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ABSTRACT

Details are provided of a project designed to develop an alternative, computer-based learning unit in mathematics and science for upper-elementary level Pueblo Indian students. A four- to six-week unit entitled "Pueblo Uses of Energy," which fused mathematical problem solving with science content related to the daily lives of Pueblo students, was produced. Fifth-grade students who participated in the field development attended Sky City Community School, a federal day school under the auspices of the Bureau of Indian Affairs. A microcomputer was used as the major mode of instruction to present material designed to introduce content and skills in a storytelling format, which capitalizes on one learning style of pueblo cupueblo culture. Sections in this document report on: (1) Background Information; (2) Objectives and Activities; (3) Time PERT Chart; (4) Description of the Unit; (5) Field Development Phase; (6) Results of the Field Development Phase; (7) Revision/Expansion Phase; and (8) Dissemination Activities. (MP)

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FINAL REPORT:
COMPUTER STORYTELLING MATHEMATICS FOR PUEBLO INDIAN UPPER ELEMENTARY LEVEL STUDENTS

NSF: SED 8012482

September, 1981

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BACKGROUND INFORMATION

Computer Storytelling Mathematics for Pueblo Indian Upper Elementary Level Students was funded by the National Science Foundation/National Institute of Education Improvement of Mathematics Education Using Information Technology Program. The major purpose of the project was to develop an alternative, computer-based learning unit in mathematics and science for upper-elementary level Pueblo Indian students by producing and field developing a four- to six-week unit entitled "Pueblo Uses of Energy" which fuses mathematical problem solving with science content related to the daily lives of the Pueblo students. The microcomputer as the major mode of instruction presents instructional programs designed to introduce content and skills in a storytelling format thus capitalizing on a specific learning style of Pueblo culture.

The project was located in Albuquerque, New Mexico at the All Indian Pueblo Council which is an organization representing more than 35,000 Pueblo Indians of the nineteen Pueblos in New Mexico. These Pueblos are located along the Rio Grande Valley and the West Central Plateau with a 175 to 200 mile radius from Albuquerque, the headquarters for the Council. These ethnically related people speak five different languages and have well-developed diverse cultures.

Under the direction of Dr. Judith A. Hakes, the project was designed to aid the Acoma tribe, one of the nineteen Pueblos, in pursuing educational improvement for their children. The Acoma Land Grant and Reservation is located sixty miles west of Albuquerque and encompasses approximately 245,500 acres. The Acomas speak one of seven dialects of the language group Keresan. It is estimated that about 2,350 persons reside on the land grant and reservation while about 1,150 live off the reservation. At the present time, most of the Acomas live in or between three farming communities of Anzac, Acomita, and McCartys. For ceremonial occasions, most of the Acoma families maintain second homes at Old Acoma or Sky City which is historically recognized as the oldest and continuously inhabited city in the United States.

The fifth grade students who participated in the field development of the computer-based learning unit attended Sky City Community School, a federal day school under the auspices of the Bureau of Indian Affairs, located on the reservation and serving approximately 300 Acoma students, K-8. These children belong to a cultural group which in many ways is more conservative than other Indian groups in the Southwest and the majority of these students is bilingual. They live in rural farming communities and are experiencing the impact of energy related industries. Many of their parents are employed in the nearby uranium mines and energy producing plants.

In the future these students will need high level technological skills in mathematics and science to aid them in wisely managing and using the energy resources of the Acoma Tribe. The need for high level technological skills in mathematics and science is becoming even greater because of the impact of technology in this area. For example, a hospital complex is now in operation and there is a need for native personnel in jobs such as medical technicians, X-ray technicians, and dental technicians. Most Pueblos who work in the nearby uranium mining and milling operations are laborers but native workers are needed in the higher level positions. A shopping center complex will be built in the near future and jobs will be available which demand technological expertise. In addition, a hydro-electric plant will soon be located in the area and today's students must be trained for tomorrow's jobs.

Traditional approaches in the teaching of mathematics and science are not working and students are falling further behind. At the intermediate grade levels many students experience difficulty with science and mathematics and these difficulties become apparent on student performance results of standardized tests. In the area of science poor performance is often shown because students lack basic content information while poor performance in mathematics is evident in basic skill weaknesses such as computation, use of the number system, word problems, number concepts, and problem solving.

The need for improvement is critical because if poor academic patterns in mathematics and science are not changed, these Pueblo students will not be able to compete in the future job market in this area. Many will be forced to leave the reservation to accept low paying, low level jobs and others will simply drop out of the job market entirely.

In an attempt to better meet the learning needs of these students, this alternative curriculum approach utilizing the microcomputer has been developed to serve as a model for improvement in mathematics and science instruction. By introducing learning technology of the future, the computer, coupled with an educational strength of the past, storytelling, it is hoped that these Pueblo Indian students will be motivated to learn more about science, mathematics, and problem solving to aid them in expanding and enriching their future.

OBJECTIVES AND ACTIVITIES

Phase I: Design

Objective 1: Insure community input in the design of the alternative mathematics and science curriculum and collect baseline data to aid in curriculum decisions.

Activity A: Collect standardized test information to identify problem areas in mathematics and science.

Activity B: Review item analyses of standardized tests to pinpoint specific difficulties in problem solving.

Activity C: Collect pertinent research and needs assessments which apply to science and mathematics.

Activity D: Plan for community involvement by contacting local people, conducting meetings, and arranging for review of materials by appropriate local educational organizations.

Objective 2: Investigate the instructional capabilities of the micro-computer and establish criteria for selection and purchasing.

Activity A: Identify the types of micro-computers which are appropriate for upper elementary students, i.e., computer language, keyboard arrangement, use of color, and the size of letters and numbers.

Activity B: Investigate the instructional capabilities of the micro-computer concerning storytelling abilities, storage space, ease of programming, evaluation capabilities, graphing, picture-making, etc.

Activity C: Determine the cost, durability, maintenance, and versatility of the different brands of micro-computers.

Activity D: Establish criteria for the selection of the micro-computer best suited to the needs of this project and purchase the micro-computer.

Objective 3: Design the teaching unit on energy which will utilize the micro-computer as the mode of instruction to teach problem solving techniques.

Activity A: Identify problem solving techniques and skills which are appropriate for upper elementary level students.

Activity B: Design and select content from the areas of mathematics and science which is appropriate to teach the identified problem solving techniques and skills.

Activity C: Fuse the selected mathematics and science content into the alternative curriculum which is based on the daily life experiences.

Activity D: Design the physical format for the teaching unit including the scope and sequence for the content and skills.

Activity E: Using accepted curriculum design principles, design the teaching unit on energy.

Activity F: Identify student activities and design the format for student learning materials.

Activity G: Design formative evaluation measures such as interviews, observations, and questionnaires which will furnish information to aid the revision of materials.

Phase II: Development, Revision and Dissemination

Objective 1: Secure authorization from school administrative personnel to conduct field development activities.

Activity A: Submit a plan for field development to school administrative personnel for review and approval.

Activity B: With the cooperation of school administrative personnel, identify and select teachers and st 'nts who will participate in the field develo ent of materials and activities.

Activity C: Schedule training sessions with the teachers to instruct them in the use of the micro-computer and to familiarize them with the approach.

Objective 2: Field develop the teaching unit on problem solving, student activities, teaching strategies utilizing the micro-computer, and formative evaluation techniques.

Activity A: Using the previously designed format, develop the teaching unit including unit objectives, skills, content, overview, lesson plans, diagnostic suggestions, teaching strategies, learning activities, and formative evaluation techniques.

Activity B: Program the computer materials.

Activity C: Develop in written form the student activities and materials.

Activity D: Prepare the written form of all materials for classroom use.

Objective 3: Gather teacher and student information about the teaching unit and complete any revision/expansion of the unit.

Activity A: Administer questionnaires to students and teachers to gather information to aid revision of materials and activities.

Activity B: Conduct participant observations.

Activity C: Conduct interviews of students and teachers to gather information to aid the revision process.

Activity D: Summarize the information gathered during the formative evaluation activities.

Activity E: Using information gathered during the field development, complete any needed revision/expansion of the teaching unit.

Objective 4: Disseminate the findings of the project.

Activity A: Present the findings of the field development effort to the school board for review.

Activity B: Submit the findings and materials to the Education Division of the Al. Indian Pueblo Council for review and dissemination to area Bureau of Indian Affairs schools, public schools, and other educational programs.

Activity C: Prepare a report to be submitted to the Educational Resources Information Center (ERIC).

Activity D: Determine any other publication activities with the cooperation and guidance of the National Science Foundation.

COMPUTER STORYTELLING MATHEMATICS

Time PERT Chart
PHASE II: Development, Revision, and Dissemination
(March, 1981 - September, 1981)

OBJECTIVES AND ACTIVITIES	March 1981	April 1981	May 1981	June 1981	July 1981	Aug. 1981	Se 19[illegible]
Objective 1: Secure authorization from school to conduct field development.							
Activity A: Submit a plan for field development.	———→						
Activity B: Identify teachers and students.	———→						
Activity C: Schedule training sessions.	———→						
Objective 2: Field develop the teaching unit.							
Activity A: Develop objectives, lessons, etc.	———→						
Activity B: Program the computer materials.	———→						
Activity C: Develop student materials.	———	———	———→				
Activity D: Prepare all materials for classroom use.	———	———	———→				
Objective 3: Gather evaluative information and revise unit.							
Activity A: Administer questionnaires.			———→				
Activity B: Conduct observations.		———	———→				
Activity C: Complete interviews.		———	———→				
Activity D: Summarize information.				———→			
Activity E: Complete revisions of materials.				———	———	———→	
Objective 4: Disseminate the findings.							
Activity A: Present findings to school board.						———→	
Activity B: Submit findings to AIPC.						———→	
Activity C: Report for ERIC.				———	———	———	———→
Activity D: Other publication activities.				———	———	———	———→

COMPUTER STORYTELLING MATHEMATICS

Time PERT Chart
Phase I: Design
(September, 1980 - February, 1981)

OBJECTIVES AND ACTIVITIES	Sept. 1980	Oct. 1980	Nov. 1980	Dec. 1980	Jan. 1980	Fe 19
Objective 1: Insure community input and collect baseline data.						
Activity A: Collect standardized test information.	——→					
Activity B: Review item analyses.	——→					
Activity C: Collect pertinent research.	——→					
Activity D: Plan for community involvement.	– – – –	(ongoing) – – – –	– – – –	– – – –	– – – –	– –→
Objective 2: Investigate micro-computers and establish selection criteria.						
Activity A: Identify types of computers.	——→					
Activity B: Investigate instructional capabilities of the micro-computer.	——→					
Activity C: Determine cost, etc.	————	——→				
Activity D: Establish selection criteria and purchase.		——→				
Objective 3: Design the teaching unit.						
Activity A: Identify problem solving techniques and skills.		——	——→			
Activity B: Design and select content.		——	——→			
Activity C: Fuse the math and science content.			——	——→		
Activity D: Design the physical format.				——	——→	
Activity E: Complete the unit design.					——→	
Activity F: Design student activities.					——	——
Activity G: Design evaluation procedures.						——

DESCRIPTION OF THE UNIT

"Pueblo Uses of Energy", a microcomputer science/mathematics learning unit, has been designed to be used at the upper elementary level from four to six weeks utilizing the microcomputer as the primary mode of instruction. The content of the unit focuses on the study of energy and mathematical problem solving while directly incorporating life situations which these elementary school Pueblo Indian students experience. The unit consists of computer software, audio tapes, student booklets, and teacher's manual.

In developing the unit of instruction three major types of computer materials were produced: instructional programs, reinforcement activities, and enrichment materials. Instructional programs, the first type, were designed to introduce science content in a storytelling format which capitalizes on a specific learning style and an educational strength of Pueblo culture. Folktales have been in use for a long time as an educational vehicle by this culture and were the prehistoric textbooks for Pueblo children. Today, the tradition of oral storytelling is strong and students will be familiar and comfortable with this approach.

Two energy cartoon figures serve as the storytellers throughout the four story sequences in the unit and introduce students to energy concepts. Bleam, a sunbeam, and Blip, a raindrop, appear against typical background scenes of the Southwest while demonstrating and illustrating energy concepts such as work, forms of energy, and new uses of energy. Voices for these characters are recorded on synchronized audio tapes. Incorporating daily life elements familiar to the students, four energy themes are used in the stories entitled "Raindrops", "Sunshine", "Flavors", and "Light Bulbs". Each story serves as a bridge to the second type of computer materials developed for the unit.

Reinforcement activities to be used after initial instruction comprise the second type of computer materials in the unit. These programs, in a game format and relating to the story sequence, are designed to provide interesting and challenging opportunities for students to experience the number system in a personalized setting while reinforcing mathematical skills. For example, in "Raindrops", students play a game in which they receive points by catching raindrops. A running tally is kept on the screen for the student displaying the individual score in number columns according to point values of the raindrops caught. Later these numbers are used in a variety of on-line activities as well as off-line activities to reinforce basic concepts about the number system.

The third type of computer program developed for this unit contains enrichment activities to motivate and to broaden students' knowledge of mathematics and science. For example, in the "Sunshine" sequence, students construct a bar graph of their individual score while in "Flavors" students use the graphics tablet to draw a picture of their favorite type of energy. Then students enter the "Print" command to obtain a black and white version of the picture to be placed in their student booklet. Yet another example of an enrichment activity is an energy guessing game where students actually teach the computer to guess an energy source.

These three types of computer programs of instruction, reinforcement and enrichment are supported by off-line student activities in the student booklets such as games, puzzles, discussion, reinforcement, extension, and practice. Organized into four parts to correspond with energy themes, the student booklet is designed with Blip and Bleam cartoon illustrations and contains activities which coordinate with the four story sequences.

In addition to the computer programs and the student booklets, a comprehensive teachers' manual also has been developed to insure the all important human input for this approach. This manual contains instructions on the use of the computer as well as teaching suggestions for each specific computer lesson and the corresponding student off-line activities. Furthermore, a unit overview, objectives, and learning sequence are included to aid the teacher in planning for the successful integration of the computer and the learning unit into the classroom.

THE FIELD DEVELOPMENT PHASE

The field development of the approach and materials took place in a fifth grade classroom at Sky City Community School in Acomita on the Acoma Reservation. The purpose of this development was twofold: to determine how to integrate the microcomputer into a classroom situation and to gain the vital curriculum input from the teacher, staff, administration, and most importantly, the students. This information gathered during this phase directed the revision and extension of the alternative curriculum unit, "Pueblo Uses of Energy". The fifth grade teacher, who is an Acoma, and 28 Acoma fifth graders participated in this four week phase of the project from May 4 through May 29, 1981.

At the inception of the project the fifth grade class had been selected by the school principal because these students had low scores in mathematics and science; they were one of the largest classes so more students would benefit from using the microcomputer; and the teacher, at that time, had voiced an interest in the project. As the school year progressed, these students became discipline problems and the first teacher resigned before the end of the first semester. A second teacher was placed in the classroom but the behavior problems grew steadily worse and with six weeks left in the school year another teacher was assigned to this class.

Under the direction of the teacher, two computer centers were set up back-to-back on two tables with a tall bookcase between to serve as a divider. After the centers were in place the principal investigator began a rather unique training session during the remainder of the math class. Three students, who would serve as technicians and peer instructors throughout the four weeks of the field development, participated and were trained at the same time as the teacher in the operation of the equipment. Occasionally the teacher had to leave the center to give assistance to other students who were finishing a math assignment at their seats. While this training format might not have been selected under more normal circumstances, it proved to be very beneficial because of the immediate involvement of students resulting in a sense of shared responsibility with the teacher.

In spite of all the student difficulties before the microcomputer was placed in the classroom such as three different teachers during one year, the field development did proceed successfully and furnished more information than was expected. This information was gathered from observations by both the teacher and the principal investigator, conversations with students, video taping of activities, and a student questionnaire which was administered during the last day of the field development effort. These procedures resulted in a wealth of information to direct the revision/expansion of the computer storytelling approach, the software lesson series, the student booklet, and the teacher's manual.

RESULTS OF THE FIELD DEVELOPMENT PHASE

These results are based on information gathered during the field development phase of the project and are reported in three categories: 1) Teacher Response and Reaction, 2) Student Questionnaire Results, and 3) Principal Investigator's Comments.

Teacher Response and Reactions:

Most of the teacher's reactions to the computer storytelling approach and the materials can be classified according to the effect on the students and the effect on classroom teaching. The teacher's first reaction was to the discipline climate that the computer helped to create in the classroom. Students were so eager to use the computer that they began to finish their regular classroom work so they would get to have time in the computer centers. This created an atmosphere of general "busyness" and the teacher was able to have time to work with individual students who needed extra help.

The training format used to introduce the computer into the classroom impressed the teacher because the student technicians became instructional partners. This started a chain reaction of peer teaching in the classroom which spilled over from the computer centers into other subject areas. The teacher was amazed and voiced pleasure at this unexpected benefit.

The integration of the computer into the classroom proved to be easier than expected and the scheduling of computer usage went smoothly throughout the field development effort. The teacher expressed many ideas about how the computer might be used to teach other content areas and was excited about incidental skills the students were using such as reading of directions, spelling, discussion, giving directions, following directions, directive conversation, recording of information, and location of letters and numbers on the keyboard.

Probably the strongest response from this teacher was the effect the computer had on individual students. For example, one very bright girl had been shy, quiet, and became almost withdrawn as the school year had progressed. She was chosen to be one of the student technicians and began to change by becoming talkative with the teacher and other students. The peer teaching experience with the computer seemed to bring out leadership qualities in this girl and this experience had a profound effect upon her interaction and relationship with her peers as well as her teacher.

Student Questionnaire Results:

The student questionnaire was administered in the fifth grade class at Sky City Community School on May 27, 1981 to 23 students. The age range of the respondents was 10-12 years and there were nine boys and fourteen girls completing the questionnaire. These results are reported in percentages for the first 24 questions and a summary of student written responses is reported for the final two questions.

		YES	NO	NOT SURE
1.	Ilike school	82.6%	8.7%	8.7%
2.	I like the computer.	100%	—	—
3.	Math is hard for me.	17%	61%	22%
4.	I like the graphics tablet.	100%	—	—
5.	Science is hard for me.	22%	56%	22%
6.	I like to play the Raindrops game.	100%	—	—
7.	I like to tally my score.	91%	4.5%	4.5%
8.	I wish we could learn more math by playing computer games.	100%	—	—
9.	The computer helps me learn.	100%	—	—
10.	I know how to make a graph of my score.	87%	4.4%	8.6%
11.	It is easy to read directions on the computer.	95.6%	—	4.4%
12.	Sometimes the TV screen hurts my eyes.	44%	56%	—
13.	I wish we could have more time on the computer.	100%	—	—
14.	I enjoyed the story lessons with Blip and Bleam.	95.6%	4.4%	—
15.	I like math better now that we use the computer.	82%	4%	14%
16.	I would rather use the computer than take my recess.	82.6%	8.7%	8.7%
17.	I like to work alone on the computer.	56.5%	30.5%	13%
18.	I like science better now that we use the computer.	60.8%	17.5%	21.7%
19.	I would like school more if we used the computer.	95.6%	—	4.4%
20.	I like to work with my friends on the computer.	100%	—	—
21.	I would like the computer to give me a math test.	74%	17%	9%
22.	Does the computer make math interesting?	78%	4%	18%
23.	Do you like to work in the booklet about Blip and Bleam?	100%	—	—
24.	Does the computer make the study of energy interesting.	95.6%	—	4.4%

25. What did you like best about the computer lessons and activities.
   a. Nineteen responses about games and twelve of these specified the game of Raindrops.
   b. Three references to the graph lesson.
   c. One reference to the tally lesson.
   d. One reference to the booklet.
   e. Four references to Blip and Bleam.

   Comments included:
   They (Blip and Bleam) helped me learn about energy.
   The computer makes me happy.
   I like pressing the buttons.
   We can play games and do math.
   It is fun to work with Blip and Bleam.
   They (the lessons) are neat and fun.
   I liked all of them. They are fun to play. I wish they can bring it next year.

26. What didn't you like about the computer lessons and activities?
   a. One reference to the format of the tally lesson. The student didn't like to wait while the words were fed onto the screen.
   b. One reference that the work in the booklet was hard.
   c. Three responses about getting a turn and friends not letting them play.
   d. Four references to bugs in the programs.
   e. Four references to having to write a story about the computer.
   f. Six students said that there wasn't anything they didn't like about the lessons and activities.

Principal Investigator's Comments:

The following comments are based on results of the student questionnaire, conversations with the teacher and students, and approximately twenty hours of classroom observation completed by the principal investigator. These comments are categorized under the most striking feature of the field development phase: Transformation in the Classroom.

1. Classroom Atmosphere:
   At the beginning of the field development these students were unruly and difficult to control but under the influence of the teacher the situation was beginning to stabilize. The students were in the traditional rows and all of them were working on the same page in the math textbook. Occasionally students were allowed to go to the board to work long division problems; for the most part they remained in their seats.

A marked change took place after the introduction of the microcomputer: students became productive and interested; the noise level of the classroom became more of a busy hum; students moved freely around the classroom; the teacher was able to spend time with individual students; and in the computer centers there was a relaxed atmosphere with student conversations, laughter, cheering, and even periods of absolute silence. Because of the influence the teacher had on these students and the classroom atmosphere, the microcomputer and the approach certainly cannot claim all of the credit for the changes but there was a definite observable contribution.

2. <u>Teacher and Student Roles</u>:

The teacher seemed to change roles somewhat in that the teacher was able to relax the authoritarian requirements of the situation to become more of an instructional partner. Sometimes the teacher was cast in the role of a student as the children taught the teacher how to play a game or how to work the computer. A new role of student technician was created by the training of three students to operate the equipment. This role was changed into one of peer instructor and students who had previously been uncooperative suddenly began to teach each other. A three way partnership of teacher, microcomputer, and students emerged during the second week of the field development phase.

3. <u>Attitudes</u>:

Possible attitude changes about mathematics, science, school, and learning were included in the results of the student questionnaire and the responses to questions 15, 16, 18, 19, and 21 are especially interesting. It would seem from this information as well as conversations with the teacher and students that the microcomputer and the approach do have an effect on attitudes.

Another interesting outcome concerns the student attitudes about the microcomputer. At first it was treated with excitement like a new game or a new piece of equipment but this changed. In this age range, children in a classroom often create a classroom body of knowledge and traditions including jokes, notes, events, gossip, games, codes, and secrets which is a delightful blend of reality and fantasy. This observer was surprised to learn that the microcomputer along with Blip and Bleam, the storytelling characters, had been incorporated into this "classroom lore" and that the computer had a special status almost like a member of the class. This type of attitude change certainly warrants further study.

4. Individual Behavior:

It was observed that passive student behavior changed into more active, participatory behavior when students were in the computer centers. As the field development progressed this change became apparent in other areas of the classroom. At the outset social behavior of some students toward other students included pushing, fighting, arguments, and ridicule. This behavior began to change as students began to praise each other especially when there was a high score in a game, take turns, and to help each other.

5. Instruction:

Even though enthusiastic about the approach and the materials, the teacher was content to follow the suggestions in the teacher's manual but after several weeks began to talk about other learning activities which could be used. In effect the teacher went from a dispenser of a prescribed set of lessons and activities to a curriculum developer who was able to begin to expand the approach and the activities and who could see other applications of the microcomputer in the content area of language arts.

6. Learning:

Many kinds of learning behavior were observed from the physical operation of the equipment to the higher levels of problem solving. These behaviors included learning to use the keyboard, paddles, the graphics tablet, and to follow directions. The exhibition of different kinds of problem solving behavior was evident in the computer centers. Students began to talk using numbers (their scores); they compared scores, they began to predict what their score would be; they estimated their actual scores; they used tallying, counting, graphing, and computation to figure their actual score. More importantly students posed problems and then talked about ways to find solutions. For example, one student wanted to know the highest possible score he could get in the game of Raindrops and he knew that he could use the graphing activity on the computer to get the answer because he said so in his conversation with another student.

During another session a student was curious about what it would have cost if each game had been 25¢ like at the computer game rooms. This student knew that estimation could be used but also decided that the computer could have kept a record of all the games the class had played. This information becomes even more valuable when the reader learns that these types of problem solving behaviors were observed during spontaneous student conversations; no teacher or other adult initiated or directed these discussions. They were stimulated by the microcomputer and this storytelling approach to teaching mathematics.

REVISION/EXPANSION PHASE

The information collected during the field development phase of the project directed the revision/expansion of the unit "Pueblo Uses of Energy". The revision/expansion processes focused on the computer materials, the student booklet, and the teachers' manual and a brief description of this work is summarized below.

Upon completion of the field development phase the computer materials were expanded to include the story sequences of "Flavors" and "Lightbulbs". The activities in these two sequences include beginning programming as well as an extension of the previously introduced mathematics and science content. All of the computer materials were "debugged" insofar as possible and several revisions were made such as menu formats and the presentation of the story sections. Experimentation with electronic voice was completed using "Super Talker" from Mountain Hardware but this method of dubbing voice for the stories proved to be unsatisfactory because it used too much memory and resulted in a very slow pace for the story. Therefore the audio tapes for each story sequence were retained for use with the computer materials.

During the field development phase many student and teacher ideas for off-line activities emerged and directed the production of the student booklet. For example the problems posed by the students during the playing of the Raindrops game have been incorporated into off-line activities. Because students related so well to the characters of Blip and Bleam, the student booklet is based on these energy characters including Blip and Bleam puzzles and work activities. These off-line activities are designed to be an integral part of the unit because they help to insure the integration of the microcomputer into the classroom, they enhance and extend the mathematics and science learnings, and they serve as a stimulus to motivate the teacher and student to go beyond what is presented via the microcomputer.

As the revision/expansion work progressed on the student booklet and the computer materials, the teachers' manual also was completed. This manual includes information to aid the teacher in planning for the integration of the microcomputer into the classroom and the teaching of the unit such as objectives for science, mathematics, and computer literacy; a four week and six week unit plan; and specific directions on the teaching of each story sequence, on-line student activities, and off-line activities.

DISSEMINATION ACTIVITIES

Dissemination of information about this project began with its inception; requests for information were received from all over the United States. Local newspaper articles have appeared, the director has given presentations at the local and national levels, and the project has received many visitors including parents, teachers, administrators, school board members, computer specialists, professional educators, and visiting dignitaries from the National Science Foundation. These dissemination activities will continue well beyond the funded period of the project as the principal investigator has scheduled presentations such as at the Childrens Literature Conference at the University of Colorado, has prepared a report to be submitted to ERIC, and will produce several articles to be published in professional journals. On the national level, the National Science Foundation is disseminating information about this project. In addition, demonstration materials will be provided to the American Indian Bilingual Education Center at the University of New Mexico, shared with area BIA schools, and will be on file at the All Indian Pueblo Council.