



The effects of a computer drill and practice program and a computer simulation program on students content aquisition and retention scores
by Sharon Ziegler Hulett

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Education
Montana State University
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Abstract:

This study was designed to investigate the effects of a computer drill and practice program and a computer simulation program on students' content acquisition and retention scores.

The researcher's review, of the literature revealed disagreement as to the effectiveness of using a simulation approach for content acquisition. Very little information was found on the effectiveness of the drill and practice approach.

Fourth grade students at Emerson Elementary School, Bozeman, Montana, were randomly assigned to one of three treatment groups for instructional computing lessons in science-related material. The treatment groups were: 1.) drill and practice done individually (DP), 2.) simulation done individually (SI), and 3.) simulation done in a group of three (SG). Analysis of a pretest administered before treatment indicated that the treatment groups were equivalent.

Treatment consisted of two ten-minute instructional computing sessions. A posttest was administered immediately following each student's second round of treatment. The retention test was administered two weeks after the posttest.

Results of the data analysis indicated that students in all . three treatment groups showed significantly higher scores after treatment and retention. As there were no other apparent experiences with the subject matter at that time, it is reasonable to conclude that these gains were a result of the two ten-minute treatment sessions.

Comparisons of gain scores between each treatment group were made to determine if any treatment was superior. A significant difference between the pretest to posttest gain scores of the DP and SI treatment groups was observed. This difference favored the SI treatment technique. No differences were observed on any other gain score comparisons between treatment groups'.

The researcher concluded that all three instructional computing techniques were effective in promoting content acquisition and retention. The SI treatment appeared to be more effective than the DP treatment for promoting content acquisition. It is also evident that learning occurred even with the brief time on task allocated each of these instructional computing techniques.

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Date June 17, 1982

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AND A COMPUTER SIMULATION PROGRAM ON STUDENTS'
CONTENT ACQUISITION AND RETENTION SCORES

by

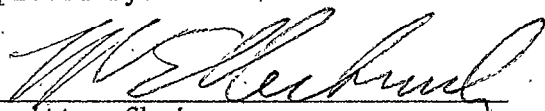
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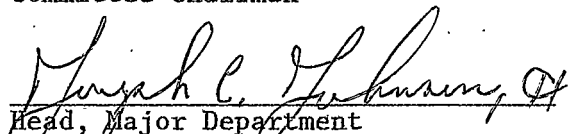
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ABSTRACT

This study was designed to investigate the effects of a computer drill and practice program and a computer simulation program on students' content acquisition and retention scores.

The researcher's review of the literature revealed disagreement as to the effectiveness of using a simulation approach for content acquisition. Very little information was found on the effectiveness of the drill and practice approach.

Fourth grade students at Emerson Elementary School, Bozeman, Montana, were randomly assigned to one of three treatment groups for instructional computing lessons in science-related material. The treatment groups were: 1.) drill and practice done individually (DP), 2.) simulation done individually (SI), and 3.) simulation done in a group of three (SG). Analysis of a pretest administered before treatment indicated that the treatment groups were equivalent.

Treatment consisted of two ten-minute instructional computing sessions. A posttest was administered immediately following each student's second round of treatment. The retention test was administered two weeks after the posttest.

Results of the data analysis indicated that students in all three treatment groups showed significantly higher scores after treatment and retention. As there were no other apparent experiences with the subject matter at that time, it is reasonable to conclude that these gains were a result of the two ten-minute treatment sessions.

Comparisons of gain scores between each treatment group were made to determine if any treatment was superior. A significant difference between the pretest to posttest gain scores of the DP and SI treatment groups was observed. This difference favored the SI treatment technique. No differences were observed on any other gain score comparisons between treatment groups.

The researcher concluded that all three instructional computing techniques were effective in promoting content acquisition and retention. The SI treatment appeared to be more effective than the DP treatment for promoting content acquisition. It is also evident that learning occurred even with the brief time on task allocated each of these instructional computing techniques.

CHAPTER 1

Introduction

There is little doubt that instructional computing has come to the attention of educators, students and the public. It is widely recognized that instructional computing via the microcomputer has great potential to affect education.

Even though schools are experiencing a budget depression, the nation's schools are purchasing microcomputers at an astounding rate. According to an editorial in "Educational Technology," January, 1981, the pessimists say the microcomputer will experience the same burst of interest and be followed by the same abandonment as did the learning and teaching machines of the late 1950's and early 1960's. It is stated in the editorial that this time the pessimists are wrong because computers are already too much a part of our lives to be eliminated from schools.

Although more and more schools are using microcomputers (Dickerson and Pritchard, 1981), there is still a significant amount of concern about how to make the best use of instructional computing in schools. Educators will need to give serious attention to the role of instructional computing in the schools.

If we agree that a major purpose of instruction is to facilitate learning, then it stands to reason that facilitation of learning should be one of the criteria in evaluating the role of instructional

computing. Wade (1980), identified the following "instructional events". Those events were:

1. Gaining attention
2. Informing the learner of the objectives
3. Stimulating recall of prerequisite learnings
4. Presenting the stimulus material
5. Providing "learner guidance"
6. Eliciting the performance
7. Providing feedback performance
8. Assessing the performance
9. Enhancing retention and transfer

It is noted that not all of these events are contained in all instruction. The events contained in instruction depend upon the objectives intended (Wade, 1980).

Wade contended that evaluation of instructional computing programs falls into two categories. One category is the evaluation of programs as they are used. ". . . programs are good only as they are good for students." In that context, it was the intent of the author of this study to investigate two types of instructional computing programs as they are being used. One type is the drill and practice program and the other is the simulation program.

Statement of the Problem

In this investigation the effects of a computer drill and practice program were compared with a computer simulation program on cognitive acquisition and retention of science-oriented material for fourth grade students.

Need for the Study

The purpose of this investigation was to compare the test scores of students participating in a computer drill and practice program and students in a computer simulation program to see if one program indicated a propensity for cognitive acquisition and retention of content material.

In a review of the literature disagreement was indicated about whether a simulation approach promotes learning of factual knowledge (DeNike, 1976). DeNike cited four studies which compared simulation approaches to "traditional" techniques. Results from one study indicated that the simulation group outperformed the "traditional" group by a substantial margin on content tests. The results of another study proposed that the simulation approach is significantly related to gains in student achievement.

The opposite view was expressed in two other studies. In one study, students using a simulation approach were compared with a group whose treatment was similar except that the simulation periods were

replaced by the lecture-discussion method. In this study, the control group made larger gains in factual and conceptual knowledge than the simulation group.

In the last study, it was reported that "the use of the simulation game 'Marketplace' resulted in a significant retardation of student learning of economics." According to DeNike, "It is unclear whether this state is due to the nature of the research or to the shortcomings of the instructional strategy."

It should be noted that these simulations are not computer simulations. In a search of the related literature very few studies were revealed comparing gains in or retention of factual knowledge by users of computer simulation programs. Many articles exist in which authors proclaim to recognize the potential of computer simulation programs as an instructional technique (Saltinski, 1981).

Critics of the drill and practice approach claimed that drill and practice with the computer does nothing that workbooks and worksheets are not already doing; and rather than actually freeing the user, the program locks the student into a fixed sequence of steps determined by the programmer.

Some of the benefits of drill and practice computer programs are described as individualizing the lessons to the student's need and giving immediate feedback. In a search of the literature, no

studies were indicated as examining acquisition or retention of content using the computer drill and practice technique.

Drill and practice computer programs are the most frequently used type of instructional computing at this time (Billings, 1980). Computer simulation is referred to as one of the most promising areas of instructional computing. Because of the microcomputer's capabilities of rapid interaction, a new door is open for new experiences in learning. Through the use of computer simulations, we may have discovered a key to promote divergent thinking in learners (Steffin, 1981).

Instructional computing is here. If it is to serve the student effectively, we must investigate several aspects of that effectiveness. One of the major questions is whether or not certain types of instructional computing programs tend to promote content acquisition and retention.

In a search of the related literature a conflict was indicated as to whether or not a simulation approach promotes learning of factual knowledge. Very little information was found about retention of information gained by a simulation approach. It was the purpose of this study to investigate content acquisition and retention using a computer simulation approach. In this study it was also proposed to investigate the computer drill and practice approach as it relates to content acquisition and retention. At the time of this writing there

appeared to be little information on content acquisition and retention using computer drill and practice programs.

Questions Addressed by This Study

Questions concerning students' performance through use of the instructional computing drill and practice and simulation techniques were investigated. The questions investigated were as follows:

1. Was there a difference in drill and practice scores from pretest to posttest?
2. Was there a difference in drill and practice scores from posttest to retention test?
3. Was there a difference in drill and practice scores from pretest to retention test?
4. Was there a difference in scores from pretest to posttest scores in the simulation done individually?
5. Was there a difference in scores from posttest to retention test scores in the simulation done individually?
6. Was there a difference in scores from the pretest to retention test in the simulation done individually?
7. Was there a difference in scores from pretest to posttest scores in the simulation done in a group?
8. Was there a difference in scores from posttest to retention test scores in the simulation done in a group?

9. Was there a difference in scores from pretest to retention test scores in the simulation done in a group?

10. Given a pretest and a posttest, was there a difference in students' content acquisition change scores for the following:

- a. the drill and practice program and the simulation done individually?
- b. the drill and practice program and the simulation done in a group?
- c. simulation done individually and simulation done in a group?

11. Given a posttest and a retention test, was there a difference in students' retention change score for the following:

- a. the drill and practice program and the simulation done individually?
- b. the drill and practice program and the simulation done in a group?

12. Given a pretest and retention test, was there a difference in students' retention change score for the following:

- a. the drill and practice program and the simulation done individually?
- b. the drill and practice program and the simulation done in a group?

- c. simulation done individually and simulation done in a group?

Procedures Followed

The procedures of this study followed in chronological order.

Procedure One

Review of the literature. The first procedure was to complete an extensive review of the literature as it related to the use of drill and practice programs and simulation programs in instructional computing situations.

Procedure Two

Obtain permission. Permission from Bozeman School District 7 Administration was requested in order to carry out the study using fourth grade students from Emerson School. The school district's guidelines were followed in obtaining the permission. A meeting was held with the principal and participating teachers to explain what the study involved. A letter was sent to parents explaining the study and to assure them that the individual's data would remain confidential.

Procedure Three

Instrument development. An instrument was developed to use as a pretest, posttest, and retention test. The instrument was validated by Dr. Paul Markovits and Dr. Elnora Old Coyote, Montana State University elementary science education specialists. The instrument was

tested for reliability by selection of students not used in the study. Two fourth grade classes at Longfellow School in Bozeman were used for reliability testing. The instrument was administered to them twice. The interval between the first and second administration was one week. A correlation coefficient was computed to determine the reliability.

Procedure Four

Assignment of students. Fourth grade students were randomly assigned with computer assistance to one of three instructional computing groups: 1.) drill and practice (DP), 2.) simulation done individually (SI), 3.) simulation done in a group of three (SG).

Procedure Five

Assignment of student numbers. Students in the study were assigned a student number which was used throughout the study for pretest, posttest, and retention test data gathering, recording, and analyzing. The purpose of the student number was to maintain confidentiality of individual scores and any other individual data collected throughout the study.

Procedure Six

Orientation of students. The students were told what was necessary for their involvement in the study. They were administered a pretest, which was then used to determine group equivalency and for

later comparison with the posttest and retention test. A short introduction to the operation of the computer was given.

Procedure Seven

Treatment. Students were given the instructional computing lesson according to the group to which they were assigned.

Posttest. A posttest was given to the students one week after treatment.

Retention Test. A retention test was given to the students two weeks after the posttest.

Procedure Eight

Analysis. Using the data from the pretest, posttest, and retention test, means of all the groups were computed and compared statistically.

Procedure Nine

Summary. After all data had been compiled, a summary of the study was prepared.

Procedure Ten

Discussion, recommendations, and implications. Discussion of the study's findings, recommendations for further research, and implications for education complete this study.

Limitations

1. The site of the study was selected where the cooperation of the school district and the building principal could be obtained.

2. The simulation program was a modified version of a commercially prepared simulation. The modification was done by the researcher and a computer science graduate student.

3. The drill and practice program was created by a computer science graduate student under the direction of the researcher. The drill and practice program was created to coordinate with the subject matter contained in the simulation.

4. The classes used in the study were self-contained.

5. Because the study was conducted in only one school, in one city, the conclusions were applied only to that school.

6. The treatment and testing were administered by the researcher conducting the study.

Delimitations

The following delimitations of the study are identified:

1. This research did not attempt to compare classroom achievement and retention with the instructional computing achievement and retention.

2. The experimental treatment involved only two ten-minute lessons per student.

3. The study was limited to fourth grade students at Emerson School, Bozeman, Montana.

4. The posttest was administered immediately following each individual's last treatment session.

5. The retention test was administered two weeks following the treatment. The retention test was administered in the self-contained classroom to the entire class at one session. A one-day variation existed for some students from the end of posttesting to the retention testing.

6. This research did not attempt to measure divergent thinking that may have occurred in the simulation program.

Definition of Terms

The following key terms will be used in the study:

1. Drill and Practice Program. This type of program presents a problem for response by the user. The user is informed whether he is correct or incorrect. Depending upon the individual program, the user may be given another opportunity to try again or may be given the correct answer.

2. Instructional Computing. Instructional computing is information that is presented by some type of computer program with specific educational objectives.

3. Microcomputer. A microcomputer is an independent, self-contained unit. It does not depend upon any other computer system hookup for its operation.

4. Simulation Program. A simulation program sets up a choice of variables for the user to apply to an event that occurs or could

occur in a real-life situation. The user is given an opportunity to try out divergent approaches to situations.

Summary

Instructional computing is recognized as having great potential to affect education of students. At present time there are four types of instructional computing techniques. They are drill and practice, simulation, games, and tutorial. Currently simulation is looked upon as having potential to promote higher levels of thinking. There is conflict as to whether simulation can promote content acquisition.

If we are to realize fully the potential of instructional computing, we must know how it is affecting the students. To do this, it is necessary to explore how the various techniques are serving the students.

In this study, the test scores of students participating in a computer drill and practice program were compared with a computer simulation program. The comparison was made to see if it was indicated that one program might be more effective for cognitive acquisition or retention of content material. The results of this experimental study may be used to determine how each of the programs can be used to serve the student effectively.

Specific limitations, delimitations, procedures, and definitions were presented as they applied to the design and implementation of this study.

CHAPTER 2

Review of Literature

Education is a complex process. Educators face the task of providing learning situations that will benefit both the cognitive and affective domain of each student. Just what constitutes a successful learning situation for all children has not been resolved. New methods and media are continually being scrutinized as to the potential value they may have in contributing to the child's education. Curriculum committees revise, update, and innovate, hoping to meet the needs of the individual.

The microcomputer has surfaced as a medium that has captured the attention of educators. "Computers have become so prolific that educators can ignore them no longer" (Billings, 1980). Watts (1981) believes that, in order to reflect the needs of the students of today, computers must be implemented into the curriculum. According to Watts, "The challenge is there for all schools to successfully introduce computers and to develop their potential in education." The fact that the potential is there is emphasized by Stahl's statement (1979) that "The microcomputer is opening a fantastic array of possibilities for education." Ropes (1980), in his article "Bringing Microcomputers Into Schools," states that "Schools are on the threshold of the computer age . . . Those who have worked with microcomputers are strongly of the opinion that no other single piece of equipment can do as much

for education." It is believed by those who have worked with microcomputers in education that the micro motivates students to a remarkable extent. Instructional computing via the microcomputer is unexcelled at providing opportunities for demonstration of student creativity and logical thinking. Application and value of instructional computing are possible in all areas of the curriculum. Instructional computing is effective in individualized review and practice of skills and can give immediate feedback on performance.

Drill and practice and simulations can be written to work in almost any curriculum. At the present time, drill and practice and games account for most of the instructional computer use in the elementary school (Billings, 1980). One explanation may be that drill and practice and games are easy to use with the traditional basic skills activities. Emphasis is being placed on the basic skills curricula by the developers of software for the microcomputer. Major publishers of textbooks and educational materials are in the process of producing basic skills curricula for use with the microcomputer (Holznagel, 1980). Science Research Associates has developed and is marketing mathematics and phonics programs. The mathematics program is a combination drill and practice with tutorial available when needed by the learner.

Teachers are under pressure to raise test scores and build skills. According to Billings (1980), drill and practice can "create better-skilled students. . ." Yoshida (1980) pointed out in his study that

many educators tend to ignore the drill and practice technique needed to consolidate a concept. He feels that educators just move on to new concepts. In his study, he indicates three conditions that must be satisfied in order to have a successful drill and practice. The three conditions are sequencing, aptitude of the learner, and the type of drill and practice. The types of drill and practice, as he defines them, are "branched" or "fixed". A branched drill and practice is described as "adaptive to the ability of the learner." The fixed drill and practice is defined as one which "ignores the ability level of a learner and involves problems of all difficulty levels." Drill and practice through instructional computing can be set up as either branched or fixed. Instant feedback with opportunities for making corrections may be incorporated into drill and practice through instructional computing. Brisson (1980) points out one value of instructional computing as providing an opportunity to allow students to practice and learn on their own with immediate feedback on their progress. It is felt that a self-testing approach allows students the opportunity to improve on their own.

According to Taba (1967), "Curriculum is a system of teaching someone something by a process." It consists of the following elements:

1. The objective to be obtained
2. The selection and organization of content

3. The selection and organization of learning experiences to be provided.

4. The formulation and organization of the teaching strategies to be employed.

The three cognitive tasks involved in learning are: concept formation, interpretation, and application. A simulation can provide an opportunity to develop all three tasks defined by Taba. The primary emphasis of simulation, according to Cohen and Bradley (1978), is on "active rather than passive participation to give pupils a meaningful learning experience." The active participation leads to motivation which helps develop greater interest, which in turn leads to longer episodes for learning.

The increased sophistication in the development of graphics and animation adds another dimension to simulations. Important and novel kinds of learning experiences are possible through this method (Sagan, 1977). The future use of holographic images will add still another dimension to simulations. Holography incorporated into a simulation will make possible simulations which closely approximate real life. While the use of holography sounds like the ultimate in providing the learner with the best possible simulation, studies by Rigney and Lutz (1976) found that copying real life pictures were less effective in concept attainment than logical, animated or schematic representations of the real object. One of the strengths of simulation seems to be

its ability to provide an abstract representation of the real event and allow students to analyze what occurs.

Simulation games have been in existence for some time. The microcomputer has made effective use of simulations by presenting situations that would otherwise be difficult to consider. The numerous variables and speed of processing and presenting the consequences of the user's decisions by the microcomputer makes simulations an area worth investigating.

Taba, Bloom and others remind us that to develop independent learners, the curriculum and instruction must contain goals and objectives that use higher-level thinking skills. Curriculum and instruction are still concerned with acquiring knowledge. According to Steffin (1981), "Much of elementary-secondary education today focuses on the development of convergent thinking skills. In many instances each student is expected not only to reach the same answer, but to apply precisely the same process as his or her classmates."

It is quite possible that the microcomputer is the vehicle which will promote divergent thinking in learners. Because of the microcomputer's capabilities of rapid interaction, a new door is opened for new experiences in learning. Through the use of computer simulations, we may have discovered a key to divergent thinking.

Steffin (1981) has set up three conditions which must be met to apply divergent thinking to intellectual/cognitive problems. These

conditions are:

1. Rigerous criteria must be established to distinguish between acceptable and unacceptable solutions;
2. Strong, positive reinforcement must support both the problem solving process and those answers which increasingly approximate the criteria developed for an "ideal" response;
3. The instructional strategies which are employed must provide for immediate feedback to the learner, communicating the status of the particular process employed and of the solution obtained.

The microcomputer allows the learner to try out divergent approaches to problem solving. The learner discovers which approaches are most appropriate to achieve his objectives.

To evaluate computer simulations may neccesitate taking another look at the purpose of the particular simulation being used. It is possible that simulation may not be the method preferred if knowledge acquisition is the goal. Findings conflict on whether or not simulation promotes knowledge acquisition (DeNike, 1976).

According to Boysen and Thomas (1979), "Recent experiments have shown that the computer can be used effectively in simulation." Boysen and Thomas turned to computer simulation in order to overcome the problem of using students in the training of reading teachers. The simulation approach allowed incorporation of a wide variety of reading disabilities. Teachers practiced administering and evaluating informal reading inventory results through computer simulation. The teachers worked at developing skills at their own rate. The program allowed the teachers to repeat items as often as necessary in order to master

the skills. In this particular simulation, teachers interacted with the simulated students by "correcting" the weaknesses. . .and observing changes in reading behavior. The program actually acted as a lab, giving the teachers the chance to experiment with the methods and theories learned in class. The program was evaluated "to determine its usefulness as a supplement to classroom instruction." The evaluation compared the mean posttest scores of trainees who received both computer and classroom instruction with those who received only classroom instruction. The mean pretest scores for both groups showed no significant difference. A significant difference appeared after treatment. Posttest scores showed a significantly higher mean score for the treatment group than for the control group. The control group then received the same treatment. After treatment, the control group received a second posttest. At that comparison, there was no significant difference between the two groups. An evaluation was made to discover the retention of the material over a four-week period. The results showed no significant loss of retention of the simulation material. Findings indicated that simulation was an effective method for the purpose described. According to Boysen and Thomas (1979), ". . .further plans call for the development of an instrument which will determine the extent of learning at the application level. It is at the application level where the simulation technique may have its greatest potential."

In a simulation study done by Shay (1980), which did not refer necessarily to computer simulation, he pointed out that there was skill acquisition for some in enhancing bargaining, persuasion, decision making, and communication. There was some evidence that simulation spurred integrative thought processes. As far as cognitive learning, Shay stated that, "If factual-intellectual outcomes are desired, simulation should not, perhaps, be the preferred teaching technique." On the other hand, there was no evidence from control-group experiments that simulations handicapped students in terms of cognitive learning and performance.

The commercially prepared program "Oregon Trail" was used with a group of students. In the program were simulated events that may have occurred as people made their way along the Oregon Trail. After completing the simulation, students were given a follow-up test. The test results indicated an increase in the students' recall of event-related facts (Osborn, 1981).

According to Shay (1980), ". . .while it cannot be proven that experience is the best teacher, it can certainly be said that the vicarious and partial experience provided by simulation may render knowledge more deeply relevant and personal."

To some, the term "game" is interpreted as not being related to "education". Using some of Bruner's ideas, Cohen and Bradley (1978) described some of the academic values of simulation. "Games go a long

way toward getting children involved in understanding language, social organization, and the rest; they also introduce. . .the idea of a theory of these phenomena. We do not know to what extent these games will be successful but we shall give them a careful try. They provide a superb means of getting children to participate actively in the process of learning--as players rather than spectators."

Good and Beckerman (1978), along with many other educators, believe that children's academic achievement seems to be related to their involvement in tasks. If they are to master material, according to Good and Beckerman, ". . .they must engage in it and react to it--read, make response."

It is through simulation that the student may be able to perform at the higher levels of cognitive process. This may be the highest and best use of instructional computing.

To determine what effect simulation has on students may be difficult to measure. Cohen and Bradley (1978) cited that research on simulation games, especially in the elementary school, has been limited. Very few studies have focused on retention of material learned through simulation. One reason may be that doing research on simulations is difficult. According to the above authors, some of the problems that produce conflicting data are as follows: "the lack of a theoretical framework, the influence of the teacher or the director in setting

the tone, the question of whether outsiders should evaluate the effectiveness of the simulation and their possible influence on the activity, the environment and the type of pupils who engage in the games, the difficulty of getting accurate and valid instruments to measure short-term changes in attitude, the consideration of the Hawthorne effect, and the immense problem of generalizing about simulations from one particular simulation."

Chen (1978) found in her study that junior high students overwhelmingly preferred the simulation games to the traditional classroom techniques. She cited that Wing used two computer simulation games with two groups of sixth graders. One group played the two simulation games individually at computer terminals. The control group worked with the subject matter by traditional classroom methods. Results showed that the experimental group outperformed the control group on the criterion test for one of the simulation games while the control group outperformed the experimental group on the test for the other simulation game.

Coleman, Livingston, Fennessey, Edwards, and Kidder (1973) have stated that simulations and other types of experiential learning are not always effective in helping students transfer to other areas the generalizations from the particular game experience. Cohen and Bradley (1978) stated that "It is probably because (generalizing) is the weakest link in experiential learning and that post-game discussions appear

to be very important in the experiential learning that takes place in simulation games." They concluded that the "appropriate mix of experiential and information processing modes of learning" might make learning in school more effective.

Yoshida (1980) stated that "One of the principal objectives of education is the understanding of concepts. To consolidate a concept in a learner's cognitive structure it is necessary to develop problem-solving skills for that concept."

Yoshida's study dealt with the use of three drill and practice programs to determine which were superior in acquiring the skill of division. The results indicated that gains made from pretest to post-test were highest with the "fixed" drill and practice followed by the "mixed" drill and practice. The "branching" drill and practice was the least effective. The particular drill and practice programs used did not give feedback as to correctness. The students did not find out how they performed until answer sheets were returned on the following day. Researchers feel that if differences in student characteristics had been considered, the branching type (adaptive to learner's ability) would have been best, with the fixed drill and practice shown as the least effective.

Bloom (1981) believes that "most students become very similar with the regard to learning ability, rate of learning and motivation for further learning when provided with favorable learning conditions."

Bloom goes on to state that "Instruction consists of the implementation of teaching-learning activities."

As educators, we have the responsibility to find the appropriate teaching-learning activities to facilitate learning for each student. In the case of instructional computing, it is important that we understand its potential and then fit the computer to the student's needs, not force the student to fit the computer.

In this study it is proposed to promote additional understanding of the effects that a drill and practice program and a simulation program have on students in the area of content acquisition and retention.

The limited amount of time that students were available for this particular study necessitated a review of the literature that discussed achievement and retention related to time on task.

In an article by Good and Beckman (1978), it is stated that "Pupils' achievement in school seems to be related to involvement in tasks. If they are to master material, they must engage in it and react to it--read, make response. It is suggested that achievement is related to time for learning and opportunity to learn." Just how much "time" is necessary was not specifically referenced in this article. In the article it was suggested that data indicate that "learning is positively related to low rates of time lost because of poor management of classrooms. . ."

The question seems to be whether a short amount of time on task can result in learning and retention. In a search of the literature, two articles were revealed that relate to short amounts of time spent on task and the learning that occurred. Huwiler (1979) says that "Quick learning is possible. . . ." The basis for this type of learning may have come from television commercials and radio advertising.

Braden (1979) teaches a visual literacy and communication course that is structured around television commercials. He found that one can teach more than one might expect in 30 seconds or less. Braden asks, "What does it mean that today's students--and many of the rest of us for that matter--can spout advertising slogans, sing product jingles, and itemize what goes on a sesame seed bun?" According to Braden, what it means is that Madison Avenue is doing a successful teaching job. He also found that ten seconds to one minute may be adequate time to present certain types of information that is to be remembered. He suggested that educators study the dozen or so communication structures that are the basis of all commercials. Braden felt that educators should give "serious thought to new presentation strategies that draw upon self-contained, extremely brief perhaps repetitive learning messages. The obvious and simple message is 'brief, but often'." He felt that repetition to the point of mental saturation aids recall.

Braden also suggested some not-so-obvious things we should notice about commercials. They are:

1. well-organized
2. purposeful
3. based upon the analysis of the person the sponsor hopes will view them
4. designed with a concern for affective as well as cognitive impact
5. intent of capturing and holding viewer's attention
6. use a variety of techniques.

The list is representative of what educators advocate as good instructional practice.

To achieve success using the quick-learning idea, it is vital that a very clear objective be stated. The teacher must know what will be taught in that short time frame. The only material which may be included in the lesson must be limited to that which is critical to the objective. Huwiler (1979) advises that the vehicle to provide the information should present that information from multiple inputs. Using both sound and visual is an effective learning method. Quick drill and tutoring involving simple rule applications work well with this technique. It would appear that the microcomputer could be the vehicle to provide the information using both sound and visual approaches.

While no one claims that the microcomputer will be an educational panacea, its usage is a growing part of our educational system. We

must investigate the impact of instructional computing as it is being used today in order to guide its use in the future.

Summary

In a review of the literature, it was indicated that the area of instructional computing holds strong potential to affect the education of our students. There are still conflicting thoughts as to how effective instructional computing is. Stahl's (1979) statement that "The microcomputer is opening a fantastic array of possibilities for education" is not disputed. What is needed are investigations to determine how well the microcomputer is actually succeeding in helping the student.

The use of microcomputers in the educational setting is increasing. Educators must investigate the impact of instructional computing as it is used today in order to guide its use in the future.

CHAPTER 3

Procedures

Introduction

In this study, the effects of a computer drill and practice program and a computer simulation program on students' content acquisition and retention scores were investigated. Data were analyzed to see if either program technique indicated more effectiveness in promoting content acquisition or retention of the material presented.

Site of the Research

The research took place in Bozeman, Montana, during the month of February, 1982. The school testing site was Emerson School. Emerson is one of the five elementary schools in Bozeman School District 7. All five elementary schools are composed of kindergarten through fourth grade. The classes are self-contained. Some students receive additional individual instruction through the resource room, speech therapist, gifted and talented program, and Title I. The students are taught music and physical education by a specialist in that particular area. Emerson School was selected because of teacher cooperation. Emerson was also selected because it has three fourth grade classrooms while some of the other schools have only two. The three fourth grade classrooms provided an adequate number of students for this study.

Assignment of Students

Fourth grade students were randomly assigned with computer assistance to one of three instructional computing groups: 1.) drill and practice (DP), 2.) simulation done individually (SI), 3.) simulation done in a group of three (SG).

Assignment of Student Numbers

All fourth grade students were assigned a student number which was used throughout the study. The purpose for the student number was to maintain confidentiality of individual scores and any other individual data that were collected during the study. The student number was used on the pretest, posttest and retention test. The students' names were not used at any other time during the study other than assigning each to the instructional computing group.

Testing Procedures

Pretesting. All students who participated in the study received a pencil and paper pretest. The pretest was given in the regular classroom by the researcher.

The pretest results were subjected to analysis of variance (ANOVA) to determine equivalency of the three instructional computing groups. If the instructional computing groups were shown not to be equivalent, the students would have been reassigned until equivalency occurred. The pretest data were subjected to ANOVA. The pretest showed the three treatment groups to be equivalent.

Posttesting. The end of the treatment occurred when all students in the study had completed the two instructional computing lessons to which they had been assigned. All students who completed the treatment were given a paper and pencil posttest. The posttest was the same instrument as the pretest. The posttest was administered immediately after an individual had finished round two of the lesson. The decision to posttest immediately after treatment was made to insure the same amount of time for each student between treatment and posttesting. Because only one computer was used, the amount of time between treatment and posttesting could have varied from one day to one week if posttesting had occurred after all students had completed the treatment. It was felt that that much variation might affect the accuracy of the study. To have designed the testing period differently would have extended the time necessary for the study. Because the researcher was already causing a certain amount of interruption of the students' schedules, this course was not taken.

Retention Testing. Two weeks after taking the posttest, the students received a retention test. The instrument was the same as the pretest and posttest. It was administered in the individual classrooms.

All the tests were administered, scored, and recorded by the researcher.

Testing Instrument. An instrument was developed to use as a pre-test, posttest, and retention test. The objectives of the instructional computing program were analyzed and the instrument was developed from the objectives established by the program.

Validity and Reliability of Instrument

Validity. The instrument was validated by Dr. Paul Markovits and Dr. Elnora Old Coyote, Montana State University elementary education science specialists. The validity was established according to the content of the lesson.

Reliability. The instrument was tested for reliability by giving it to a selection of students not used in the study. The instrument was administered to the group twice. The interval between the first and second administration was two weeks. A Pearson correlation coefficient of .63 was computed with a probability of .00 which was significant at the .01 level. Because the correlation was low, one must use caution in making generalizations.

Treatment

There were three different treatment groups. The content information for each group was the same. The instructional computing technique used to present the content information was what constituted the difference in treatment for the groups. The three instructional computing groups were as follows: 1.) drill and practice (DP), 2.) simulation done individually (SI), and 3.) simulation done in a

group of three (SG). A sample listing of each program is included in the appendix of this study. The content material was fish survival. Three species of fish were used in this program.

The DP program presented a question that asked whether a particular species of fish could eat certain other species of fish. The student responded with a yes or no answer. The student was then informed of the correctness of his response. If the response was incorrect, the correct answer was given. After making several comparisons of fish, the student was asked questions about the survival of the different species of fish when encountering an osprey and an otter. The same response-feedback pattern used in the other questions was followed for this part of the program. The combinations of the two comparisons for each question were generated at random. Therefore, if a student responded incorrectly to a question, that combination was likely to be presented again.

The simulation program used in the study was adapted from ODELL LAKE. ODELL LAKE, produced by Minnesota Educational Computing Consortium, is a simulation about fish survival. Both the SI and SG groups used this program. The adaptation was made to reduce the number of fish from six to three. The length of time for the treatment was not long enough to accommodate the program containing six fish. Some other modifications were made so that amount of information on the screen was less than in the original program. This was done to accommodate

the reading ability of the fourth graders in the study. The simulation program used animated graphics and text. The student was given a choice of which fish he wanted to role play. An animated representation of that fish appeared on the screen. The student was told he was that fish. Representation of a different fish then appeared on the screen. The student was told what species the fish was. He was then given options of chasing it, ignoring it, eating it, escaping deeper, or escaping to shallow water. After several options concerning fish, the student determined what options to take when encountering an osprey or an otter. After selecting an option, the result was shown through animated graphics. For example, the osprey might fly down and snatch the fish if the decision was to ignore the osprey. A written description of what happened followed the graphic presentation.

The difference in treatment for the SI and SG groups was as follows: the members of the SI group received and responded to the simulation lesson individually. The members of the SG group received and responded to the simulation lesson in groups of three. SG members were allowed to discuss the alternatives provided by the lesson before making a response.

Students in both drill and practice and simulation groups had control of advancing the program to new information by pressing the

spacebar when they were ready to go on. This was done so that different reading rates could be accommodated.

Students were given two instructional computing sessions according to the type of program to which each had been assigned. The program for each session was the same. Each session was ten minutes. A timer was set when the session began. Sessions which extended beyond the ten-minute limit would have been eliminated from the study. No session exceeded the ten-minute limit. Construction of the program did not constitute stopping and starting. Both programs presented various and continual combinations of the content information. Therefore, students were not aware of the number of times they may have gone through the information. The treatment took place in a separate room set aside for this study.

Because this study involved using two ten-minute sessions, it was necessary to cite research in which it was indicated that learning and retention can occur within short time frames. Huwiler (1979) believes that "quick learning is possible." He based this thought on research that he had done involving learning that comes from television and radio commercials. Braden (1979), who teaches a visual literacy course that is structured around television commercials, has found that one can teach more than one might expect in thirty seconds or less. He has found that ten seconds to one minute may be adequate time to present certain types of information that is to be remembered.

Good and Beckerman (1978) believe that student's academic achievement is related to task involvement. According to Good and Beckerman, if students are to master material, they must "engage in it and react to it--read, make response." Huwiler advised that the vehicle to provide the information should present the information from multiple inputs. Using both sound and visual methods is effective. It would appear that the microcomputer could be an effective vehicle by which information is presented in this manner.

Organization of Data

The data gathered during this study were organized and presented in the following manner.

1. Pretest scores. The pretest scores of the individual students, using their student number rather than their name, were compiled. Descriptive statistics for each instructional computing group was computed and the results were presented. The groups were compared by use of analysis of variance (ANOVA).

2. Posttest scores. The posttest scores were compiled for individuals. Group means for the DP, SI, and SG groups were determined. Gain scores from pretest to posttest were analyzed for each group. Comparisons of treatment group gain scores were made. When a significant difference occurred, further analysis using Scheffe was performed to isolate the difference. A significance level of .05 was chosen.

3. Retention scores. Retention scores were compiled for individuals. Group means for the DP, SI, and SG were computed. Gain scores from pretest to retention test and from posttest to retention test were analyzed using analysis of variance (ANOVA), LSD, defined by the SPSS manual as least significant difference, and t-test. The analysis was made within each treatment group and between each treatment group.

Statement of Hypotheses

The hypotheses of this study dealt with the performance of the students in the three instructional computing groups.

The hypotheses were as follows:

1. There is a difference in drill and practice scores from pretest to posttest.
2. There is a difference in drill and practice scores from posttest to retention test.
3. There is a difference in drill and practice scores from pretest to retention test.
4. There is a difference in scores from pretest to posttest scores in the simulation done individually.
5. There is a difference in scores from posttest to retention test in the simulation done individually.
6. There is a difference in scores from pretest to retention test in the simulation done individually.

7. There is a difference in scores from pretest to posttest in the simulation done in a group.

8. There is a difference in scores from posttest to retention test in the simulation done in a group.

9. There is a difference in scores from pretest to retention test in the simulation done in a group.

10. Given a pretest and a posttest, there will be a difference in students' content acquisition change scores for:

- a. the drill and practice program and the simulation done individually
- b. the drill and practice program and the simulation done in a group
- c. simulation done individually and simulation done in a group.

11. Given a posttest and a retention test, there will be a difference in students' retention change score for:

- a. the drill and practice program and the simulation done individually
- b. the drill and practice program and the simulation done in a group
- c. simulation done individually and simulation done in a group.

12. Given a pretest and retention test, there will be a difference in students' retention change score for:

- a. the drill and practice program and the simulation done individually
- b. the drill and practice program and the simulation done in a group
- c. simulation done individually and simulation done in a group.

Statistical Analysis

Descriptive Statistics. Descriptive statistics was used to describe each instructional computing group's pretest, posttest, and retention test.

ANOVA. In order to compare all three instructional computing groups, analysis of variance (ANOVA) was used.

Precautions Taken for Accuracy

The testing done in this study was conducted by the researcher. The researcher also scored and recorded the tests. Students' test scores were recorded on test score sheets using student numbers instead of student names.

The data analysis was conducted under the direction of the researcher's major advisor, Dr. L. W. Ellerbruch. The analysis was done on the Honeywell level 66 computer at Montana State University using SPSS.

The final data set was verified against the raw data.

Management of Situations Beyond Researcher's Control

The following situations were considered in order to properly manage this study:

1. Scores that may have been recorded for a student were deleted if the student left school, decided not to participate in the study, or was absent, which resulted in missing any of the required treatment or testing.
2. Testing, scoring, and recording were done by the researcher.
3. Presentation of the instructional computing lessons did not vary because of their nature. What was contained in the computer program could not unintentionally be changed to vary the presentation.
4. Verification of data occurred at each stage by the researcher's major advisor, Dr. L. W. Ellerbruch.

Summary

This study was designed to examine the effects of a computer drill and practice program and a computer simulation program on students' content acquisition and retention scores.

Three instructional computing groups were established. The groups were as follows: 1.) drill and practice (DP), 2.) simulation done individually (SI), 3.) simulation done in a group of three (SG). The groups were composed of the fourth grade students at Emerson School

in Bozeman, Montana. The experimental period was during the month of February, 1982.

All three of the instructional computing groups subjects received the same amount of time on the computer program to which they were assigned.

Data collection included pretesting, posttesting, and retention testing. The instrument used for those purposes was developed by the designer of this study. Validation was done by Dr. Paul Markovits and Dr. Elnora Old Coyote, Montana State University elementary science education specialists. Reliability was established by administering the instrument to subjects not involved with the study.

Steps to insure confidentiality were taken. The study also included precautions for accuracy.

Statistical analysis was supervised by Dr. L. W. Ellerbruch, Montana State University elementary math education specialist. The University's computer was used for the statistical process.

CHAPTER 4

Data Analysis

This study was designed to examine the effects of three instructional computing approaches on students' content acquisition and retention scores.

Overview of Design

In order to examine the effects of instructional computing, three treatment sequences were designed and implemented at Emerson School in Bozeman, Montana. The treatment groups were composed of fourth grade students from three self-contained classrooms.

Students were randomly assigned to one of three instructional computing treatment sequences by the aid of a random number program implemented on the Honeywell Level 66 computer at Montana State University. The instructional computing treatment sequences used in this study are designated as: 1.) individual drill and practice (DP), 2.) individual simulation (SI), and 3.) group simulation composed of three students per treatment group (SG).

After students had been assigned to an instructional computing treatment sequence, the students were assigned individual code numbers. Those code numbers were used for scoring, recording and analyzing the data collected in this study.

A pretest was administered to all students participating in this study. Based on this pretest, equivalency of the three treatment groups was verified.

Students received two ten-minute sessions of an instructional computing lesson according to the treatment group to which they had been assigned. The amount of time between the first and second session was five to six days.

After the instructional period, a posttest was administered to determine if the instruction had produced any change in scores from pretest to posttest as a result of treatment. The posttest was also used to determine if a difference occurred between groups.

The same instrument was used two weeks after the last instructional session as a retention test. All tests were administered, scored and recorded by the researcher. The analysis was done on the Honeywell Level 66 computer at Montana State University using SPSS under the direction of Dr. L. W. Ellerbruch, Montana State University elementary math education specialist.

Organization

In Chapter Four is contained the presentation and discussion of the results of the data analysis. The results are presented and discussed in the following order:

1. Pretest results to establish equivalency of treatment group
2. Posttest results for each treatment group

3. Pretest to posttest gain scores for each treatment group
4. Retention test scores for each treatment group
5. Means of pretest to retention test scores for each treatment group
6. Pretest to retention test mean gain scores for each treatment group
7. Means of posttest to retention test scores for each treatment group
8. Posttest to retention test mean gain scores for each group.

Statistical Techniques

T-test, descriptive statistics, LSD, and analysis of variance (ANOVA) were the statistical tools used for the data analysis for this study. A significance level of .05 was chosen. When appropriate, further analysis was performed using Scheffe to isolate treatment differences.

Pretest

The pretest was administered to students from the three fourth grade classes participating in the study.

The treatment groups were determined to be equivalent by use of the t-test. The pretest scores were later used to compute gain score (pretest to posttest) and net gain score (pretest to retention test). ANOVA was used for comparison of treatment groups mean scores.

Results of the pretest are shown in Table I. The purpose of this analysis was to determine if the DP, SI, and SG treatment groups were equivalent before administration of the treatment. The F value derived was 1.06 which has a significance equal to .36. Based on the analysis of the data, no significant difference was found at the .05 level. It was concluded that the three treatment groups were equivalent prior to treatment.

Table I. Pretest Comparability for Treatment Groups

Group	N	Mean	SD
DP	17	3.00	2.18
SI	20	2.20	1.47
SG	21	2.57	1.33
F ratio 1.06		P value .35	

Treatment

After the treatment groups were determined to be equivalent, all the participants were subjected to round one of the treatment which consisted of the ten-minute instructional computing sequence. When all participants had completed round one, the second ten-minute instructional sequence was administered in the same manner.

Posttest

Immediately after a student completed the second instructional session, a posttest was administered. This procedure was used to insure the same amount of time between treatment and posttest for each participant.

After treatment and posttesting, data were analyzed according to treatment group. Means and mean gain scores were computed and then analyzed. The purpose of this analysis was to determine whether there were differences in treatment group scores.

Posttest means by treatment group are shown in Table II.

Data from the posttest means were subjected to ANOVA. An F score of .96 was derived with a probability of .39. It was determined that there was no significant difference at the .05 level. In the analysis it is suggested that there was no difference in posttest means for the three treatment groups. It may be concluded that the three treatment groups were equal at the end of treatment and posttesting. Because the three different treatments did not result in differences in scores, we can conclude that none of the treatment techniques was more effective than another.

Table II. Posttest Means for Treatment Groups

Group	N	Mean	SD
DP	17	6.52	3.02
SI	20	7.75	2.31
SG	21	7.09	2.70
F ratio .96		P value .39	

Posttest Means Compared to Pretest Means

Each treatment group's posttest and pretest mean was compared. This comparison was performed to determine whether there was a difference in students' scores after treatment.

The means of the DP treatment group changed from 3.00 on the pretest to 6.52 on the posttest. The computed t-value was -4.69. The means of the SI treatment group changed from a pretest mean of 2.20 to 7.75 on the posttest. A t-value of -10.56 was computed. The means of the SG treatment group changed from a pretest mean of 2.60 to 7.09 for the posttest. The t-value was computed at -7.99. All three treatment groups increased their scores from pretest to posttest at a significant level. It may be concluded that content acquisition occurred during the time from the pretest to the posttest for each group. The only apparent treatment that occurred between pretest and posttest

was the instructional computing lesson. It can be inferred that the treatment was responsible for the increase in scores.

In a search of the literature it is indicated that not much research has been done to determine the effectiveness in using simulation as a technique to promote content acquisition (Cohen and Bradley, 1978). In the research that has been done it is indicated that the value of simulation may well lie in promoting divergent thinking rather than learning content material. Conflicting views are expressed concerning the effectiveness of simulation as a means of promoting content acquisition (Boysen and Thomas, 1979). According to the literature, one might expect that content acquisition would occur using the drill and practice approach. It might be doubted that content acquisition would occur using the simulation approach. In the results of this study it is indicated that content acquisition can occur using the simulation technique.

This information is presented in the following tables: In Table III are presented the results of data subjected to ANOVA. In Tables IV, V, VI, and VII are presented the t-test results. The t-value, degrees of freedom and correlation probability are also given.

Table III. Pretest to Posttest Means for Comparison of Treatment Groups

Group	N	Pretest		Posttest	
		Mean	SD	Mean	SD
DP	17	3.00	2.17	6.52	3.02
SI	20	2.20	1.47	7.75	2.31
SG	21	2.60	1.35	7.09	2.70

Table IV. T-Test Comparison of Pretest to Posttest Means

DP Treatment Group			
	N	Mean	SD
Pre	17	3.00	2.17
Post	17	6.52	3.02

t-value = -4.69

probability = .00

mean difference = -3.52

standard deviation = 3.11

Table V. T-Test Comparison of Pretest to Posttest Means

DP Treatment Group			
	N	Mean	SD
Pre	20	2.20	1.47
Post	20	7.75	2.31

t-value = -10.56
 probability = .00
 mean difference = - 5.55
 standard deviation = 2.35

Table VI. T-Test Comparison of Pretest to Posttest Means

SG Treatment Group			
	N	Mean	SD
Pre	21	2.60	1.36
Post	21	7.09	2.71

t-value = -7.99
 probability = .00
 mean difference = -4.52
 standard deviation = 2.67

Table VII. T-Test Comparison of Pretest to Posttest Means for Treatment Groups

Pre to Post	Mean Dif	SD	T	P
DP	-3.52	3.11	- 4.7	.00
SI	-5.55	2.35	-10.5	.00
SG	-4.52	2.67	- 8.0	.00

Gain Score From Pretest to Posttest

The gain score was computed from the pretest to the posttest to determine whether a particular type of treatment would result in differences in content score.

Gain scores for each treatment group were computed by subtracting the pretest mean from the posttest mean within each group.

An F score of 2.69 with a probability of .08 was computed. There was no significant difference at the .05 level. This information would lead us to conclude that none of the three treatment groups was more effective in promoting content acquisition. However, LSD procedures performed on the same data showed a significant difference at the .05 level when comparing the DP group with the SI group. The SI group had a mean gain of 5.55 with a standard deviation of 2.35. The DP group's mean gain was 3.52 with a standard deviation of .75. No significant difference occurred when comparing the SG group's mean gain

of 4.52 with the mean gain of the DP and the mean gain of the SI. Because a significant difference occurred when comparing the DP and the SI, Scheffe procedures were used to attempt to locate the difference at the .05 level. The results indicated no two groups were significantly different at the .05 level. LSD procedures tend to be more sensitive than Scheffe procedures, which could account for the difference being picked up by LSD and not picked up by Scheffe. Although there may be a difference in gain score from pretest to posttest when comparing DP and SI, it is not so strong as to be demonstrated by Scheffe. Thus, the implications may have to be questioned.

All three treatment groups showed a positive gain score. Based on the results of the tests, it can be inferred that the three types of treatment used were effective in instruction. If the type of treatment influenced the gain score, it can be said that the SI approach was more effective than the DP approach. It is important to keep in mind that the more sensitive LSD procedure indicated a difference while the less sensitive Scheffe procedure did not locate a difference.

In Table VIII is presented the information for each of the treatment group gain scores. By the asterisk (*), a significant difference at the .05 level is identified.

Table VIII. Gain Scores from Pretest to Posttest for Treatment Groups

Group	N	Mean	SD
DP	17	3.52	3.10*
SI	20	5.55	2.35*
SG	21	4.42	2.73

*indicates a significant difference at the .05 level comparing the SI group with the DP group.

F ratio 2.69

P value .08

Retention Testing

After a two-week period following the posttest, a retention test was administered to the three treatment groups. The instrument used was the same instrument administered as the pretest and posttest. The retention test was administered in a single session in each individual classroom. Three students were tested three days after the regular retention test date because of absence from school.

The purpose of the retention testing was to determine whether there was a difference in scores of any of the three treatment groups.

ANOVA was used to compare treatment group retention means. The analysis showed no significant difference at the .05 level. The F ratio was computed as .26 with the P value of .78. The treatment groups were considered equal at the end of the retention testing.

Since no difference was found, none of the treatment techniques used can be considered as more effective than another.

In Table IX are the results of the analysis of retention test means.

Pretest to Retention Test

A t-test was used to compare the retention test mean with the pretest mean of each treatment group. All three treatment groups showed a significant difference at the .05 level from pretest to retention test. It can be concluded that all three treatment techniques were effective in retention of the acquired content material.

In the following tables is shown the t-test comparison of pretest to retention test for all three treatment groups.

Table IX. Retention Test Means for Treatment Groups

Group	N	Mean	SD
DP	17	7.00	3.08
SI	20	7.60	2.14
SG	21	7.19	2.68

F ratio = .26

P value = .78

Table X. T-Test Comparison of Pretest to Retention Test Means

	DP Treatment Group		
	N	Mean	SD
Pre	17	3.00	2.17
Post	17	7.00	3.08

t-value = -5.58
 probability = .00
 mean difference = -4.00
 standard deviation = 2.96

Table XI. T-Test Comparison of Pretest to Retention Test Means

	SI Treatment Group		
	N	Mean	SD
Pre	20	2.20	1.47
Post	20	7.60	2.13

t-value = -10.70
 probability = .00
 mean difference = - 5.40
 standard deviation = 2.26

Table XII. T-Test Comparison of Pretest to Retention Test Means

	SG Treatment Group		
	N	Mean	SD
Pre	21	2.57	1.32
Post	21	7.19	2.67

t-value = -7.65
 probability = .00
 mean difference = -4.61
 standard deviation = 2.76

Table XIII. T-Test Comparison of Pretest to Retention Test Means

Pre to Ret	Mean Dif	SD	T	P
DP	-4.00	3.00	- 5.60	.00
SI	-5.40	2.30	-10.70	.00
SG	-4.61	2.76	- 7.70	.00

Posttest to Retention Test

A t-test was used to compare posttest means to retention test means for each treatment group. The comparison was made to determine whether there was a difference in treatment group scores from post-testing to retention testing. No difference was found in any of the treatment groups. It can be concluded from the analysis of the

scores that each treatment group maintained retention of the content acquired.

Table XIV. T-Test Comparison of Posttest to Retention Test Means

DP Treatment Group			
	N	Mean	SD
Post	17	6.52	3.02
Ret	17	7.00	3.08

t-value	=	-1.12
probability	=	.28
mean difference	=	-.47
standard deviation	=	.42

Table XV. T-Test Comparison of Posttest to Retention Test Means

SI Treatment Group			
	N	Mean	SD
Post	20	7.75	2.31
Ret	20	7.60	2.13

t-value	=	.28
probability	=	.79
mean different	=	.15
standard deviation	=	2.43

Table XVI. T-Test Comparison of Posttest to Retention Test Means

	SG Treatment Group		
	N	Mean	SD
Post	21	7.09	2.70
Ret	21	7.19	2.67

t-value = - .23
 probability = .82
 mean difference = - .695
 standard deviation = 1.86

Gain Score From Pretest to Retention Test

Gain scores were computed for three treatment groups and compared by ANOVA. The comparisons were made to determine whether there were any differences in gain scores for the three treatment groups. No difference occurred between the three treatment groups' gain score from pretest to retention test. This indicates that none of the treatment techniques was more effective in promoting retention of the content material.

The results of the pretest to retention test gain score are shown in Table XVII.

Table XVII. Retention Text Gain Score Pretest to Retention Test

Group	N	Mean	SD
DP	17	4.00	2.96
SI	20	5.40	2.26
SG	21	4.62	2.77

F ratio = 1.29

P value = .28

Gain Score From Posttest to Retention Test

Comparison by ANOVA showed no difference between the three treatment groups' gain score from posttest to retention test. This indicates that none of the treatment techniques was more effective in promoting retention of the content material.

Table XVIII. Retention Test Gain Score Posttest to Retention Test

Group	N	Mean	SD
DP	17	.47	1.74
SI	20	-.15	2.43
SG	21	.10	1.87

F ratio = .43

P value = .66

Summary

In Chapter Four are presented the results of the pretesting, posttesting, and retention testing of the three treatment groups involved in this study.

Data were analyzed and compiled for the following:

1. Establishing equivalency of treatment groups
2. Results of pretests for the three treatment groups
3. Results of posttests for the three treatment groups
4. Results of retention tests for the three treatment groups.

ANOVA was used to compare the three treatment groups. The three treatment groups were found to be equivalent at the beginning of treatment.

All three treatment groups acquired content at a significant level from the pretest to the posttest. The SI group showed a significant difference in gain score from pretest to posttest when compared by LSD to the DP group. This indicates that the SI treatment was more effective at promoting content acquisition than the DP treatment. It should be noted that, when Scheffé was used to isolate the difference, no significant difference occurred. The LSD procedure is a more sensitive procedure than the Scheffe procedure. Although a difference did occur, it must be noted that the difference was not great enough to be picked up by Scheffe.

There was no significant difference from posttest to retention test between any of the treatment groups. That information leads us to the conclusion that none of the treatment techniques was more effective in promoting retention of the acquired content. Analysis of the data indicates that each treatment group maintained the acquired content throughout the two-week retention period.

An important observation about simulation as a vehicle for learning content material was noted. Simulation has been claimed to be valuable for promoting higher-level thinking (Boysen and Thomas, 1979). Suggestions have been made that simulation may not be a desirable method for learning content material (Shay, 1980). This study has found that certain content material can be acquired through simulation.

Studies have been limited on retention of material acquired through simulation. In this study is indicated that retention of content acquired through simulation can occur.

The claim that acquisition and retention of content material occurs through drill and practice is not disputed by other studies, nor by this study.

Huwiler's (1979) theory that "Quick learning is possible" seems to be verified in this study. A significant difference in content

acquisition occurred from pretest to posttest and from pretest to retention test for all three groups. These students acquired the content in two ten-minute instructional computing sessions and retained the content throughout the two-week retention period. There was no other time spent on acquisition of the material. It seems that students can acquire certain content material in a short amount of time.

Discussion, recommendations, and implications of these findings are discussed in Chapter Five.

CHAPTER 5

Discussions, Recommendations, and Implications

Computers are now a part of our lives. Homes, businesses, and schools are finding ways to effectively implement the microcomputer. Educators are continually searching for new and better ways to help students in learning situations. In that search, the microcomputer is being analyzed as to how it can best serve the student. A part of that search must be to determine whether certain types of instructional computing techniques are more effective for specific purposes. This research was developed to help add information to that search.

The specific purpose of this study was to compare the effects of a computer drill and practice program with a computer simulation program on cognitive acquisition and retention of science-oriented material for fourth grade students at the Emerson School, Bozeman, Montana.

The fourth grade students were randomly assigned to one of the three treatment groups for instructional computing lessons in science-related material. The treatment groups were as follows: 1.) drill and practice done individually (DP), 2.) simulation done individually (SI), and 3.) simulation done in a group of three (SG).

In a pretest administered before treatment, it was determined that the treatment groups were equivalent.

Treatment consisted of two ten-minute instructional computing sessions for each individual or, in the case of the SG students, two ten-minute sessions for each group of three.

At the present time, there is conflicting evidence as to whether simulation is a technique which can promote learning of content material. It is felt by many that the best use of simulation is to promote higher levels of thinking and problem solving. There is some question as to whether or not the use of simulation can promote content acquisition. Very little research has been conducted on retention as it relates to content acquisition through simulation. It is generally felt that drill and practice programs are well-suited for computer use where learning a defined objective with specific outcomes is the goal (Wall and Taylor, 1982).

Twelve hypotheses were tested for this study. Through the testing of the hypotheses, it was found that content acquisition and retention are possible using the computer simulation technique. Content acquisition and retention also occurred using the computer drill and practice technique.

Organization

In Chapter Five are the discussion, recommendations, and implications concerning this study. The Chapter is organized around the following items:

1. The hypotheses are presented as being accepted or rejected.

2. The statement of the problem is discussed in reference to the information obtained from the data.

3. Conclusions are presented dealing with the results of test analysis.

4. Subjective information collected during the study is discussed.

5. Recommendations for further research are presented.

6. Implications for educational uses are discussed.

Hypotheses Acceptance or Rejection Based Upon Data Analysis

The hypotheses in this study dealt with the performance of the students in the three instructional computing groups. Each of the hypotheses was reviewed according to the analysis of the data and then accepted or rejected.

Hypotheses

1. There is a difference in drill and practice scores from pretest to posttest. This was accepted. A significant difference occurred for the DP treatment group from pretest to posttest.

2. There is a difference in drill and practice scores from posttest to retention test. This was rejected because no significant difference occurred for the DP group from posttest to retention test.

3. There is a difference in drill and practice scores from pretest to retention test. This was accepted because a significant difference occurred for the DP group from pretest to retention test.

4. There is a difference in scores from pretest to posttest scores in the simulation done individually (SI). This was accepted because significant difference occurred for the SI group from pretest to posttest.

5. There is a difference in scores from posttest to retention test in the SI. This was rejected because no significant difference occurred for the SI group from posttest to retention test.

6. There is a difference in scores from pretest to retention test in the SI. This was accepted because a significant difference occurred for the SI group from pretest to retention test.

7. There is a difference in scores from pretest to posttest in the simulation done in a group (SG). This was accepted because a significant difference occurred for the SI group from pretest to posttest.

8. There is a difference in scores from posttest to retention test in the SI. This was rejected because no significant difference occurred for the SI group from posttest to retention test.

9. There is a difference in scores from pretest to retention test in the SI. This was accepted because a significant difference occurred for the SI group from pretest to retention test.

10. Given a pretest and posttest, there will be a difference in student's content acquisition gain scores for:

- a. the DP and SI

This was accepted because there was a significant difference when comparing the DP and the SI treatment groups. The SI treatment group showed a higher gain score than the DP group.

- b. the DP and SG

This was rejected because no significant difference occurred.

11. Given a posttest and a retention test, there will be a difference in the retention gain score for:

- a. the DP and SI

This was rejected because no significant difference occurred.

- b. the DP and SG

This was rejected because no significant difference occurred.

- c. the SI and SG

This was rejected because no significant difference occurred.

12. Given a pretest and retention test, there will be a difference in student's retention gain score for:

- a. the DP and SI

This was rejected because no significant difference occurred.

- b. the DP and SG

This was rejected because no significant difference occurred.

- c. the SI and SG

This was rejected because no significant difference occurred.

Twelve hypotheses were tested. The hypotheses that related to difference in scores from pretest to posttest were accepted. All three treatment groups showed a significant difference from pretest to posttest. Hypotheses that related to the difference in scores from pretest to retention test were accepted. All three treatment groups showed a significant difference from pretest to retention test.

Hypotheses that related to the difference in scores from posttest to retention test were rejected. None of the three treatment groups showed a significant difference from posttest to retention test.

Hypotheses that related to differences when comparing treatment groups' scores were rejected with one exception. The hypothesis that there would be a difference in content acquisition gain scores for the DP treatment group and the SI treatment group was accepted. In the results of data analysis it was indicated that the SI treatment was more effective than the DP treatment for content acquisition.

Statement of the Problem

In this investigation the effects of a computer drill and practice program were compared with a computer simulation program on cognitive acquisition and retention scores of science-oriented material for fourth grade students.

Discussion of the Statement of the Problem

In this study was addressed the question of what effects the three instructional computing techniques would have on cognitive acquisition and retention of science-oriented material for fourth grade students in the Emerson School, Bozeman, Montana. The purpose of the study was to compare the test scores to see if one technique is more effective for acquisition and/or retention of content material. The findings of the study provided information on this question.

A significant difference occurred from pretest to posttest in all three instructional computing groups. It can be concluded that all three techniques were effective in content acquisition. A significant difference occurred when using LSD to compare the pretest to posttest gain scores for the DP and SI groups. The SI gain score was higher than that of the DP. This indicates that the SI technique was more effective than the DP technique for content acquisition. It should be noted that when Scheffe was used to isolate the difference, no significant difference occurred. The LSD procedure tends to be more sensitive than the Scheffe procedure. Although a difference did occur, it must be noted that the difference was not great enough to be picked up by Scheffe. This must be taken into account when considering any implications or generalizations.

No significant difference occurred between any of the instructional computing groups' gain scores in the posttest to retention

test. It must then be concluded that no treatment technique was more effective in promoting retention of the content material.

Conclusions

This study was designed to investigate the effects of a computer drill and practice program and a computer simulation program on students' content acquisition and retention scores.

Fourth grade students were randomly assigned to one of three treatment groups for instructional computing lessons in science-related material. The treatment groups were: 1.) drill and practice done individually (DP), 2.) simulation done individually (SI), and 3.) simulation done in a group of three (SG). A pretest administered before treatment determined that the treatment groups were equivalent.

Treatment consisted of two ten-minute instructional computing sessions. A posttest was administered immediately following each student's second round of treatment. The retention test was administered two weeks after the posttest.

Data obtained from pretesting, posttesting, and retention testing were analyzed to determine whether a particular treatment technique indicated a difference in scores for content acquisition or retention.

Posttest conclusions

In the results of the posttest it was indicated that the three instructional computing groups gained in content acquisition the

science material presented. This gain was attributed to the instructional computing techniques used in the treatment because there was no other apparent treatment that could have significantly influenced the change in score from pretest to posttest.

According to the literature, it would be expected that the DP group would acquire content. There was, according to the literature, some question and doubt as to whether the SI group or the SG group would acquire content. In the results of this study it was shown that students in the SI group generated a significant difference in gain score from pretest to posttest when compared with the DP group. It can be concluded that the SI group was more effective than the DP group in content acquisition for this study. It must be noted that although the difference was found by LSD procedures, a difference was not found by the less-sensitive Scheffe procedure. In making generalizations or discussing implications, it is necessary to realize the difference was not strong enough to be picked up by Scheffe procedures.

One factor not measured could have had some influence on the score for each group. That factor not measured is the number of cycles through the program. It is probable that the number of cycles through the program were not equal in number for each child. This could have been affected by reading ability, time spent in discussion, learning style and construction of the program.

Student's reading ability could have affected the number of times the student went through the sequence of information in the two-ten-minute sessions. Students controlled the reading of the information by pressing a key to go to additional material. This was done to allow children to progress through the material at their own rate. Whether or not the student worked in a group or worked alone could have affected the number of cycles through the program because of time spent or not spent in discussion.

The student's learning style may or may not have matched the type of program to which he was assigned. No attempt was made to determine or match learning styles with the instructional computing technique. It is possible that students who prefer to work alone were assigned to work in a group and visa versa. In the written comment section about this study, one student expressed he would rather work alone if he had another chance. It is also possible that students who learn better by visualization were assigned to a program with no graphics.

The difference in construction of the computer drill and practice program and the computer simulation program could have had an effect on the number of times the information was presented to the students. Students were allowed ten minutes from the time the program was started. The DP treatment group was presented a question, the student responded and received the feedback as to whether his/her

response was correct or incorrect. The SI and SG treatment involved more reading and more time for the computer to display the graphics. Additional time was taken by decision-making. Students in the SI and SG treatment groups decided which fish to role play and what option to take for each situation that the program generated.

One of the theories of drill and practice is that learning occurs by repetition. It is probable that the DP treatment group was presented the content information more times than the SI or the SG treatment groups. However, it is also possible that the decision-making in the SI and SG treatment groups may have promoted more concrete learning than the stimulus-response-feedback provided for the DP treatment group. Thus the decision-making in the simulation program may have been more efficient for learning than the repetition of the material.

One other consideration is the incubation or digestion time from treatment to posttest. Research indicates that the amount of time from treatment to posttest may affect the score. Some students appear to benefit by an incubation period between treatment and testing. The students in this study were administered the posttest immediately after completing round two of the treatment. This procedure was taken to insure the same amount of time for each student from treatment to posttest.

Retention Test Conclusions

A significant difference was reported for all three instructional computing groups from pretest to retention test. It is concluded that all treatments used were effective in promoting learning and retention of the content acquired. In the results from the posttest to the retention test it was indicated that the students maintained their content acquisition level over the two-week retention period. There was no significant difference in retention between any of the groups. It is not known whether a longer period for retention would have affected the retention test results. It can be concluded that the instructional computing techniques used in treatment were effective in retention of the material learned in the treatment. None of the treatment techniques was more effective than another in promoting retention from posttest to retention test.

Discussion of Subjective Information

Collection of subjective information could not be subjected to statistical analysis. The researcher finds it worthwhile to mention the subjective information that was collected during the study.

The principal and the three classroom teachers involved in the study were interested and cooperative throughout the entire project. They observed the students and the instructional computing programs. Two of the teachers indicated a desire to learn more about instructional computing. One of the teachers attended an inservice at

another school to learn more about using computers with students. The other teacher has decided to take a university course in instructional computing. Other staff members stopped for brief observations, questions, and tried sample runs of the programs. Some of the staff members expressed previous feelings of intimidation involving the computer. One teacher visited another elementary school to observe what was being done with computers at that school. It appears that this casual type of exposure to computers was non-threatening to the teachers and may facilitate implementation of instructional computing in the future. As a contrast to the teachers, the students seemed relaxed and eager to attempt the instructional computing lessons.

All students that were in the group simulation technique (SG) participated in discussion and decision-making during the program. Often they took turns reading the information. Occasionally they read it out loud simultaneously. Discussion and speculation occurred in all cases. The decision of what action to take was usually the result of consensus of the group. Frequently they left it up to one individual if the group couldn't agree. Usually the decision was made by the person at the keyboard. The determination of who was at the keyboard was usually decided shortly after the program had begun. A rotation system was the method all groups used. The determining point of when to rotate varied from general time limits to completion

of a simulation situation. The researcher made no attempt to interfere or make suggestions.

In the photographs taken by the researcher of students running the programs, the students are shown as intent and not distracted by other elements. From the tape recordings of students running the programs, the researcher indicated the students were enthusiastic about both the first and second round of the treatment. Many of them were interested in other programs that might be available. One boy asked if there might be a program similar to the one he was using so he could learn about snakes. When students saw the researcher at the school after the study was completed, they frequently asked to have the computer brought back. In the appendix is contained a section on student reaction to this instructional computing study. The comments were written by the students after taking the retention test.

In informal questioning about computer use it was revealed that about one-fourth of the students had used computers outside of the school before this treatment. None of the students who had experienced computers had seen the program used in this study.

The school district superintendent observed three groups of students during treatment. He noted that the students were not intimidated by the computer and he was interested in the number of students who had already experienced computers outside of the school setting. He expressed interest in the study and speculated on the results.

In reviewing the subjective information, it appears that the use of instructional computing was well-accepted by students, staff, and administration.

Recommendations for Further Research

Recommendations for further research derived from this study's objective data and subjective information are:

1. to investigate content acquisition by drill and practice and simulation programs using a larger sample
2. to replicate this study and include a control group to compare with the instructional computing group(s)
3. to investigate whether a student's computer experience has any effect on his score
4. to replicate the study and keep track of the number of passes through the program or the number of responses during the program
5. to identify students' learning styles and compare with performance on varying instructional computing techniques
6. to investigate what role graphics play in learning
7. to investigate the outcome of dividing the sample into three groups (group one would have a determined number of passes through the program, group two would have a certain amount of time, and group three would be free to use whatever number and length of sessions necessary to feel they had learned the content. Careful

recording of the time, number of sessions, and passes through the program would be necessary)

8. to investigate difference in performance between students allowed to choose their preferred instructional computing technique and students not allowed to choose

9. to investigate varying amounts of incubation time on retention

10. to investigate varying amounts of incubation time of a specific instructional computing technique

11. to investigate varying amounts of time on task for content acquisition

12. to investigate varying amounts of time on task for content acquisition for a specific computing technique.

Implications for Educational Uses

1. Educators should be aware of specific computer techniques. They should then determine which technique will best provide instruction for the objective in mind. Although this study found that content acquisition and retention of that content can occur through both simulation and drill and practice techniques, generalizations must be approached with caution. It is possible that the type of content and

the design construction of the program may determine the effectiveness of the program. As software development progresses, hopefully evaluations of programs will spell out the objective and how effective that individual program is at meeting the stated objective. Until then, educators must pay careful attention to the programs they are using with students.

2. Because in this study it was found that there was a significant difference in gain score from pretest to posttest when comparing the DP and SI treatment groups, we should focus attention of further research that may provide more information on this finding.

3. In this study information was not included about learning styles of the students. Educators should be aware that certain students may perform better on a certain type of instructional computing technique. Teacher observation and students' input should be taken into consideration when determining what program or program technique is to be used with each individual.

4. Although in this study the researcher did not investigate simulation use for promoting higher-level thinking or divergent thinking, educators should be aware that the literature generally claims that may be the best use of simulation. One reason for the claim is that the computer has the capabilities required to quickly process the variety of situations and responses necessary in a simulation.

5. Peer discussion occurs in situations where students are allowed to work on a simulation in a group. It is possible this discussion can promote or reinforce thought processes in a different method than the typical classroom setting. Students can share ways to approach a situation and predict what and why they perceive a particular outcome. The rapid response of the computer allows immediate, non-judgmental feedback on their thinking.

6. Educators should be aware that it is possible to acquire certain types of content in relatively short amounts of time on task. It is possible that the intentness that the student shows to the program may account for this success. One must be aware that "quick learning" is probably only possible when the objective of the program is very clear to the learner. Teachers may want to transfer this technique to certain classroom instruction that does not involve the computer.

7. The rapid increase of home computers will no doubt make changes in education. Software that is used in schools will be available for purchase by parents and students for use at home. Some school librarians are already checking out software for students to use with home computers. This will allow students to work on specific skill acquisition, content acquisition, problem solving and areas of individual interest at their own rate and own style. Students may choose the amount of time, the number of sessions, the time of day, place in the home, levels of noise needed or tolerated and other

combinations of environment that make up the student's learning style. Parents, extended family members, friends, and peers may become involved in the student's learning or quite possibly decide to do some additional learning of their own. The microcomputer may well be the vehicle to encourage students and adults to continue learning outside the classroom (Elliott, 1982).

If this type of learning becomes successful, according to Toffler (1981), the role of the teacher as we perceive it today will change. Rather than a provider of information, the teacher will move more toward a role of an educational facilitator. This should not be taken to mean that the computer will replace the teacher. The computer will enhance, rather than replace, the teacher's effectiveness.

Summary

As the computer increasingly becomes a part of our lives, it is necessary to determine how it will affect students. This study investigated the effects of a drill and practice program and a simulation program on students' content acquisition and retention scores.

Fourth grade students in the Emerson School, Bozeman, Montana, were randomly assigned to one of three instructional computing treatment groups. The treatment groups were as follows: 1.) drill and practice done individually (DP), 2.) simulation done individually (SI), and 3.) simulation done in a group of three (SG).

Treatment consisted of two ten-minute instructional computing lessons of science-related material. The content of the programs was the same for each treatment group. The difference in the programs was in the design construction. The drill and practice program consisted of a question, the student responded and received feedback about the response. The simulation program presented a role-playing situation in which the student selected an option, watched the result via graphics, read information about his choice of options and was presented another situation. Both the SI and SG treatment groups used the same simulation program. The difference was that the SI group received the treatment individually, and the SG group received the treatment in a group of three students per group. The students in the SG group were free to discuss the program and their decisions during the treatment.

In the results of the data analysis it was indicated that students in all three treatment groups acquired and retained the content material. This was shown by the significant difference which occurred for each treatment group from pretest to posttest and from pretest to retention test.

An interesting finding occurred when comparing the gain score of the DP treatment group to the gain score of the SI treatment group. Doubts have been raised as to the effectiveness of using a simulation approach for content acquisition. While the benefits of simulation

have been acclaimed for use in divergent thinking, claims have also been made that simulation may not be the approach to use if content acquisition is the goal. Although caution must be taken in generalizing the findings of this study, it is important to note that a significant difference occurred when comparing gain scores of the DP and SI treatment groups. According to the results of the analysis of the data, the treatment for the SI group was more effective than the treatment for the DP group in promoting content acquisition. Because of this finding, the researcher suggests further investigation be conducted.

It should also be noted that the treatment sessions consisted of two ten-minute instructional computing lessons. Because content acquisition and retention did occur, it is reasonable to believe that learning can occur in a short amount of time. Before making generalizations, it is important to note that "quick learning" may only be possible when the objective is very clear to the learner.

Suggestions for further research include investigating learning styles and student performance on computer drill and practice and computer simulation programs.

There are many aspects of instructional computing that appear to be beneficial to students. We must continue to investigate how the computer can best serve the educational needs of the student.

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APPENDICES

APPENDIX A

Listing of Drill and Practice Program

P
JLIST

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5 REM GREETING
10 PRINT "      DRILL AND PRACTICE PROGRAM"
11 PRINT
20 PRINT "      CREATED BY"
25 PRINT
30 PRINT "      KIM HASTING AND SHARON HULETT"
35 PRINT
40 PRINT
51 PRINT "      FOR"
55 PRINT
60 PRINT "      USE IN A COMPUTER STUDY"
75 PRINT
80 PRINT "      JANUARY, 1982"
85 PRINT
86 PRINT "      MONTANA STATE UNIVERSITY"
87 PRINT
88 PRINT
89 PRINT
90 PRINT "TO START THE PROGRAM, TYPE"
95 PRINT
100 PRINT "      RUN FISH2"
110 END

```

JLOAD FISH2
JLIST

```

10 HOME
20 REM ODELL LAKE DRILL & PRACTICE
30 REM VERSION 1.0 1/16/82 KH
40 REM
50 REM F : FISH TYPE
60 REM A : ATTACKER TYPE
70 REM P1 : PHASE I (1 IF COMPLETE)
80 REM P2 : PHASE II
90 REM P3 : PHASE III
100 REM T : # OF TRIES
110 REM R : NUMERIC RESPONSE
120 REM R# : CHARACTER RESPONSE
130 REM R1# : CORRECT RESPONSE
140 REM N# : FISH NAMES
150 REM
190 N$(1) = "RAINBOW TROUT"
200 N$(2) = "MACKINAW TROUT"
210 N$(3) = "DOLLY VARDEN"
220 REM START OF PROGRAM
230 HOME : VTAB (10): PRINT "      THIS IS A PROGRAM ABOUT FISH."
240 FOR X = 1 TO 2000
250 NEXT X
260 VTAB (24)
270 PRINT "PRESS SPACEBAR TO CONTINUE."
280 GET X#
290 IF ASC (X#) < > 32 THEN 280
300 HOME : VTAB (10): PRINT "YOUR JOB IS TO LEARN:"
310 PRINT
320 PRINT
330 PRINT "      1.  THE SIZE OF THE FISH.....AND"
340 PRINT

```

```

350 FOR X = 1 TO 2500
360 NEXT X
370 PRINT "      2. THE ENEMIES OF THE FISH"
380 FOR X = 1 TO 1500
390 NEXT X
400 VTAB (24): PRINT "PRESS SPACEBAR TO CONTINUE"
410 GET X$
420 IF ASC (X$) < > 32 THEN 410
430 HOME : VTAB (7): PRINT "THE FISH YOU WILL LEARN ABOUT ARE:"
440 PRINT
450 PRINT
460 PRINT "      1. DOLLY VARDEN"
470 PRINT
480 PRINT "      2. RAINBOW TROUT"
490 PRINT
500 PRINT "      3. MACKINAW TROUT"
501 FOR X = 1 TO 3000
502 NEXT X
503 VTAB (23)
504 PRINT "PRESS SPACEBAR TO CONTINUE"
505 GET X$
506 IF ASC (X$) < > 32 THEN 505
510 P1 = 0:P2 = 0:P3 = 0
520 HOME : VTAB (10): PRINT "REMEMBER,"
521 PRINT
522 PRINT
523 PRINT "FISH SIZE IS OFTEN IMPORTANT."
530 FOR X = 1 TO 3000
540 NEXT X
550 PRINT
560 FOR X = 1 TO 1500
570 NEXT X
580 HOME : VTAB (9)
590 HOME : VTAB (9)
600 T = 0
610 IF T = 6 THEN 1370: REM PHASE II
620 F = INT ( RND (1) * 3 + 1)
640 A = INT ( RND (1) * 3 + 1)
660 IF A = F THEN 640
661 PRINT
662 PRINT
670 PRINT "CAN A "N$(F)" EAT"
680 PRINT
690 PRINT " A "N$(A)" (Y/N) ";
700 INPUT R$
710 IF F < 2 THEN R1$ = "N"
720 IF F = 2 THEN R1$ = "Y"
730 IF (F = 3) AND (A < 2) THEN R1$ = "Y"
740 IF (F = 3) AND (A = 2) THEN R1$ = "N"
750 R$ = LEFT$ (R$,1)
760 IF (R$ < > "Y") AND (R$ < > "N") THEN PRINT "PLEASE ANSWER YES OR NO.":
GOTO 670
770 T = T + 1
780 PRINT
790 HOME : VTAB (14)
800 IF R$ < > R1$ THEN 1040
810 IF R$ = "N" THEN 920
820 PRINT "YOU ARE RIGHT."
821 PRINT
822 PRINT

```

```

823 PRINT "A "N$(F)"
830 PRINT
840 PRINT " CAN EAT A "N$(A)". "
850 FOR X = 1 TO 1500
860 NEXT X
870 VTAB 24
880 PRINT "PRESS SPACEBAR TO CONTINUE"
890 GET X$
900 IF ASC (X$) < > 32 THEN 890
910 GOTO 1320
920 PRINT "YOU ARE RIGHT."
921 PRINT
922 PRINT
923 PRINT "A "N$(F)" CANNOT EAT"
924 PRINT
925 PRINT "A "N$(A)". "
930 PRINT
950 FOR X = 1 TO 2500
960 NEXT X
970 PRINT
980 PRINT
990 VTAB 24
1000 PRINT "PRESS SPACEBAR TO CONTINUE"
1010 GET X$
1020 IF ASC (X$) < > 32 THEN 1010
1030 GOTO 1320
1040 IF R1$ = "N" THEN 1200
1050 PRINT "SORRY. THAT IS NOT RIGHT."
1051 PRINT
1052 PRINT
1053 PRINT "A "N$(F)" CAN EAT A "N$(A)". "
1060 PRINT
1080 FOR X = 1 TO 2000
1090 NEXT X
1100 PRINT
1110 PRINT
1120 PRINT
1130 PRINT
1140 PRINT
1150 PRINT
1160 PRINT "PRESS SPACEBAR TO CONTINUE"
1170 GET X$
1180 IF ASC (X$) < > 32 THEN 1170
1190 GOTO 1320
1200 PRINT "YOU MISSED THIS ONE."
1201 PRINT
1202 PRINT
1210 PRINT
1220 PRINT " A "N$(F)" CANNOT"
1230 PRINT
1240 PRINT " EAT A "N$(A)". "
1250 PRINT
1260 PRINT
1270 PRINT
1280 PRINT
1290 PRINT "PRESS SPACEBAR TO CONTINUE"
1300 GET X$
1310 IF ASC (X$) < > 32 THEN 1300
1320 IF (T = 3) AND (P2 = 1) THEN 1640: REM PHASE III
1330 HOME : VTAB (10)

```

```

1340 IF T = 6 THEN 1370
1350 PRINT
1360 GOTO 610
1370 PRINT
1380 PRINT "SOMETIMES AN OSPREY"
1390 PRINT
1400 PRINT " FLIES ABOVE THE LAKE."
1401 FOR X = 1 TO 2000
1402 NEXT X
1405 PRINT
1410 PRINT
1420 PRINT
1430 PRINT "CAN AN OSPREY EAT A "N$(F)"?"
1440 INPUT R$
1450 R$ = LEFT$(R$,1)
1460 IF (R$ < > "Y") AND (R$ < > "N") THEN PRINT "PLEASE ANSWER YES OR NO.":
GOTO 1430
1470 HOME : VTAB (9)
1480 PRINT
1490 IF R$ = "Y" THEN PRINT "RIGHT."
1491 IF R$ = "N" THEN 1550
1492 PRINT
1493 PRINT "AN OSPREY CAN EAT A "N$(F)". "
1494 FOR X = 1 TO 2000
1495 NEXT X
1500 VTAB (23)
1510 PRINT "PRESS SPACEBAR TO CONTINUE"
1520 GET X$
1530 IF ASC (X$) < > 32 THEN 1520
1540 HOME : VTAB (15)
1541 GOTO 1600
1550 PRINT "THAT IS NOT CORRECT."
1551 PRINT
1552 PRINT
1553 PRINT "AN OSPREY CAN EAT A "N$(F)". "
1554 FOR X = 1 TO 2000
1555 NEXT X
1556 VTAB 23
1557 PRINT "PRESS SPACEBAR TO CONTINUE."
1558 GET X$
1559 IF ASC (X$) < > 32 THEN 1558
1600 HOME : VTAB (15)
1610 P2 = 1
1620 PRINT
1630 GOTO 600
1640 HOME : VTAB (15)
1660 PRINT
1670 PRINT
1680 HOME : VTAB (9)
1685 PRINT "OTTERS ALSO LIVE IN LAKES."
1686 PRINT
1687 PRINT
1690 PRINT "CAN AN OTTER EAT A "N$(F)"?"
1700 INPUT R$
1710 IF (R$ < > "Y") AND (R$ < > "N") THEN PRINT "PLEASE ANSWER YES OR NO.":
GOTO 1690
1720 HOME : VTAB (9)
1730 PRINT
1740 IF R$ = "Y" THEN PRINT "YOU ARE RIGHT."
1741 IF R$ = "N" THEN 1801

```

```

1742 PRINT
1743 PRINT "AN OTTER CAN EAT A "N$(F)". "
1745 FOR X = 1 TO 2000
1746 NEXT X
1750 VTAB (23)
1760 PRINT "PRESS SPACEBAR TO CONTINUE"
1770 GET X$
1780 IF ASC (X$) < > 32 THEN 1770
1790 HOME : VTAB (15)
1791 GOTO 1830
1801 PRINT "THAT IS NOT CORRECT."
1802 PRINT
1811 PRINT
1812 PRINT "AN OTTER CAN EAT A "N$(F)". "
1819 FOR X = 1 TO 2000
1820 NEXT X
1821 VTAB (24)
1822 PRINT "PRESS SPACEBAR TO CONTINUE"
1823 GET X$
1824 IF ASC (X$) < > 32 THEN 1823
1830 HOME : VTAB (9)
1840 P3 = 1
1850 PRINT
1860 PRINT "YOU MAY CHOOSE WHAT YOU WANT TO DO NEXT."
1870 PRINT
1871 PRINT
1872 PRINT
1880 PRINT "YOU MAY CHOOSE:"
1890 PRINT
1891 PRINT
1900 PRINT " 1. FISH AGAINST FISH"
1901 PRINT
1910 PRINT " 2. FISH AGAINST OSPREY"
1911 PRINT
1920 PRINT " 3. FISH AGAINST OTTER"
1921 PRINT
1930 PRINT " 4. QUIT"
1931 PRINT
1940 PRINT
1950 INPUT "TYPE THE NUMBER AND PRESS RETURN. "; R
1955 HOME : VTAB (9)
1960 IF (R < 1) OR (R > 4) THEN PRINT "PLEASE CHOOSE 1,2,3 OR 4.": GOTO 1950
1970 IF (R = 2) OR (R = 3) THEN F = INT ( RND (1) * 3 + 1)
1980 ON R GOTO 590,1420,1680,1990
1990 HOME : VTAB (9)
2000 PRINT "    GOOD BYE."

```

APPENDIX B

Listing of Simulation Program

The following program is an adaptation of ODELL LAKE. The program has been adapted to include only three fish instead of six fish. Data statements still include the original six fish. Statements have been inserted to skip the first three fish in the data statements.

The section on water insects and plankton has been eliminated in this adaptation.

Other modifications were made to lessen the amount of information on the screen. Some wording was changed to make it more applicable for this study.

```

JLOAD X
JLIST

```

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5 X1 = PEEK (600): POKE 600,0: DIM S(6)
10 C = 0: TEXT : HOME : Z$ = "": PRINT : IF X1 = 9 THEN 60
11 HOME : VTAB (14): PRINT "GET READY FOR A TRIP TO ODELL LAKE"
12 FOR X = 1 TO 2000
13 NEXT X
14 HOME
15 PRINT
16 VTAB (7): PRINT "YOU WILL HAVE A CHANCE TO BE"
17 PRINT
18 PRINT "EACH FISH THAT LIVES IN THE LAKE."
19 PRINT
20 FOR X = 1 TO 4000
21 NEXT X
25 PRINT
35 PRINT
40 PRINT "      YOUR JOB WILL BE TO FIND OUT:"
45 PRINT
50 PRINT "          1.  THE SIZE OF THE FISH"
55 PRINT
60 PRINT "          2.  THE ENEMIES OF THE FISH."
61 VTAB (24):
62 VTAB (24): PRINT "PRESS SPACEBAR TO CONTINUE."
63 GET X$
64 IF ASC (X$) < > 32 THEN 63
65 HOME : VTAB (9): PRINT "THE FISH YOU SEE ON THE SCREEN"
67 PRINT
68 PRINT "MAY NOT BE:"
69 PRINT
70 PRINT "          1.  THE SAME SIZE IN REAL LIFE"
71 PRINT
72 PRINT "          2.  THE SAME SHAPE IN REAL LIFE"
73 VTAB (23): PRINT "PRESS SPACEBAR TO CONTINUE."
74 GET X$
75 IF ASC (X$) < > 32 THEN 74
80 D$ = CHR$ (4)
83 PRINT D$;"NEW"
84 HOME : VTAB (15)
85 PRINT D$;"RUN EDIT"

```

33
3

LOAD EDIT
LIST

```

60 PRINT : PRINT "THE FISH YOU CAN CHOOSE FROM ARE:": PRINT
80 RESTORE : FOR X = 1 TO 3: READ A$: NEXT X
81 FOR X = 1 TO 3: READ A$: PRINT "    "X". "A$: NEXT X
140 PRINT : PRINT "WHICH FISH DO YOU WANT TO BE ": INPUT A$
151 A = VAL (A$) + 3
152 IF A < 4 OR A > 6 THEN 10
160 DATA "WHITEFISH","CHUB","BLUEBACK SALMON","RAINBOW TROUT","MACKINAW TROUT
", "DOLLY VARDEN"
161 RESTORE : FOR X = 1 TO A: READ A$: NEXT X
170 IF X1 = 9 THEN 241
180 D$ = CHR$ (4): PRINT D$:"NOMON C": TEXT : HOME : VTAB 10: PRINT "    TRAVELI
NG TO ODELL LAKE..."
200 HIMEM: 8164: POKE 232,0: POKE 233,64: SCALE= 1: HCOLOR= 3: ROT= 0
205 PRINT D$:"BLDAD SCENES ": HOME : HGR
210 Z1 = 5:Z2 = 20:Z$ = "AS A " + A$ + " YOU WILL LOOK LIKE": GOSUB 30000
220 DRAW 5 AT 120,60
230 Z1 = 5:Z2 = 100:Z$ = "THE FISH YOU ENCOUNTER WILL LOOK LIKE ": GOSUB 30000
235 DRAW 2 AT 110,126: VTAB (21): PRINT "IN REAL LIFE THE FISH ARE DIFFERENT"
236 PRINT "SIZES. YOUR JOB IS TO DISCOVER THE": PRINT "ACTUAL SIZE OF THE FISH
.": GOSUB 10000
241 HOME : HGR : HCOLOR= 3: SCALE= 1: ROT= 0: DRAW 1 AT 1,55: VTAB 21
252 Z1 = 5:Z2 = 8:Z$ = "AS A": GOSUB 30000
255 Z1 = 42:Z2 = 8:Z$ = A$ + " YOU CAN": GOSUB 30000
256 Z1 = 5:Z2 = 16:Z$ = "1 ESCAPE DEEPER": GOSUB 30000
258 Z2 = 24:Z$ = "2 ESCAPE SHALLOW": GOSUB 30000
260 Z2 = 32:Z$ = "3 IGNORE IT": GOSUB 30000
263 Z2 = 16:Z1 = 140:Z$ = "4 EAT IT": GOSUB 30000
264 Z2 = 24:Z$ = "5 CHASE IT": GOSUB 30000
275 GOTO 301
300 S1 = S1 + 1: GOTO 355
301 FOR S1 = 1 TO 6
310 S = INT (6 * RND (1) + 1)
320 FOR S2 = 1 TO S1 - 1
330 IF S = S(S2) THEN 310
340 NEXT S2
345 S(S1) = S: NEXT S1
350 S1 = 1
355 IF S1 > 6 THEN 50000
356 IF A = S(S1) THEN 300
360 ON S(S1) GOTO 300,300,300,2000,3000,2500
300 HOME : VTAB (21): PRINT "YOU FIND YOURSELF CLOSE TO A WHITEFISH"
501 GOSUB 40000: GOSUB 12000
505 ON A GOTO 530,520,530,530,510,510
510 ON B GOSUB 4000,5000,9050,7000,8000
512 IF B = 1 OR B = 2 OR B = 5 THEN GOSUB 9000: GOSUB 9050: GOSUB 10000:C = C
+ 15: GOSUB 9150: GOTO 300
514 IF B = 4 THEN GOSUB 9100: GOSUB 10000:C = 0: GOTO 300
516 GOSUB 10000: GOTO 300
520 ON B GOSUB 4000,5000,9030,7020,9040
521 IF B = 1 OR B = 2 THEN GOSUB 9000: GOSUB 10000:C = C + 5: GOSUB 9150: GOTO
300
524 IF B = 4 THEN GOSUB 9070: GOSUB 10000:C = C + 5: GOSUB 9150: GOTO 300

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529 GOSUB 10000: C = C + 5: GOSUB 9150: GOTO 300
530 IF B < > 5 THEN 520
531 GOSUB 8000: GOSUB 9100: GOSUB 10000: GOTO 300
1000 HOME: VTAB 21: PRINT "ALONG COMES A CHUB": GOTO 501
1500 HOME: VTAB 21: PRINT "IN YOUR VICINITY IS A BLUEBACK SALMON,": GOSUB 4000
0
1505 GOSUB 12000: IF A > 4 THEN 505
1520 ON B GOSUB 4000,5000,9080,7020,8000
1522 IF B = 1 OR B = 2 OR B = 5 THEN GOSUB 9000: GOSUB 9050: GOSUB 10000: C = C
+ 15: GOSUB 9150: GOTO 300
1524 IF B = 4 THEN GOSUB 9070: GOSUB 10000: GOTO 300
1526 GOSUB 10000: GOTO 300
2000 HOME: VTAB (21): PRINT "YOU SEE A RAINBOW TROUT IN FRONT OF YOU": GOTO 50
1
2500 HOME: VTAB (21): PRINT "YOU FIND A DOLLY VARDEN VERY NEAR": A9% = "DOLLY V
ARDEN"
2501 GOSUB 40000: GOSUB 12000
2505 ON A GOTO 2506,2506,2506,2506,2506,2506
2506 ON B GOSUB 4500,5000,6000,7500,7500
2510 IF B = 1 AND R = 1 THEN R = 0: GOSUB 9075: GOTO 11000
2512 IF B = 1 OR B = 2 THEN GOSUB 9075: GOSUB 10000: GOTO 300
2515 GOSUB 9078: GOSUB 10000: GOTO 11000
2580 GOTO 510
3000 HOME: VTAB (21): PRINT "A MACKINAW TROUT IS IN FRONT OF YOU,": A9% = "MACK
INAW TROUT": GOTO 2501
4000 HCOLOR= 0: DRAW 5 AT 110,118
4005 X = 110: FOR Y = 118 TO 150 STEP 2: HCOLOR= 3: DRAW 5 AT X,Y: HCOLOR= 0
4007 DRAW 5 AT X,Y: IF Y / 10 = INT (Y / 10) THEN X = X + 6: NEXT Y
4011 HCOLOR= 3: DRAW 5 AT 134,150: E1 = 5: E2 = 134: E3 = 150: RETURN
4500 HCOLOR= 0: DRAW 5 AT 110,118
4505 IF RND (1) < .90 THEN 4005
4506 DRAW M AT E4,E5
4510 X = 110: FOR Y = 118 TO 140 STEP 2: HCOLOR= 3: DRAW 5 AT X,Y: DRAW 2 AT E4,
Y: HCOLOR= 0
4520 DRAW 5 AT X,Y: DRAW 2 AT E4,Y: IF Y / 10 = INT (Y / 10) THEN X = X + 6
4525 E4 = E4 - 6: IF E4 - 23 > X THEN NEXT Y
4526 HCOLOR= 3: DRAW 5 AT X,Y: X1 = X
4528 R = 1: FOR X = E4 TO E4 - 36 STEP - 2: DRAW 15 AT X,Y - 5: HCOLOR= 0: DRAW
15 AT X,Y - 5: HCOLOR= 3: NEXT X
4529 HCOLOR= 0: DRAW 5 AT X1,Y
4530 HCOLOR= 3: DRAW 2 AT X,Y: E1 = 5: E2 = X1: E3 = Y: E4 = X: E5 = Y: M = 2: RETURN

5000 HCOLOR= 0: DRAW 5 AT 110,118
5005 X = 110: FOR Y = 118 TO 110 STEP - 1: HCOLOR= 3: DRAW 4 AT X,Y: HCOLOR= 0
5007 DRAW 4 AT X,Y: X = X - 4: NEXT Y
5011 HCOLOR= 3: DRAW 4 AT 78,110: E1 = 4: E2 = 78: E3 = 110: RETURN
5714 E1 = 124: E2 = 118: E3 = 5: E4 = 114: E5 = 118: M = 2: RETURN
6000 HCOLOR= 0: DRAW M AT E4,E5
6001 HCOLOR= 3: FOR X = E4 TO 100 STEP - 6: DRAW 2 AT X,118: HCOLOR= 0: DRAW 2
AT X,118: HCOLOR= 3
6003 DRAW 14 AT X - 2,118: HCOLOR= 0: DRAW 14 AT X - 2,118: HCOLOR= 3: DRAW 15
AT X - 4,118
6005 HCOLOR= 0: DRAW 15 AT X - 4,118: NEXT
6007 DRAW 5 AT 110,118: HCOLOR= 3: DRAW 2 AT 100,118: E1 = 5: E2 = 110: E3 = 118: E
4 = 100: E5 = 118: M = 2: RETURN
7000 HCOLOR= 0: DRAW 5 AT 110,118
7007 Y = 100: FOR X = 110 TO E4 + 26 STEP 2: HCOLOR= 3: DRAW 7 AT X,Y: HCOLOR= 0
7008 DRAW 7 AT X,Y: NEXT X
7011 HCOLOR= 3: DRAW 5 AT E4 + 20,118: E1 = 5: E2 = E4 + 20: E3 = 118: RETURN
7020 HCOLOR= 0: DRAW 5 AT 110,118

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```

7021 DRAW 2 AT E4,E5
7022 FOR X = 0 TO 220 - E4 STEP 4: HCOLOR= 3: DRAW 7 AT X + 110,100: DRAW 3 AT
E4 + X,110: HCOLOR= 0
7024 DRAW 7 AT X + 110,100: DRAW 3 AT E4 + X,110: NEXT X
7025 HCOLOR= 3: DRAW 3 AT E4 + X,110:M = 3:E4 = E4 + X:E5 = 110
7026 HCOLOR= 3: DRAW 5 AT X + 110,110:E1 = 5:E2 = X + 110:E3 = 110: RETURN
7500 FOR X = 110 TO 124 STEP 2: HCOLOR= 0: DRAW 5 AT X,118: HCOLOR= 3: DRAW 5 A
T X + 2,118: NEXT X
7505 HCOLOR= 0: DRAW M AT E4,E5: FOR X = E4 TO 114 STEP - 6: HCOLOR= 3: DRAW 2
AT X,118: HCOLOR= 0
7508 DRAW 2 AT X,118: HCOLOR= 3: DRAW 14 AT X - 2,118: HCOLOR= 0: DRAW 14 AT X
- 2,118
7510 HCOLOR= 3: DRAW 15 AT X - 4,118: HCOLOR= 0: DRAW 15 AT X - 4,118: NEXT
7512 HCOLOR= 0: DRAW 5 AT 126,118: HCOLOR= 3: DRAW 2 AT 114,118
7514 E1 = 2:E2 = 126:E3 = 118:E4 = 114:E5 = 118:M = 2: RETURN
8000 HCOLOR= 0: DRAW 5 AT 110,118
8005 DRAW M AT E4,E5:Y = 118: FOR X = 1 TO 230 - E4 STEP 2: HCOLOR= 3: DRAW 5 A
T 110 + X,118: DRAW 3 AT E4 + X,118
8007 HCOLOR= 0: DRAW 5 AT 110 + X,118: DRAW 3 AT E4 + X,118: NEXT X
8009 HCOLOR= 3: DRAW 5 AT 110 + X,118:E1 = 5:E2 = 110 + X:E3 = 118: RETURN
9000 PRINT "THAT WAS A WASTE OF ENERGY": RETURN
9030 PRINT "THAT FISH JUST ATE YOUR LUNCH.": RETURN
9040 PRINT "YOU ARE TOO LITTLE": RETURN
9050 PRINT "YOU ARE GETTING HUNGRY..BETTER EAT": RETURN
9070 PRINT "YOU CAN NOT KILL THIS ANIMAL AND": PRINT "YOU USED A LOT OF ENERGY
NEEDLESSLY": RETURN
9075 PRINT "YOU GOT AWAY FOR THE TIME BEING": RETURN
9078 PRINT "NO.....THAT WAS THE WRONG MOVE": RETURN
9080 PRINT "GOOD, IT DOES NOT OCCUPY THE SAME NICHE": RETURN
9100 PRINT "YOU HAVE BEEN SUCCESSFUL": RETURN
9150 IF C < 30 THEN RETURN
9160 HGR : TEXT : HOME : VTAB 11: PRINT "YOU PASSED UP TOO MANY CHANCES AT FOOD
": PRINT
9162 PRINT : PRINT " YOU STARVED TO DEATH."
9164 GOSUB 10000
9175 TEXT : HOME : VTAB 12: INPUT "DO YOU WANT TO TRY AGAIN?":A$
9177 IF LEFT$(A$,1) = "N" THEN HGR : TEXT : HOME : GOTO 55555
9178 IF LEFT$(A$,1) = "Y" THEN X1 = 9: GOTO 60
9179 GOTO 9175
10000 POKE - 16368,0: VTAB 24: HTAB 13: PRINT "PRESS SPACE BAR";
10010 IF PEEK ( - 16384) < 127 THEN 10010
10011 HCOLOR= 0: DRAW E1 AT E2,E3: DRAW M AT E4,E5: RETURN
11000 HGR : TEXT : HOME : VTAB 9: PRINT "REMEMBER A "A9$" WILL": PRINT : PRINT
"EAT A "A$".
11001 PRINT : PRINT "NOW RUN THE PROGRAM AGAIN AND SEE IF ": PRINT : PRINT "YOU
CAN SURVIVE": GOSUB 10000
11002 GOTO 9175
12000 HOME : VTAB 21: ON B GOTO 12005,12007,12009,12012,12014
12005 PRINT "ATTEMPT TO ESCAPE TO DEEPER WATER": RETURN
12007 PRINT "ATTEMPT TO ESCAPE TO SHALLOW WATER": RETURN
12009 PRINT "JUST IGNORE IT": RETURN
12012 PRINT "ATTACK AND EAT IT": RETURN
12014 PRINT "CHASE IT OUT OF YOUR TERRITORY": RETURN
30000 FOR Z = 1 TO LEN (Z$):Z3 = ASC ( MID$ (Z$,Z,1))
30015 IF Z3 > 64 THEN DRAW Z3 - 44 AT Z1 + (Z - 1) * 7,Z2: GOTO 30050
30016 IF Z3 = 32 THEN 30050
30030 DRAW Z3 - 1 AT Z1 + (Z - 1) * 7,Z2
30050 NEXT Z
30060 RETURN
40000 HCOLOR= 3: DRAW 5 AT 110,118:B$ = "":A1$ = "":E1 = 5:E2 = 110:E3 = 118: D

```

```

RAW 2 AT 160,110: POKE - 16368,0
40003 VTAB (23): PRINT "WHAT DO YOU WISH TO DO? ";
40004 HCOLOR= 0: DRAW 2 AT 160,110
40005 FOR X = 162 TO 210 STEP 2:M = 3
40007 HCOLOR= 0: DRAW 3 AT X - 2,110: HCOLOR= 3: DRAW 3 AT X,110
40008 IF PEEK ( - 16384) > 127 THEN 40020
40009 NEXT X
40011 HCOLOR= 0: DRAW 3 AT 210,110: FOR X = 210 TO 160 STEP - 2:M = 2
40013 HCOLOR= 0: DRAW 2 AT X + 2,110: HCOLOR= 3: DRAW 2 AT X,110
40014 IF PEEK ( - 16384) > 127 THEN 40020
40015 NEXT X: GOTO 40004
40020 A1 = PEEK ( - 16384) - 128
40021 POKE - 16368,0: IF A1 = 13 THEN B = VAL (B%): IF B > 0 AND B < 6 THEN E
4 = X:E5 = 110: RETURN
40022 IF A1 = 13 OR (A1 = 8 AND LEN (B%) < = 1) THEN B% = "": GOTO 40025
40023 IF A1 = 8 THEN B% = LEFT$ (B%, LEN (B%) - 1): GOTO 40025
40024 B% = B% + CHR$ (A1)
40025 VTAB (23): HTAB 25: PRINT B% " "
40026 IF M = 2 THEN 40015
40027 GOTO 40009
50000 POKE 600,A: POKE 601,C
50003 HCOLOR= 0: DRAW M AT E4,E5: DRAW E1 AT E2,E3: VTAB (21): PRINT : PRINT C
HR$ (4);"RUN LAKEP2"
55555 PRINT : IF PEEK (1023) = 123 THEN PRINT CHR$ (4);"PR#6"
56666 END

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JPR#0
J
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LIST
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```
10 HOME : VTAB (21)
20 A = PEEK (600)
25 C = PEEK (601)
30 FOR X = 1 TO A: READ A$: NEXT
35 DATA "WHITEFISH","CLUB","BLUEBACK SALMON","RAINBOW TROUT","MACKINAW TROUT"
,"DOLLY VARDEN"
225 C = PEEK (326)
260 DIM S(2)
275 E2 = 180:E3 = 118
276 GOTO 301
300 S1 = S1 + 1: GOTO 355
301 FOR S1 = 1 TO 2
310 S = INT (2 * RND (1) + 1)
320 FOR S2 = 1 TO S1 - 1
330 IF S = S(S2) THEN 310
340 NEXT S2
345 S(S1) = S: NEXT S1
350 S1 = 1
355 IF S1 > 2 THEN 50000
360 ON S1 GOTO 1500,2000
500 HOME : VTAB (21): PRINT "YOU SEE WATER INSECTS AHEAD OF YOU,"
501 R1 = 60:R2 = 100:R3 = 90:A2 = 1:M = 12: GOSUB 40000: GOSUB 12000
505 ON A GOTO 520,520,520,520,580,580
520 ON B GOSUB 4000,3000,4500,5000,6000
521 R5 = 0: IF B = 4 THEN GOSUB 9100:C = 0: GOSUB 10000: GOTO 300
522 IF B = 3 THEN GOSUB 9050:C = C + 5: GOSUB 10000: GOSUB 9150: GOTO 300
523 IF B = 5 THEN GOSUB 9170:C = C + 10: GOSUB 10000: GOSUB 9150: GOTO 300
524 GOSUB 9000: GOSUB 9050:C = C + 10: GOSUB 10000: GOSUB 9150: GOTO 300
580 ON B GOSUB 4000,3000,4500,5500,6000
582 IF B = 3 THEN GOSUB 9173: GOSUB 10000: GOTO 300
583 IF B = 4 THEN GOSUB 9174: GOSUB 10000: GOTO 300
590 GOTO 524
1000 HOME : VTAB 21: PRINT "AT THE SURFACE LIES SOME ANIMAL PLANKTON,"
1001 R1 = 60:R2 = 100:R3 = 94:M = 13
1002 A2 = 2: GOSUB 40000: GOSUB 12000
1004 R5 = 1: GOTO 505
1500 HOME : VTAB (21): PRINT "YOU SEE AN OSPREY CLOSE TO THE SURFACE,"
1501 A2 = 4
1502 R1 = 100:R2 = 200:R3 = 60:M = 9: GOSUB 40000: GOSUB 12000
1505 ON B GOSUB 4000,3000,5700,5700,5700
1506 A2 = 0
1507 IF B = 1 THEN GOSUB 9100: GOSUB 10000: GOTO 300
1508 GOSUB 9060: GOSUB 10000: GOTO 300
2000 HOME : VTAB 21: PRINT "NEAR THE SHORELINE IS AN OTTER,"
2002 R1 = 94:R2 = 110:R3 = 95:A2 = 3:M = 11: GOSUB 40000: GOSUB 12000
2005 ON B GOSUB 4000,6450,6450,6500,6500
2006 GOSUB 9100: GOSUB 10000: GOTO 300
3000 HCOLOR= 0: DRAW 4 AT 180,118
3002 X = 180: FOR Y = 118 TO 110 STEP - 1: HCOLOR= 3: DRAW 4 AT X,Y: HCOLOR= 0:
DRAW 4 AT X,Y:X = X - 2: NEXT Y
3004 HCOLOR= 3: DRAW 4 AT 168,106
3005 IF A2 = 4 AND 100 * RND (1) + 1 < 19 THEN 3050
3006 E1 = 4:E2 = 168:E3 = 106: RETURN
3050 PRINT "YOU DID NOT MAKE IT THIS TIME": GOTO 5710
4000 HCOLOR= 0: DRAW 4 AT 180,118
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4002 X = 180: FOR Y = 118 TO 140 STEP 2: HCOLOR= 3: DRAW 5 AT X,Y: HCOLOR= 0
4004 DRAW 5 AT X,Y: X = X + 4: NEXT Y
4006 HCOLOR= 3: DRAW 5 AT X,Y: E1 = 5: E2 = X: E3 = Y: RETURN
4500 HCOLOR= 0: DRAW 4 AT 180,118: HCOLOR= 3: DRAW 5 AT 180,118
4502 E1 = 5: E2 = 180: E3 = 118: RETURN
5000 HCOLOR= 0: DRAW 4 AT 180,118
5002 FOR X = E2 TO 70 STEP - 2: HCOLOR= 3: DRAW 16 AT X,93
5004 HCOLOR= 0: DRAW 16 AT X,93: NEXT X
5005 IF 100 * ( RND (1)) + 1 < 15 THEN 5007
5006 HCOLOR= 3: DRAW 4 AT X,114: E1 = 4: E2 = X: E3 = 114: RETURN
5007 IF A2 = 2 THEN 5011
5008 HCOLOR= 0: DRAW 17 AT 30,50: HCOLOR= 3: DRAW 18 AT 30,50: PRINT "WITH THE
INSECTS WAS A HOOK. YOU WERE"
5009 PRINT "CAUGHT BY A FISHERMAN.": GOSUB 10000
5010 GOTO 9175
5011 HOME : TEXT : HGR : TEXT : VTAB (13): PRINT "THIS WAS PART OF A FISH TRAP"
: PRINT
5012 PRINT "YOU WERE CAUGHT....TRY AGAIN.": GOSUB 10000: GOTO 9175
5500 HCOLOR= 0: DRAW 4 AT 180,118
5502 FOR X = 180 TO 170 STEP - 2
5504 HCOLOR= 3: DRAW 16 AT X,93: HCOLOR= 0: DRAW 16 AT X,93: NEXT X
5506 HCOLOR= 3: DRAW 4 AT 170,118: E1 = 4: E2 = 170: E3 = 118: RETURN
5700 HCOLOR= 0: DRAW 4 AT 180,118
5702 X = 118
5705 FOR Y = 180 TO 168 STEP - 1: HCOLOR= 3: DRAW 4 AT Y,X: HCOLOR= 0: DRAW 4
AT Y,X
5706 X = X - 1: NEXT Y
5708 HCOLOR= 3: DRAW 4 AT 168,106
5709 IF A2 = 3 THEN E1 = 4: E2 = 168: E3 = 106: RETURN
5710 IF M = 8 AND E4 > 170 THEN 5790
5711 IF M = 9 THEN 5800
5712 HCOLOR= 0: DRAW 8 AT E4,E5
5715 X = INT (168 - E4) / 10: FOR Y = 60 TO 70: HCOLOR= 3: DRAW 8 AT E4 + X,Y
5717 HCOLOR= 0: DRAW 8 AT E4 + X,Y: E4 = E4 + X: NEXT Y
5720 HCOLOR= 0: DRAW 4 AT 168,106: FOR X = E4 TO 220 STEP 2: HCOLOR= 3: DRAW 10
AT X,Y - 3
5722 HCOLOR= 0: DRAW 10 AT X,Y - 3: NEXT X: GOSUB 10000
5723 HGR : TEXT : HOME : VTAB 10: PRINT "AN OSPREY WILL EAT A "A$".": PRINT
5724 PRINT "TRY AGAIN": GOSUB 10000: GOTO 9175
5790 HCOLOR= 0: DRAW M AT E4,E5
5800 M = 9: FOR X = E4 TO 100 STEP - 3: HCOLOR= 3: DRAW M AT X,E5: HCOLOR= 0: D
RAW M AT X,E5: NEXT X
5802 E4 = 120: GOTO 5715
6000 HCOLOR= 0: DRAW 4 AT 180,118
6001 X1 = 0
6005 FOR X = E4 TO 60 STEP - 2: HCOLOR= 3: DRAW M AT X,E5: DRAW 4 AT 180 - X1,
118: HCOLOR= 0
6006 DRAW M AT X,E5: DRAW 4 AT 180 - X1,118
6007 X1 = X1 + 2: NEXT X
6008 HCOLOR= 3: DRAW 4 AT 180 - X1,118: E1 = 4: E2 = 180 - X1: E3 = 118: E4 = 60: R
ETURN
6450 IF A > 4 AND INT (100 * RND (1)) > 20 THEN 5702
6500 HCOLOR= 0: DRAW M AT E4,E5: FOR X = 100 TO 170 STEP 2: HCOLOR= 3: DRAW 19
AT X,100: HCOLOR= 0
6505 DRAW 19 AT X,100: NEXT
6506 PRINT "AN OTTER WILL EAT A FISH."
6510 HCOLOR= 0: DRAW 4 AT 180,118: FOR X = 180 TO 100 STEP - 2: HCOLOR= 3: DRA
W 11 AT X,100
6520 HCOLOR= 0: DRAW 11 AT X,100: NEXT X
6521 HCOLOR= 3: DRAW 11 AT X,100

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6522 GOSUB 10000: GOTO 9175
9000 PRINT "YOU WASTED ALOT OF ENERGY": RETURN
9030 PRINT "THAT FISH JUST ATE YOUR LUNCH.": RETURN
9050 PRINT "YOU ARE GETTING HUNGRY...BETTER EAT"
9051 RETURN
9060 PRINT "YOU GOT AWAY THIS TIME...": RETURN
9070 PRINT "YOU CAN NOT KILL THIS ANIMAL AND": PRINT "YOU USED A LOT OF ENERGY
NEEDLESSLY.": RETURN
9075 PRINT "YOU GOT AWAY FOR THE TIME BEING.": RETURN
9078 PRINT "NO.....THAT WAS THE WRONG MOVE.": RETURN
9100 PRINT "YOU HAVE BEEN SUCCESSFUL.": RETURN
9150 IF C < 30 THEN RETURN
9160 HGR : TEXT : HOME : VTAB (10): PRINT "YOU PASSED UP TOO MANY CHANCES AT FO
OD ": PRINT
9162 PRINT "AND USED YOUR ENERGY WASTEFULLY.": PRINT : PRINT "      YOU STARVE
D TO DEATH."
9164 GOSUB 10000: GOTO 9175
9170 PRINT "WHY CHASE FOOD AWAY?"
9171 RETURN
9173 PRINT "THAT'S RIGHT!": RETURN
9174 PRINT "YOU CAN'T SURVIVE ON THAT TYPE OF FOOD.": RETURN
9175 TEXT
9176 HOME : VTAB 12: INPUT "DO YOU WANT TO TRY AGAIN?";A$
9177 IF LEFT$ (A$,1) = "N" THEN HGR : TEXT : HOME : GOTO 55555
9178 IF LEFT$ (A$,1) = "Y" THEN X = FRE (0): POKE 600,9: PRINT CHR$ (4);"RUN
LAKE"
9179 GOTO 9176
10000 POKE - 16368,0: VTAB 24: HTAB 13: PRINT "PRESS SPACE BAR";
10010 IF PEEK ( - 16384) < 127 THEN 10010
10011 HCOLOR= 0: DRAW E1 AT E2,E3: DRAW M AT E4,E5: RETURN
11000 HGR : TEXT : HOME : VTAB (9): PRINT "REMEMBER A ";A9$;" WILL": PRINT : PR
INT "EAT A ";A$;". "
11001 PRINT : PRINT "NOW RUN THE PROGRAM AGAIN AND SEE IF ": PRINT : PRINT "YOU
CAN SURVIVE": GOSUB 10000
11002 GOTO 9175
12000 HOME : VTAB (21)
12001 ON B GOTO 12005,12007,12009,12012,12014
12005 PRINT "ATTEMPT TO ESCAPE TO DEEPER WATER": RETURN
12007 PRINT "ATTEMPT TO ESCAPE TO SHALLOW WATER": RETURN
12009 PRINT "JUST IGNORE IT": RETURN
12012 PRINT "ATTACK AND PREY UPON IT"
12013 RETURN
12014 PRINT "CHASE IT OUT OF YOUR TERRITORY": RETURN
40000 HCOLOR= 3: DRAW 4 AT 180,118:B$ = "":A1$ = "":E2 = 180:E3 = 118
40001 DRAW M AT R1,R3
40002 POKE - 16368,0
40003 VTAB 23: PRINT "WHAT DO YOU WISH TO DO?"
40004 HCOLOR= 0: DRAW M AT R1,R3: IF A2 = 3 THEN R1 = 94:R2 = 130:M = M + 8
40005 IF A2 = 4 THEN M = M - 1
40006 FOR X = R1 TO R2 STEP 2
40007 HCOLOR= 0: DRAW M AT X - 2,R3: HCOLOR= 3: DRAW M AT X,R3
40008 IF PEEK ( - 16384) > 127 THEN 40020
40009 NEXT X
40010 HCOLOR= 0: DRAW M AT R2,R3: IF A2 = 3 THEN R1 = 50:R2 = 110:M = M - 8
40011 IF A2 = 4 THEN M = M + 1
40012 FOR X = R2 TO R1 STEP - 2
40013 HCOLOR= 0: DRAW M AT X + 2,R3: HCOLOR= 3: DRAW M AT X,R3
40014 IF PEEK ( - 16384) > 127 THEN 40020
40015 NEXT X
40016 GOTO 40004

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40020 A1 = PEEK ( - 16384) - 128
40021 POKE - 16384,0: IF A1 = 13 THEN B = VAL (B$): IF B > 0 AND B < 6 THEN E
4 = X:E5 = R3: RETURN
40022 IF A1 = 13 OR (A1 = 8 AND LEN (B$) < = 1) THEN B$ = "": GOTO 40025
40023 IF A1 = 8 THEN B$ = LEFT$ (B$, LEN (B$) - 1): GOTO 40025
40024 B$ = B$ + CHR$ (A1)
40025 VTAB 23: HTAB 25: PRINT B$"
40026 IF A2 = 3 AND M = 11 THEN 40015
40027 IF A2 = 3 AND M = 9 THEN 40015
40028 GOTO 40009
50000 HGR : HOME : TEXT : VTAB (10): PRINT "YOU MADE IT....FANTASTIC": PRINT :
PRINT "TRY AGAIN AS A DIFFERENT FISH AND"
50001 PRINT : PRINT "SEE IF YOU CAN SURVIVE.": GOSUB 10000: GOTO 9175
55555 IF PEEK (1023) = 123 THEN PRINT CHR$ (13); CHR$ (4);"RUN HELLO"
55556 NEW

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APPENDIX C

Instrument

NAME _____

CODE _____

DATE _____

READ THE NAMES OF THESE FISH:

Rainbow trout

Mackinaw trout

Dolly Varden

1. Decide which fish you think is largest. Put the name of that fish on the number one line. Put the next largest fish on the number two line. Put the smallest fish on the last line.

1. _____

2. _____

3. _____

2. What is an osprey? _____

3. Which fish in the list can attack and eat all of the others? _____

4. Which fish will an otter eat? _____

5. Which of the fish on the list has the best chance for survival and why?

6. What advice would you give to:

the rainbow trout _____

the mackinaw trout _____

the Dolly Varden _____

APPENDIX D

Permission Letter From District 7



DIANE THOMAS-RUPERT
assistant superintendent

12-28-81

Sharon,

You have my approval to proceed
with your study as outlined. of course
the building principal must approve
before you can proceed in the building.
dtr

APPENDIX E

Letter to Parents for Permission
to Participate

Dear Parents,

Instructional computing is recognized as having great potential to affect the education of students. If we are to fully realize the potential of instructional computing, we must know how it is affecting students.

The Bozeman School District has approved a study to analyze the effects of three different types of instructional computing programs. The study will be conducted by Sharon Hulett, who is completing her masters degree in elementary education.

Content of the computer programs will be science-oriented supplementary material for fourth-grade students. Each child participating in the study will spend approximately twenty minutes interacting with the computer in the school. Students' grades will not be affected.

Data will be collected and analyzed as group data. Individual names will not be used in the study in order to maintain confidentiality. Results of the study will be available in March, 1982.

We think your child will find the opportunity to use the computer in a learning situation a stimulating and enjoyable experience.

In order for your child to participate in this activity, it is necessary to have your permission. Please indicate whether your child may participate by returning the permission slip to your child's teacher as soon as possible.

Thank you for your cooperation.

Sharon Hulett *Nonnie Hughes*

_____ has my permission to participate in the
 computing study.

 signature

 relationship to student

 date

APPENDIX F

Students' Comments

COMMENTS WRITTEN BY STUDENTS AFTER THE RETENTION TEST

The comments are grouped according to treatment group. They are presented as the students wrote them. No spelling changes were made.

The comments were:

DRILL AND PRACTICE (DP TREATMENT GROUP)

It was very neat and i Did everything right thank you

I like computers because there funer than watching T.V.

I liked it very much becaus I like working with computers and I hope I can work with them more.

I Like the cumpter be cus it was cool..

I thought it was neat because I never heard abuot mackinaw trout or the Dolly varden

I was fun working with you'r cunputer

I liked to work with the comuter. I would Like to study snakes on a computer sometime. I would Like to know when

we could.

I liked working by myself. But one thing I didn't like, is I wanted to do the one with The picture.

I like working with the computer it is fun.

I liked working with the comupters.

I kind a liked it except I only got to do one thing I only got questions sone kids got games like I don't think thates right

I really liked working with the computer. I whis I could work with it again.

I liked it and I hope I can do it again.

I liked it

It was fun I would like to come agen

I thought it was fun. Because I learned a little more

about fish.

114

SIMULATION DONE INDIVIDUALLY (SI TREATMENT GROUP)

I liked the computer and there wasn't anything I disliked about it. It was alot of fun I hope I can work with it more.

It's a lot of fun.

halares

I Did like it because I seen that things I didn't no like the seal can eat a makinow trout

I like computers

I liked it it was fun. I hope we have one in our class.

I like to work in a group. It was fun.

They were very fun working with.

it's a good program Do more of it

Excellent! it was fun and I learned alot.

It was very fun I learned alot.

It was fun using the computer.

I liked it better working with a partner.

I liked the computer game it was very fun to do.

SIMULATION DONE IN A GROUP (SG TREATMENT GROUP)

it was fun.

I would like to work by my shilf

I liked playing when the fish would eat each other.

I liked working with the computers I think they're fun.

I hope we can use them again

I liked working in a group. If we did it again I wold like to be alone. it was a good expeerense.

I thing it was neat to work with the computer

I loved it!

I thought it was to nice to work with a computer: P.S.

Thank you

I liked it becauce I lear something. It was fun thank you.

It was fun to play games on the computer P.S. Thankyou

I thot that working with the compoter was very fun and I'd like to do it agian It was neat to see the fish eat each other

I liked to play with the comuder.

I didn't like when you didn't survive.

BUT, I realy loved the rest

3 1762 00116389 6

cop.2

The effects of a computer drill and practice program and a computer simulation...

DATE ISSUED TO 9
Loreen Peterson
320 S. Boyman 6-5659
Melinda 7-0889
7 Broadway View
[REDACTED]

MAIN 11
N378
H878
cnp

MAIN LINE

N378
H878
cup 2

GAV