frac{3}{5} \times 1\frac{1}{2}$	$8\frac{1}{10}$
$7\frac{1}{2} \times 3\frac{1}{3} \times 2\frac{2}{5}$	60
$3\frac{1}{3} \times 4\frac{1}{2} \times 5\frac{1}{3}$	80

$9 \times 2\frac{1}{12} \times \frac{3}{25}$	$2\frac{1}{4}$
$\frac{2}{3} \times \frac{3}{4} \times 14$	7
$21 \times \frac{2}{5} \times \frac{10}{14}$	6
$\frac{1}{6} \times 5\frac{3}{5} \times 1\frac{1}{14}$	1

$\frac{3}{8} \times 72 \times \frac{4}{9}$	12
$(\frac{10}{13} \times \frac{13}{15}) \div \frac{4}{3}$	$\frac{1}{2}$
$\frac{1}{4} \times \frac{1}{2} \times 5\frac{1}{3}$	$\frac{2}{3}$
$1\frac{7}{8} \times 5 \times 1\frac{1}{15}$	10

$2\frac{1}{3} \times 2\frac{2}{7} \times \frac{3}{8}$	2
$\frac{2}{7} \div \frac{1}{2} \div 1\frac{3}{7}$	$\frac{2}{5}$
$2\frac{1}{2} \div 1\frac{3}{4}$	$1\frac{3}{7}$
$6\frac{1}{11} \div \frac{7}{22}$	$19\frac{1}{7}$

$\frac{5}{8} \div 2\frac{1}{3}$	$\frac{15}{56}$
$\frac{1}{16} \div 2\frac{3}{4}$	$\frac{1}{44}$
$\frac{5}{6} \div \frac{1}{9}$	$7\frac{1}{2}$
$\frac{2}{7} \div \frac{3}{10}$	$\frac{20}{21}$

ACTIVITY: Integer Concentration **STRAND:** Operations

OBJECTIVES:

71202	To add integers having like signs
71204	To add integers having unlike signs
71205	To subtract integers having unlike signs
71207	To subtract integers having like signs

PREREQUISITE:
To define integer, like signs and unlike signs

MATERIALS NEEDED:
Construction paper or heavy bond
Master sheets for copier
Coin or die per team

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:

1. Copy and cut out enough master sheets to have one set of cards per team.
2. See Appendix 1 for blanks and other instructions.

DIRECTIONS TO THE STUDENT:

1. Play in teams of two.
2. Place the cards face down in six rows of five cards each.
3. Flip coin to determine who has the first turn.
4. A player may turn over two and only two cards per turn.
5. When the two cards are a match (a problem and its answer), the player places the pair in their stack.
6. Play is over when there are no more matches to make.
7. Player with the most matched pairs wins the game.

$^{-}4 + {}^{-}3$	$^{-}7$
$^{-}3 + {}^{-}2$	$^{-}5$
$9 + 7$	16
$^{-}5 + 7$	2

9 + $^-$11	$^-$2
15 + $^-$8	7
$^-$1 + $^-$8	$^-$9
$^-$5 - $^-$6	1

$^-7 - ^-2$	$^-5$
$^-9 - ^-1$	$^-8$
$^-15 - 2$	$^-17$
$^-19 - 1$	$^-20$

$^{-}5 - {}^{-}2$	$^{-}3$
$7 - {}^{-}2$	<u>9</u>
$^{-}15 - {}^{-}18$	3
$30 + {}^{-}22$	8

SAMPLE ACTIVITIES

TAKEN FROM: MATHEMATICS ACTIVITIES MANUAL FOR GRADE EIGHT

ACTIVITY: I Have . . . Who Has . . .?

STRAND: Fractions and Decimals

OBJECTIVES:
81308 To convert a number in standard form to scientific notation
81309 To convert a number in scientific notation to standard form

PREREQUISITES:
To write numbers in expanded form using exponents through 10 and vice versa
To evaluate expressions which include exponents

MATERIALS NEEDED:
A set of *I have . . . Who has . . .?* cards

INSTRUCTIONS TO THE TEACHER FOR MAKING ACTIVITY:
See Appendix 2 for instructions for *I Have . . . Who Has . . .?*

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

1. Shuffle the cards and pass them out to each class member.
2. Have a student read only the question on a card. The student who has the answer to that question reads the answer and the question at the bottom of the card.
3. Play ends when the answer to a question is on the beginning card.

I have 4.6×10^{2}. Who has 3200?	I have 3.2×10^{3}. Who has 266,000?
I have 2.66×10^{5}. Who has 4.9×10^{4}?	I have 49,000. Who has 1.5×10^{-3}?
I have 0.0015 Who has 8.3×10^{-5}?	I have 0.000083. Who has 2.61×10^{-4}?
I have 0.000261. Who has 0.051?	I have 5.1×10^{-2}. Who has 50,370?

I have 5.037×10^4. Who has 68,040,000?	I have 6.804×10^7. Who has 8.201×10^6?
I have 8,201,000. Who has 131,000?	I have 1.31×10^5. Who has 0.0000000714?
I have 7.14×10^{-8}. Who has 9.16×10^{-6}?	I have 0.00000916. Who has 610,000?
I have 6.1×10^5. Who has 325?	I have 3.25×10^2. Who has 4.67×10^5?

I have 467,000. Who has 780?	I have 7.8×10^{2}. Who has 5.6×10^{-3}?
I have 0.0056. Who has 10,200?	I have 1.02×10^{4}. Who has 1.56×10^{8}?
I have 156,000,000. Who has 0.000000843?	I have 8.43×10^{-7}. Who has 520?
I have 5.2×10^{2}. Who has 57,900,000?	I have 5.79×10^{7}. Who has 4.76×10^{3}?

I have 4760. Who has 763?	I have 7.63×10^2. Who has 8047?
I have 8.047×10^3. Who has 9,636,000?	I have 9.636×10^6. Who has 8.703×10^6?
I have 8,703,000. Who has 3,201?	I have 3.201×10^3. Who has 0.02000?
I have 2×10^{-2}. Who has 2.16×10^{-1}?	I have 0.216. Who has 156,000,000?

I have 1.56×10^8. Who has 9.83×10^4?	I have 98,300. Who has 704,600?
I have 7.046×10^5. Who has 5.21×10^6?	I have 5,210,000. Who has 432,700,000?
I have 4.327×10^8. Who has 0.00183?	I have 1.83×10^{-3}. Who has 7.92×10^2?
I have 792. Who has 841,000?	I have 8.41×10^5. Who has 460?

I HAVE - WHO HAS

	I HAVE	WHO HAS		I HAVE	WHO HAS
1.	4.6×10^2	3200	22.	8.43×10^{-7}	520
2.	3.2×10^3	266,000	23.	5.2×10^2	57,900,000
3.	2.66×10^5	4.9×10^4	24.	5.79×10^7	4.76×10^3
4.	49,000	1.5×10^{-3}	25.	4760	763
5.	0.0015	8.3×10^{-5}	26.	7.63×10^2	8047
6.	0.000083	2.61×10^{-4}	27.	8.047×10^3	9,636,000
7.	0.000261	0.051	28.	9.636×10^6	8.703×10^6
8.	5.1×10^{-2}	50,370	29.	8,703,000	3,201
9.	5.037×10^4	68,040,000	30.	3.201×10^3	0.02000
10.	6.804×10^7	8.201×10^6	31.	2×10^{-2}	2.16×10^{-1}
11.	8,201,000	131,000	32.	0.216	156,000,000
12.	1.31×10^5	0.0000000714	33.	1.56×10^8	9.83×10^4
13.	7.14×10^{-8}	9.16×10^{-6}	34.	98,300	704,600
14.	0.00000916	610,000	35.	7.046×10^5	5.21×10^6
15.	6.1×10^5	325	36.	5,210,000	432,700,000
16.	3.25×10^2	4.67×10^5	37.	4.327×10^8	0.00183
17.	467,000	780	38.	1.83×10^{-3}	7.92×10^2
18.	7.8×10^2	5.6×10^{-3}	39.	792	841,000
19.	0.0056	10,200	40.	8.41×10^5	460
20.	1.02×10^4	1.56×10^8			
21.	156,000,000	0.000000843			

ACTIVITY: Unit Price **STRAND:** Ratio, Proportion and Percent

OBJECTIVE:
81807 To determine the unit cost of items to compare price

PREREQUISITES:
To solve one-step equations using multiplication and division of whole numbers
To solve two-step equations with whole numbers

MATERIALS NEEDED:
Trial size and regular size packages of the same name brand product (shampoo, hand lotion, tooth paste, dog food, cereal, hair spray, etc.)
Largest and smallest size of several different items (peanut butter, cereal, washing powder, etc.)
A name brand item and generic item containing same product

INSTRUCTIONS TO THE TEACHER FOR CONDUCTING ACTIVITY:

1. Number each pair of items and set up in different places around the classroom.

2. Students may go in pairs to each station, compare the two items and determine the unit cost of each.

3. When all students have visited each station, work is checked orally and price differences are discussed.

EXTENSION:
When buying these items, look for sale items or items that have increased in price with new price stickers. Percent of increase or decrease may be determined. These figures can then be used in unit price comparisons.

ACTIVITY: Integer Concentration **STRAND:** Operations

OBJECTIVES:	
81201	To multiply integers having unlike signs
81202	To multiply integers having like signs
81203	To divide integers having unlike signs
81204	To divide integers having like signs

MATERIALS NEEDED:

See Appendix 1.

Concentration cards on the following pages or some made by the teacher

DIRECTIONS TO THE STUDENT:

1. Shuffle the cards.

2. Lay all cards face down on the floor or desk top. Spread them out so that they do not overlap.

3. Each person turns over two cards, one at a time, trying to get a match. A correct match is a problem and the answer such as:

(-5)(5)	-25

4. When two cards that match are turned over in one turn, the player who turned them over gets to keep them.

5. At the end of the game, the person with the most matching pairs is the winner.

(-3)(-9)	27
(4)(8)	32
(4)(-8)	-32
(8)(-9)	-72

(-4) (3)	-12
(-2) (-4)	8
(-2) (4)	-8
(-3) (2)	-6

(-12) ÷ (4)	-3
(-15) ÷ (3)	-5
(-15) ÷ (-3)	5
(6) ÷ (3)	2

(-18) ÷ (3)	-6
(-24) ÷ (-8)	3
(-72) ÷ (8)	-9
(-500) ÷ 50	-10

APPENDIX B:

AEL Workshop Evaluation Instrument

Training Teachers To Implement Mathematics Activities Manuals

June 9-15, 1991
The University of Tennessee at Martin (UTM)
Evaluation Form

A. Background

1. Name: ______________________________

2. Employing Agency (check only one):
   ___ Local School District (specify) ____________________
   ___ Education Association
   ___ College or University
   ___ State Department of Education
   ___ Other (specify) ____________________

3. Professional Role (check one):
   ___ Teacher (specify) ____________________
   ___ Principal or Assistant Principal
   ___ School Board Member
   ___ Administrator (specify) ____________________
   ___ Other (specify) ____________________

B. Rating

This section asks you to evaluate this particular UTM event and its associated staff on a series of service quality scales. Please mark your response with an "x" (corresponding to your answer) at any point along the scale provided. If you cannot reply to any scale, please check the "Cannot Reply" option for that item.

1. Did UTM carry out planned activities at the times scheduled?
   ___Cannot reply

   Never — Somewhat — Always
   0 10 20 30 40 50

2. How responsive were UTM staff and/or consultants to your requests for service and/or assistance during this event?
   ___Cannot reply

   Not at all — Somewhat — Very Responsive
   0 10 20 30 40 50

3. In this event, how skilled were UTM staff and/or consultants in completing their tasks?
   ___Cannot reply

   Not At All Skilled — Somewhat Skilled — Very Skilled
   0 10 20 30 40 50

4. How convenient was this UTM event to your location?
   ___Cannot reply

   Very Inconvenient — Convenient — Very Convenient
   0 10 20 30 40 50

5. During this event, how clear were UTM staff's and/or consultants' explanations?
   ___Cannot reply

   Very Unclear — Very Clear
   0 10 20 30 40 50

6. Did this event enhance UTM's credibility as an R & D service provider?
   ___Cannot reply

   Not At All — Somewhat — Very Much
   0 10 20 30 40 50

7. How well did UTM staff and/or consultants understand your professional needs during this event?
   ___Cannot reply

   Not At All — Somewhat — Very Well
   0 10 20 30 40 50

8. How useful were the materials provided to you during this UTM event?
   ___Cannot reply

   Not At All Useful — Somewhat Useful — Very Useful
   0 10 20 30 40 50

C. Comments

1. I really liked:

____
____
____
____
____

2. For the next event, I'd change

____
____
____
____
____

6/91

APPENDIX C:

SoC Questionnaire

Date:

AEL/RE
SoCQ 01
IMAM

____ ____ ____
Month Day Year

CONCERNS QUESTIONNAIRE

Name (optional) ____

Please give us your Social Security number:

___ ___ ___ - ___ ___ - ___ ___ ___ ___

The purpose of this questionnaire is to determine what people who are using or thinking about using various programs are concerned about at various times during the innovation adoption process. The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years experience in using them. Therefore, a good part of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale.

For example:

This statement is very true of me at this time.	0 1 2 3 4 5 6 (7)
This statement is somewhat true of me now.	0 1 2 3 (4) 5 6 7
This statement is not at all true of me at this time.	0 (1) 2 3 4 5 6 7
This statement seems irrelevant to me.	(0) 1 2 3 4 5 6 7

Please respond to the items in terms of your present concerns, or how you feel about your involvement or potential involvement with the Training Teachers to Implement Mathematics Activities Manuals. We do not hold to any one definition of this innovation, so please think of it in terms of your own perceptions of what it involves. Since this questionnaire is used for a variety of innovations, the name Training Teachers to Implement Mathematics Activities Manuals never appears. However, phrases such as "the innovation," "this approach," and "the new system" all refer to the Training Teachers to Implement Mathematics Activities Manuals. Remember to respond to each item in terms of your present concerns about your involvement or potential involvement with the Training Teachers to Implement Mathematics Activities Manuals.

Thank you for taking time to complete this task.

QUESTIONNAIRE ITEMS

0	1		3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

Item	Statement	Scale
1.	I am concerned about students' attitudes toward this innovation.	0 1 2 3 4 5 6 7
2.	I now know of some other approaches that might work better.	0 1 2 3 4 5 6 7
3.	I don't even know what the innovation is.	0 1 2 3 4 5 6 7
4.	I am concerned about not having enough time to organize myself each day.	0 1 2 3 4 5 6 7
5.	I would like to help other faculty in their use of the innovation.	0 1 2 3 4 5 6 7
6.	I have a very limited knowledge about the innovation.	0 1 2 3 4 5 6 7
7.	I would like to know the effect of reorganization on my professional status.	0 1 2 3 4 5 6 7
8.	I am concerned about conflict between my interests and my responsibilities.	0 1 2 3 4 5 6 7
9.	I am concerned about revising my use of the innovation.	0 1 2 3 4 5 6 7
10.	I would like to develop working relationships with both our faculty and outside faculty using this innovation.	0 1 2 3 4 5 6 7
11.	I am concerned about how the innovation affects students.	0 1 2 3 4 5 6 7
12.	I am not concerned about this innovation.	0 1 2 3 4 5 6 7
13.	I would like to know who will make the decisions in the new system.	0 1 2 3 4 5 6 7
14.	I would like to discuss the possibility of using the innovation.	0 1 2 3 4 5 6 7
15.	I would like to know what resources are available if we decide to adopt this innovation.	0 1 2 3 4 5 6 7
16.	I am concerned about my inability to manage all the innovation requires.	0 1 2 3 4 5 6 7
17.	I would like to know how my teaching or administration is supposed to change.	0 1 2 3 4 5 6 7
18.	I would like to familiarize other departments or persons with the progress of this new approach.	0 1 2 3 4 5 6 7

0	1	2	3	4	5	6	7
Irrelevant	Not true of me now		Somewhat true of me now			Very true of me now	

19. I am concerned about evaluating my impact on students.	0	1	2	3	4	5	6	7
20. I would like to revise the innovation's instructional approach.	0	1	2	3	4	5	6	7
21. I am completely occupied with other things.	0	1	2	3	4	5	6	7
22. I would like to modify our use of the innovation based on the experiences of our students.	0	1	2	3	4	5	6	7
23. Although I don't know about this innovation, I am concerned about things in the area.	0	1	2	3	4	5	6	7
24. I would like to excite my students about their part in this approach.	0	1	2	3	4	5	6	7
25. I am concerned about time spent working with nonacademic problems related to this innovation.	0	1	2	3	4	5	6	7
26. I would like to know what the use of the innovation will require in the immediate future.	0	1	2	3	4	5	6	7
27. I would like to coordinate my effort with others to maximize the innovation's effects.	0	1	2	3	4	5	6	7
28. I would like to have more information on time and energy commitments required by this innovation.	0	1	2	3	4	5	6	7
29. I would like to know what other faculty are doing in this area.	0	1	2	3	4	5	6	7
30. At this time, I am not interested in learning about this innovation.	0	1	2	3	4	5	6	7
31. I would like to determine how to supplement, enhance, or replace the innovation.	0	1	2	3	4	5	6	7
32. I would like to use feedback from students to change the program.	0	1	2	3	4	5	6	7
33. I would like to know how my role will change when I am using the innovation.	0	1	2	3	4	5	6	7
34. Coordination of tasks and people is taking too much of my time.	0	1	2	3	4	5	6	7
35. I would like to know how this innovation is better than what we have now.	0	1	2	3	4	5	6	7

APPENDIX D:

Activity Log Sheet

Mathematics Activities Class Log

Teacher

Grade Period

Directions: Please maintain a separate log for **each math class** you teach. Record all activities you use in each class (minimum of one per week per class). Record the date, name of activity, primary purpose of the activity, effectiveness rating, and comments on factors concerning the effectiveness of the activity during implementation. When the same activity is used in more than one class, it should be recorded separately in each class log since the purpose and effectiveness rating may be quite different.

Date	Activity Title	Purpose [check (✓) one]			Effectiveness [check (✓) one]				Comments
		Introduce	Teach	Review	Excellent	Good	Fair	Poor	

☞ Continue on Back ☞

Side 2

Date	Activity Title	Purpose [check (✓) one]			Effectiveness [check (✓) one]				Comments
		Introduce	Teach	Review	Excellent	Good	Fair	Poor	

APPENDIX E:

Questions in Telephone Interview

Appendix E

QUESTIONS IN TELEPHONE INTERVIEW

1. How many years of teaching experience do you have?

2. Which of the following represents the highest level of education you have obtained?

   Bachelor's Degree ___
   Bachelor's plus 15 ___
   Masters ___
   Masters plus 15 ___

3. Are you personally in favor of allowing students to use calculators in class and in doing their homework?

4. As a mathematics teacher, do you see yourself as being most effective with able students, average students, or low achieving students?

5. If you had to choose between teaching a math class of predominantly males or a class of predominantly females, which would you choose, all other things being equal?

APPENDIX F:

Full Length Affective Scales

AEL / CESME

NAME ______________________ DATE ________

SCHOOL ____________________ GRADE ___ PERIOD ___

MATHEMATICS ATTITUDE SCALE

Directions: Please write your name, date, school, grade, and class period in the upper right-hand corner. Each of the statements on this questionnaire is a **feeling** or **attitude** toward mathematics. Please circle the response that shows the extent to which you agree (or disagree) with each statement.

SD = Strongly Disagree
D = Disagree
U = Undecided
A = Agree
SA = Strongly Agree

1.	Most of my classmates are better than I am in math.	SD	D	U	A	SA
2.	Math is a very interesting subject.	SD	D	U	A	SA
3.	Math class is fun.	SD	D	U	A	SA
4.	I am **not** able to think clearly when working math problems.	SD	D	U	A	SA
5.	Math class makes me feel uncomfortable.	SD	D	U	A	SA
6.	When I look at a difficult problem, I think, "I can do it!"	SD	D	U	A	SA
7.	When I think about mathematics, I get depressed.	SD	D	U	A	SA
8.	Math makes me feel lost in a jungle of numbers from which there is no escape.	SD	D	U	A	SA
9.	I look forward to math class.	SD	D	U	A	SA
10.	Time flies when I'm working math problems.	SD	D	U	A	SA
11.	I don't understand students who talk about liking math.	SD	D	U	A	SA
12.	I approach mathematics with a feeling of confidence.	SD	D	U	A	SA
13.	It makes me nervous to even think about math homework.	SD	D	U	A	SA
14.	I have always enjoyed working math problems.	SD	D	U	A	SA
15.	If I had any choice, I would **never** do difficult math assignments.	SD	D	U	A	SA
16.	I am happier in math class than in any other class.	SD	D	U	A	SA

☞ PLEASE TURN PAGE OVER ☞

SD	=	Strongly Disagree
D	=	Disagree
U	=	Undecided
A	=	Agree
SA	=	Strongly Agree

17.	I doubt that I will ever understand mathematics very well.	SD	D	U	A	SA
18.	Solving difficult math problems makes me feel good.	SD	D	U	A	SA
19.	I do **not** like mathematics.	SD	D	U	A	SA
20.	I try to think about other things in math class.	SD	D	U	A	SA
21.	I like learning new things about math.	SD	D	U	A	SA
22.	It's hard for me to see what math is all about.	SD	D	U	A	SA
23.	I like mathematics.	SD	D	U	A	SA
24.	I am good in mathematics.	SD	D	U	A	SA
25.	Mathematics is more for boys than for girls.	SD	D	U	A	SA

AEL / CESME

NAME ______________________ DATE __________

SCHOOL ______________________ GRADE ___ PERIOD ___

MATHEMATICS OPINIONNAIRE

Directions: Please write your name, date, school, grade, and class period in the upper right-hand corner. Each of the statements on this questionnaire is an opinion about the **meaning** or **usefulness** of mathematics. Please circle the response that shows the extent to which you agree (or disagree) with each statement.

SD = Strongly Disagree
D = Disagree
U = Undecided
A = Agree
SA = Strongly Agree

1. Studying math is more important for boys than girls.	SD	D	U	A	SA
2. I need to learn math to help me get ahead later in life.	SD	D	U	A	SA
3. Mathematics has had a big influence in many fields of knowledge.	SD	D	U	A	SA
4. I want to learn as much math as possible.	SD	D	U	A	SA
5. Math is **not** very important to progress in civilization and society.	SD	D	U	A	SA
6. Knowing math would help people do most jobs better.	SD	D	U	A	SA
7. Learning math well helps a person to think better.	SD	D	U	A	SA
8. I sometimes use math to help me do things outside of school.	SD	D	U	A	SA
9. Mathematics is **not** a very worthwhile subject.	SD	D	U	A	SA
10. Math is needed to solve many everyday problems.	SD	D	U	A	SA
11. Mathematics is **not** needed to keep the world running.	SD	D	U	A	SA
12. Mathematics is an important way to understand the world.	SD	D	U	A	SA
13. I want to stop studying mathematics as soon as I can.	SD	D	U	A	SA
14. Artists and writers—as well as scientists—need to know mathematics well.	SD	D	U	A	SA

☞ PLEASE TURN PAGE OVER ☞

SD	= Strongly Disagree
D	= Disagree
U	= Undecided
A	= Agree
SA	= Strongly Agree

15.	Other subjects—like literature and art—are a lot more important than math.	SD	D	U	A	SA
16.	Mathematics is about one thing—getting the right answer.	SD	D	U	A	SA
17.	Mathematics is **not** a very creative subject.	SD	D	U	A	SA
18.	Mathematics is just memorizing formulas and facts.	SD	D	U	A	SA
19.	Mathematics helps people to make sense out of the world.	SD	D	U	A	SA
20.	I don't really understand why everybody says math is so important.	SD	D	U	A	SA
21.	Scientists use math to help them make new discoveries.	SD	D	U	A	SA
22.	Most people use math in their jobs.	SD	D	U	A	SA
23.	People who know math well have a lot better chance to do well in life.	SD	D	U	A	SA

APPENDIX G:

Teacher Agreement Form

AGREEMENT BETWEEN THE APPALACHIA EDUCATIONAL LABORATORY (AEL) AND PARTICIPATING MATHEMATICS TEACHERS

Participating teacher agrees to:

1) Utilize all funds received from the Appalachia Educational Laboratory to purchase manipulatives for use in her math classes. It is the teacher's responsibility to maintain records of her purchases (receipts, invoices, etc.).
2) Utilize one activity from the appropriate grade level Mathematics Activities Manual each week in each math class she teaches. The teacher is expected to maintain a log listing the activity, the purpose of the activity and a rating of its effectiveness. These log are to be submitted to AEL each quarter.
3) Provide pre- and post-test achievement data on all students in her math classes. This information will be taken from the state testing program data.
4) Complete questionnaires, opinionaires, etc., during the school year.
5) Administer questionnaires to her math students regarding their attitudes toward mathematics, the value of mathematics, etc., at selected times during the school year.

AEL agrees to:

1) Provide one hundred fifty dollars ($150.00), upon receipt of signed contract, to purchase manipulatives for use in her classroom.
2) Provide additional one hundred dollars ($100.00) for manipulatives upon completion of all tasks.
3) Provide copies of all data collection forms, and to reimburse postage/freight expenses.

Teacher's Name ____________________
Home Address ____________________
School Name ____________________
School Address ____________________
Phone (Home) __________ (School) __________

How many math classes will you teach this year and at what grade level?
Grade 5______ Grade 6______ Grade 7______ Grade 8______

How many math students do you expect at each grade level?
Grade 5______ Grade 6______ Grade 7______ Grade 8______

I agree to participate in the Activities Manuals Project.

____
(Teacher's Signature)

The above teacher has my permission to participate in this project.

____
(Principal's Signature)

APPENDIX H:

Twelve-Item Affective Scale Used in Analyses

Twelve-Item Mathematics Affective Instrument

Factor 1 (Attitude)

1. Most of my classmates are better than I am in math.
   (item 1 on original attitude instrument)

2. I am not able to think clearly when working math problems.
   (item 4 on original attitude instrument)

3. Math makes me feel lost in a jungle of numbers from which there is no escape.
   (item 8 on original attitude instrument)

4. I doubt that I will ever understand mathematics very well.
   (item 17 on original attitude instrument)

5. It's hard for me to see what math is all about.
   (item 22 on original attitude instrument)

6. I am good in mathematics.
   (item 24 on original attitude instrument)

Factor 2 (Opinion)

7. Mathematics has had a big influence in many fields of knowledge.
   (item 3 on original opinion instrument)

8. Math is not very important to progress in civilization and society.
   (item 5 on original opinion instrument)

9. Mathematics is not a very worthwhile subject.
   (item 9 on original opinion instrument)

10. Mathematics is about one thing--getting the right answer.
    (item 16 on original opinion instrument)

11. I don't really understand why everybody says math is so important.
    (item 20 on original opinion instrument)

12. Scientists use math to help them make new discoveries.
    (item 21 on original opinion instrument)

APPENDIX I:

Pre- and Post-Project Responses to Items on Affect Scales

Mathematics Attitude Scale

1. Most of my classmates are better than I am in math.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	109	375	290	145	35	954
(%)	11.4	39.3	30.4	15.2	3.7	100.0
Posttest (n)	124	397	232	141	60	954
(%)	13.0	41.6	24.3	14.8	6.3	100.0

2. Math is a very interesting subject.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	52	149	178	397	178	954
(%)	5.5	15.6	18.7	41.6	18.7	100.1
Posttest (n)	77	156	182	402	137	954
(%)	8.1	16.4	19.1	42.1	14.4	100.1

3. Math class is fun.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	51	122	208	378	195	954
(%)	5.3	12.8	21.8	39.6	20.4	99.9
Posttest (n)	98	150	212	361	133	954
(%)	10.3	15.7	22.2	37.8	13.9	99.9

4. I am not able to think clearly when working math problems.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	229	453	119	115	38	954
(%)	24.0	47.5	12.5	12.1	4.0	100.1
Posttest (n)	225	447	133	117	32	954
(%)	23.6	46.9	13.9	12.3	3.4	100.1

5. Math class makes me feel uncomfortable.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	323	407	116	81	27	954
(%)	33.9	42.7	12.2	8.5	2.8	100.1
Posttest (n)	293	423	135	73	30	954
(%)	30.7	44.3	14.2	7.7	3.1	100.0

6. When I look at a difficult problem, I think, "I can do it!"

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	46	161	198	389	160	954
(%)	4.8	16.9	20.8	40.8	16.8	100.1
Posttest (n)	77	142	205	376	154	954
(%)	8.1	14.9	21.5	39.4	16.1	100.0

7. When I think about mathematics, I get depressed.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	298	411	122	90	33	954
(%)	31.2	43.1	12.8	9.4	3.5	100.0
Posttest (n)	259	420	140	103	32	954
(%)	27.1	44.4	14.7	10.8	3.4	100.4

8. Math makes me feel lost in a jungle of numbers from which there is no escape.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	367	346	108	100	33	954
(%)	38.5	36.3	11.3	10.5	3.5	100.0
Posttest (n)	311	381	101	107	54	954
(%)	32.6	39.9	10.6	11.2	5.7	100.0

9. I look forward to math class.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	76	178	197	319	184	954
(%)	8.0	18.7	20.6	33.4	19.3	100.0
Posttest (n)	120	183	243	288	120	954
(%)	12.6	19.2	25.5	30.2	12.6	100.1

10. Time flies when I'm working math problems.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	96	189	127	335	207	954
(%)	10.1	19.8	13.3	35.1	21.7	100.0
Posttest (n)	102	195	156	341	160	954
(%)	10.7	20.4	16.4	35.7	16.8	100.0

11. I don't understand students who talk about liking math.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	216	407	153	127	51	954
(%)	22.6	42.7	16.0	13.3	5.3	99.9
Posttest (n)	179	419	153	133	70	954
(%)	18.8	43.9	16.0	13.9	7.3	99.9

12. I approach mathematics with a feeling of confidence.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	32	113	208	417	184	954
(%)	3.4	11.8	21.8	43.7	19.3	100.0
Posttest (n)	36	136	211	437	134	954
(%)	3.8	14.3	22.1	45.8	14.0	100.0

13. It makes me nervous to even think about math homework.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	279	436	97	104	38	954
(%)	29.2	45.7	10.2	10.9	4.0	100.0
Posttest (n)	231	461	112	98	52	954
(%)	24.2	48.3	11.7	10.3	5.5	100.0

14. I have always enjoyed working math problems.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	117	249	197	245	146	954
(%)	12.3	26.1	20.6	25.7	15.3	100.0
Posttest (n)	139	256	189	252	118	954
(%)	14.6	26.8	19.8	26.4	12.4	100.0

15. If I had any choice, I would never do difficult math assignments.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	167	299	192	140	156	954
(%)	17.5	31.3	20.1	14.7	16.4	100.0
Posttest (n)	146	297	196	156	159	954
(%)	15.3	31.1	20.5	16.4	16.7	100.0

16. I am happier in math class than in any other class.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	171	253	256	136	138	954
	(%)	17.9	26.5	26.8	14.3	14.5	100.0
Posttest	(n)	190	282	238	140	104	954
	(%)	19.9	29.6	24.9	14.7	10.9	100.0

17. I doubt that I will ever understand mathematics very well.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	345	394	105	79	31	954
	(%)	36.2	41.3	11.0	8.3	3.2	100.0
Posttest	(n)	298	437	104	77	38	954
	(%)	31.2	45.8	10.9	8.1	4.0	100.0

18. Solving difficult math problems makes me feel good.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	51	93	128	336	346	954
	(%)	5.3	9.7	13.4	35.2	36.3	99.9
Posttest	(n)	48	79	127	359	341	954
	(%)	5.0	8.3	13.3	37.6	35.7	99.9

19. I do not like mathematics.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	351	285	133	102	83	954
	(%)	36.8	29.9	13.9	10.7	8.7	100.0
Posttest	(n)	280	329	146	91	108	954
	(%)	29.4	34.5	15.3	9.5	11.3	100.0

20. I try to think about other things in math class.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	217	490	127	90	30	954
	(%)	22.7	51.4	13.3	9.4	3.1	99.9
Posttest	(n)	172	480	143	124	35	954
	(%)	18.0	50.3	15.0	13.0	3.7	100.0

21. I like learning new things about math.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	29	73	189	423	240	954
	(%)	3.0	7.7	19.8	44.3	25.2	100.0
Posttest	(n)	39	109	179	430	197	954
	(%)	4.1	11.4	18.8	45.1	20.6	100.0

22. It's hard for me to see what math is all about.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	219	416	139	134	46	954
	(%)	23.0	43.6	14.6	14.0	4.8	100.0
Posttest	(n)	209	414	161	124	46	954
	(%)	21.9	43.4	16.9	13.0	4.8	100.0

23. I like mathematics.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	86	108	179	309	272	954
	(%)	9.0	11.3	18.8	32.4	28.5	100.0
Posttest	(n)	107	102	190	361	194	954
	(%)	11.2	10.7	19.9	37.8	20.3	99.9

24. I am good in mathematics.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	55	109	240	394	156	954
	(%)	5.8	11.4	25.2	41.3	16.4	100.1
Posttest	(n)	77	91	237	411	138	954
	(%)	8.1	9.5	24.8	43.1	14.5	100.0

25. Mathematics is more for boys than girls.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	574	199	142	10	29	954
	(%)	60.2	20.9	14.9	1.0	3.0	100.0
Posttest	(n)	584	184	147	16	23	954
	(%)	61.2	19.3	15.4	1.7	2.4	100.0

Mathematics Opinionnaire

1. Studying math is more important for boys than girls.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	534	257	115	29	19	954
	(%)	56.0	26.9	12.1	3.0	2.0	100.0
Posttest	(n)	552	260	105	19	18	954
	(%)	57.9	27.3	11.0	2.0	1.9	100.1

2. I need to learn math to help me get ahead later in life.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	2	12	53	413	474	954
	(%)	.2	1.3	5.6	43.3	49.7	100.1
Posttest	(n)	13	16	55	381	489	954
	(%)	1.4	1.7	5.8	39.9	51.3	100.1

3. Mathematics has had a big influence in many fields of knowledge.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	12	34	145	448	315	954
	(%)	1.3	3.6	15.2	47.0	33.0	100.1
Posttest	(n)	14	27	147	399	367	954
	(%)	1.5	2.8	15.4	41.8	38.5	100.0

4. I want to learn as much math as possible.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	26	59	178	391	300	954
	(%)	2.7	6.2	18.7	41.0	31.4	100.0
Posttest	(n)	37	73	181	401	262	954
	(%)	3.9	7.7	19.0	42.0	27.5	100.1

5. Math is not very important to progress in civilization and society.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	511	323	92	22	6	954
	(%)	53.6	33.9	9.6	2.3	.6	100.0
Posttest	(n)	508	318	91	27	10	954
	(%)	53.2	33.3	9.5	2.8	1.0	99.8

6. Knowing math would help people do most jobs better.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	7	16	95	445	391	954
(%)	.7	1.7	10.0	46.6	41.0	100.0
Posttest (n)	6	16	88	445	399	954
(%)	.6	1.7	9.2	46.6	41.8	99.9

7. Learning math well helps a person to think better.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	19	82	312	376	165	954
(%)	.2	8.6	32.7	39.4	17.3	98.2
Posttest (n)	29	73	327	377	148	954
(%)	3.0	7.7	34.3	39.5	15.5	100.0

8. I sometimes use math to help me do things outside of school.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	19	48	62	600	225	954
(%)	.2	5.0	6.5	62.9	23.6	98.2
Posttest (n)	24	65	46	582	237	954
(%)	2.5	6.8	4.8	61.0	24.8	99.9

9. Mathematics is not a very worthwhile subject.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	389	383	122	40	20	954
(%)	40.8	40.2	12.8	4.2	2.1	100.1
Posttest (n)	362	396	119	45	32	954
(%)	37.9	41.5	12.5	4.7	3.4	100.0

10. Math is needed to solve many everyday problems.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	12	43	101	476	322	954
(%)	1.3	4.5	10.6	49.9	33.8	100.1
Posttest (n)	15	41	101	506	291	954
(%)	1.6	4.3	10.6	53.0	30.5	100.0

11. Mathematics is not needed to keep the world running.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	450	337	115	33	19	954
(%)	47.2	35.3	12.1	3.5	2.0	100.1
Posttest (n)	484	319	96	32	23	954
(%)	50.7	33.4	10.1	3.4	2.4	100.0

12. Mathematics is an important way to understand the world.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	23	65	310	395	161	954
(%)	2.4	6.8	32.5	41.4	16.9	100.0
Posttest (n)	33	76	294	387	164	954
(%)	3.5	8.0	30.8	40.6	17.2	100.1

13. I want to stop studying mathematics as soon as I can.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	383	336	147	56	32	954
(%)	40.1	35.2	15.4	5.9	3.4	100.0
Posttest (n)	313	382	152	59	48	954
(%)	32.8	40.0	15.9	6.2	5.0	99.9

14. Artists and writers--as well as scientists--need to know mathematics well.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	18	29	102	391	414	954
(%)	1.9	3.0	10.7	41.0	43.4	100.0
Posttest (n)	20	22	104	438	370	954
(%)	2.1	2.3	10.9	45.9	38.8	100.0

15. Other subjects--like literature and art--are a lot more important than math.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	200	425	273	39	17	954
(%)	21.0	44.5	28.6	4.1	1.8	100.0
Posttest (n)	194	419	277	35	29	954
(%)	20.3	43.9	29.0	3.7	3.0	99.9

16. Mathematics is about one thing--getting the right answer.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	191	386	178	132	67	954
	(%)	20.0	45.2	16.0	13.7	5.0	99.9
Posttest	(n)	220	402	154	116	62	954
	(%)	23.1	42.1	16.1	12.2	6.5	100.0

17. Mathematics is not a very creative subject.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	182	338	214	142	78	954
	(%)	19.1	35.4	22.4	14.9	8.2	100.0
Posttest	(n)	161	352	190	173	78	954
	(%)	19.1	35.4	22.4	14.9	8.2	100.0

18. Mathematics is just memorizing formulas and facts.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	232	429	139	113	41	954
	(%)	24.3	45.0	14.6	11.8	4.3	100.0
Posttest	(n)	191	431	153	131	48	954
	(%)	20.0	45.2	16.0	13.7	5.0	99.9

19. Mathematics helps people to make sense out of the world.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	21	80	256	422	175	954
	(%)	2.2	8.4	26.8	44.2	18.3	99.9
Posttest	(n)	26	72	275	429	152	954
	(%)	2.7	7.5	28.8	45.0	15.9	99.9

20. I don't really understand why everybody says math is so important.

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest	(n)	286	445	118	70	35	954
	(%)	30.0	46.6	12.4	7.3	3.7	100.0
Posttest	(n)	265	469	129	66	25	954
	(%)	27.8	49.2	13.5	6.9	2.6	100.0

21. Scientists use math to help them make new discoveries.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	14	24	115	459	342	954
(%)	1.5	2.5	12.1	48.1	35.8	100.0
Posttest (n)	12	24	113	487	318	954
(%)	1.3	2.5	11.8	51.0	33.3	99.9

22. Most people use math in their jobs.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	9	9	51	517	368	954
(%)	.9	.9	5.3	54.2	38.6	99.9
Posttest (n)	11	12	61	478	392	954
(%)	1.2	1.3	6.4	50.1	41.1	100.1

23. People who know math well have a lot better chance to do well in life.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total
Pretest (n)	23	44	132	320	435	954
(%)	2.4	4.6	13.8	33.5	45.6	99.9
Posttest (n)	21	49	123	338	423	954
(%)	2.2	5.1	12.9	35.4	44.3	99.9

APPENDIX J:

Completed Evaluation Standards Checklist

Citation Form*

The *Standards for Evaluations of Educational Programs, Projects, and Materials* guided the development of this (check one):

request for evaluation plan/design/proposal
evaluation plan/design/proposal
evaluation contract
✓ evaluation report
other

To interpret the information provided on this form, the reader needs to refer to the full text of the standards as they appear in Joint Committee on Standards for Educational Evaluation, *Standards for Evaluations of Educational Programs, Projects, and Materials.* New York: McGraw-Hill, 1980.

The *Standards* were consulted and used as indicated in the table below (check as appropriate):

	Descriptor	The Standard was deemed applicable and to the extent feasible was taken into account	The Standard was deemed applicable but could not be taken into account	The Standard was not deemed applicable	Exception was taken to the Standard
A1	Audience Identification	x			
A2	Evaluator Credibility	x			
A3	Information Scope and Selection	x			
A4	Valuational Interpretation	x			
A5	Report Clarity	x			
A6	Report Dissemination	x			
A7	Report Timeliness	x			
A8	Evaluation Impact	x			
B1	Practical Procedures	x			
B2	Political Viability			x	
B3	Cost Effectiveness	x			
C1	Formal Obligation	x			
C2	Conflict of Interest	x			
C3	Full and Frank Disclosure	x			
C4	Public's Right to Know			x	
C5	Rights of Human Subjects	x			
C6	Human Interactions	x			
C7	Balanced Reporting	x			
C8	Fiscal Responsibility	x			
D1	Object Identification	x			
D2	Context Analysis	x			
D3	Described Purposes and Procedures	x			
D4	Definsible Information Sources	x			
D5	Valid Measurement	x			
D6	Reliable Measurement	x			
D7	Systematic Data Control	x			
D8	Analysis of Quantitative Information	x			
D9	Analysis of Qualitative Information	x			
D10	Justified Conclusions	x			
D11	Objective Reporting	x			

Name: Robert D. Childers (typed) Date: November 1993

[signature] (signature)

Position or Title: Director, Rural Excel Program

Agency: Appalachia Educational Laboratory

Address: P. O. Box 1348, Charleston, West Virginia 25325-1348

Relation to Document: Co-Author

(e.g., author of document, evaluation team leader, external auditor, internal auditor)