DOCUMENT RESUME

ED 459 702 IR 021 061

AUTHOR Coleman, Connie; King, Jeff; Ruth, Mary Helen; Stary, Erin
TITLE Developing Higher-Order Thinking Skills through the Use of Technology.
PUB DATE 2001-12-00
NOTE 54p.; Master of Arts Action Research Project, Saint Xavier University and Skylight Professional Development Field-Based Master's Program.
PUB TYPE Dissertations/Theses (040) -- Tests/Questionnaires (160)
EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Access to Information; *Computer Uses in Education; *Creative Thinking; *Critical Thinking; Curriculum Development; Grade 4; *Instructional Development; Intermediate Grades; *Skill Development; Teacher Developed Materials; Teaching Methods; *Thinking Skills; World Wide Web
IDENTIFIERS *Technology Utilization; Web Based Instruction

ABSTRACT

This report describes a program, utilizing both critical and creative thinking skills, to enhance the educational process through the use of technology. The targeted population consisted of fourth grade students in a growing middle class community located in northern Illinois. The lack of higher-order thinking skills was documented through teacher-made inventories, teacher-made content area tests, and a thinking skills rubric. Data revealed that students lacked skills related to higher-order thinking, the ability to explain problem-solving strategies, and the ability to transfer knowledge to new situations. Educators consistently fail to provide explicit instruction in higher-order thinking skills and resist change in teaching practices and curriculum to include the needed instruction. Reviews of curricula and instructional strategies revealed a curricular under-emphasis on information pertaining to higher-order thinking skills. A review of solution strategies, combined with an analysis of the problem setting, resulted in the selection of one intervention: implementation of a teacher-constructed program with an increased emphasis on higher-order thinking processes. The World Wide Web-based project provided students with unlimited access to information and activities using the higher-order thinking skills of application, analysis, synthesis, and evaluation. Post intervention data indicated an increase in student use of higher-order thinking skills. Recommendations by the researchers include making the project school-wide and having one person coordinate the program. (Contains 37 references.) (Author/MES)

DEVELOPING HIGHER-ORDER THINKING SKILLS THROUGH THE USE OF TECHNOLOGY

Connie Coleman
Jeff King
Mary Helen Ruth
Erin Stary

An Action Research Project Submitted to the Graduate Faculty of the

School of Education in Partial Fulfillment of the

Requirements for the Degree of Masters for Arts in Teaching and Leadership

Saint Xavier University & SkyLight

Field-Based Master's Program

Chicago, Illinois

December 2001

Abstract

Authors: Connie Coleman
Jeff King
Mary Helen Ruth
Erin Stary

Date: December 2001

Title: DEVELOPING HIGHER-ORDER THINKING SKILLS THROUGH THE USE OF TECHNOLOGY

This report describes a program, utilizing both critical and creative thinking skills, to enhance the educational process through the use of technology. The targeted population consisted of fourth grade students in a growing, middle class community, located in northern Illinois. The lack of higher-order thinking skills was documented through teacher-made inventories, teacher-made content area tests, and a thinking skills rubric.

Analysis of probable cause data revealed that students lacked skills related to higher-order thinking, lacked the ability to explain problem-solving strategies, and lacked the ability to transfer knowledge to new situations. Educators consistently fail to provide explicit instruction in higher-order thinking skills and resist change in teaching practices and curriculum to include the needed instruction. Reviews of curricula and instructional strategies revealed a curricular under-emphasis on information pertaining to higher-order thinking skills.

A review of solution strategies suggested by knowledgeable others, combined with an analysis of the problem setting, resulted in the selection of one intervention: an implementation of a teacher-constructed program with an increased emphasis on higher-order thinking processes. The web based project provided students with unlimited access to information and activities using the higher-order thinking skills of application, analysis, synthesis, and evaluation.

Post intervention data indicated an increase in student use of higher-order thinking skills. Recommendations by the researchers include making the project school-wide and having one person coordinate the program. Creating and maintaining an on-site butterfly garden would promote hands on experience, which would further increase motivation.

SIGNATURE PAGE

This project was approved by

Ed.D.
Advisor

Cheryl B. Casper
Advisor

Beverly Gulley
Dean, School of Education

TABLE OF CONTENTS

CHAPTER 1 – PROBLEM STATEMENT AND CONTEXT 1

General Statement of the Problem 1

Immediate Problem Context 1

The Surrounding Community 2

National Context of the Problem 4

CHAPTER 2 – PROBLEM DOCUMENTATION 7

Problem Evidence 7

Probable Causes 11

CHAPTER 3 – THE SOLUTION STRATEGY 13

Literature Review 13

Process Objectives and Processes 18

Project Action Plan 20

Methods of Assessment 23

CHAPTER 4 – PROJECT RESULTS 24

Historical Description of the Problem 24

Presentation and Analysis of Results 26

Conclusions and Recommendations 30

REFERENCES CITED 34

APPENDICES 37

CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students in the targeted fourth grade classrooms in a growing northwestern suburb of a major midwestern city exhibited a lack of higher-order thinking skills that caused an inability to effectively apply, analyze, synthesize, and evaluate. Evidence for the existence of the problem included anecdotal records that documented inadequate computer skills, teacher checklists that described student usage of the computer, and student, teacher, and parent surveys that provided an indication of their attitudes.

Immediate Problem Context

School A was a two-story brick facility, which included 22 classrooms, a gym, cafeteria, library, computer lab, and music and art rooms. Built in 1955, the school had been modified to accommodate varied age groups throughout the years. The building was situated in a small residential neighborhood and bordered a main highway.

The faculty of school A consisted of one principal, one wing leader, 14 classroom teachers, two special education teachers, and eight specialists for the areas of art, music, physical education, library, speech, social services, and psychological services. The support staff consisted of four lunchroom assistants, a computer aide, a school nurse, and two secretaries.

Nine faculty members had master's degrees, and the average length of teaching experience was ten years.

School A consisted of fourth and fifth grades. School A had an enrollment of 294 students with an enrollment of 89.3% Caucasian, 1.5% African-American, 5.4% Hispanic, and 2.8% Asian. Of this number, 3.6% received public aid. The attendance rate was 96.4% with a student mobility rate of 13.9%. Truancy rate consisted of 1.8%, including 0.0% chronic truants. The average class size in School A was 23 students.

Programs offered in School A included Drug Awareness Resistance Education (D.A.R.E.), Bank at School, ET (Exceptionally Talented), Young Authors, Star Lab, prairie restoration project, and band. Before and after school programming available included Extended Time Care (ETC), Boy Scouts, Girl Scouts, and Spanish Club.

The district was located in the fastest growing county in the state. Each year, rapid escalation in new housing development added new students at an approximate rate of 25% of the student enrollment per year. The created multiple challenges such as providing adequate classroom space, maintaining classroom size, hiring qualified staff, and establishing a well-balanced curriculum to meet the diverse needs.

The Surrounding Community

The target school was located in a north central Illinois region. Based on the latest information available, the base city had a population of 7,221 people. The total population of the research community included 6,448 Caucasians, 108 African-Americans, 380 Hispanics, 267 Asians, and 18 Native Americans or Eskimos. The median household income was $51,471, with the median home value at $125,225. In addition, the median tax rate was 8.0205. The community was governed by an elected president and a six-member board of trustees.

The district included two pre-schools, two elementary schools (grades kindergarten through three), two elementary schools (grades four and five), one middle school (grades six through eight), and one senior high school (grades nine through twelve). The total district enrollment was 2,031 students.

A superintendent and seven board members governed the district. The central administration included an assistant superintendent, a financial advisor, a curriculum coordinator, a public relations coordinator, a special education director, a technology coordinator, a gifted coordinator, and a human resource manager. The district experienced the benefits of strong community support and viewed technology as a top priority. The primary mission of the district was to develop confident, productive, thoughtful, and caring citizens who would succeed in a highly technological, international community. The district owned and operated its own school bus transportation system and offered a food service program in all buildings. In addition, the district thrived on its strong academic curriculum, as well as its well-rounded athletic, music, and art programs. The average teacher salary in the district was $34,000, and the average administrator salary was $73,000.

The average overall temperature in the community was 46 degrees Fahrenheit. The average annual rainfall was 32 inches, while the average annual snowfall was 31 inches. Some of the major industries included Weber Grill, DuoFast, and Freund International. With the rapid growth of the district, the opportunity for the employment also increased. The area was serviced by nine different religious affiliations.

The new 15,000 square foot library opened in July 1999 to accommodate its growing and widely used collection and to serve the expanding population of the district. The facility included study areas, a meeting room, computers for personal use, and Internet access.

The community provided a variety of recreational activities. The park district catered to the needs of both the old and new residents of all ages. Some of the more popular programs included: before and after school care, a workout room, sports for all ages, karate and dance lessons, preschool programs, and a teen center. An important part of the community's strategic plan was to obtain as much open space as possible while it was still available through developer donations, grants, and purchases. A unique opportunity became available to the district in the fall of 1999. A referendum to purchase an existing building and adjoining land for the development of a recreation center and an aquatic center was passed.

Some of the special annual area events that took place consisted of a pageant, parades, a town picnic, firemen's water fights, fireworks, craft shows, and hayrides. Several area community groups and organizations also existed, including the American Legion, Boy Scouts and Girl Scouts, Communities Against Gangs and Drugs, 4-H Club, the Lions Club, and the Senior Citizens Club.

Another unique addition to the area was a large retirement community, serving several thousand residents. This living community was opened in 1998 and included a recreation center, health spa, fitness center, restaurant, and a wide variety of activities for all to enjoy.

The major concerns of the community were the loss of farmland and a rural atmosphere and the ensuing road construction and traffic congestion due to the tremendous rate of growth.

National Context of the Problem

The problem with the lack of higher order thinking skills has generated concern at the state and national levels (Coley, 1997). The limited use of the higher level thinking skills, such as application, analysis, synthesis, and evaluation, has also hindered academic performance. According to research, recent evidence implies that the more complex uses of the computer, such

as using the Internet in small groups to conduct research, offer promising possibilities on the future of teaching and learning. Reports show that students have experienced positive effects on academic achievement in all major subject areas. Some researchers have found that fourth graders with on-line access scored significantly higher on learning measures than those without computer integration (Schmeltzer, 2000).

Evidence indicates that when used effectively, "technology can encourage collaborative learning, development of critical thinking skills, and problem solving" (Means & Olson, 1994, p. 15). Instead of focusing on isolated, skill-based uses of technology and rote memorization, researchers have examined students' abilities to understand complex ideas and to analyze and synthesize information and relate it to their own knowledge. By providing access to enormous resources and information and by promoting inquiry and discovery, students can learn about the world outside of the classroom and can perform challenging tasks. All students must have these opportunities to use technology in meaningful projects that develop higher order thinking skills.

Students' learning is facilitated when highly engaging learning experiences that motivate and challenge are provided. In addition, classrooms that are structured with engaging, long-term projects are important for all learners. When students are provided with fun-filled, meaningful activities, learning strategies are taught, while nurturing students' higher order thinking skills at the same time. By not challenging students, nor encouraging them to use higher order thinking skills, educators underestimate their students' abilities and delay meaningful grade-level work, as well as deprive them of a significant environment for learning (Means & Knapp, 1991).

Many recent changes in evaluating these higher-level thinking processes exist. Serious consideration has been given to social programming, knowledge use, and knowledge construction in order to retrieve the most accurate results. In changing the evaluation process,

students with higher level thinking skills tend to emerge from their peers (Heinecke, Blasi, Milman, & Washington, 1999). Each individual student's needs will surface, and at this point, individual needs can be addressed.

One concern the researchers had was the lack of higher-order thinking skills in the daily curriculum. The main focus had traditionally been on knowledge and comprehension skills, while the higher-order thinking skills of analysis, application, synthesis, and evaluation were often overlooked. The researchers chose the Internet site, Journey North, as a means to enhance these higher-order thinking skills.

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

One of the shortcomings exhibited by the students in the targeted fourth grade classes was the inability to effectively use higher-order thinking skills. Evidence for the existence of the problem included a preassessment inventory of higher-order thinking skills, student interview questions, and student and teacher surveys. (See Appendices A, B, C, and D)

In order to document the problem, researchers developed a preassessment and post-assessment inventory targeting the higher-order thinking skills of application, analysis, synthesis and evaluation. Students were asked to infer, anticipate probabilities, find relevant information, recognize fallacies, plan, draw conclusions, test generalizations, and make decisions. Some students were also interviewed, and student and teacher surveys were distributed. Of the 75 students in the targeted classrooms, 58 students were pretested on the higher-order thinking skills. More than 90 % of the students participated in the 16-week intervention.

The researchers, using a preassessment inventory, analyzed the information. Responses to 60 questions, 12 pertaining to the higher-level thinking skill of application, 20 pertaining to analysis, 15 pertaining to synthesis, and 13 pertaining to evaluation, were examined. Scores ranged from a low of 48% to a high of 78%, with 63% of the students scoring below 70%.

The 58 targeted students produced an average score of 66%. A summary of the students' performance is presented on Figure 1.

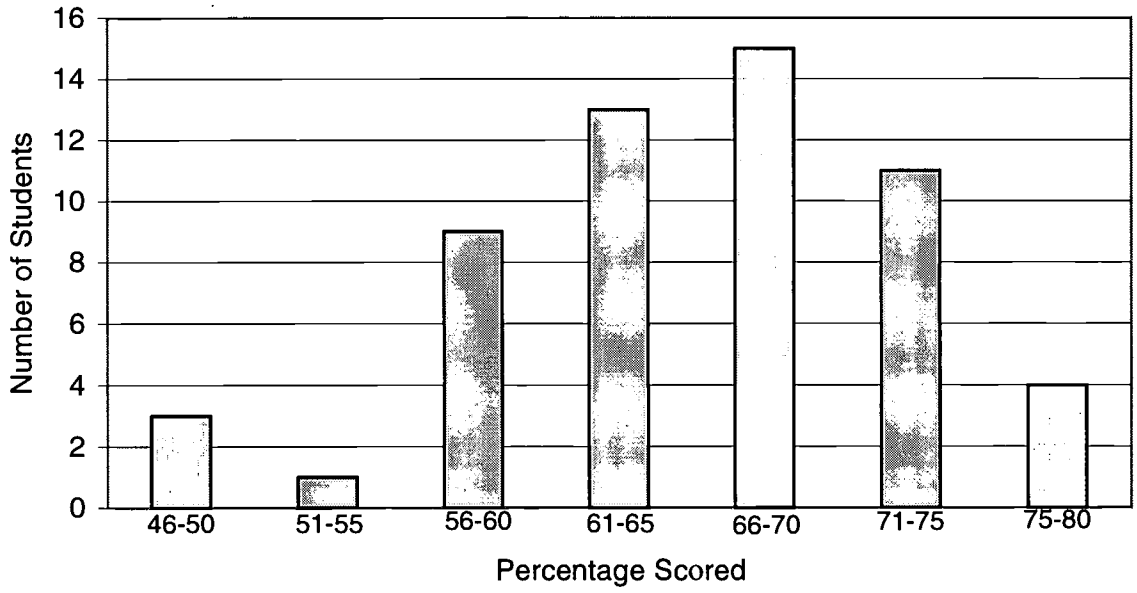

Figure 1. Students' range of pretest scores on the higher-level thinking assessment

The average score on application questions was 66%; the average on analysis questions was 91%. The average score for synthesis questions was the lowest, at 28%, and the average score for evaluation questions was 62%. A summary of the students' performance on the generated assessment inventory is presented in Figure 2.

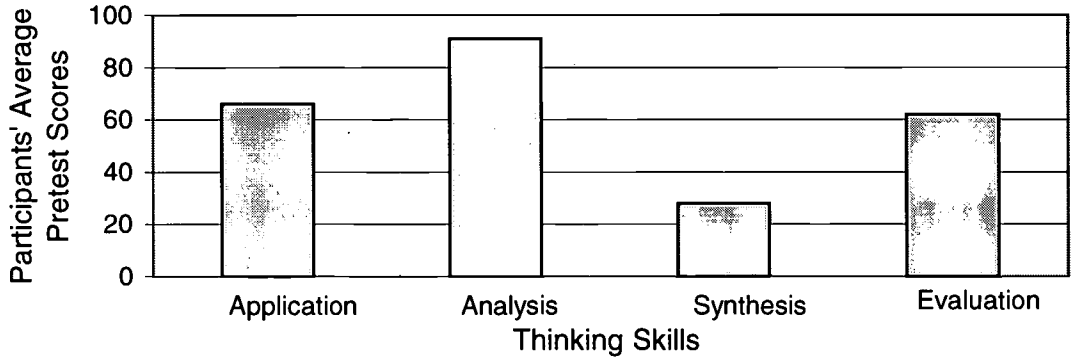

Figure 2. Participants' average pretest scores on the higher-order thinking skills

The results of the inventory indicated that the area with the greatest need for instruction appeared to be the higher-level thinking skill of synthesis. This suggests that students would possibly enhance their learning and benefit from learning to use old ideas to create new ones, to generalize from given facts, to relate knowledge from several areas, and to predict and draw conclusions (Bloom, 1956). Evaluation and application question scores were below 70%. This indicates that students experienced inadequacies in using methods and concepts in new situations and in solving problems using required skills or knowledge. Additionally, this indicates that students could benefit from more practice comparing and discriminating between ideas, making choices based on reasoned arguments, verifying the value of evidence, and recognizing subjectivity. A further analysis of the inventory suggests that students scored the highest on the skill of analysis. This conclusion suggests that students have strong sense and foundation of seeing patterns, organizing parts, recognizing hidden meanings, identifying components, and differentiating or discriminating among items.

The results of the survey indicated that 71% of the teachers were aware of Bloom's Taxonomy (Q1), while 24% indicated they consistently used Bloom's questioning techniques in the classroom (Q3). Of those surveyed, 34% have been trained in questioning techniques (Q5); 68% thought the use of questioning for higher-order thinking was beneficial (Q6). Results indicated 19% believed that the basic curriculum targeted each level of Bloom's Taxonomy and 6% found that the curriculum workbooks and worksheets tested higher-order thinking skills (Q2). In addition, 32% of the respondents thought use of the Internet helped in the development in the higher levels of thinking (Q8). Approximately 60% of the teachers believed it was important to use higher-order thinking questions in their classrooms (Q7). A small percentage of

respondents did not think training would benefit them in their higher-order questioning techniques. After analyzing the results of the teacher survey, the researchers recorded the following key findings in Figure 3.

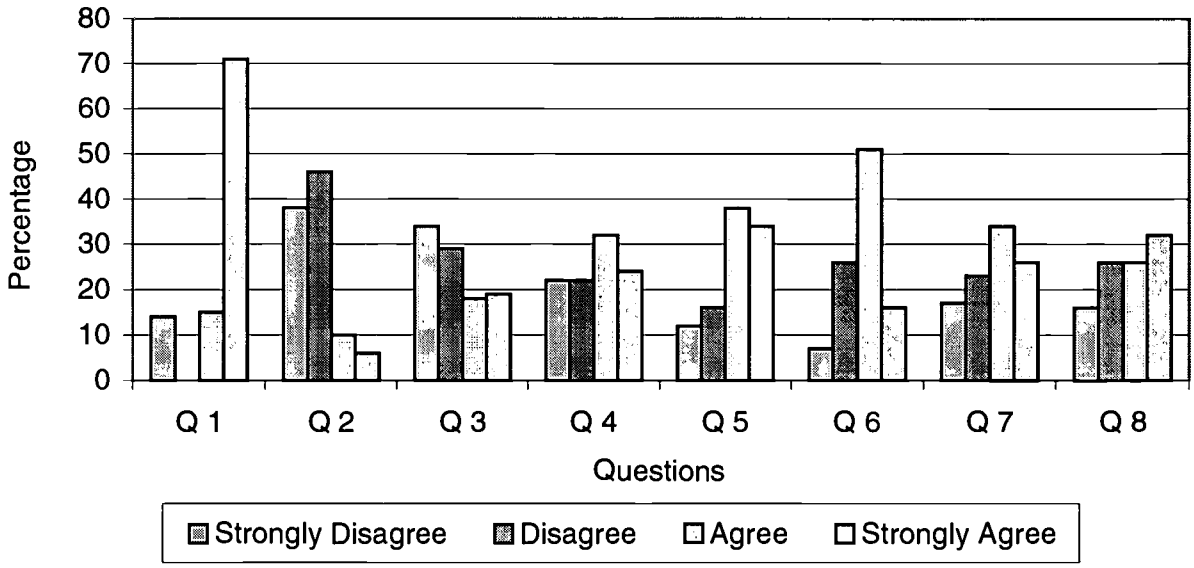

Figure 3. Percentage of teachers who use higher-order thinking skills

The results of the student survey indicated that 32% of the students surveyed thought they were competent using the Internet, while 38% indicated a desire to become more proficient (Q8). Of those who responded, 19% used the Internet only at school, while 16% used the Internet for research and school assignments (Q3). The Internet was used mainly for e-mail and games by 26% of the students surveyed (Q7). Results indicated 6% of those surveyed spent approximately three or more hours a day using the Internet (Q2). The data showed 7% of students surveyed used the Internet primarily for school assignments and research (Q6). A slightly larger percentage of respondents said they were interested in learning more about using the Internet. The majority of student responses indicated a moderate interest in use of the Internet and a desire in becoming a more proficient user of the Internet. When using the Internet, the majority of

students surveyed stated that they were monitored by a parent, guardian, or authority figure. These results can be seen in Figure 4.

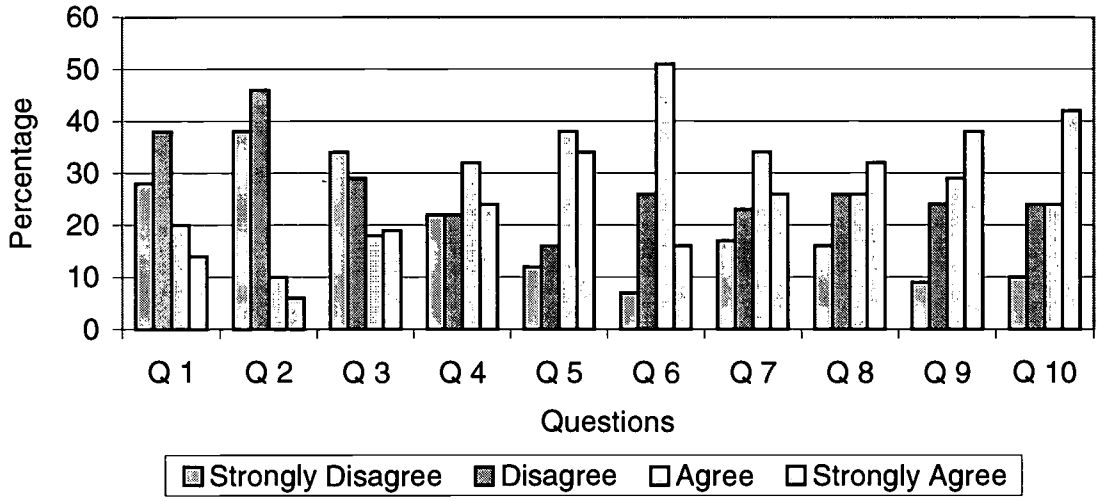

Figure 4. Percentage of students who use technology

Probable Causes

A major cause of concern in the schools was the lack of use of computers and unfamiliarity with software. In nearly 15 years since the introduction of computers into schools, the most prevalent use of this tool had been drill and word processing. Although changes in the use of educational technology had been anticipated for many years, the infusion of technology into the curriculum has not yet reached its full potential. Only within the last few years has the use of technology become a priority and computers were accessible to all students. Prior to this time, a computer-integrated curriculum was rarely used as a means of instruction by classroom teachers (McCracken, 1995). Traditionally, schools had not focused on technology as a way of supporting engaged learning.

A second concern was the lack of time available for teachers to devote to the development of thinking skills activities in order for students to learn those skills well. Traditional instruction often neglects open-ended questioning, class discussion, collaboration, and reflections of real-life situations (Pogrow, 1988). In addition, technology changes at such a fast rate that teachers have very little time to master the software before it changes again.

A third concern was the lack of teacher training in creating and providing learning conditions that are conducive to critical thinking and problem solving. Teachers' knowledge of how to implement instructional strategies that promote higher-order thinking skills is limited. The majority of classroom instruction is often teacher-directed and assessed through traditional means. Students cannot be expected to benefit from technology if their teachers are neither familiar nor comfortable with use of the Internet for the purpose of promoting critical thinking. Teachers need to be supported in their efforts to use technology.

Literature suggests that there are underlying causes for students' inability to use the higher-order thinking skills of application, analysis, synthesis, and evaluation. Educators have spent the past 15 years encouraging the use of the Internet in the schools to promote literacy. However, computer literacy alone should no longer be the primary focus. According to Harris and Sullivan (2000), the system which is presently used was created for a different time and a different population. Educators should engage students, expect their students to maintain and increase their technological skills, and develop flexibility and an ability to learn independently. Children by the age of 10 are generally competent with concrete learning but need to branch out. Healy (1998) believed this would be an appropriate time for multimedia applications, development of research skills, and manipulating databases or spreadsheets.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

Traditionally, classroom instruction has focused on memorization, has used traditional resources, has based assessment on quantitative work, and has been teacher-directed. The curriculum is designed to enable students to gain information according to a set and inflexible time schedule with little room for reflection or metacognition. The end result is usually to find out if students can answer the questions correctly (Caine & Caine, 1995). The literature suggests that this traditional mode of learning is being challenged and methods such as technology are being used to improve higher-order thinking skills.

According to Walker (1999), many people find the concept of using technology as a way to challenge students difficult to accept. Elementary schools need to realign instruction to guide students in their educational growth (Oakes, 1996). Developing critical thinking and problem solving skills is fundamental for living in a global and changing society. Educators often assign tasks to students that require them to apply the knowledge they have learned to new situations. Education is more meaningful when students draw from their prior experiences rather than through the use of drills and worksheets. As Arnold (1994) implied, technology can perform as a partner in promoting learning through the use of higher-order thinking skills.

Educational Testing Service researchers have examined classroom computer use and its relationship to students' academic achievement. The researchers have indicated that students whose teachers used computers primarily for simulations and applications that support higher-order thinking skills performed better than students whose teachers used computers mainly for learning games. There was also an indication that students whose teachers had professional development in technology outperformed those students whose teachers did not have any professional development (Norman, 1999).

Technology in the classroom, according to Arons (1995), is essential for preparing students for the modern workplace. Computers are transforming nearly every sector of the economy. Without training in new technology, students could be at a disadvantage in the job market. Trying to tackle these real life problems are often complicated and need to be broken down into sequential steps. Using information technology to collect and analyze data may help students organize their thoughts and use information more effectively. The students work collaboratively to solve the problems. Through interactive computer software, students may have a better opportunity to develop higher-order thinking skills (Kennedy, 1994).

Computers offer students opportunities to think, create, and explore (Burns, Roe, & Ross, 1992). Students should view computers as tools for helping them with writing assignments, keeping track of information, and comparing sets of data. Computers also serve as tools to promote cooperative work in solving simulations and problems as well as analyzing various types of databases.

Vast amounts of information can be found online, and certainly the Internet can be used as a source for simple information retrieval, but doing so misses its power and short-changes students. When using the Internet for the development of higher-order thinking skills, children

have an opportunity to research, make comparisons, analyze, and evaluate information. Students must be able to take the information and make comparisons, develop hypotheses, or draw conclusions.

Effective teachers facilitate students' learning by providing highly engaging learning experiences which are both motivating and challenging to students (Gardner & Perkins, 1989). Student attitudes and academic achievement are improved when learning experiences revolve around the interests, talents, and needs of students. By providing students with challenging, meaningful activities, effective teachers are able to teach basic skills and learning strategies while nurturing students' higher-order thinking skills and utilizing multiple intelligences.

Until recently, teachers have trained students how to answer questions. However, students need to start learning how to ask questions (Nelson, 1987). Students need to learn how to search through masses of data to bring an array of information together in creative ways which, in turn, will help them solve their own particular problems.

In order for computer technology to impact education, attention to students' needs and development of technological skills must be consistent, according to Hatfield, Edwards, & Bitter (1993). Even in its infancy, computer-assisted instruction has been shown through various studies to improve initial results and retention of basic facts. Students who studied using computer-assisted instruction learned faster than their non-computer-assisted instruction peers.

March (1999) suggested the Internet, specifically Web Quests, bring together the most effective instructional practices into one integrated student activity. Students use the vast resources to research topics and create special reports and projects that enhance the curriculum. Every Web Quest uses key elements to integrate Internet use with students' higher-order thinking skills. One central open-ended question lets students know that real learning will be

taking place. Besides in-class resources, several teacher-selected sites support students as they explore the topic. Students must transform what they have learned through such cognitive skills as application, analysis, synthesis, and evaluation. In addition to increasing higher-order thinking skills, student motivation also increases because students are faced with authentic tasks, not something that only carries meaning in a classroom.

Training teachers to teach and use higher-order thinking skills has not been a priority on some administrative agendas. In 1989, the U. S. Department of Education, through the office of Educational Research and Improvement, stated that there was a controversy between teaching thinking skills independently or integrating thinking skills into established curriculum. Research suggests that thinking skills should be taught directly and integrated into the existing curriculum at the same time. This should be done in a systematic way and the process should be developed over a period of time (Beyer, 1988).

According to Fogarty (1997), teaching the skills of thinking involves two components: development of academic skills in the educational setting and development of personal skills in order to become competent in life and society. The skills are best taught to students beginning at the basic level and moving toward an advanced level. With competent and proficient use of a combination of both academic and social skills, the learner is able to function self-sufficiently within the classroom learning environment and throughout life.

Chalupa (1992) described inservice training that helps teachers remodel lesson plans and incorporate knowledge of learning styles and assessments in cognitive development. Assessing the achievement of higher-order thinking skills is a challenge because the qualities of learners' thinking and knowledge must be observed, not merely the results or products of learning. Assessment, rather than testing, is recommended (Miller, 1990). New forms of evaluation being

developed include the Tailored Response Test, simulated recall, scenario analysis, and concept mapping. Existing methods, such as true/false, multiple choice, and essays, can be adapted by having students indicate why an answer is false, asking how two things are similar or different, or requiring evaluation or critique of an issue. Assessment could involve credit for sound reasoning.

According to Kopp and Ferguson (1996), teachers need support for learning to use new technologies and for acquiring skills in designing and implementing high-quality, student-centered projects. The researchers stated that commercially developed programs, which make measured differences in academic performance, are time-intensive. Programs such as Odyssey, made up of 100 forty-five minute lessons, and higher-order thinking skills, for at-risk students with limited experiences in applying higher-order thinking strategies, require more time than traditional classroom practices. At least 35 minutes, 4 days a week, for several months must be spent on these programs for true thinking to occur (Pogrow, 1988). Debates over education reform and staff development in the use of technology continue. In February 1997, the National Center for Education Statistics published a report indicating that Internet access in K-12 schools in the United States had increased from 35% in 1994 to 65% in 1996, while only 14% of the schools surveyed had provided mandatory teacher training in that time span (Burniske, 1998).

With increased pressure and possible financial rewards connected to test results, curriculum instruction time increasingly becomes a problem for teachers (Wallace, 2000). In the quest to raise standardized scores, many school districts are cutting into critical instructional time. Piaget maintained that children learn new concepts through a two-part method: discovery and practice. As curriculum needs are addressed, teachers are reluctant to provide time for students to process information (Flaxman, 2000).

Much has been written on the need for students to use higher-order thinking skills but texts rarely provide specific instruction in what the skills are or how to execute them (Beyer, 1983). Martin (1989) believed that many thinking skills programs should include teacher training; however, most of the training in the past has been done in the form of inservice workshops. This, in itself, does not provide the needed practice in actual teaching of these skills. Martin further stated that formal teacher education in this vital area has been ignored (Rosenshine & Meister, 1992).

According to studies conducted by Crump, Schlichter, & Palk (1988), training teachers to teach thinking skills leads to student achievement gains. Teacher training is considered to be as important as the program content in bringing about learning gains. Noll (1997) remarked that if educators are not equipped with adequate teacher training, many will continue to regard teaching as show and tell, learning as passive listening, and tests as memory samples.

Two factors that contribute to the success of education include teacher development and funding. Barth and Mitchell (1992) stated that the major resource for education is the teachers' professional skill, and the professional development of teachers is a most pressing need. Teachers cannot be expected to change their teaching techniques without enlarging their repertoire and being allowed time for this. Furthermore, education is inadequately funded because it produces no wealth directly. Legislatures do not perceive it as they should: the nation's most important investment for the future (Barth & Mitchell, 1992).

Process Objectives and Processes

As a result of using instructional technology for problem solving activities, during the period of January 2001 through May 2001, the fourth grade students from the targeted classes will increase their use of higher-order thinking skills as measured by student journals, responses

to challenge questions, and student achievement. The following activities will be used to develop higher-order thinking skills.

1. Develop instructional materials to foster knowledge of geography.
2. Design a series of learning activities to address Internet usage.
3. Create an assessment to measure student achievement.
4. Design a schedule for computer access.
5. Use the Internet to obtain information for a purpose.

As a result of increased instructional emphasis on higher-order thinking skills during the period of January 2001 through May 2001, the targeted fourth students will increase their ability to predict and draw conclusions as measured by KWL charts, student journals, and responses to challenge questions. The instructors and students will prepare the following.

1. Design a series of learning activities to address predicting skills and drawing conclusions.
2. Create a KWL chart.
3. Show examples of appropriate journal recordings.
4. Create a list of challenge questions.

As a result of increased instructional emphasis on communication skills, during the period of January 2001 through May 2001, the targeted fourth grade students will increase their ability to present conclusive information orally as measured by presenting written and oral reports. The instructors will address the following two strategies.

1. Emphasize communication strategies needed for oral presentation.
2. Promote cooperative group interaction and discussion.

Project Action Plan

The targeted fourth grade students will receive instruction in computer use and in monitoring the Journey North project. This intervention will take place in the researchers' individual classrooms and the computer lab. The instruction will be incorporated into researchers' schedule, once a week, for a 30-minute period. The program will use materials specific to Journey North and teacher-developed lessons. The researchers will introduce new skills for student practice. Students will apply those skills using the Journey North Internet site. The researchers will then implement the following action plan.

I. Fall 2000

A. Create materials

1. Preassessment inventory (Appendix A)
2. Postassessment inventory
3. Student interview questions (Appendix B)
4. Student survey (Appendix C)
5. Teacher survey (Appendix D)
6. Challenge Questions
7. KWL Chart
8. Rubric

B. Prepare and gather materials

1. Maps
2. Journals
3. Resource books

II. January 2001

A. Administer preassessment inventory

B. Pass out student surveys

C. Pass out teacher surveys

D. Interview students

E. Explain intervention to students

1. Introduce topic of Journey North -- "When Will Spring Be Here?"

2. Journals (reflections and challenge questions)

3. Begin recording high/low temperatures

4. Begin recording sunrise/sunset times

F. Introduce Internet usage

1. Safety

2. Provide Internet web site for Journey North

3. Practice locating and entering data on field data tables

4. Check data and student responses to challenge questions weekly

III. February 5 – 16

A. Make maps to chart migrations and sightings

B. Continue to check sites weekly for updates

C. Record and answer challenge questions

D. Record observations/sightings on-line

E. Explain higher-order thinking skill of application

F. Make predictions based on individual journal entries

1. Ground Hog Day

2. Spring Equinox

3. Photoperiods

IV. February 20 – March 2

A. Plot migratory patterns and data on maps

B. Continue to monitor Journey North web site for updated information

C. Begin making backyard observations

D. Explain higher-order thinking skill of analysis

V. March 6 – 16

A. Students will create questions to ask experts in the field

B. Explain the higher-order thinking skill of synthesis

C. Continue checking web site and recording information

D. Students will respond to challenge questions in personal journals

VI. March 19 – April 6

A. Students continue to answer challenge questions

B. Record sightings on maps

C. Explain higher-order thinking skill of evaluation

VII. April 9 – 20

A. Researchers will explain the term "hardiness zones"

B. Students will use information gathered to write a report

VIII. April 23 – May 4

A. Students will complete journals

B. Students will give group presentations

C. Researchers administer postassessment inventory

Methods of Assessment

Inventories testing the higher-order thinking skills of application, analysis, synthesis, and evaluation will be developed in order to assess the effects of the intervention. These inventories will be used as part of the assessment process. Student journals and recorded data on maps and charts will be kept and checked throughout the intervention period. Rubrics will be used to help assess and evaluate the students' growth and progress throughout the implementation.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Problem

The objective of this project was to improve higher-order thinking skills through the use of technology. With the results of teacher surveys, the researchers determined that more emphasis needed to be placed on higher-order thinking skills. Teacher responses indicated a lack of awareness and training in questioning techniques. A student preassessment on the higher-order thinking skills of application, analysis, synthesis, and evaluation was administered. The results indicated an average score of less than 70% the areas of application, synthesis, and evaluation. As a means of student motivation and student achievement, the researchers chose to utilize technology to meet the students' needs. To facilitate the students in the process of developing higher-order thinking, the researchers implemented a series of learning activities using a Web Quest project on the Internet.

Prior to implementing technology as a tool to address problem solving and critical thinking, the researchers discovered that teachers relied mainly on textbook reproducible worksheets and tests. Supplemental textbook materials targeted the lower levels of thinking, specifically knowledge and comprehension. The researchers noted that additional resources were critical in the development of higher-order thinking skills.

After reviewing the student surveys, the researchers found that most students devoted their time on the computer to playing games and practicing skills. Little time was spent using the computer to research, compare and contrast, gather data, or predict. Students expressed an interest in becoming more proficient in problem solving through the use of the Internet. For these reasons, the researchers chose to utilize technology as a means of developing the higher levels of thinking.

Children were guided in appropriate use of the Internet and in locating the Internet site, Journey North. Journey North was introduced and implemented as an instructional aid in improving application, analysis, synthesis, and evaluation. A lesson plan format was designed so that one of the four higher thinking skills was introduced every three weeks. Each of the lessons involved problem solving, questioning, and predicting. Activities included recording data and observations, and each session encouraged the students' personal reflections. Students met 45 minutes one day a week in the computer lab. The first 20 minutes in the lab were spent on data collection.

Journey North was introduced during the last week of January. The researchers introduced and modeled each of four higher thinking skills of application, analysis, synthesis, and evaluation with classroom activities and projects. After the introduction of each specific skill, opportunities were provided through the Internet site for students to practice the skill during the following three week time period.

Students began their data collecting by recording the sunrise and sunset times and high and low temperatures for the town. Based on these daily recordings, students made predictions about the photoperiod and further applied their knowledge with predictions about the arrival of Spring. As children spent more time in the computer lab exploring the Journey North web site,

the researchers noticed a transfer of the skill of application to their daily routine. Children further demonstrated the skill of application by plotting the migratory pattern on maps.

To introduce the skill of analysis, students were required to investigate how weather affects migration. Students also compared the daily temperature in different states and categorized them according to regions in the United States. The findings were reported on a large wall chart.

To illustrate the concept of synthesis, the children used the data collected to hypothesize when the monarch butterfly would reach northern Illinois. To further illustrate this idea, students wrote, produced, and shared a local weather forecast. Additionally, students were required to write about the migration of a monarch butterfly in first-person narrative.

As the Journey North project was nearing its completion, students were asked to express their likes and dislikes about the program. Next, students were asked to prioritize what they felt was most valuable about Journey North. Furthermore, researchers required the students to evaluate the impact that technology had on their learning.

Throughout the 16-week implementation, students were required to respond in their journals to weekly challenge questions posted on the Journey North web site. The questions included all levels of Bloom's Taxonomy. Students also had an opportunity to pose questions to experts in the field through the Internet. The response journals were used as an assessment of the students' ability to use higher-level thinking skills.

Presentation and Analysis of Results

In order to assess the effectiveness of the intervention, the researchers gave the students a written assessment. The assessment given was the same as the one given prior to the implementation. The data from responses of the 58 students participating in the assessment were

grouped into four areas of thinking skills: application, analysis, synthesis, and evaluation. Figure 5 represents the average score of the total number of participants in each of the four levels of thinking. Of the 12 application questions, the number of correct responses ranged from 4 to 12. The average for these questions was 79%. Out of 20 analysis questions, the number of correct responses ranged from 14 to 20. The average for these questions was 96%. Of the 15 synthesis questions, the number of correct responses ranged from 3 to 13. The average for these questions was 39%. Out of 13 evaluation questions, the number of correct responses ranged from 4 to 13. The average for these questions was 70%. The results can be seen in Figure 5.

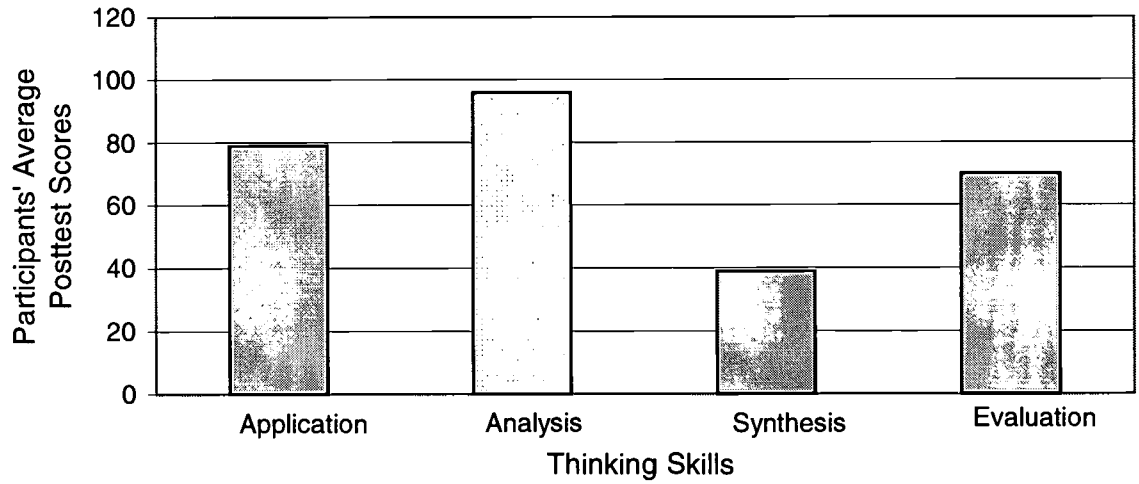

Figure 5. Participants' average posttest scores on the higher-order thinking skills

The researchers thought that using journals to observe and monitor student progress and use of higher-order thinking skills was enlightening and enjoyable but also time-consuming. Reflections and student responses were difficult to assess due to the subjective nature of the assignments. Additionally, most students had little experience expressing personal thoughts, conclusions, and applications. The researchers believed the journal entries provided opportunities for the students to process what they had learned while exploring the Journey

North site. Although specific academic growth was not measurable, the researchers believed that this time of reflection and self-evaluation was a valuable and important part of the learning process.

The KWL chart was a useful tool to gauge prior knowledge of the students and to plan motivating activities. This chart was partially effective because of the students' natural curiosity. However, their basic science knowledge was limited, and this did not provide the anticipated springboard for class discussion. The final column on the KWL chart, completed at the conclusion of the project, did show examples of a gain in general knowledge. The researchers concluded that additional use of the KWL chart in other subject areas might facilitate higher-level questions.

Students' responses to challenge questions posed on the Journey North Internet site were used as a means of assessing the higher-order thinking skills of application, analysis, synthesis, and evaluation. As students responded to the questions, they analyzed data, made predictions, drew conclusions, and evaluated the purpose of the web site. Responses to the challenge questions improved during the course of the project as evidenced through the use of a student rubric.

To further assess students' increased knowledge of the higher-order thinking skills, a written and oral project was required of groups of students at the end of the project. Information obtained from the Journey North Internet site and personal student journals were used to prepare the oral presentation. Researchers noticed an increased use of application, analysis, synthesis, and evaluation in journal entries and in the creative group presentations. A student rubric was used for both the written and oral assessments.

Researchers evaluated the targeted students using the postassessment test. Of the sixty questions asked on the posttest, the students scored highest in the areas of application and analysis. A comparison of scores from the January and May collection are shown in Figure 6.

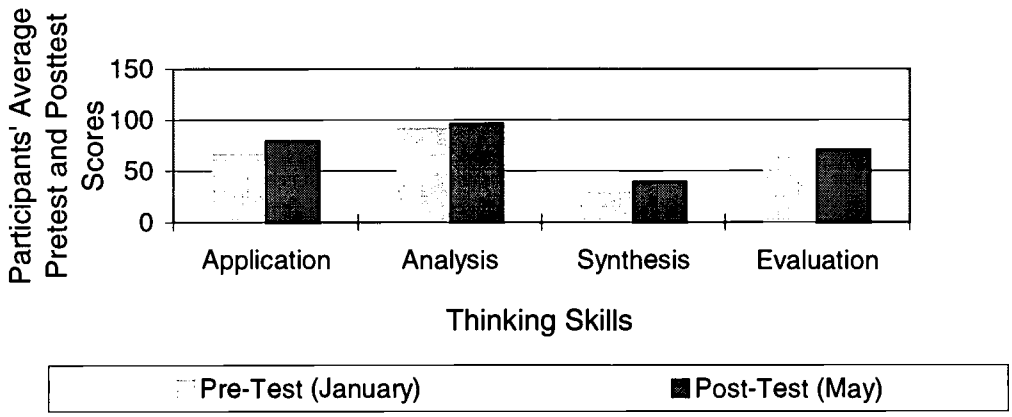

Figure 6. Comparison of participants' pretest and posttest scores

After examining the results, researchers noted a slight improvement in the posttest scores when compared to the pretest scores. Using a percentage comparison of the responses of the January and May assessments, the researchers noted that the greatest improvements were in the areas of synthesis and application. The students' responses that showed the ability to evaluate and analyze increased by 8% and 5% respectively. Students displayed an improvement of 13% in the area of application, 5% in the area of analysis, 19% in the area of synthesis and 8% in evaluation.

Initially, the targeted students demonstrated the greatest proficiency in the thinking skill of analysis. Next, the students showed the most improvement in the thinking skill of application. Students' proficiency increased slightly on questions pertaining to evaluation and synthesis. Overall, improvement was shown in each of the four higher-order thinking skills as demonstrated through students' journals, challenge questions, and postassessment.

Conclusions and Recommendations

Based on the presentation and analysis of the data, the students displayed a minimal improvement in application, analysis, synthesis, and evaluation. The researchers noted several factors that might have influenced the effectiveness of the intervention.

The comparison of the assessment test scores showed a slight improvement from the January to May as shown in Figure 6. The scores for four of the higher-level thinking skills increased, but the two areas in which students demonstrated the most gain were application and synthesis. There was not as much growth in the areas of analysis and evaluation.

The researchers noted that the analysis and evaluation questions were slightly more difficult and required some teacher assistance in decoding and pronouncing some of the words. A number of students struggled with comparing and contrasting words or distinguishing how words are similarly related on the posttest. Another area of difficulty for the students was sequencing events in logical order. Apparently, students struggled with being able to determine the logical order of events in a short narrative.

There were several other factors that may have contributed to the minimal increase in the scores. The assessment test was administered at the completion of the implementation. Researchers noted that students were not very enthusiastic about taking another lengthy test at that time. In addition, the last two weeks of school were used for field trips, field days, school picnics, and end-of-the-year book inventory and cleaning. These activities made it difficult to get all of the tests completed in a timely fashion, as well as having the students who had been absent on particular days get the tests completed. All of these elements may have contributed to the lack of growth in the posttest results.

When examining the areas of evaluation, the researchers noted that the students had a hard time expressing their thoughts and ideas in their journal entries. Students were not accustomed to evaluating their growth and progress in their writing from their Journey North observations and findings. They displayed difficulty getting their ideas down on paper. The researchers believed that evaluating journal entries was subjective, even though consistency was stressed and a scoring rubric was used.

The researchers thought it was interesting to find most gains in the areas of application and synthesis. This could be attributed to the fact that students were required to do a short presentation on their discoveries from Journey North and on the migratory path of their chosen animals. They had to do a two-minute presentation and then answer any questions that other students may have had. This opportunity proved to be a very positive experience for the students. The presentations also provided researchers an opportunity to assess students' aptitude in higher-order thinking and in problem solving.

Overall, the researchers believed that there was limited contact time with students to make any difference other than a small impact. Sixteen weeks were devoted to this intervention, without accounting for any interruption in the daily schedules. With the classes meeting in the computer labs only once weekly for 45 minutes, the intervention time totaled 12 contact hours for each class. Allowing adequate time during weekly sessions to permit for work samples, such as journal responses, was hampered by snow days, assemblies, the malfunctioning of the computers on two different occasions, and on some slight changes to the rest of the fourth grade curriculum.

The researchers noted that, several times during the intervention, the students' reflection and response times were shortened or eliminated in order to complete other assignments or to

dismiss the class according to the daily schedule. The researchers also noted several interruptions to the schedule due to field trips or other school events, which conflicted with the computer lab time. The researchers would recommend providing a shorter preassessment and postassessment. A second recommendation would be allowing students the option of creating a project to show their understanding of the higher-order thinking skills.

Additionally, all of the researchers were required to travel to the lab to set up and prepare all of the computers. Even more time was necessary to get the students logged on to the Internet. This took several minutes away from the 45 minutes allowed for each lab session. The researchers also had to use some of the scheduled class time to prepare activities for each session. An adequate number of computers in each classroom would provide additional opportunities for students to utilize the Internet more efficiently.

Another contributing factor for the minimal increase in the postassessment scores was the lack of training for researchers in higher-order theories. Promoting metacognition in their students was hindered as a result. Even after reading, studying, and previewing the Journey North web site for this action research, the project and related activities conducted by the researchers were not fluid or consistent. The researchers attempted to utilize effective implementation practices with individuals and groups of students in the computer lab on a weekly basis to encourage and promote higher-order thinking skills. However, the regular classroom teachers in the school district had many responsibilities, in addition to aiding the students in the computer lab. The researchers commented that more staff development in both technology and higher-order thinking skills would have been beneficial for teachers and students.

All of the researchers concluded that the students benefited from the intervention and planned to use similar activities in the targeted classrooms, as well as other classes. However,

the development of higher-order thinking skills cannot be accomplished in a short period of time. It takes both time and experience for cognitive development and higher-level thinking to develop. Students need more background knowledge in the elements of migration and Internet use, as well as cognitive experiences in the classroom. With more cognitive experiences and opportunities provided during the primary years, students would have a better foundation for application, analysis, synthesis, and evaluation. Students need numerous opportunities to discover, explore, and problem solve through the use of the Internet.

The researchers concluded the program, Journey North, was an effective intervention and beneficial to all participants. The program provided motivation for student learning, increased their curiosity about computer use, and could be easily adapted to existing curriculum.

References Cited

Arnold, J. B. (1994). Virtual students, digital classroom. The Nation, 9, 19-25.

Arons, S. (1995). Constitutional implications of national curriculum standards. The Educational Forum, 58, 125-130.

Barth, P., & Mitchell, R. (1992). Smart Start: Elementary Education for the 21st Century, Denver, CO: Fulcrum Publishing.

Beyer, B. K. (1988). Developing a scope and sequence for thinking skills instruction. Educational Leadership, 45 (2), 26 –30.

Beyer, B. K. (1983). Common sense about teaching thinking skills. Educational Leadership, 41 (1), 44-49.

Bloom, B. S. (Ed.) (1956). Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain. New York: Longman, Green.

Burniske, R. W. (1998). Think critically about classroom technology. Phi Delta Kappan, 80, 155-157.

Burns, P. C., Roe, B. D., & Ross, E. P. (1992). Teaching reading in today's elementary schools. Boston: Houghton Mifflin Company.

Caine, R. N., & Caine, G. (1995). Reinventing schools through brain-based learning. Educational Leadership, 52 (3), 43-47.

Chalupa, M. (1992). Critical thinking: Getting minds to work. Business Education Forum, 47 (1), 21-24.

Coley, R. (1997). Technology's impact. [38 paragraphs]. Electronic School [On-line], (703). Available http://www.electronic~school.com/0997f3.html (2000, June 20).

Crump,W. D., Schlichter, C. L., & Palk, B. E. (1988). Teaching HOTS in the middle and high school: A district-level initiative in developing higher-order thinking skills. Roeper Review,10 (4) 205-211.

Flaxman, S. (2000). Play: An endangered species. Instructor, 110 (2), 39-43.

Fogarty, R. (1997). Brain compatible classrooms. Arlington Heights, IL: SkyLight Training and Publishing, Inc.

Gardner, H., & Perkins, D. (Eds.) (1989). Art, mind, and education. Ithaca, NY: The University of New York Press.

Harris, P., & Sullivan, M. (2000). Plugging in to high-tech takes a new vision for education. TECHNOS: Quarterly for Education and Technology, 9, 35-36.

Hatfield, M. M., Edwards, N. T., & Bitter, G. G. (1993). Mathematics methods for the elementary and middle school. Boston: Allyn and Bacon.

Healy, J. M. (1998). Failure to connect: How computers affect our children's minds – for better and worse. New York: Simon & Schuster.

Heinecke, W., Blasi, L., Milman, N., & Washington, L. (1999). New directions in the evaluation of the effectiveness of educational technology [28 paragraphs]. [Online]. Available http://www.ed.gov/Technology/TechConf/1999/whitepapers/paper8.html (2000, June 20).

Kennedy, E. M. (1994). On the common core of learning. The Educational Forum, 58, 120-124.

Kopp, O. W., & Ferguson, K. E. (1996). Teacher training: Helping to construct the information highway. Technological Horizons in Education Journal, 3, 4-8.

March, T. (1999). Web Quest: Using the Internet to transform student learning. Educational Leadership, 58 (5), 3-5.

Martin, D. S. (1989) Restructuring teacher education programs for higher-order thinking skills. Journal of Teacher Education, 40, 2-8.

McCracken, E. (1995). Core concepts for technology implementation [22 paragraphs]. Secretary's Conference on Educational Technology [Online]. Available http://www.ed.gov/Technology/Plan/MakeHappen/Core.html

Means, B., & Knapp, M. S. (1991). Models for teaching advanced skills to educationally disadvantaged children. In B. Means & M.S. Knapp (Eds.), Teaching Advanced Skills to Educationally Disadvantaged Students. Washington, D.C.: U.S. Department of Education, Office of Planning, Budget and Evaluation.

Means, B., & Olson, K. (1994). The link between technology and authentic learning. Educational Leadership, 53 (2), 15-18.

Miller, C. (1990). Higher-order thinking: An integrated approach for your classroom. Vocational Education Journal, 65 (6), 26-27, 69.

Nelson, M. R. (1987). Children and social studies: Creative teaching in the elementary classroom. San Diego, CA: Harcourt Brace Jovanovich, Publishers.

Noll, J. W. (1997). Taking sides: Clashing views on controversial issues. Guilford, CT: Dushkin/McGraw-Hill.

Norman, M. (1999). The human side of school technology. The American School Board Journal, 186, 16-20.

Oakes, J. (1996). Keeping track: The policy and practice of curriculum inequality. Phi Delta Kappan, 13, 14-19.

Pogrow, S. (1988). HOTS: A thinking skills program for at-risk students. Principal, 67 (4), 19-24.

Rosenshine, B., & Meister, C. (1992). The use of scaffolds for teaching higher-order level cognitive strategies. Educational Leadership, 51 (4), 26-32.

Schmeltzer, T. (2000). Models of success: Case studies in technology in schools. Marietta, GA: National School Board Association.

U.S. Department of Education. (1989). Critical thinking skills and teacher education. (Contract No. 400-83-0022). Washington, DC: Office of Educational Research and Improvement.

Walker, D. (1999). Technology and literacy: Raising the bar. Educational Leadership, 57 (2),18-21.

Wallace, D. (2000). Results, results, results. Educational Leadership, 57 (5), 66-72.

Pretest

Name:_____ Date:_____

Read each story and the sentences that tell about each person. Underline the sentence that tells who spoke.

1. The team is playing the last baseball game of the season. This is the last inning and the score is tied. The two players have struck out and now the bases are loaded. Someone says, "I'm sure I can help the team win with a base hit. I'll probably even hit a homer."

   a. Bill, who does not brag, is one of the team's better hitters.
   b. Janet has made many hits this year and is very sure of herself.
   c. Johnny, the pitcher, has had one hit so far this year.

2. Last Wednesday, Mr. Frank asked if someone would stay after school to help him clean the chalkboards. One student offered, "I will, Mr. Frank. You can count on me."

   a. Erin's brother was coming home today after spending three years in the army.
   b. Anne's mother was going to the doctor and expected Anne to watch her younger brother after school.
   c. Ryan's parents both work until six o'clock and won't be home.

3. Sharon didn't know that her friends were planning a surprise birthday party for her. She wondered why everyone stopped talking when she came by or why they giggled so much. She was also puzzled when someone said, "Sharon, this will be a weekend you'll never forget."

   a. Chad likes to brag.
   b. Jim has trouble keeping a secret.
   c. Connie is jealous of Sharon.

*For each situation below, there are three different endings. Put **1** before the ending that is **most likely** to happen. Put **2** before the ending that could **possibly** happen. Put **3** before the ending that is **not very likely** to happen.*

4. Rick is the smallest player on the basketball team. He practices often and is determined to be a good player. Rick will probably be

_____ the worst player on the team.
_____ about as good as the other players.
_____ one of the better players.

5. Travis has just moved to the city and does not know his way around the neighborhood. Late one afternoon, while walking down a street, he becomes so interested in the sights that he forgets to watch where he is going. He will probably

_____ feel lost and ask a police officer to take him home.
_____ wander around until he finds a familiar street.
_____ walk all evening until his family finally finds him.

6. It has always been difficult for Allison to write stories. She wants to improve, so she probably will

_____ ask a friend to help her.
_____ ask for help from her teachers at school.
_____ work with a professional writer from the newspaper.

***Relevant** information is information that is important to you.*

Put a check by the two sentences that tell the most important things to do in order to successfully complete each activity.

7. Buy a bicycle.

_____ Check the kind of tires the bicycle has.
_____ Compare the quality of different kinds of bicycles.
_____ Decide which color looks best.
_____ Visit some stores to compare prices.

8. Try out for beginners' band.

_____ Tell the band teacher all about yourself.
_____ Let the band teacher know that your parents are musical.
_____ Follow directions carefully during the tryout.
_____ Be quiet unless you are asked to talk or play an instrument.

9. Make a project for the science fair.

_____ Begin early so you will have enough time to work on it.
_____ Make a fancy project, which uses only costly materials.
_____ Find a project you're interested in and can do yourself.
_____ Help plan the science fair.

10. Race in the school track meet.

_____ Practice every day for several weeks before the track meet.
_____ Enter every event that you can.
_____ Help your coach by being nearby when you might be needed.
_____ Do the best you can.

*An **analogy** is a special kind of comparison.*

In each analogy below, decide how the first two words are related. Then relate the second two words in the same way by choosing a word from the word box.

---

alphabet mountain bottom island climb light
dig find king foot soup pool

---

11. **clean** is to **dirty** as **top** is to _____
12. **run** is to **track** as **swim** is to _____
13. **creek** is to **river** as **hill** is to _____
14. **finger** is to **hand** as **toe** is to _____
15. **feel** is to **touch** as **discover** is to _____
16. **drum** is to **band** as **letter** is to _____
17. **bang** is to **noise** as **flash** is to _____
18. **girl** is to **boy** as **queen** is to _____
19. **broom** is to **sweep** as **shovel** is to _____
20. **stove** is to **cook** as **ladder** is to _____
21. **frame** is to **picture** as **water** is to _____
22. **glass** is to **milk** as **bowl** is to _____

*The students in the school patrol decided to go to Washington, D.C. for their year-end trip. They made this list of things to do before going on the trip. Decide on the 10 things which you think are the most important as they plan their project. Number the steps **1** to **10** to show the order in which they should be done.*

_____ 23. Raise money for the trip.

_____ 24. Get parental permission slips to go on the trip.

_____ 25. Decide when to go.

_____ 26. Decide on the length of the trip.

_____ 27. Make travel arrangement plans.

_____ 28. Make housing and eating arrangements.

_____ 29. Plan recreation for free time in Washington.

_____ 30. Decide which clothes are needed for the trip.

_____ 31. Read up on some of the things to see and do in Washington.

_____ 32. Decide whether the students will be required to write about the trip after they return.

_____ 33. Decide how much spending money to take.

_____ 34. Plan the number of adults who will be invited to go along.

_____ 35. Decide whether to use a buddy system.

_____ 36. Plan whether or not cameras will be taken.

_____ 37. Decide how to pack the suitcases.

_____ 38. Estimate the cost of the whole trip after checking the cost of each part.

*A **hypothesis** is an explanation of why something may have happened. A hypothesis is built upon facts that are given to you. Sometimes the same set of facts can lead to different hypotheses.*

Below each story are three hypotheses that explain why the situation in the story may have happened. Read the story. Then put a check before the most likely hypothesis. Then, on the writing lines, give still another hypothesis of your own.

39. One summer night, Jeff left his bicycle out in the front yard. The next morning, he found that his bicycle was all wet.

_____ a. It rained during the night.

_____ b. The evening dew made the grass and the bicycle wet.

_____ c. The bicycle was parked near a lawn sprinkler that had been left on all night.

_____

_____

40. Julie and Mike discovered that the library corner was in a mess. Some books were leaning on the shelves. Others had fallen to the floor.

_____ a. The children had been careless about putting books on the shelves. As a result, some books had fallen off.

_____ b. The books had not been neatly stacked in the beginning.

_____ c. The pegs which hold the bookshelf had slipped and caused the books to fall.

_____

_____

Read each story. Then, check the sentence under it that gives the best conclusion for each.

41. Brian folded up the lawn chairs and put them in the shed. He brought the potted plants indoors. He also put the garbage cans in the garage. Brian checked to make sure nothing else was loose in the yard. Then he went inside and listened once more to the reports on the radio.

_____a. Brian is going away on vacation.

_____b. Brian is expecting a big storm.

_____c. Brian has heard that a criminal is loose.

42. Miss Frizzle hunted all over the house. The longer she looked, the more upset she became and the more she squinted. Finally, in exasperation, she put her hand to her head. How Miss Frizzle smiled when she realized what a silly mistake she had made.

_____a. Miss Frizzle found she was wearing her eyeglasses.

_____b. Miss Frizzle's headache went away.

_____c. Miss Frizzle realized she was wearing her missing ring.

43. Colin got in the elevator and pushed the button. When the door opened, he trudged wearily to his apartment door. It took Colin several minutes before he realized that his key just wouldn't fit into the lock. When he looked up, he saw why.

_____a. Colin had the wrong key.

_____b. The lock on the door was broken.

_____c. Colin had gotten off at the wrong floor.

*A good **generalization** is a statement that is true for all the details that lead up to it.*

*Read each statement and the words that follow. If the statement is true for **all** of the words, write **T** on the line.*
*If the statement is not true about **one** of the words, write **F** on the line.*

44. These items can be used to tie something.
rope string ribbon cord wire

45. These animals are covered with feathers.
chicken robin ostrich peacock dolphin

46. These are different kinds of workers.
teacher writer electrician carpenter florist

47. These articles can be found in a kitchen.
refrigerator cabinets dishes car stove

When you write a report, you get information from different sources. It is important to make good choices about the sources you use.

Read the paragraph below. Then fill in each blank with one of the sources given in the box. Choose the best source for each sentence.

---

globe encyclopedia poem chart newspaper
dictionary television interpreter

From looking at a (48)_____, you can tell that China has many neighbors, including Russia. According to the (49)_____, only two other countries in the world have more land than China. They are Russia and Canada. On a (50)_____ showing world population, you can see that China has more people than any other nation. China also has the world's oldest living civilization. A recent program on (51)_____ showed that the Chinese were the first people to develop the compass, paper, silk, and fine china. China also has an old and great body of literature and painting. Many of the paintings are a kind of fine handwriting called **calligraphy**. The (52)_____ says that it is pronounced kə lĭg´rə fē. This ancient art is still practiced today.

There are often many ways to do something. Some ways are better than others. It is good idea to stop and think about all the possibilities before you decide.

Each sentence tells about what someone wants to do. The three sentences that follow give ways that this could be done. Underline the sentence that you think tells the best way.

53. Becky doesn't have enough money to buy flowers for the table of a fall party she is giving.

a. She could use a green houseplant.
b. She could use autumn leaves.
c. She could make a centerpiece.

54. Jim wants to remember to call his grandmother on a certain date to wish her a happy birthday.

a. He could tie a string around his finger.
b. He could mark the date on a calendar.
c. He could write a note to himself and put it in a place he always looks.

55. Steve wants to buy a used bicycle.

a. He could ask his friends if they want to sell theirs.
b. He could check the local classified ads for bicycle.
c. He could ask at the bike shop to see if they have any.

56. Tom wants to find an original way to thank his neighbor for a weekend at the seashore.

a. He could write a thank-you note.
b. He could go over and thank the neighbor in person.
c. He could give the neighbor a scrapbook of photos he took during the weekend.

Student Interview Questions

1. **Do you feel comfortable using the computer as a tool to find research material for a classroom project?**

2. **How often do you use the computer to type a report or to make a visual?**

3. **Do you enjoy working by yourself or in a small group when you are doing a project?**

4. **Would you be interested in using a computer to organize your work or projects?**

5. **Do you ever think about how other students in the country do projects at their school?**

6. **Would you be interested in being part of a long-term project that involves other classes here at your school and in other states?**

7. **Have you ever kept a journal or portfolio to show your work, progress, interests, etc.?**

8. **Do you think using a computer would help you organize your thoughts and become a better thinker?**

9. **When or where to you do your best/most thinking and planning for schoolwork?**

Student Survey

Please take a few minutes to answer the following questions. Thank you! Indicate your responses by checking the appropriate letters (only one response per question).

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

1. **On average, I use the Internet three or more days a week.**
   SD _____ **D** _____ **A** _____ **SA** _____

2. **I spend approximately three or more hours a day using the Internet.**
   SD _____ **D** _____ **A** _____ **SA** _____

3. **I use the Internet only at school.**
   SD _____ **D** _____ **A** _____ **SA** _____

4. **I use the Internet at locations other than school.**
   SD _____ **D** _____ **A** _____ **SA** _____

5. **If I use the Internet somewhere other than at school, I always have the permission of a parent, guardian, or authority figure to be on-line.**
   SD _____ **D** _____ **A** _____ **SA** _____

6. **I use the Internet primarily for school assignments and for researching information.**
   SD _____ **D** _____ **A** _____ **SA** _____

7. **I use the Internet mainly for e-mail and for playing games.**
   SD _____ **D** _____ **A** _____ **SA** _____

8. **I feel I know how to use the Internet fairly well.**
   SD _____ **D** _____ **A** _____ **SA** _____

9. **I would like to learn more about using the Internet.**
   SD _____ **D** _____ **A** _____ **SA** _____

10. **I would use the Internet more if I knew more about it.**
    SD _____ **D** _____ **A** _____ **SA** _____

Teacher Survey on the Use of Higher Order-Thinking Skills

Please rate each question from 1-4. At the end of the survey, please feel free to add any additional comments you may have regarding Higher-Order Thinking Skills. Thank you.

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Are you aware of the levels of Bloom's Taxonomy?	4	3	2	1
2. Do you think our curriculum workbooks and worksheets test higher-order thinking skills?	4	3	2	1
3. Do you think questions and questioning techniques used in our basal target each level of knowledge?	4	3	2	1
4. Do you use higher-order thinking questions in your classroom?	4	3	2	1
5. Have you been trained in questioning techniques for higher-order thinking?	4	3	2	1
6. Do you think training in the art of questioning for higher-order thinking skills would be beneficial to you?	4	3	2	1
7. Do you think it is important for teachers to use higher-order thinking questions in their classroom?	4	3	2	1
8. Do you think use of the Internet helps in developing the higher levels of thinking?	4	3	2	1

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Developing Higher-Order Thinking Skills Through the Use of Technology

Author(s): Coleman, Connie; King, Jeff; Ruth, Mary Helen; Stary, Erin

Corporate Source: Saint Xavier University

Publication Date: ASAP

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1

[X]

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A

[ ]

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B

[ ]

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, → please

Signature: Connie L. Coleman Jeff King Mary Helen Ruth Erin Stary

Printed Name/Position/Title: Connie Coleman, Jeff King, Mary Helen Ruth, Erin Stary, Student/FBMP

Organization/Address: Saint Xavier University, 3700 W. 103rd St. Chgo, IL

Telephone: 708-802-6279 FAX: 708-802-6208

E-Mail Address: crannell@sxu.edu Date: October 31, 2001

William Crannell, Ed.D.

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

ERIC/REC
2805 E. Tenth Street
Smith Research Center, 150
Indiana University
Bloomington, IN 47408