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ABSTRACT

This action research project sought to develop students' critical thinking skills by implementing a variety of instructional strategies. Targeted for this study were students in one early childhood special education program, one kindergarten class, and one eighth grade science class. The deficit in critical thinking and problem-solving skills was documented through teacher observation checklists, student journals, and surveys of teachers, parents, and students. Analysis of probable causes revealed that students were not challenged to use critical thinking skills in the classroom on a consistent basis. Several instructional strategies were used in an 11-week intervention to boost students' critical thinking skills, including environmental enhancements, graphic organizers, journaling, problem-based learning, technology, and questioning techniques. Teachers guided students in a variety of developmentally appropriate activities to assist individual, small, and whole groups in problem-solving activities and in acquiring concepts and skills. Pretest and posttest data were collected on the skills of sorting, recalling, describing, problem solving, predicting, and estimating. Post-intervention data revealed definite improvements in student critical thinking skills for most students in the early childhood, kindergarten, and eighth-grade classes. (Thirty appendices include data collection instruments and sample instructional materials. Contains 17 references.) (KB)

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DEVELOPING CRITICAL THINKING SKILLS THROUGH A VARIETY OF INSTRUCTIONAL STRATEGIES

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An Action Research Project

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Abstract

The goal of this study was to develop students' critical thinking skills by implementing a variety of instructional strategies. Environmental enhancements, graphic organizers, journaling, problem-based learning, technology, and questioning techniques were used in an effort to boost students' critical thinking skills. Data was collected on the skills of sorting, recalling, describing, problem solving, predicting, and estimating. The targeted population was early childhood, kindergarten, and eighth grade science students.

Analysis of probable cause revealed that students were not challenged to use critical thinking skills in the classroom on a consistent basis. National curriculum expectations, the lack of professional development, and the need for appropriate teaching and assessment materials contributed to this problem. The problem was documented by data that was collected from teacher observation checklists, teacher, parent, and student surveys, and student journals.

A variety of instructional strategies were implemented in the classrooms to enhance students' critical thinking skills. Well-designed lessons and genuine problems were used to teach the curriculum while the students were engaged in authentic learning activities. Teachers guided the students in a variety of activities to assist individual, small, and whole groups in problem solving activities and the acquisition of concepts and skills.

Post-intervention data revealed that definite improvements were noted in student critical thinking skills for most students in the early childhood, kindergarten, and eighth grade classes. Analysis of post-intervention data confirmed that it is imperative for educators to make a noteworthy effort to teach critical thinking skills in a meaningful and decisive manner.

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SIGNATURE PAGE

This project was approved by

Advisor

Advisor

Dean, School of Education

We dedicate this book to our families…
for their love and support.

And to God…
for guidance and
the strength to endure.

We love you.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

Students in preschool, kindergarten, and eighth grade lack adequate critical thinking skills that are necessary to become successful learners. Critical thinking skills are essential for gathering, processing, and applying information and knowledge. The ability to reason, problem solve, make decisions, and think creatively are all vital life skills that students need in order to successfully function in school and in life. Evidence for the existence of the problem includes test scores that indicate student academic performance, teacher observation checklists that document student behaviors, and portfolio information that illustrates a collection of student work samples linked to critical thinking.

Immediate Problem Context

The focuses of our study include an early childhood special education program, a kindergarten class, and an eighth grade science class. The early childhood class and the eighth grade science class are both located in the same school district but in separate buildings. In this study, the early childhood class will be referred to as Site A. The eighth

grade science class will be referred to as Site B. The kindergarten classroom is located in a different school district that is geographically near the elementary school district of Site A and B. The kindergarten class will be referred to as Site C.

Site A

The special education early childhood (EC) program is located in a primary school building, one of six in the school district. The school was built in 1962. It contains one EC special education classroom, two kindergarten classrooms, two first grade classrooms, one speech therapy classroom, one Writing to Read lab, two second grade classrooms, two third grade classrooms, a learning center-library, one music room, and a professional development classroom. Most of the classrooms are located in a continuous hallway. There are 14 full-time certified teachers in the school, which includes 1 speech therapist, 1 learning center teacher, 1 early childhood teacher, 2 kindergarten teachers, 2 first grade teachers, 2 second grade teachers, 2 third grade teachers, 2 Reading Recovery teachers, and a teacher for gifted students. Part-time certified staff includes a music teacher, a gym teacher, and a nurse. Average years of experience for all certified staff are 23 years, and 50% of the certified teachers have their master's degrees. There are six teacher assistants; four are full-time and two are part-time. The school has one principal, one secretary, two lunchroom and playground supervisors, two cafeteria workers, one janitor, and three latchkey workers. The facility also has one gymnasium that doubles as the lunchroom, one cafeteria, one administrative office, one nurse office, one teacher workroom and lunchroom, and one latchkey room. The building was remodeled in 1996-97, with new windows, paint, carpeting and technology updates (wall-mounted monitors, wiring for classroom computer labs, etc.). The school's large, partially fenced playing

field contains a playground jungle gym set, which was installed in 1993 complete with basketball hoops, and a biking and walking path. The school is located in a middle-class neighborhood in the southeast area of the community. Students come from the immediate area, and some are bussed from various areas surrounding the school's location. This elementary school is the smallest of six buildings in the community-wide K-8 school district.

According to the 2000 State School Report Card, total enrollment of the school is 174 students. The racial and ethnic background for the school is 97.4% White students, 1.1% Asian-Pacific Islander students, 0.0% Native American students, and 0.0% Black students. Low-income students make up 31.7% of the school's total population. Low-income students may come from families receiving public aid, may live in institutions for neglected or delinquent children, may be supported in foster homes with public funds, or may be eligible to receive free or reduced-price lunches. This school has a 95.1% attendance rate with no chronic truancy problems and a mobility rate of 9.6%.

Average class size, a grade's total enrollment divided by the number of classes for that grade, reported for the first school day in May is 20.5 students in the kindergarten classes, 23 students in the first grade classes, and 21.5 in the third grade classes. The EC program has a state-mandated enrollment limit of 10 students per class, and the class size averages between 8 to10 students. The teacher racial and ethnic background for this school is 100% White and 100% female.

There are currently a total of 19 students enrolled in the EC program, 10 students in the morning class and 9 students in the afternoon session. EC students attend 1 of 2 daily sessions, each of which is 2 and one-half hours long.

Students who are placed in the program must meet special education eligibility requirements based on state guidelines. Students are placed in the program through the district-wide preschool screening process, doctor referrals, referrals from community preschools, and other agencies. Students who are placed in the EC class have disabilities that range from mild to severe in one or more areas of development.

EC students are bussed to school from the immediate area surrounding the school as well as from other parts of the community. Door-to-door bus service is provided through a district contract with the city. The bus has one monitor who handles bus attendance forms and helping the students on and off the bus. There are currently three early childhood staff members: one full-time certified teacher, one full-time classroom assistant, and one part-time personal assistant. The early childhood classroom is fully carpeted with windows along the west side of the room. The block walls in the room are painted a soft cream-color with neat and stimulating wall art, signs, and hangings. The soft up-lighting, scented room fragrances and softly played classical music creates a calm and comfortable setting. Two student computer stations are located next to a small refrigerator, a free-time choice board, and a classroom job assignment chart. A large-screen monitor is located next to the computers and is used for group computer activities. One EC student has a severe disability and is able to operate within the regular classroom structure with the help of her personal assistant. The program curriculum is based upon individualized student needs as stated in their individualized educational programs (I.E.P.'s). The program curriculum is also based on the State Preschool Standards, which serve as a guide to state preschool programs. Class activities focus in the areas of speech and language development, motor development, cognition and readiness skills, self-help

skills, behavioral dispositions (creativity, curiosity, etc.), and social-emotional development. The students in the EC program receive support services for speech and language therapy, occupational therapy, social services, and parent-teacher consultation based on needs identified in their I.E.P. and by the classroom teacher. The EC students do not receive services from the school learning center, reading, music, gym, or gifted teachers. There are five other early childhood classrooms in the district, which are located in other district primary buildings throughout the community.

Site B

The eighth grade science class is located at a junior high facility in the same elementary district as Site A. It is one of two junior high buildings in the school district. The brick, single-story school was built in 1953. It houses approximately 400 students and 30 full-time certified staff members. Classrooms are organized into one continuous hallway. A learning center, a computer lab, music room, band room, one large gym, one small gym, and a cafeteria are also included in the building design. Site B was recently remodeled with new windows, paint, classroom carpeting, hallway tile, lockers, and technology updates (wall-mounted monitors, wiring and cable for classroom computer labs, etc.).

In order to connect the curriculum in a departmentalized setting, and to create a more personalized student experience, Site B has adopted the middle school approach. Students are assigned to one of four seventh and eighth grade teaching teams. Three of the four teams consist of one language arts, one math, one science, one social studies, and one special education teacher. The fourth team includes students identified as gifted. Students assigned to the fourth team visit one teacher for language arts and social studies,

and a second teacher for math and science instruction. In addition, Site B employs one teacher to serve students with behavior disorders. The exploratory staff consists of one male and one female physical education teacher, a music teacher, band teacher, and art teacher. Communications and industrial technology are additional exploratory courses that are offered every other year by a qualified instructor. Site B employs one principal, one assistant principal, two secretaries, six cafeteria workers, and two janitors. A part-time police officer patrols the building, alternating his days between the two junior high schools in the district.

According to the 2000 State School Report Card, total school enrollment is 446 students. The average class size is 29.3 students. Each day, a full hour is devoted to each of the core subject areas including mathematics, science, English, and social science. The racial and ethnic background for school staff is 100% White. The background for students is 98.2% White, 0.9% Hispanic, 0.7% Asian-Pacific Islander, 0.2% Native American, and 0% Black. Low-income students make up 31.6% of the student population. The student attendance rate is 93.8%. The mobility rate is 9.6%. The chronic truancy rate is at 1.7%. There are eight students classified as chronically truant at Site B. Teachers at Site B average 15 years teaching experience with the district, and 57% have earned a master's degree (District Seniority List 2000-2001).

Students in the eighth grade science class are seated at eight separate tables to allow for activity-based lessons. The west wall of the classroom includes a working countertop with a built in sink, electric, and gas outlets. A wall-length bulletin board runs along the north end of the room. The bulletin board typically features a new scientist each week, current science news, calendar activities, and homework assignments. Five student

computer stations and a printer are available along this back wall of the classroom. Students have supervised access to the Internet, word processing, PowerPoint, and a variety of software. The east wall is lined with windows, and below it, bookshelves run the length of this side of the room. Several sets of encyclopedias, dictionaries, science textbooks, and science related print materials are available to students. At the front, the south end of the room, there is one teacher computer station with a removable laptop connected to a large overhead monitor for whole classroom instruction. A large white board and overhead screen are also available for instruction.

The eighth grade science curriculum involves the content areas of physics, chemistry, human anatomy, health, earth, and space science. Lessons are aligned with the State Standards for middle school students and district guidelines. The eighth grade teacher is responsible for approximately 20 homeroom students. Students meet in their homeroom for the first 20 minutes of each day. They return to their homeroom following lunch for a 30-minute study hall. In addition to homeroom, lunch, and study hall, the daily schedule includes five, one-hour class periods.

Site C

The third focus of this study is a kindergarten class, which will be referred to as Site C. This kindergarten classroom is located in a primary school situated on a large open field adjoining park district tennis courts. The area is largely an affluent neighborhood surrounded by woods and two small lakes within walking distance from the school. A large private park, farm area, and two churches are within a quarter of a mile radius from the site. There are no businesses or public transportation in the immediate area.

The school is a well kept, twenty-five year-old, modern air-conditioned two-story building. There are two main hallways on the first floor. Conventional self-contained classrooms for grades K-2 border the back main hallway with the office, computer lab, library, teacher's lounge and gymnasium with adjoining multipurpose cafeteria bordering the front main hallway. A circular staircase at either end of the front hallway leads to the second floor, which houses the third and fourth grade classes. The second floor consists of one main hallway lined by eight classrooms. Two very large classrooms are partitioned and are used for a music room, a meeting room, and a teacher resource area.

The primary school services grades K-4. There are at least three classrooms for each grade level, including a full inclusion classroom in grades 1-4. The school is technology-minded. Along with the library and computer media center, two or more computers with Internet access are located in each classroom. The kindergarten classroom of Site C is partially carpeted and freshly painted in a warm cream color. The walls are used as an interactive instructional area with displays of print rich material and student-created charts and graphs. A double blackboard on the east wall and a double bulletin board on the south wall are used to display current classroom activities. There is one large window with an alphabet valance in the southeast corner. Centers for writing, housekeeping, blocks, table activities, math, and computers are in designated areas of the room. The computer area includes three computers and two printers. Long linear shelves divide the carpeted area from the tiled area with four hexagon shaped tables. A bright yellow five-foot counter with a sink, located three feet from the west inside wall, allows for easy painting clean up. In the near northwest corner is a single classroom bathroom. Next to the bathroom is a wall hung drinking fountain. Continuing down the north wall is

two bright yellow, double door storage cabinets. A triple section of coat hooks complete this wall.

The school program is primarily traditional and is largely based on state guidelines and the required minutes per day in the core subject areas. According to standardized scores on the 2000 state report card, the school had 27% of the students at the third grade level falling below standards in reading with 3% of the students on academic warning. In math, 18% of the students did not meet the state standards. Creative writing scores indicated that 44% of the students did not meet state standards.

This school is part of a unit type district (grades kindergarten through 12th grade) with a student population of 387 students. The racial and ethnic population consists of 64.3% White, 29,7% Black, 3.4% Asian, 2.3% Hispanic, and 0.3% Native American students. Although the school is located in an upper middle class neighborhood, 36% of the students come from low-income families. Six busses transport students from a variety of areas within the city. Only a small percentage of the students walk to and from the school daily. The attendance rate is 96.1% with a mobility rate of 16.6% with no chronic truants (2000 State School Report Card).

The school faculty consists of 17 regular division teachers, four special education teachers, one full-time physical education teacher, a speech and language therapist, an ESL (English as a Second Language) teacher and a part-time teacher in each of the areas of science, music, orchestra and technology. The average experience of the faculty is 16 years of teaching with 56% holding a master's degree in education.

School District Information

Site A and B

Site A and B are part of an elementary school district that includes six primary school buildings, two intermediate (4-6) schools, and two junior high (7-8) schools that are located throughout the community. Enrollment for the district is 3,930 students with a certified teaching staff of 267. Of the 267 teachers, 100.0% are White, 14.2% are male, and 85.8% are female. The racial and ethnic makeup of the district's students is 98.4% White students, 0.5% Black students, 0.6% Hispanic students, 0.5% Asian-Pacific Islander students, and 0.1% Native American students according to the 2000 State School Report Card for this district. In the past several years, this district has received national recognition for its technology program. Each K-8 classroom in the district has a computer lab with at least five student workstations and a large wall-mounted computer monitor. Each certified teacher has a laptop computer, and each intermediate and junior high school has a student laptop-lending program. The district participates in the Learning Community 2000 grant project that is funded by a $3.5 million challenge grant from the United States Department of Education. The purpose of the learning community is to foster citizenship, communication, collaboration, consensus, and connectivity between all community members.

Site C

A large public school unit district serves the area. Private schools of several denominations also serve the area. The district of Site C has a student population of 15,134. The district is comprised of 5 high schools, including 1 alternative high school, 12 middle schools, 14 primary schools, 1 magnet school (K-8), 1 gifted middle school, 4

other sites for special needs and an early childhood center (2000 Facts, school district brochure). Two years ago a private management firm was hired by the school board to manage two primary schools. A year ago a middle school was added to the list of schools to be managed by the private company. A private sector managing public schools has caused much concern from parents and the general public. According to the 2000 State School Report Card, the racial and ethnic background for the district is 40.6% White students, 55.2% Black students, 2.2% Hispanic students, 1.8% Asian students, and 0.1% Native American students. Low-income students make up 60.3% of the school district's total population. There is a mobility rate of 36% and a truancy rate of 7.3%. In order to meet state segregation laws, the district has a large bussing program. In accordance with state statutes, the school district is governed by an elected board of education. The superintendent is employed by the board and serves as the chief administrative officer.

The Surrounding Community

Site A and B

The community setting for Site A and B, has two local school districts, an elementary school district and a high school district. It is located in the central portion of a Midwestern state along the banks of a major state river. According to the city's chamber of commerce, the total population is approximately 33,200. The city is located 10 miles from a metropolitan market area with a total population of approximately 345,000. At the time of this report, the 2000 Census information is not yet available. According to the 1990 census, the racial and ethnic makeup of this community's population is approximately 99% White, 0.1% Black, 0.2% Native American, 0.4% Asian-Pacific

Islander, 0.6% Mexican-American, and 0.1% is designated from other origins. This community continues to struggle with racial and ethnic issues that have troubled this city in the past. The median age is 34.4 years. There are 17,381 households with an average household size of 2.55 people. There are a total of 12,497 families with an average family size of 3.06 people. Of those families, 82.4% are married couples, 50.9% are households with children, and 32% are single parent households. In addition, 25.5% of the households are occupied by people 65 years of age or older.

A profile of socioeconomic indicators showed that the median family income in the community is $31,533, and the per capita income is $12,424. According the to 1990 Census, there were 984 families, or approximately 10.9% of all families in the community, with incomes that fell below the poverty level. In the local community, 55.0% of the families are eligible to apply for free or reduced school lunch prices. Of the 20,982 persons 25 years and older, 75.7% have a high school diploma, and 10.5% have a bachelor's degree or higher. According to the 1990 Census, the average cost of a home in the community is $41,319.

Site C

Site C is located at the edge of a large Midwestern-manufacturing city with a population of 113,504 people (City Statistical Abstract, extracted from 1990 U.S. Census). The city is part of a greater metropolitan area with a population of 345,000. The city is known for its world-renowned industries and the shipping business via a major river that runs through the area. The fine arts are represented through the city's ballet company, symphony, and a community of artists. There are higher educational opportunities available through a private college, a local community college, a medical

school and three teaching hospitals.

According to the 1990 Census, the racial and ethnic makeup of this community's population is 76.5% White, 20.9% Black, 0.2% Native American, 1.7% Asian-Pacific, and 1.6% Hispanic. There are 44,976 households with an average size of 2.42 people. Of the households, 63.2% are families, 45.8% are married couples, 30.8% have children under the age of 18, 14.7% are single female households, 10.1% of the single female households have children, and 24.1% of the households are occupied by persons 65 years of age or older. The median family income of the area is $34,003 (as cited by the 1990 Census). The personal per capita income of the area is $25,438 (as cited by the 1999 State Statistical Abstract for 1997). According to the 1990 Census, 15.1% of the families fall below poverty level. Of those families, 25.1% have children under the age of 18. According to the city's abstract from the 1990 Census, 77.9% of the population has a high school diploma or higher and 23.6% have a bachelor's degree or higher. The average cost of a home is $49,200 (as cited by the 1999 State Statistical Abstract).

The community plays an important role as partners in education with the public school district. The school district has been able to utilize the expertise of the business community and promote better understanding of the public school district through the large adopt-a-school program. This has proven to be a major link from the school to business, government agencies, churches, clubs, and other social services.

National Context

The development of student critical thinking skills has become an issue that concerns educators across the country (Tama, 1989). The need to teach critical thinking skills is not a new idea. Education pundits have called for renewed interest in problem solving as far back as 1967 (as cited in Carr, 1990), Raths, Jonas, Rothstein, and Wassermann decried the lack of emphasis on thinking in schools. They noted that memorization, drill, homework, the three R's, and the quiet classrooms were rewarded, while inquiry, reflection, and the consideration of alternatives were frowned upon. National curriculum expectations and standardized tests have put heavy influence on teachers to focus on lower-lever thinking skills and rote memorization. (Tener, 1995-96; Rodd, 1999).

John Dewey said, "To think is to question."(pg.1) The responsibility for teaching critical thinking skills lies with teachers and schools. It is the job of educational professionals to enhance cognitive development and to teach children how to think. However, training programs have not equipped teachers with an adequate insight about what critical thinking skills are or how to teach them (Rodd, 1999; Tama, 1989). The need for teachers to pose appropriate questions was recognized almost two decades ago. According to Gall in 1984 (as cited in Johnson, 1992) only 20% of teachers' questions require students to think, while about 60% require factual recall, and 20% are procedural in nature. These figures indicate that most teachers are stimulating low-level thinking skills of recall and comprehension about 80% of the time. Johnson (1992) also referred

to Gall's 1970 study that says, "...the predominance of lower-level thinking questions is caused by:

1. The necessity for students to know facts before they progress to speculation or higher levels of thought.
2. The curriculum, by nature, is fact-oriented; and if teachers want their students to learn the curriculum, they will naturally focus on factual questions.
3. Teachers lack the necessary skills to formulate questions that require higher-level thought."(pg.1)

Teaching materials and tools for measuring the development of critical thinking skills are scarce or non-existent (Gadzella, 1998; Richard, 2001). Evaluating students' critical thinking abilities such as gathering, processing, and applying tends to be of a qualitative nature. It is easier for teachers to assess quantitative skills that can be measured in objective questions with measurement tools that are readily available (Tener, 1995-96).

Finally, consideration is given to the learning environment. Rodd ((1999) mentioned that research suggests that either too much or too little structure can prevent development of higher order, critical, and creative thinking skills, and so children are not equipped with an active, strategic approach to learning tasks. Carr (1990) noted McMillen as saying, "It really boils down to whether teachers are creating an environment that stimulates critical inquiry."

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

Students of all ages demonstrate a deficiency in critical thinking and problem solving skills. Sormunen and Chalupa (1994) stated that the interest in teaching critical thinking skills is based on documentation that indicates American students lack thinking abilities. In an effort to further explore this problem, several methods were used to collect documentation of student critical thinking skills.

A teacher survey containing five questions was developed and distributed at Sites A, B, and C to document preschool, kindergarten, and eighth grade students' use of critical thinking skills (Appendix A). Twelve teachers responded to the survey at Site A, 22 teachers responded at Site B, and 20 teachers responded at Site C. The results were compiled and represent the total responses of 54 teachers, as illustrated in Figure 1.

The first survey question asked teachers how well they felt their students solved problems. Almost 25 % of the teachers noted that their students seldom attempted to solve problems without help. The second survey question asked teachers to rate their students' ability to solve problems in a variety of ways. More than 50% of the teachers reported that, when having difficulty in solving a problem, most of their students did

not attempt to solve problems in other ways. The third survey question asked teachers about students' ability to create visual aides. Almost 50% of the teachers reported that their students seldom or never created visual aides in an attempt to better understand a problem.

According to Rodd, 1999 and Tama, 1989, training programs have not equipped teachers with an adequate insight about what critical thinking skills are or how to teach them. On the fourth survey question, almost 50% of the teachers reported that there were not adequate professional development activities available for teaching critical thinking skills. On the fifth survey question, almost 50% of the teachers felt that the availability of assessment and instructional materials for teaching and assessing critical thinking skills were not adequate. The last survey question indicated that more than 50% of the teachers felt that the curriculum did not allow time to adequately teach critical thinking skills because the curriculum focus is on teaching information that students need to know for standardized tests. The teacher survey concluded that most teachers felt students had inadequate critical thinking and problem solving abilities.

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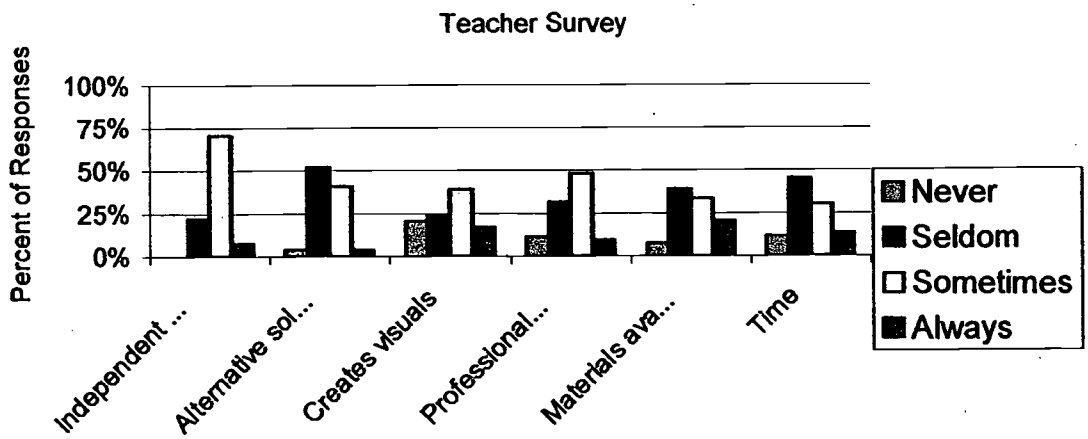

Figure 1 Teacher Survey of Students' Ability to Problem Solve at the Pre-Kindergarten, Kindergarten, and Eighth Grade Levels.

Surveys were given to parents of students in the preschool, kindergarten, and eighth grade classes to determine the extent to which parents felt their children used critical thinking and problem solving skills (Appendix B). Skills that are important for the development of critical thinking are the ability to solve problems in persistent, creative, and analytical ways, the ability to recall details from stories and past experiences, the ability to listen attentively, and the ability to work cooperatively with others. Curiosity and inquisitiveness are character traits that are also important in the development of critical thinking skills. Survey questions pertaining to these skills and abilities were presented to parents who were asked to circle a number between one and four to indicate the extent to which they felt their child used these particular skills. Circling a number one indicated that the parent felt their child did not use these skills at all, and circling a number four indicated that the parent felt their child uses these skills frequently. At Site A, 15 parents responded to the survey, 19 parents responded at Site B, and 18 parents

responded at Site C. The results were compiled and represent the total responses of 52 parents as illustrated in Figure 2.

On the first survey question, 50% of the 52 parents responded that they felt their child sometimes attempted to solve problems on their own, and less than 50% of those surveyed felt that their child almost always attempted to solve problems on their own. Being inquisitive is an important character trait for solving problems and thinking critically. On the second survey question, most of the parents surveyed felt that their child did ask questions when they did not understand a concept. Persistence is another important quality in problem solving. When one solution does not work, trying other solutions and strategies may lead to success. On the third survey question, 30% of the parents reported that when having difficulty solving a problem, their child seldom attempted to solve the problem in another way.

In attempting to solve problems, a useful strategy is to create pictures, charts, or diagrams to visualize a problem. On the fourth survey question, more than 30% of the parents felt that their child did not attempt to solve problems by creating visual aides, and less than 40% of the parents surveyed felt that their child sometimes or almost always used visual aides for solving problems.

Being able to recall directions and retell details, information, and ideas from stories and past experiences is an important skill for critical thinking and problem solving. On the fifth and sixth survey questions, approximately 25% of the parents reported that their child was seldom or never able to recall directions, details or information from stories or past experiences.

Working well with others is a skill that all students need in order to function successfully at school, in the workplace, and in society. On the seventh survey question, a large majority of the parents, approximately 75%, reported that their child interacted and worked well with others.

Being an attentive listener in the classroom is important for learning to solve problems and think critically. On the eighth survey question, over 50% of the parents felt that only sometimes was their child an attentive listener in a group setting.

Being inquisitive and curious of one's surrounding is a favorable characteristic for problem solving and thinking skills. On the ninth survey question, over 70% of the parents felt that their child was inquisitive and curious of their surroundings.

Being able to describe events and ideas indicates ones' understanding of concepts and ideas, which is important in solving problems and critical thinking. On the last survey question, almost 50% of the parents reported that their child was able to describe events and ideas.

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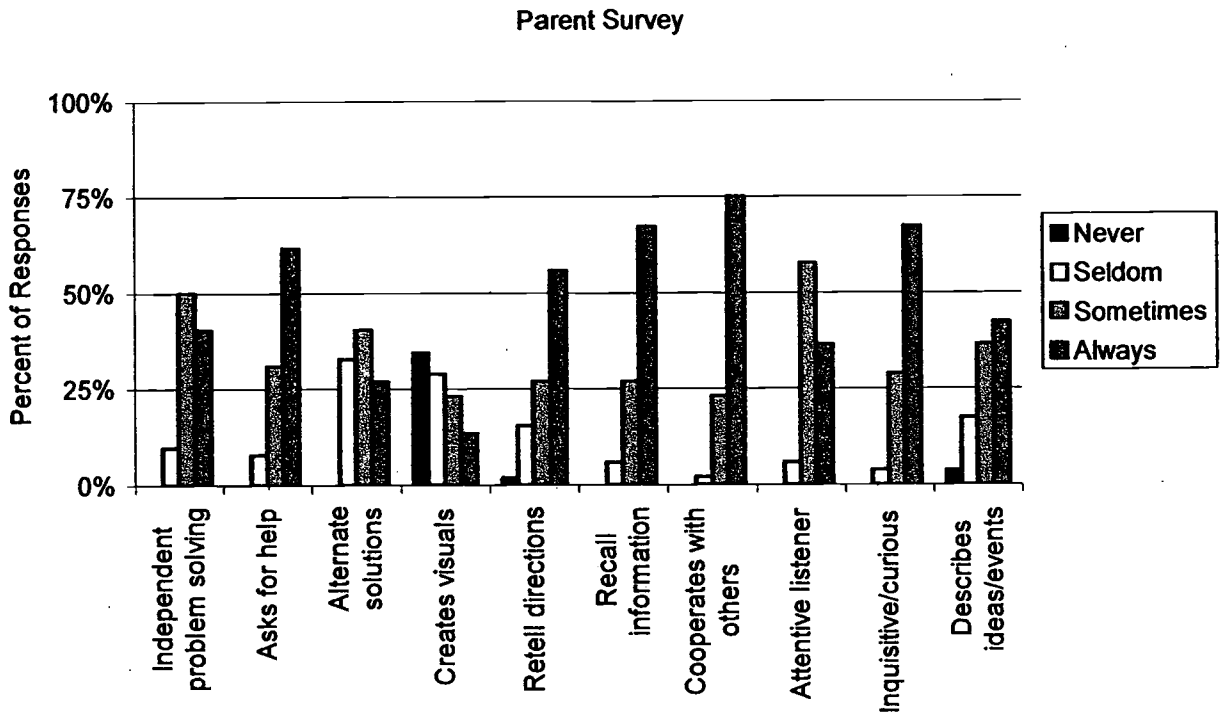

Figure 2 Parent Survey to Measure the Parents' View on Students' Use of Critical Thinking Skills.

The eighth grade students at Site B were asked survey questions that were similar to the parent survey to indicate the extent to which they felt they used critical thinking and problem solving skills (Appendix C).

On the student survey (Figure 3), over 60 % of the students reported that they almost always attempt to solve problems on their own. When asked whether or not they sought assistance when not understanding a concept, the student survey showed that over 50% of the students reported they sometimes, but not always, ask questions when they did not understand a concept.

When problem solving, if one solution to a problem did not work, only 40% of the students reported that they sometimes, but not always, attempted to solve problems in other ways. Additionally, more than 60% of the eighth grade students reported that they seldom or never created visual aides to help them in problem solving.

Approximately 50% of the students surveyed reported that they sometimes, but not always, were able to retell directions or recall details from stories or past experiences. On the seventh survey question, the eighth grade students were asked if they felt they worked well with others. A large majority, almost 75% of the students, reported that they did work well with other students. The eighth survey question pertained to attentive listening. Over 50% of the students reported that they were sometimes, but not always, attentive listeners in a group setting. According to the student survey, approximately 50% of the students reported that they were inquisitive and actively curious about their surroundings. The last survey question asked students if they were able to describe events and ideas. Only 35% of the eighth grade students reported that they were able to accurately describe events and ideas.

In comparison, the parents and students gave similar answers on several survey questions. Approximately 30 to 40% of both students and parents reported that the students did attempt alternate solutions to problems, however, only on an infrequent basis. When asked if they thought the students worked well with others, a large majority of both the parents and students felt that students were able to work well with others. Over 50% of both the parents and students reported that the students were sometimes or almost always attentive listeners in a group setting. Last, approximately 50 to 70% of the parents and students noted that the students were inquisitive and curious about their environment.

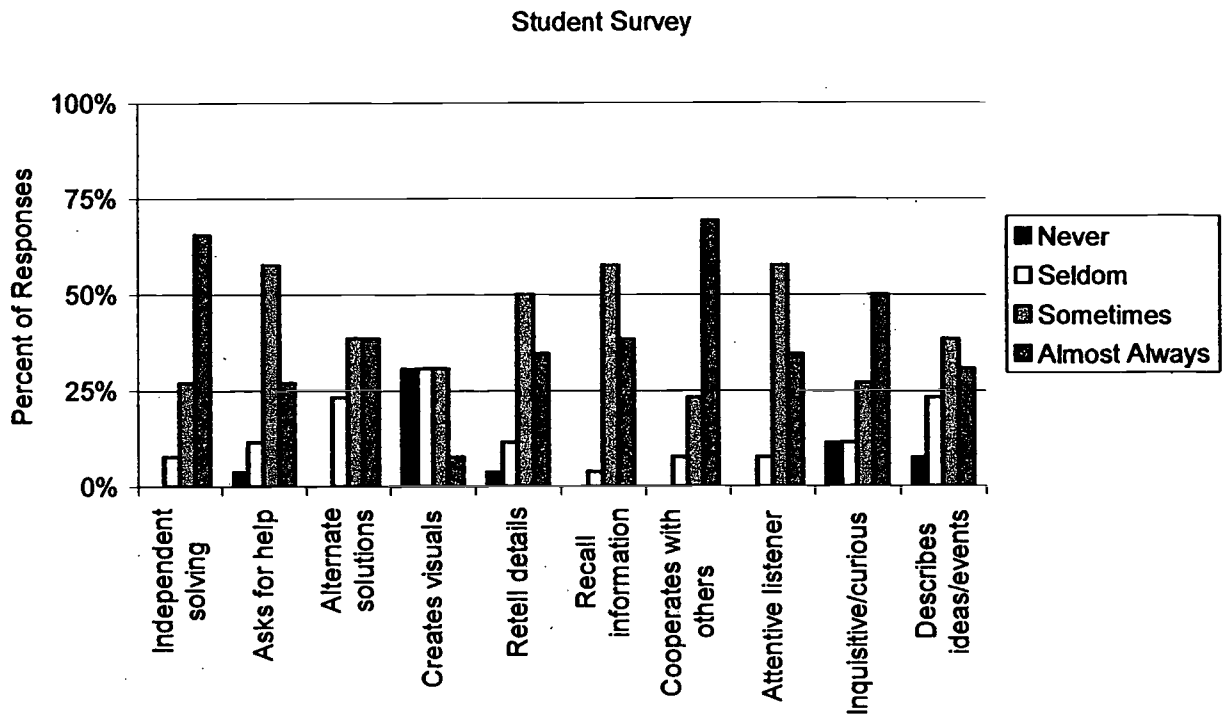

Figure 3 Site B Eighth Grade Student Survey to Measure Students' Views on Their Use of Critical Thinking Skills.

Overall, some of the information that was gathered from both the parent and the student survey showed that students demonstrated a lack of skills necessary for critical thinking and problem solving.

Twenty-six eighth grade students from Site B were asked to respond to newspaper articles through journal writing prior to action research intervention. Each student completed six journal responses which were then rated on a scale of zero to three in order to assess students' level of thoughtfulness in journal writing (Appendix D):

0 points (Undeveloped)	Response only
1 point (Partial)	Response supported by specific examples
2 points (Competent)	Response supported by examples and personal reflections
3 points (Powerful)	Response supported by examples and personal reflections to adapt to an entirely new situation

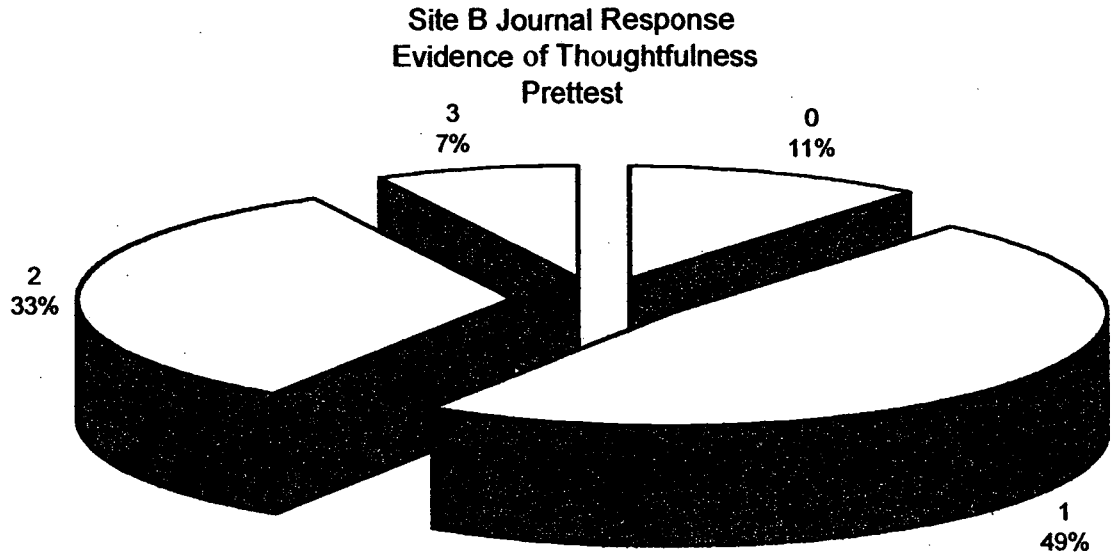

Figure 4 Site B Students' Journal Response Showing Evidence and Depth Thoughtfulness About Newspaper Articles

Sixty percent of the compiled journal responses scored below the competent level. According to Oliver Wendell Holmes' three-story intellect model (Appendix E) which is based on Bloom's taxonomy, the majority of Site B students are functioning at the gathering level of critical thinking. These students lacked the ability to process the information they read and apply the science in the newspaper articles to new situations, indicating that eighth grade students lack critical thinking skills necessary to become successful learners.

Classroom observation checklists were used to measure the level at which students were functioning on skills that required critical thinking and problem solving ability (Appendix F). These skills were chosen from Oliver Wendell Holmes' three-story intellect model. The targeted observation checklist skills are the ability to recall, describe, sort, problem solve, estimate, and predict.

The observation checklist data that was collected by the teacher in the classroom showed these students performed poorly in the areas of critical thinking and problem solving. Over a three-week period, the early childhood and kindergarten classroom teachers at Site A and Site C collected pretest data on the targeted skills. The classroom teachers gave individual and small group student assessments during various classroom lessons and activities that focused on the targeted skills. Tally marks were recorded and individual, averaged scores were given to students for each skill area that was assessed.

Based on grade level expectations, student performance was given a rating of high, average, or low on the classroom observation checklist. Students received a high rating if 80% or more of the task was completed correctly. Students who completed a task with at least 50% accuracy received an average rating and students who were not able to complete at least 50% of the task correctly, received a low rating.

The observation checklist data showed that almost 25% of the students performed poorly in the area of predicting and estimation skills. Approximately 33% of the students performed poorly when asked to complete a task in which they were required to describe a picture or an object, and more than 35% of the students scored low on problem solving tasks. Almost 50% of the students performed below age expectations when asked to recall details from a story or an experience. Only 3 students were given low scores in the area of sorting skills, and over 75% of the students scored in the average range.

Table 1 Documentation of Skills and Levels for Site A and C Students Pretest Data

Skill and Level	EC Class	Kindergarten
Sorting		
High level	8	3
Average	9	16
Low level	1	2
Recalling		
High level	1	2
Average	3	3
Low level	14	16
Describing		
High level	1	6
Average	5	1
Low level	12	14
Problem Solving		
High level	2	5
Average	3	4
Low level	13	12
Prediction and Estimation		
High level	4	5
Average	7	9
Low level	7	7

Classroom observation checklist data revealed that many students performed poorly on more than half of the targeted skills and indicated a lack of student critical thinking and problem solving abilities. Students lacked important skills that are necessary to think critically and to solve problems in appropriate ways. For that reason, educators need to make critical thinking and problem solving skills a curriculum priority and teach these skills in a more meaningful, specific, and purposeful manner.

Probable Causes

Research documenting the reason for a lack of critical thinking skills among students has led to several dominant causes. It is believed that one cause is many teaching methods overemphasize rote memorization. Carr (1988) stated that as far back as 1967, educators as Raths, Jonas, Rothstein and Wasserman recognized that the type of

classroom rewarded was a quiet one that promoted memorization, drill, and homework, with a strong emphasis on the 3R's. Any deviation was deemed inappropriate. Tener (1995-96) concurred that "...possessing information without the ability to apply it is not enough..." to develop critical thinking skills. "Such a deficiency can be traced to a method of teaching that overemphasizes memorization and rote learning. Rote implementation, which is often robotic, differs from application, which is thought-process activity"(p 69).

A second cause to consider is that standardized tests and curriculum requirements may force teachers to teach lower level thinking skills. Beyond the fact that the established tradition of teaching to the 3R's has long been retained as the preferred method, a Boston College study for the National Science Foundation concluded that the use of standardized tests has forced teachers to teach lower-level thinking skills and rote memorization. This approach distorts the curriculum by encouraging teachers to teach to the test (Tener, 1995-96). In addition, "While striving to meet the demands of the National Curriculum, some teachers tend to focus upon imparting knowledge, without teaching pupils how to think" (Rodd, 1999, p.1). Costa (1991) pointed out that, like it or not, what is inspected is what is expected, thus the traditional use of norm-referenced, standardized tests have dictated what should be learned (the goals) and have influenced how they should be taught.

Even if one were to try to test critical thinking skills, tools for measuring the development of critical thinking skills are scarce or non-existent. Experts agree that thinking is extremely difficult to assess. Consequently, evaluating complex thinking is overlooked and often ignored for several reasons. One such reason is that evaluation, or

in essence passing judgement, is a fearful thing to do. As a result of the complexity and fear of evaluating critical thinking skills, evaluation is often put off until after all the energy and funds are spent (Udall, Daniels, 1991). One may assume that this is a reason for the lack of developing assessment tools for evaluating thinking skills. Udall and Daniels further comment that the main reason for the lack of evaluation tools is that no one knows how to effectively evaluate whether students are thinking on higher levels (Udall, Daniels, 1991).

Tener (1995-96) stated that critical thinking skills have not been emphasized because of the scarcity of methods for meaningful appraisal of curriculum programs for teaching essential skills. It is much easier to assess quantitative skills that can be measured in objective questions. As the research has indicated, it is plainly more difficult to assess that which cannot be seen or touched.

Classroom environment is addressed as a major component to encouraging critical thinking skills. It would follow therefore, that the opposite, or lack of a stimulating environment would retard the development of critical thinking skills. In McMillan's study (as cited by Carr, 1990) "It really boils down to whether teachers are creating an environment that stimulates critical inquiry." Another component of the classroom environment issue addressed by McLeod (as cited in Rodd, 1999) suggested that either too much or too little structure can prevent development of higher-order critical and creative thinking skills. Fogarty (1997) stated that the impact of the elements that make up a student-centered, brain-compatible classroom has been studied, yet schools are trapped in the traditions of the past and neglect to evaluate the effectiveness of current practices.

Finally, another cause for the lack of critical thinking skills among students is the fact that teachers do not know how to teach critical thinking skills and are not trained in using appropriate strategies. Therefore, thinking skills are not being taught. According to Tama (1989) some teachers focus on imparting knowledge rather than teaching students how to think. Tama noted that teachers need to be trained in specific instructional approaches that integrate a "learning to think"(p. 5) component into the curriculum.

Costa (1991) used the following rationale:

> Children need help in developing this feeling for, awareness of, and intuitiveness about the forces affecting the universe . . . But can this attitude be taught in specific lesson plans and instructional models? Are steps for its development written in method books? Can we construct instructional theory for cognitive education that includes aesthetics as basis for learning?

Costa implied that teachers are a key element in developing critical thinking skills in students, but as the researchers have stated, teachers need to be equipped with the tools for thinking in order to teach the students how to use the tools themselves.

CHAPTER 3
THE SOLUTION STRATEGY

Literature Review

In Thinking is the Key, Johnson (1992) stated, "Good teachers prepare students for life.... They have the unique opportunity to model effective thinking techniques. The result produces life long learners who are more than good students. They are life long thinkers" (p.1).

Many solutions are recommended to assist instructors in teaching critical thinking and to overcome the obstacles that hinder the development of appropriate thinking skills. In the classroom, teachers teach a curriculum that is based on the national standards and give tests that are required by their local and state school administration. While striving to meet national curriculum and standardized test expectations, Tener (1995-96) cited a variety of instructional strategies that teachers can use to promote critical thinking skills in the classroom when teaching the required curriculum. Some of those strategies include: outlining, graphing, summarizing, interpreting, relating, classifying, researching,

evaluating, identifying fact or opinion, generalizing, drawing parallels, self-correcting, applying criteria, and hypothesizing.

Costa (1991) recognized that the traditional use of norm-referenced standardized tests in the past had determined the goals and delivery of what was learned and taught. However, as students are presented with challenges of the future, motivating students to achieve the goals of a new curriculum is necessary. Costa listed the following goals for students to meet the demands of the 21st century and the capacity for continued learning:

> How to learn; cooperation and team building; communicating with precision in a variety of modes; coping with disparate value systems; solving problems requiring creativity and ingenuity; enjoyment of resolving ambiguous, discrepant, and paradoxical situations; dealing with an over abundance of technologically produced information; taking pride in the craftsmanship of their products; and building personal commitment to larger organizational and global goals. (p.139)

Adopting these new goals are necessary in order to change the curriculum and most importantly, the delivery system. Teachers can especially make the difference by presenting instructional strategies that will increase critical thinking skills.

As research provides the strategies, the education of teachers becomes a large part of the solution. Emphasis needs to be placed on professional development activities that help teachers gain insight into the understanding and implementation of critical thinking skills so that it can be taught across the curriculum (Rodd, 1999). Rodd stated that teachers have an obligation to learn how to enhance children's cognitive development through exposure to cognitive development research, awareness of multiple intelligence, and models for teaching thinking skills.

According to Udall and Daniels (1991), many teachers feel that by injecting a number of isolated critical thinking activities such as worksheets and discussions that provide some opportunity for thinking, they achieve the objective of teaching complex thinking skills. However, the strategy of infusion implies that the injection of complex-thinking activities into a classroom curriculum should be implemented in a uniform and consistent manner. One research study of public schools and universities showed that in determining the emphasis on critical thinking in instruction, researchers found that most teachers felt obliged to claim they were both familiar with critical thinking skills and were committed to teaching them. However, few educators have had any in-depth exposure to the research on the concept of critical thinking and most teachers have only a vague understanding of what it is and what is involved in successfully teaching it (Paul, Elder, and Bartell, 1994).

One model for teaching critical thinking skills in the classroom was the problem-based learning model (Krynock, 1999). Krynock described problem-based learning as a technique in which students receive a real or potentially real problem and devise practical solutions based on the research that they do. Well-designed problems that simulate real-life help students to learn a variety of skills as well as meet curriculum objectives. Problem-based learning can also be used as a way to encourage students to work cooperatively in groups while seeking solutions to complex, real-world problems (Meirson, 2000).

Presently, technology plays a large part in classroom instruction. Computer-assisted instruction is a motivating and effective strategy in promoting early academic skills and cognitive development in young children (Hitchcock, 2000). Hitchcock also supported the

need for further research on computer-assisted instruction stating that researchers have noted that few empirical studies have been done to evaluate whether computers are more effective than traditional approaches to teaching academic skills to children. He suggested that young students require direct teacher guidance and carefully chosen software that focus on appropriate concepts and basic skills that are foundational for higher-level thinking.

Tama (1989) summarized literature by Tobin (1987) that referred to wait-time as a strategy in which teachers allow students time to cognitively process questions and information. Additionally, Tobin found that "...high achieving students were consistently permitted more wait time than were less skilled students, indicating that teachers need to monitor and evaluate their own behavior while using such strategies"(p. 2).

Questioning techniques become valuable in developing critical thinking. As Johnson (1992) stated:

> Every good scientist knows that for every action there is usually a reaction. So it is with questions, especially those that do not have right or wrong answers. One good question can start a fascinating chain reaction in the human brain; a reaction that stimulates the production of more ideas, then more questions, then more ideas, then more questions, etc...." (p. 6)

Johnson explained that the chain is made of powerful links and connectors or questions. Johnson called these "question connections," (p. 6) which are good questions that can mean the difference between low level and high level thinking. Potts (1994) addressed asking open-ended questions as a skill related to critical thinking. "Critical thinking is often exemplified best when the problems are inherently ill-defined and do not

have a right answer. Open-ended questions also encourage students to think and respond creatively, without fear of giving the wrong answer"(p.1).

The insufficient availability of teaching materials and measurement tools have compelled teachers to develop their own activities and tools to assess the development of critical thinking skills such as student portfolios and writing samples (Sormunen, Carolee, Chalupa, Marilyn, 1994). Rhoades and McCabe (as referenced by Burke, 1999) provided an option for assessing thinking:

> "Assessing thinking skills with a paper-and-pencil test places our students in untenable situations, but there is a technique teachers can use to measure thinking skills. It isn't perfect, but it seems fairer and more reliable than paper-and-pencil tests—observation." (p.139)

Burke also cited Costa's concurrence that characteristics of intelligent behavior, including flexibility in thinking and metacognition can be taught and observed by parents, students, and teachers. Costa's article, "Is Testing Thinking An Oxymoron?" stated that, "Teachers are learning how to more skillfully collect data about student performance of thinking skills through direct observation, group projects and discussions, anecdotal records, recording critical incidents, keeping checklists, journal writing, and engaging students in extended projects." (p. 140). In the book <u>If Mind Matters</u>, Costa and Kallic (1992) wrote that there is a nationwide movement from standardized, norm-referenced, computerized tests to innovative assessment methods such as writing samples, materials manipulation, open-ended multiple-answer questions, portfolios, performance, and exhibitions. These methods are more useful than traditional testing for several reasons.

First, these assessment methods are good indicators of student problem solving and creative abilities and they allow teachers to more accurately assess these abilities. Also, they take place during instruction time and provide more immediate results that assist teachers in evaluating their own effectiveness, curriculum decisions, and instructional efforts.

According to Potts (1994), a physical and intellectual environment that encourages a spirit of discovery facilitates critical thinking in the classroom. First, the physical layout of the classroom should be arranged so that the students share the stage with the teacher so that all can see and interact with everyone in the classroom. Second, visual aids and posters in the classroom such as "What Do You Think?" or "Why Do You Think That?" can encourage on-going attention to critical thought processes (p.3).

Tama (1989) also felt that teachers need to become more tolerant of conflict and confrontation in the classroom. Students need to be allowed to raise issues, spark debate, and solve problems. In Brain Compatible Classrooms, Fogarty (1997) presented the four-corner framework of the brain-compatible classroom. The framework consists of teaching for, of, with, and about thinking. These four elements are felt to be essential in developing a thoughtful classroom that encourages and values thinking in order to meet the standards of high achievement. Environment plays an important part in this framework. Specifically addressing the classroom environment, Fogarty (1997) described teaching for thinking as creating a classroom climate that presents a rich and stimulating setting for learners to explore, investigate, and inquire as well as an emotionally safe and caring environment.

The key to a classroom environment that nurtures the development of critical thinking skills is one that is safe and predictable. Udall and Daniels (1991) felt that establishing this

type of classroom came before all else because few students would be willing to take the risk of challenge or verbalizing their thoughts if there was pending ridicule. In addition, the major part to providing a safe and predictable environment was having an established routine. It was noted that it might take years to implement and maintain a set routine, yet this was a very important prerequisite to teaching thinking. The next step to implementing a thoughtful classroom was to look at how it differs from a traditional classroom. Udall and Daniels described this type of classroom as one where the students frequently disagreed with each other and the teacher. Critical thinking skills are used when students are encouraged to explain their thinking to support their thoughts and opinions. Activities in the thoughtful classroom ranged from large-group, teacher-directed discussions to cooperative learning groups. It was felt that different learning styles were encouraged through the use of different discussion formats. In the large-group discussion format, teachers and students engaged in discussion as the primary means of communicating ideas. In the active-learning format, students and teacher engaged in thinking tasks often involving hands-on activities using manipulatives. Knowing when to use each format was also important. Fogarty (1997) also encourages the use of graphic organizers as an instructional strategy to promote a brain compatible classroom. Mind maps, graphs, Venn diagrams, and flow charts help students visualize and organize their thinking and learning.

Project Objectives and Processes

The goal of this study is to develop the critical thinking skills in early childhood, kindergarten, and eighth grade students by implementing a variety of instructional strategies in the classroom that include problem-based learning, the use of technology, cognitively guided instruction, and direct instructional strategies. The research will begin

on August 27th, 2001, and end on January 25th, 2002. Pretest data will be collected the first 3 weeks of the project; the intervention will be administered the following 12 weeks; and posttest data will be collected the last 3 weeks of the study. Student critical thinking skills will be documented in the areas of gathering, processing, and applying. Any changes that may occur in student performance will be documented through the use of teacher observation checklists, parent, student, and teacher surveys, and student journals.

Process Statements

Prerequisite steps necessary to accomplish these objectives are as follows:

1. Lessons and activities that address critical thinking skills will be planned.
2. Materials and equipment necessary for lesson implementation will be gathered or developed by the teacher.
3. Additional assessment tools will be developed to measure change in student performance in specific skill areas for the varying age levels involved in this study.

Project Action Plan

The project action plan will be organized, planned, and implemented by the researchers in the following manner:

Week 1

1. Secure parent and student consent forms to conduct the research.
2. Send out parent and student surveys.
3. Discuss the project with students. Explain the goal and activities of the project.
4. Establish a safe environment and a predictable routine by implementing a

revised behavior routine, and examined the physical arrangement of the room made adjustments to minimize disruptions.

Site A: Room tour, free exploration

Site B: Room tour, biobags activity (Appendix G), and personal business cards (Appendix H)

Site C: Room tour, free exploration

Week 2

1. Continue to establish a safe environment and a predictable routine.
2. Begin to administer pretest activities and lessons to gather data on student critical thinking skills in the areas of gathering, processing, and application.

Site A: Pretest sorting checklist (Appendix I)

Site B: Review Respect Code (Appendix J) , fishbone to determine the cause of poor student behavior (Appendix K), lotus to address student disorganization (Appendix L)

Site C: Pretest sorting checklist

"Looks Like/Sounds Like T-Chart (Appendix M)

Weeks 3 and 4

1. Continue to establish a safe environment and a predictable routine.

Site B: Field trip to local park teams course. Bologna Lab on prediction and estimation (Appendix N), Introduce "Science in the News" journaling project (Appendix O).

Site C: Model the Twenty Question Attribute bag activity for describing skills (Appendix P), model making a web graphic organizer for recall and quantity questions (Appendix Q), introduce and model counting jar activity for estimating (Appendix R).

2. Continue pretest data collection by implementing gathering, processing, and application activities.
3. Plan intervention lessons and activities.

Weeks 5 and 6

1. Begin implementation of treatment strategies including journaling, problem-based learning, questioning techniques, computer programs, and graphic organizers.
2. Collect data using teacher observation checklist and record forms.

   Site A: Begin daily computer activities using the following computer programs: Dr. Seuz Toddler, Jumpstart Preschool, A to Zap, Freddie Fish, Little Bear's Thinking Adventure, My First CD Rom, and I-spy Junior. Begin using a variety of graphic organizers for language activities.

   Site B: Begin collecting article submissions, metric measurement lab (predict, estimate, measure, and convert), Pangea jigsaw lab (sort and analyze), rock classification lab, pneumonic device, staircase graphic organizer, and flow chart.

Site C: Teach story-mapping (Appendix S), lesson for the book Ten Apples Up On Top (identifying problems and solutions), teach "quiet game" (sorting and classifying), Cooperative group lesson for the book The Shape of Thing (recall and applying information) (Appendix T), teach five senses lesson for making apple observations (developing descriptive vocabulary) (Appendix U), introduce Venn diagram using two versions of the Johnny Appleseed story (comparing and contrasting questions) (Appendix V).

Weeks 7, 8, and 9

1. Continue treatment implementation.
2. Continue data collection using teacher observation checklists and record forms.

Site A: Continue to use a variety of computer activities and graphic organizers to practice the skills of problem solving, recalling, sorting, predicting estimating, and describing.

Site B: Continue to collect journal responses, provide feedback on article submissions, earthquake lab (identifying, describing, and classifying), Venn diagram (comparing and contrasting earthquakes and volcanoes), galaxy card activity (sorting), create and illustrate a pneumonic device to remember the nine planets in order from the sun (recalling).

Site C: Counting jar and measurement lesson (estimate), 20 Question Attribute bag, lessons 2, 3, and 4 (describing and questioning), name cube lesson (sorting and comparing) (Appendix W), and

Anno's Counting Book lesson (opinion questions) (Appendix X), I Love Spiders poetry lesson (describing and quantity questions) (Appendix Y), affinity chart graphic organizer (identify and describe) (Appendix Z).

Weeks 10, 11, and 12

1. Continue treatment implementation.
2. Continue data collection using teacher observation checklists and record forms.

Site A: Continue to use a variety of computer activities and graphic organizers to practice the skills of problem solving, recalling, sorting, predicting estimating, and describing.

Site B: Peer edit "Science in the News" scrapbook, implement problem-based learning activities by presenting the problem (Should teens be allowed to participate in the Space Program?), create and refine "Know/Need to Know" T-chart, lab rotations, and daily journals

Site C: Counting jar and measurement lesson (predicting), 20 Question Attribute bag, lesson 5, (describing and questioning), lesson about squirrels using big book (predicting), A Turkey For Thanksgiving lesson (fat questions) (Appendix AA), web graphic organizer on homes (recall and quantity questions), animals in winter lesson (classifying, describing, and applying)

Weeks 13, 14, and 15

1. Continue treatment implementation.
3. Continue data collection using teacher observation checklists and record forms.

Site A: Continue to use a variety of computer activities and graphic organizers to practice the skills of problem solving, recalling, sorting, predicting estimating, and describing.

Site B: Peer edit "Science in the News Scrapbook", teens in space presentations, discussions, and debate (problem-based learning), Human Anatomy staircase graphic organizer (organization of human cells), create tree diagrams representing ten different organ systems, digestive system flow chart

Site C: 20 Question Attribute bag, lesson 6 (describing and questioning), measurement lessons (predicting and checking) (Appendix BB), compare two versions of The Gingerbread Man using a Venn diagram (comparing and contrasting questions), and relate five senses to Christmas (describing)

Weeks 16 and 17

Begin collecting posttest data to compare with pretest data.

Site A: Classroom performance checklist and teacher observations.

Site B: Student survey, collect "Science in the News" journaling scrapbook for posttest data.

Site C: Classroom performance checklist and teacher observations.

Week 18

Calculate statistical information in order to compare pretest and posttest data to show changes that may have occurred in students' critical thinking skills.

Methods of Assessment

A variety of pretest and posttest measurement tools will be used to assess the treatment effects on the students' critical thinking skills of gathering, processing, and application. These tools will include a classroom observation checklist, teacher anecdotal notes, and teacher and parent pretest surveys. In addition, student surveys and journals will be used to assess eighth grade science students' critical thinking skills.

ERIC

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The goal of this study was to develop critical thinking skills by implementing a variety of instructional strategies with early childhood, kindergarten, and eighth grade science students. Use of environmental enhancement, graphic organizers, technology, problem-based learning, journal response, and questioning techniques were implemented in the classroom to enhance students' critical thinking skills.

Pretest data was collected during the first 3 weeks of the project, the intervention strategies were implemented throughout the following 12 weeks, and posttest data was collected during the last 3 weeks of the study. The goal of these measurements was to document changes in student critical thinking skills in the areas of gathering, processing, and application.

During the first three weeks of the research project, surveys were administered to parents, students, and teachers. Parents were asked to respond to a series of ten questions regarding their child's ability to think critically by circling an answer of never, seldom, sometimes, or almost always. Students completed similar surveys during class and were asked to respond to a series of ten questions in order to self-evaluate their own use of critical thinking skills, circling an answer of never, seldom, sometimes, or almost always.

Teacher surveys were distributed to all classroom teachers at all three research sites. Teachers were asked to respond to a series of six questions regarding their observations of student use of critical thinking skills, the availability of instructional materials to enhance critical thinking skills, and their opinion on the amount of available time to teach critical thinking skills by circling an answer of never, seldom, sometimes, or almost always.

At Site B, students were evaluated on their work-in-progress while creating a "Science in the News" scrapbook. After collecting and reading six separate newspaper articles, students were responsible for writing a journal response to each article. Students were then evaluated for evidence of thoughtfulness for each article on a scale of zero to three. Zero indicated no level of thoughtfulness, while a score of three indicated the highest level of thought.

For this research project, six basic skills were chosen from Oliver Wendle Holmes' version of the three story intellect model as the focus skills of this study. The skills of recalling and describing were representative of the gathering level. The skills of sorting and problem solving were representative of the processing level. The skills of estimating and predicting were representative of the application level. Lesson plans were developed to provide practice in each section of the intellect model.

All sites used environmental enhancements and graphic organizers as part of the intervention strategies. In addition, Site A focused on computer activities, Site B implemented problem-based learning and journal activities, and Site C instituted questioning techniques as part of the intervention plan.

In an effort to boost student achievement and critical thinking skills, a safe environment and a predictable routine were established at the onset of the project by making several classroom and instructional changes. The physical arrangement of the classroom was examined and adjustments were made to minimize potential behavior problems. Classroom centers were examined and furnished with necessary materials and supplies that provided interesting and stimulating opportunities for exploration and manipulation. Print-rich materials were displayed throughout the classroom. Modifications were made to the classroom behavior management plan in an effort to create a secure and predictable learning atmosphere. More classroom responsibilities were given to the students in an effort to create an engaged learning environment and to provide more opportunities for student involvement.

At Site B, the first two weeks of class were dedicated to team-building activities in order to create a safe learning environment. No books were distributed until after this time. During this period, class activities included presenting biobags, creating personal business cards, and developing a top-ten list of classroom responsibilities. Students also created a student expectation time capsule, reviewed the school's respect code and rewrote the words to the respect song. Additionally, students created a fishbone in order to determine the root cause of poor student behavior and created a lotus in order to contend with student disorganization. The first two weeks culminated in a field trip to a team's course at a local park facility.

Graphic organizers were used at all three research sites as an instructional strategy to enhance students' critical thinking skills through brainstorming activities with whole or small cooperative group lessons. Venn diagrams, webs, affinity charts, story maps, and

flow charts were used in a variety of ways. Venn diagrams were used to compare and contrast two items or stories with similar characteristics and content. Webs and affinity charts were used for brainstorming activities to assess students' prior knowledge. Webs were used to introduce a unit of study such as the fall unit. Story maps and flow charts were used to review literature read to the class. Story maps provided a visual picture of the characters, setting, problem, and solution. Flow charts provided recall of the sequence of events that took place in the story (Appendix CC).

Site A

A variety of computer activities were planned and implemented throughout the 12-week intervention period in an effort to enhance students' critical thinking skills. At the beginning of the intervention period, students were given approximately 3 weeks to become familiar with the basic computer functions such as using the computer mouse and moving it about in the computer programs. Computer lessons and activities were planned and implemented to address the targeted skills.

Site B

Problem-based learning was used as an intervention strategy. Students were presented with the problem, "Should teens be allowed to participate in the Space program?" In addition, feedback was provided as an intervention in response to student journal pretests. Students were given suggestions on methods of elaboration in order to improve their scores for their "Science in the News" Scrapbook project. Posttest data was collected and evaluated on six journal responses for evidence of thoughtfulness after having the benefit of peer editing and teacher feedback.

Site C

Questioning techniques were presented and practiced in a whole group setting. A variety of questioning strategies was utilized: quantity, compare and contrast, Feelings-opinions-personification, what would happen if…, fat and skinny questions (fat questions require time to think through and answer in depth, whereas skinny questions typically require a simple response of yes or no), and extended wait time. Quantity type questions were used for brainstorming and making lists when introducing a new unit or theme. This was used in conjunction with KWL charts (Appendix DD). Compare and contrast questions were used to compare two items or stories and were used in conjunction with Venn diagrams. Feeling-opinion-personification questions were used as culminating activities to express views on a unit of learning that were presented. Journal entries were used to answer these types of questions. What would happen if… questions were used to motivate students during a unit of study. Fat and skinny questions were also used for promoting discussions in reviewing literature. An additional questioning strategy used to encourage students to organize thoughts was allowing for wait-time. This was a time of 3 to 10 seconds of silence in which the student was given an opportunity to process and formulate an answer to the question.

The final three weeks of the research project were devoted to collecting posttest data. Sites A and C utilized observational checklists to document an improvement in critical thinking skills in the targeted areas of gathering, processing, and application. Site B evaluated student journals in response to teacher-provided feedback.

Presentation and Analysis of Results

In order to assess the effects of the intervention strategies for critical thinking skills on the students, a variety of posttest measurement tools were used. Through the use of teacher observation checklists, anecdotal records, and student journals, changes that occurred in student performance were documented.

At Site A and Site C to assess sorting skills, students were given beads or buttons to sort into cups according to color, shape, and size. They were also given the task of sorting objects or pictures into groups. The students' abilities to make predictions were assessed using a prediction checklist. Tally marks were recorded for each prediction a student gave during a predicting task. Student problem solving skills and their ability to recall information, events, or ideas from a story were also assessed using a tally mark checklist. Students were given one tally mark for each original and relevant answer, idea or solution for each task. Students' ability to describe objects was assessed using the same tally mark system. Describing skills were assessed on an individual basis. Data was collected in small groups for sorting, predicting and estimation, problem solving, and recalling.

Based on grade level expectations, 39 students from Sites A and C were pretested and 38 students were posttested. Student performance in these skill areas was given a rating of high, average, or low as illustrated in Table 2. The intervention appears to have had a positive effect on enhancing critical thinking skills. Posttest data illustrates improvement in each of the six targeted skill areas. Sixty-six percent of the total number of students from Sites A and C scored high for posttest sorting skills as opposed to 28 percent prior to research intervention. Ninety-seven percent of students scored high or average for

posttest recall skills as opposed to 23 percent prior to research intervention. Eighty-four percent of students scored high or average for posttest describing skills versus 33 percent prior to research intervention. Ninety percent of students scored high or average for posttest problem solving skills versus 36 percent prior to research intervention. Finally, 84 percent of students scored high or average for posttest prediction and estimation skills as opposed to 64 percent prior to research intervention.

Table 2 Data Collection Results of Skills and Levels for Site A and C Students

Skill and Level	Pretest Data % of 39 Students	Posttest Data % of 38 Students
Sorting		
High level	28	66
Average	64	24
Low level	8	10
Recalling		
High level	8	42
Average	15	55
Low level	77	3
Describing		
High level	18	37
Average	15	47
Low level	67	16
Problem Solving		
High level	18	24
Average	18	66
Low level	64	10
Prediction and Estimation		
High level	23	37
Average	41	47
Low level	36	16

At Site B, students were evaluated on their work-in-progress while creating a "Science in the News" scrapbook. After collecting and reading six separate newspaper articles, students were responsible for writing a journal response to each article. Pretest and

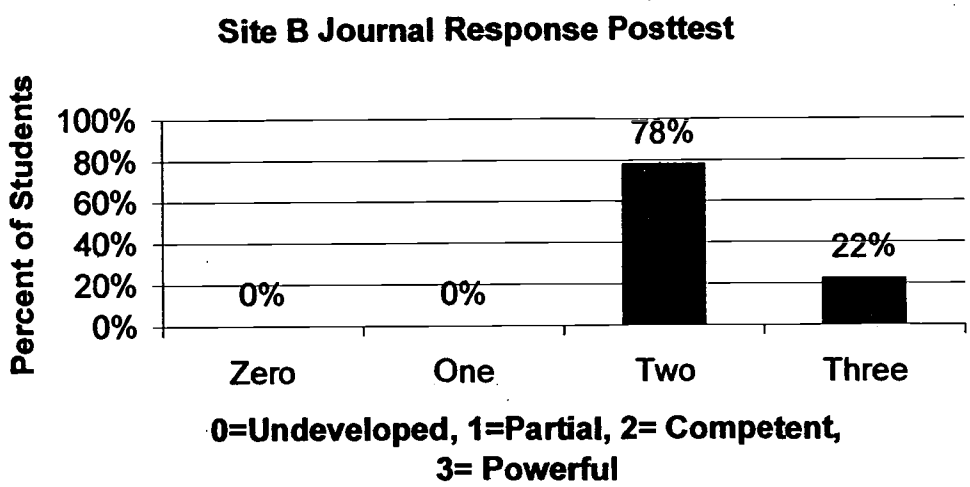

Figure 5 Site B Students' Journal Response Showing Evidence and Depth off Thoughtfulness about Newspaper Articles

The intervention appears to have had a positive effect on enhancing critical thinking skills. Posttest data illustrates a clear improvement in depth of thoughtfulness. Prior to research intervention, 60 percent of eighth grade pretest science reflections at Site B were scored as a zero-undeveloped (indicating that only a response was given) or a one-partial (indicating that a response, supported by examples was given). This 60 percent fell below the competent level on the journal response scoring rubric. Posttest assessments, illustrated in Figure 5, include zero percent of eighth grade science reflections below the competent level, and 100 percent at or above the competent level. Seventy-eight percent of the journal reflections were scored as a two-competent (indicating that a response was given and supported by examples and personal reflections). Twenty-two percent of the journal reflections were scored as a three-powerful (indicating the highest level of thoughtfulness; a response supported by examples and personal reflections to adapt to an entirely new situation).

Figures 6 and 7 illustrate pretest and posttest averages for six journal response scores given to 27 individual eighth grade science students. Thirteen of the 27 students' average scores fell below two-competent prior to research intervention. Following research intervention, all 27 students were evaluated at or above the two-competent level. Twenty-one students scored a two-competent, and six students scored a three-powerful as a posttest assessment.

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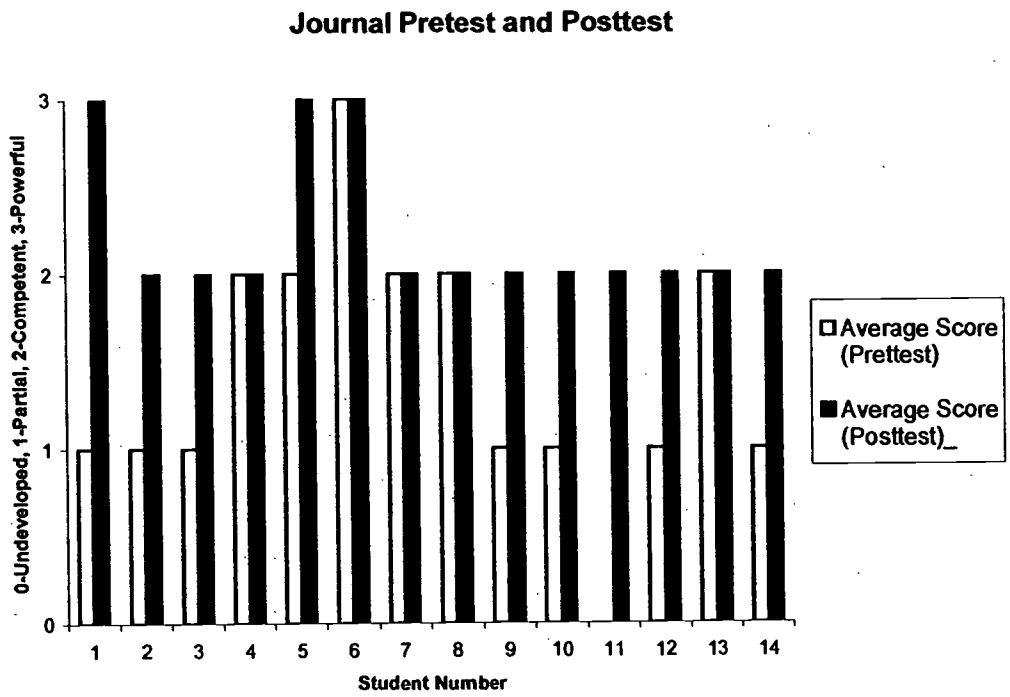

Figure 6 Site B Students 1-14 Average Journal Response Scores Showing Evidence and Depth of Thoughtfulness about Newspaper Articles

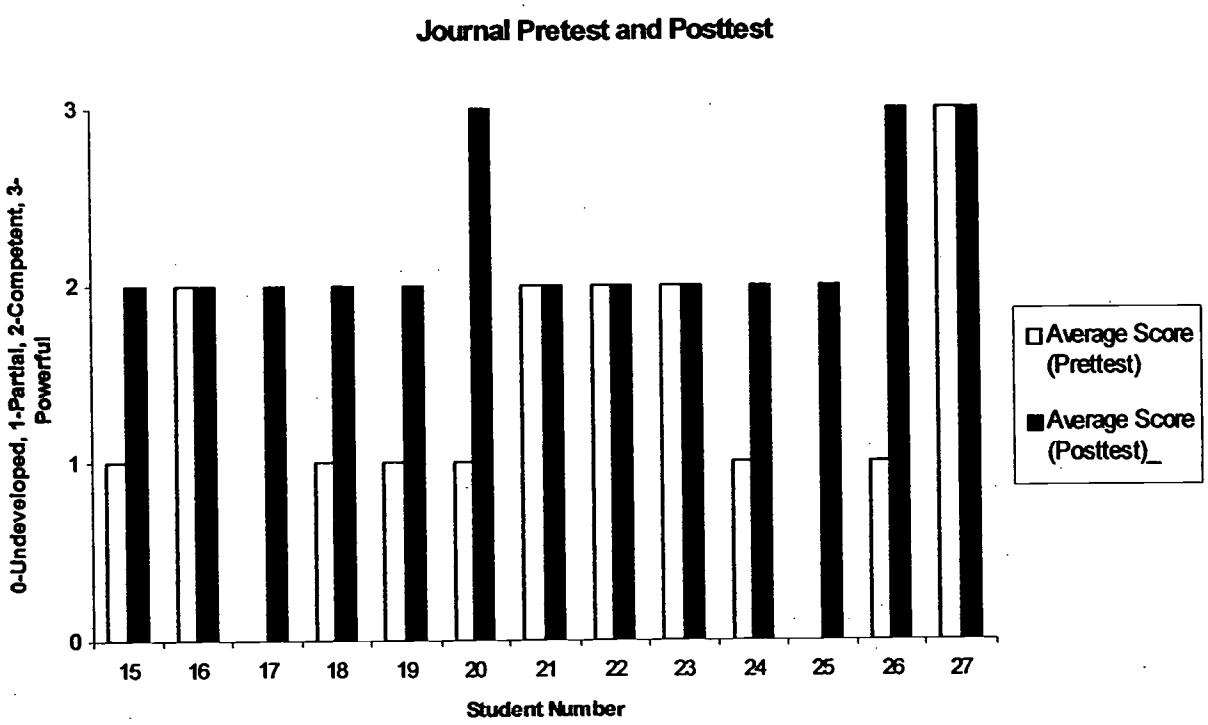

Figure 7 Site B Students 15-27 Average Journal Response Scores Showing Evidence and Depth of Thoughtfulness about Newspaper Articles

Conclusions and Recommendations

The classroom pretest data collection and parent, student, and teacher surveys at all three sites revealed that many of the students were deficient in many of the targeted skill areas which attributed to a lack of critical thinking skills. Based on this information, the researchers began an intervention plan of action to increase the critical thinking skills of their students.

Environment became an important component of the action plan. Brain-based learning theory and education advocates suggest that the classroom environment plays an important role in how students learn. Educational settings that provide a safe, calm, and pleasant atmosphere can help students to feel secure and confident in their learning, which may enhance their chances for success. Considering the brain-based theory, steps were taken to enhance the classroom environment in an effort to boost student achievement, basic skill knowledge, and critical thinking skills. The environmental enhancements made at Sites A, B, and C did improve the overall tone of the classroom and created a positive, secure, and organized learning environment. Decreasing the amount of behavioral disruptions in the classroom helped to enhance the students' chances for success. This was noted by a general respect and confidence the students displayed for each other and themselves.

The use of graphic organizers as an instructional strategy to enhance student critical thinking skills appeared to have had a positive effect on students at Sites A, B, and C. Throughout the intervention period, a wide variety of graphic organizers were consistently used in all three classrooms. Presenting lessons, introducing concepts, generating solutions, and helping students to visually organize their thoughts and ideas

apparently enhanced students' thinking and creativity. Students in all three classrooms showed overall improvements in their abilities to answer questions, demonstrate understanding of learned concepts, and formulate new and creative solutions to problems. Graphic organizers are instructional tools that can simultaneously address the needs of both visual and auditory learners alike. Since classrooms are filled with students who learn in many different ways, educators of all age levels would be very wise to use graphic organizers in a consistent and proficient manner.

Several issues and difficulties emerged while implementing technology activities and lessons. As the intervention period proceeded, it became evident that the young students at Site A required a much longer exploration period than was expected. Most of the students did not have any prior computer experience and needed far more time to develop basic computer skills and become familiar with the various classroom computer programs.

Specific computer lessons that focused on the targeted skills were planned and attempts were made to implement these lessons. However, the students were far more interested in experimenting and exploring with the computer games and activities that were new and fascinating to them rather than focus on planned lessons. When direct teacher guidance was given for the planned computer lessons, students often became frustrated and lost interest in the activity.

Another problem with classroom computer activities was the lack of direct teacher guidance. The computer lessons were planned and implemented during classroom centers time. The classroom teacher and assistant were often busy directing and attending to students in several other center areas. Students who were at the

computers did not receive adequate teacher guidance while working on specifically planned computer lessons that focused on the targeted skills. An attempt was made to enlist parent volunteers to assist with computer and class activities. However, the inconsistent attendance of the volunteers became a detriment to student behavior and the classroom environment.

With limited teacher guidance, the students greatly enjoyed experimenting with the various computer programs, helping each other with games and activities, and learning about the computer on their own. It became clear that using the computer with young children can be beneficial when they are given adequate time to learn and experiment at their own pace, providing them with a variety of developmentally appropriate software, in addition to guiding them in their own exploration and learning.

At Site B, the use of problem-based learning interventions appeared to enhance eighth grade students' application of each step of the scientific method: state the problem, gather information, form a hypothesis, experiment to test, record and analyze data, and state a conclusion. As students thought through the debatable issue of "teens in space," they stated opinions, gathered information in an attempt to support their opinions, participated in lab simulations of an anti-gravity environment, and presented their argument to a group of their peers for discussion. Students at Site B probably learned more about space, a portion of the state-mandated curriculum for eighth grade science, then their textbooks could have possibly offered. Problem-based learning is open-ended learning. Teachers interested in this concept must be prepared to act as a facilitator of discussions and provide resources for students when the need presents itself. Although the time involved in problem-based learning tends to be extensive, it is an investment in learning.

Assessment of problem-based learning can best be accomplished though KWL charts, observations during classroom discussions, and journaling activities.

Site B journal interventions appeared to be successful in developing critical thinking skills in eighth grade science students. Journal pretest data did not coincide with parent and student survey data. According to the surveys, both parents and students felt that Site B eighth grade students had higher critical thinking skills than what their original journal responses illustrated. After evaluating the first set of journals, it was clear that this group of students experienced difficulty reflecting beyond a general summary of their readings. Offering time for peer and teacher feedback proved to be a successful tool for enhancing the level of thoughtfulness from 0-undeveloped or 1-partial, to 2-competent or 3-powerful. Teachers interested in providing this intervention must consider the time involved is intensive, but worthwhile.

At Site C, the use of a variety of questioning techniques greatly enhanced the classroom discussion and encouraged well thought out answers. This questioning process did not happen overnight, but gradually evolved with each lesson that was presented. The key to the success of the students understanding fat questions and then responding with fat answers was practice, practice, and practice. At first, students did not always know how to respond appropriately when faced with a question that required more than a simple one-word response. However, as time went on, students gained the confidence to venture an answer. The answers were not always plausible, but good discussion and reasoning developed. Recommendations to other instructors who wish to encourage good question and answer skills would be to allow for plenty of time for discussion, be patient, and to assume the role as a facilitator.

In retrospect, the project was successful, but it became evident that too many skills were targeted for the project. A recommendation would be to limit the targeted skills in order to focus on the development of more specific skill areas.

Much of the data collected from the pretest parent and student surveys did not coincide with the pretest data that was collected by teachers from the classroom observation checklists. The classroom data showed that students' performance level in critical thinking skills was far lower than the information that was reported by the students and their parents. It became clear that the parents and student did not fully understand several of the survey questions. In formulating survey questions, it would be prudent to be specific in order to insure that the survey answers are correct and the data collected is as accurate as possible.

It was also discovered that it was essential for the researchers to model the intervention techniques in order to help the students gain an understanding of what was expected of them. Developing critical thinking skills in the students was not directly taught, but became a process of learning, which was perfected through time and experience. Overall, the students made significant gains in the development of critical thinking skills. The researchers were confident that the goals of this project were achieved.

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Appendices

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Appendix A

TEACHER SURVEY

In order to collect data for our Action Research Project, we ask that you circle one number per question. Thank you for your support and cooperation!

1= Never 2=Seldom 3=Sometimes 4=Almost Always

1. Most of my students attempt to solve problems on their own.
   1 2 3 4

2. If my students have difficulty solving a problem one way, they will attempt to solve the problem in another way.
   1 2 3 4

3. Most of my students create pictures, diagrams, and/or charts to help them visualize and better understand a problem.
   1 2 3 4

4. I feel that there are adequate professional development activities available for teaching higher order critical thinking skills.
   1 2 3 4

5. I feel that adequate instructional and assessment materials that promote and measure critical thinking skills are available.
   1 2 3 4

6. I feel that the curriculum allows time for me to adequately teach higher order critical thinking skills.
   1 2 3 4

Please return to our mailbox. Thank you.

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Appendix B

PARENT SURVEY

Student Code # _____

For purposes of confidentiality, please do not include any names on this survey.

Use the following scale to respond to questions concerning your child.

1=Never 2=Seldom 3= Sometimes 4= Almost Always

Circle one number per question.
Please feel to write any additional comments on the back of this form.

1. My child attempts to solve problems on his/her own.
   1 2 3 4

2. My child asks questions when he/she does not understand a concept.
   1 2 3 4

3. If my child has difficulty solving a problem one way, he/she will attempt to solve the problem in another way.
   1 2 3 4

4. My child creates pictures, diagrams, and/or charts to help him/her visualize and better understand a problem.
   1 2 3 4

5. My child can retell a story with details.
   1 2 3 4

6. My child can recall information from previous experiences.
   1 2 3 4

7. My child interacts well with others.
   1 2 3 4

8. My child is an attentive listener in a group setting.
   1 2 3 4

9. My child is inquisitive, actively curious, about their surrounding environment.
   1 2 3 4

10. My child describes to me what they do at school.
    1 2 3 4

Appendix C

STUDENT SURVEY

Student Code # _____

For purposes of confidentiality, please do not include any names on this survey.

Use the following scale to respond to the questions listed below.

1=Never 2=Seldom 3= Sometimes 4= Almost Always

Circle one number per question.
Please feel to write any additional comments on the back of this form.

3. I attempt to solve problems on my own.
1 2 3 4

4. I ask questions when I do not understand a concept.
1 2 3 4

5. If I experience difficulty solving a problem one way, I will attempt to solve the problem in another way.
1 2 3 4

6. I create pictures, diagrams, and/or charts to help visualize and better understand a problem.
1 2 3 4

11. I can retell a story with details.
1 2 3 4

12. I can recall information from previous experiences.
1 2 3 4

13. I interact well with others.
1 2 3 4

14. I am an attentive listener in a group setting.
1 2 3 4

15. I am inquisitive, actively curious, about my surrounding environment.
1 2 3 4

16. I describe to my parents what I am involved in at school.
1 2 3 4

Appendix D

Journal Response Preassessment
Evidence of Thoughtfulness

Criteria	Undeveloped 0 Points	Partial 1 Point	Competent 2 Points	Powerful 3 Points	Total
Evidence Of Thoughtfulness	Response Only	Response supported by specific examples	Response supported by examples and personal reflections	Use response supported by examples and personal reflections to adapt to an entirely new situation	

Student Number	Journal 1 Score	Journal 2 Score	Journal 3 Score	Journal 4 Score	Journal 5 Score	Journal 6 Score	Average Score
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

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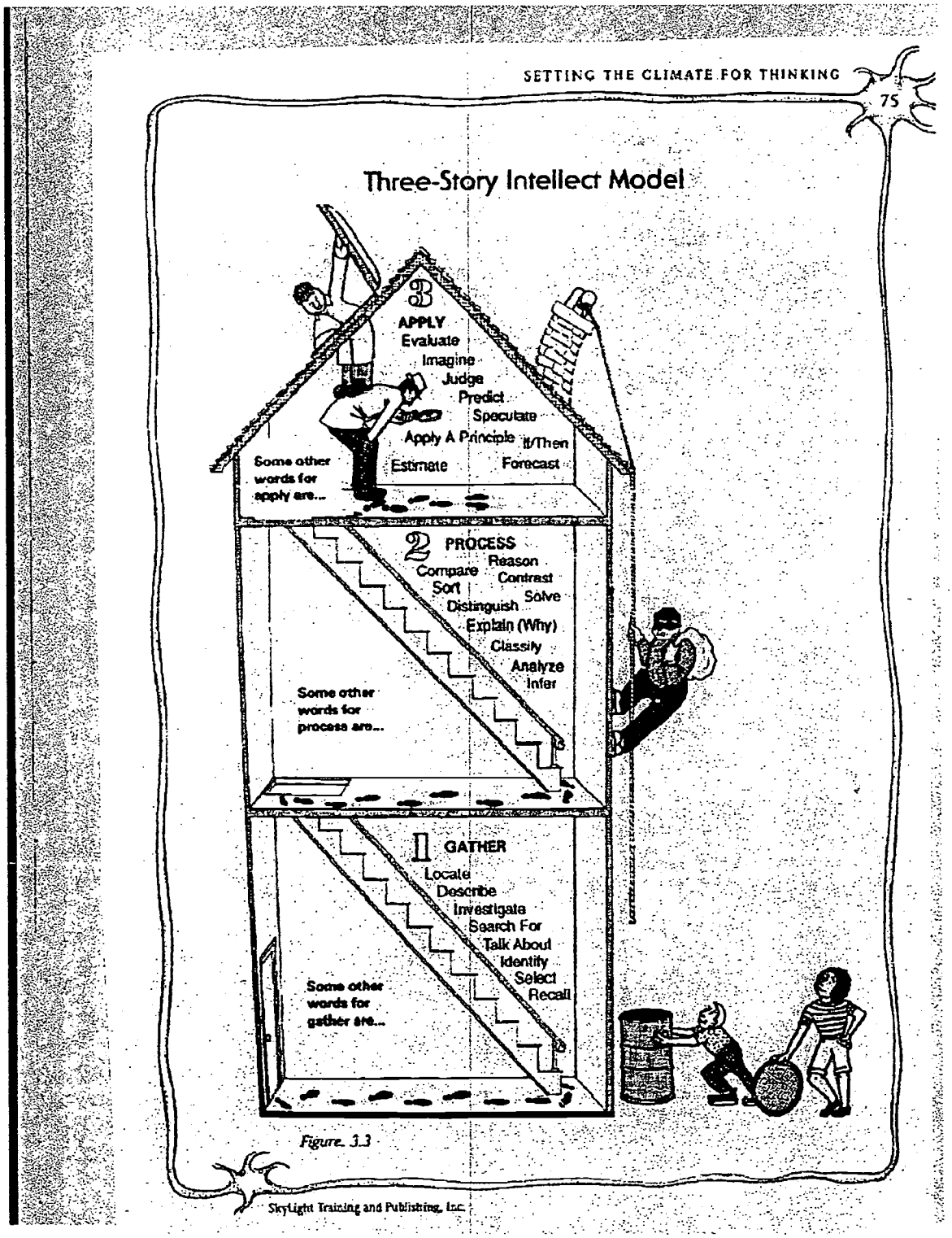
Appendix E

Oliver Wendle Holmes' Three-Story Intellect Model



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Appendix F

Classroom Observation Checklist

Site_____ **Date:**_____

Student Code Number	Skill:	Notes:
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25		

Appendix G

Bio-Bags

Supply List

- Post-it Notes (1 pkg., large size)
- Lined Note Cards (2 pkgs. of 4 x 6 cards)
- 1 Spiral-Bound Set of 3x5 Lined Note Cards
- Loose-Leaf Paper
- 4 Spiral Notebooks (different colors if possible)
- One 1 inch, 3 Ring Binder with 5 Tabbed Dividers
- One 2-Pocket Folder
- Large Crayola Markers (1 pkg.)
- Small Crayola Markers (1 pkg.)
- Colored Pencils (1 pkg.)
- Highlighter Markers
- Glue
- Scissors
- Pencils
- Pens
- Ruler
- Calculator (a scientific calculator is recommended but not required)

BIOBAG

Your first homework assignment is to prepare a biobag. Collect five to six items that represent you. Place these items in a small brown paper lunch sack. Your name should not be indicated at any place in or on the bag. No pictures please! Be prepared with your biobag the first day of science class. Thank you.

Create Your Own

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Appendix H

Personal Business Card

UPPER LEFT-HAND CORNER
Draw a symbol representing your favorite movie.

UPPER RIGHT-HAND CORNER
Draw a picture representing your Favorite summer activity.

CENTER
Write your name, followed by the name of your Alter Ego in your favorite color.

LOWER LEFT-HAND CORNER
Draw a picture of your favorite character from a novel you have read.

UPPER RIGHT-HAND CORNER
Write one word that represents how you are feeling at this moment.

After you have used color to complete your business card on an 8 ½ x 11 piece of paper, find your assigned partner and share the information on your card. Be prepared to present your partner's card to the rest of the class

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Appendix I

Classroom Observation Checklist
Sorting Skills

Site_____ **Date:**_____

Student Code Number	Skill: Sorting Can sort by:				Notes:
	Color	Shape	Size	Other	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25					

Appendix J

Respect Code

R.E.S.P.E.C.T.

SOCIAL SKILLS	PRACTICE
Responsibility	❑ Follow student handbook guidelines ❑ Accountable ❑ Organized
Etiquette	❑ Be prepared & on time for class ❑ Display consideration for others ❑ Use manners
Safety	❑ Freedom from danger or harm ❑ Feeling of security ❑ Accidents happen, please report them to the teacher
Pride	❑ Good sense of self esteem ❑ Shows ownership ❑ Good hygiene
Encouragement	❑ Assisting others ❑ Provide positive feedback ❑ Open mind to others' opinions
Character	❑ Honesty ❑ Compassion ❑ Explore new ideas
Team Effort	❑ Cooperation ❑ Working for success ❑ Ability to work together

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Appendix K

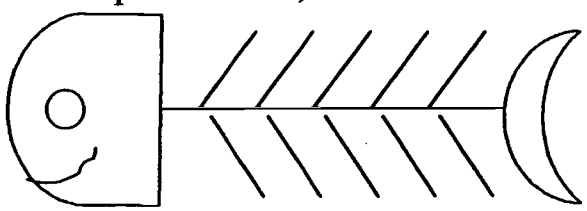
Fish Bone

Create a

FISHBONE

Graphic Organizer to Illustrate
Cause and Effect

Necessary Materials: large sheets of paper, markers, post-it notes, and stickers



- Get organized into small groups of 3-4 students.
- On a large piece of paper, use markers to draw a fish skeleton (one per group).
- Be sure to include the head, spine, rib bones, and tail.
- Write an effect inside the fish head (i.e. poor student behavior).
- Individually brainstorm causes for the effect, writing one cause per post-it note.
- Then together with your small group create an affinity chart by combining like ideas. Place post-it notes with similar ideas together on the same fish rib bone.
- Develop a name for each affinity group (i.e. social issues, family issues, boredom, etc.), and write the name on a fish rib bone.
- Have small groups come together to assemble one large classroom fishbone diagram, including all causes generated within the small groups.
- Give each student three stickers to vote for what they feel are the top three causes for the effect.
- After each student has had the opportunity to vote, determine the top five causes. Use this information in order to determine the root cause of the effect. Write out the top five causes. Draw an arrow from one cause that causes another to happen. The cause with the most arrows drawn out, and fewest arrows drawn in is the root cause of your effect.

Appendix L

Lotus Chart

Create a
LOTUS
Graphic Organizer

	A **Disorganized Student**	

- Record the main idea in the center box, "A Disorganized Student"
- Brainstorm attributes of a disorganized student and write them in the eight boxes surrounding the main idea.
- A LOTUS can be expanded into a SUPERLOTUS by placing each of the eight attributes in their own center box and then brainstorming suggestions to combat the attributes of a disorganized student. A SUPERLOTUS contains a total of 81 boxes.

Appendix M

T–Chart for Looks Like/Sounds Like

Looks Like	Sounds Like

Appendix N

Bologna Lab

Name: _____

MY BOLOGNA

Use the Scientific Method to Find the Answer
to this Amazing Phenomena!

State the Problem:

Gather Information:

Brainstorm...

And then Create a Hypothesis (an Educated Guess) worded as an If... Then.. Statement

Experiment to Test
Describe your procedure in detail, describing necessary materials. Be sure to include a control. Remember to test one variable at a time. Why is it important to test just one variable at a time?

_____

_____

Data Collection:

Analyze Results:

State a Conclusion:

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Appendix O

Science in the News

Science is continuously evolving. Even the most recent science textbooks contain out of date information. In an attempt to keep pace with advances in science and their effects on our society, we must refer to current resources. Many of you receive a weekly or daily newspaper in your home. All students have access to the_____ at _____school.

As an eighth grader, you will be expected to find, read, summarize, and reflect upon one newspaper article per week during the first and third grading quarters. You will create a scrapbook of articles that represent SCIENCE IN THE NEWS for 2001-2002.

- Cut out and attach your article selection into your scrapbook.
- Write out the name of your newspaper article.
- Write out the name of the newspaper.
- Write out the section and page number.
- Indicate which branch of science is represented in the article
  LIFE SCIENCE EARTH/SPACE SCIENCE PHYSICAL SCIENCE
- Write a paragraph summarizing the article.
- Write a reflection on how the information in the article impacts, or has the potential to impact our lives in society today. Your reflection will be graded according to the following rubric:

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Appendix P

20 Question Attribute Bag

Objective: To provide practice in identifying words and forming questions that describe an object.

Materials: A bag or box with question marks sewn or glued on. An object for the bag or box. A small chalkboard or paper to record tally marks up to 20.

Procedure: Explain to the students that the bag contains an object. The students will be allowed 20 tries or questions to guess what the object is. The questions that may be asked are those that use words to describe the object. Questions that ask directly what the object is or tries to guess what the object is by saying is it a (noun) will not be accepted. For each acceptable question, the instructor will answer yes to questions that describe the mystery object or no to the questions that do not. A tally mark will be recorded for each question, whether the answer is yes or no. A sample dialogue for an apple as a mystery object may sound something like this:

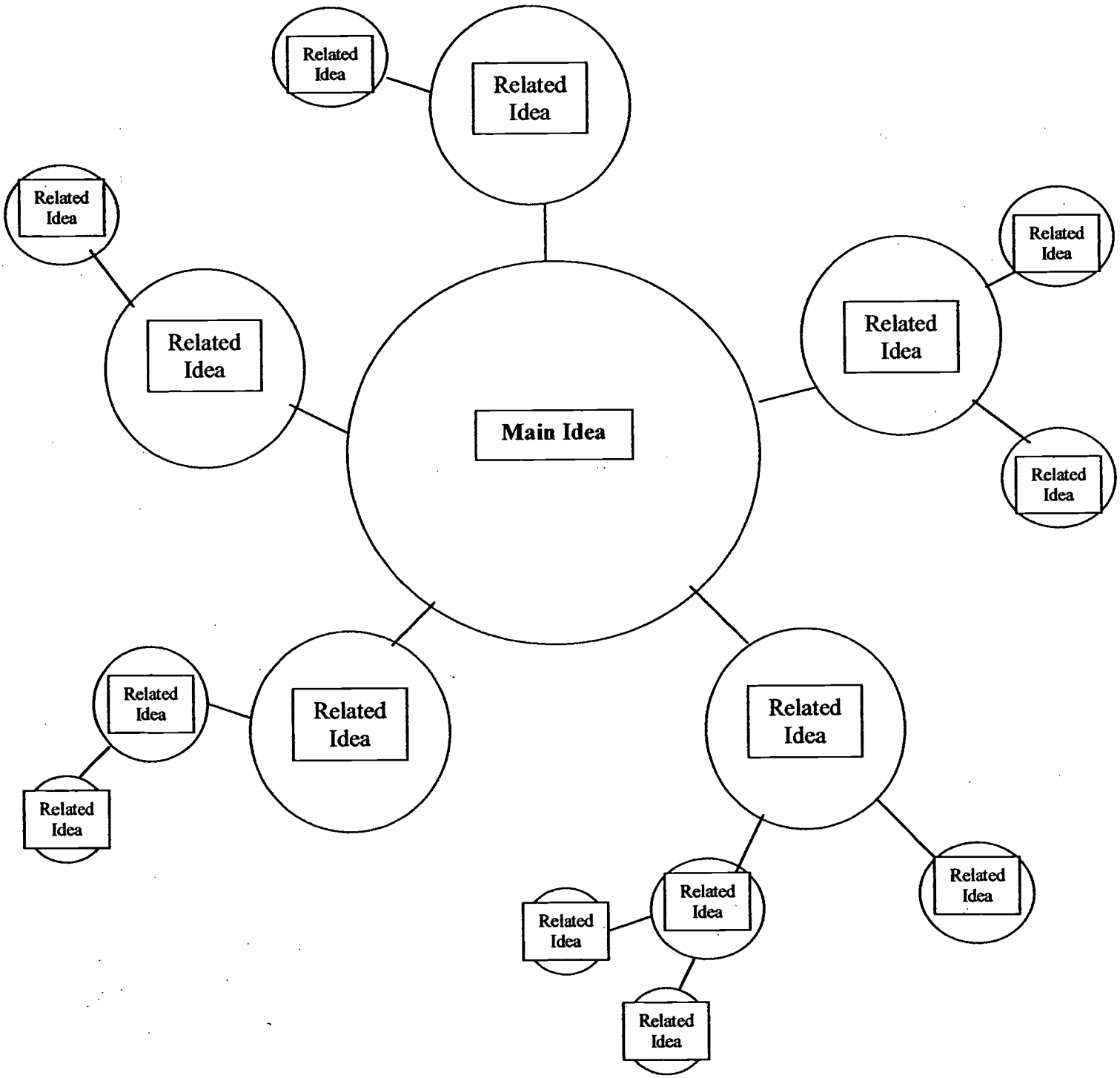
Student: Is the object round?
Teacher: Yes.
Student: Is the object smooth?
Teacher: Yes.
Student: Is the object purple?
Teacher: No.
Student: Does the object grow on a tree?
Teacher: Yes.
Student: Does the object begin with the letter o?
Teacher: No.

The dialogue continues until 20 tally marks are recorded (group the tally marks by 5's to help the students count and keep track of the amount). At the end of the 20 questions, a student is chosen to guess what is in the bag.

Applications: This activity is a good introductory lesson for a unit of study or theme that the class will be studying. A variation of the activity is to place several objects in the bag that are alike in some way. Pull an object out after a few questions and have the students guess what the objects have in common. (Example: to introduce a fall unit, a leaf, a sweater, a small rake or picture of a rake, an apple, nuts, squirrels, orange, brown, yellow, and red color cards, and the letter f may be placed in the bag).

Appendix Q

Web Diagram



Appendix R

Counting Jar

Objective: To provide practice in estimation and number concepts.

Materials: A large clear jar, a selected number of the same object, post-it notes, paper plates, a variety of countable objects from the classroom.

Procedure: Present the counting jar containing a predetermined number of the same object to the whole group. Ask the students to look at the jar of objects and estimate the number of objects that the jar contains. After each student is allowed to make a guess, the contents of the jar is counted. Post-it notes are then passed out to each student and the students are asked to represent the number from the counting jar in a different way (a written number, a picture, a number sentence, etc.). The post-it notes are displayed on a counting jar poster board and discussed with the whole group. For further understanding of number concept each student is given a paper plate and asked to find the same number of objects in the classroom as represented in the counting jar. The students gather in a circle in the meeting area to share and count the objects found and placed on their paper plates.

Applications: This activity provides a good opportunity for students to develop estimating skills and recognition of a variety of ways that a number is represented. By using a checklist, the activity also provides feedback for the instructor. As the objects are estimated and represented on the post-it notes and the paper plates, student concept of numbers may be noted for future instructional planning.

Appendix S

Story Mapping

Setting

Characters

Problem

Solution

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Appendix T

"The Shape of Things" Lesson Plans

Objective: To provide practice in identifying plane figures, recalling and applying shapes to real life examples and to analyze, categorize, and draw conclusions about shapes.

Materials: What's the Shape? By Erin Sullivan, a variety of shapes (circle, oval, square, rectangle, triangle, and rhombus) in a variety of colors, manila paper, 11" by 18" white paper, drawing tools.

Procedure: The lesson is introduced by reading the book, What's the Shape? The book lists a variety of shapes and uses in everyday life. From these examples, a large class chart is created entitled, "What Do Shapes Make?" This is done by recalling the objects made by shapes from the book and brainstorming about other objects seen in the environment. Shapes gathered from magazines are also added to the chart.

Application: When the students seem to have a good understanding of how shapes appear in everyday objects, cooperative groups are formed to create pages for a class shape book. Cooperative groups are asked to use their knowledge about shapes to create a picture of an object in everyday life. The first step in creating a cooperative picture is to give each group a piece of manila paper in which to plan their pictures. Groups are to draw a shape and add any details needed to create an object from that shape. When the groups have completed their plan, the plan is shared with the instructor. The instructor then provides the material to create the page for the class book. When all of the pages are complete, the sheets are bound together and a cover page is created. Each group is then given the opportunity to share the page that they created.

Appendix U

Five Senses Apple Observations

Objective: To provide an opportunity to use the five senses to observe an object and to develop a vocabulary of descriptive words.

Materials: A variety of apples in different colors and shapes (students may be asked to bring in their favorite type of apple for this activity)
Allow time for the students to wash their apple prior to the lesson.
Big paper, divided into five sections (see, touch, smell, hear, taste) for recording observations

Procedure: Each student is asked to get his/her apple for the activity. Explain that we will use our five senses to make observations about our apples. As the students make their observations, encourage them to use a word that describes what they are observing. After using each sense, pause to record the descriptive words suggested by the whole group. The lesson may proceed as follows:

See:
Place the apple in front of you. Take a good look at it.
What does it look like?
What color is it?
Is it shiny or dull?
What shape does it resemble?
Can you think of a fruit that is larger (or smaller) than an apple?
What do you think it will look like inside?
How many seeds do you estimate that you would see on the inside?

Touch:
Pick up the apple and hold it in your hand.
What does it feel like?
Does it feel rough or smooth, light or heavy?
Do feel any bumps?
Is it warm or cool or cold?

Smell:
Take time to smell the apple.
What does it smell like?
Does the smell remind you of anything else that you have smelt before?

Hear:
Shake the apple. Does it make a noise?
Take a bite. Does the apple make a noise when you eat it?

Taste:
Take a bite of the apple. What does it taste like (sweet, sour, bitter, salty)?
Does the taste remind you of anything else that you have tasted before?

Applications and Extension Activities:

An apple is a good object to introduce and use for exploring the five senses since most students are familiar with apples. This same lesson could be applied to other fruits, vegetables, or a spice such as ginger in gingerbread.

An additional activity would include using a recording sheet to draw a picture of the apple, weighing the apple with a nonstandard measurement, and measuring the distance around the apple using yarn.

The apples that the students bring from home could also be used as a graphing activity for "What is your favorite kind of apple?" (red, yellow, or green). Prior to graphing ask the students to predict which apple color will be the favorite of the class. Graph the real apples on a real graph. Transfer this information to a classroom picture graph. For a further graphing activity, give each student a generic graph with squares to transfer the information from the picture graph to a representational graph. Discuss the three different types of graphs. Develop vocabulary words by asking which apple is the most or least favorite. Additional questions that may be asked are: Is there anything else that the graph tells us? How many more or less red apples are there than green apples? How many more or less red apples are there than yellow apples?

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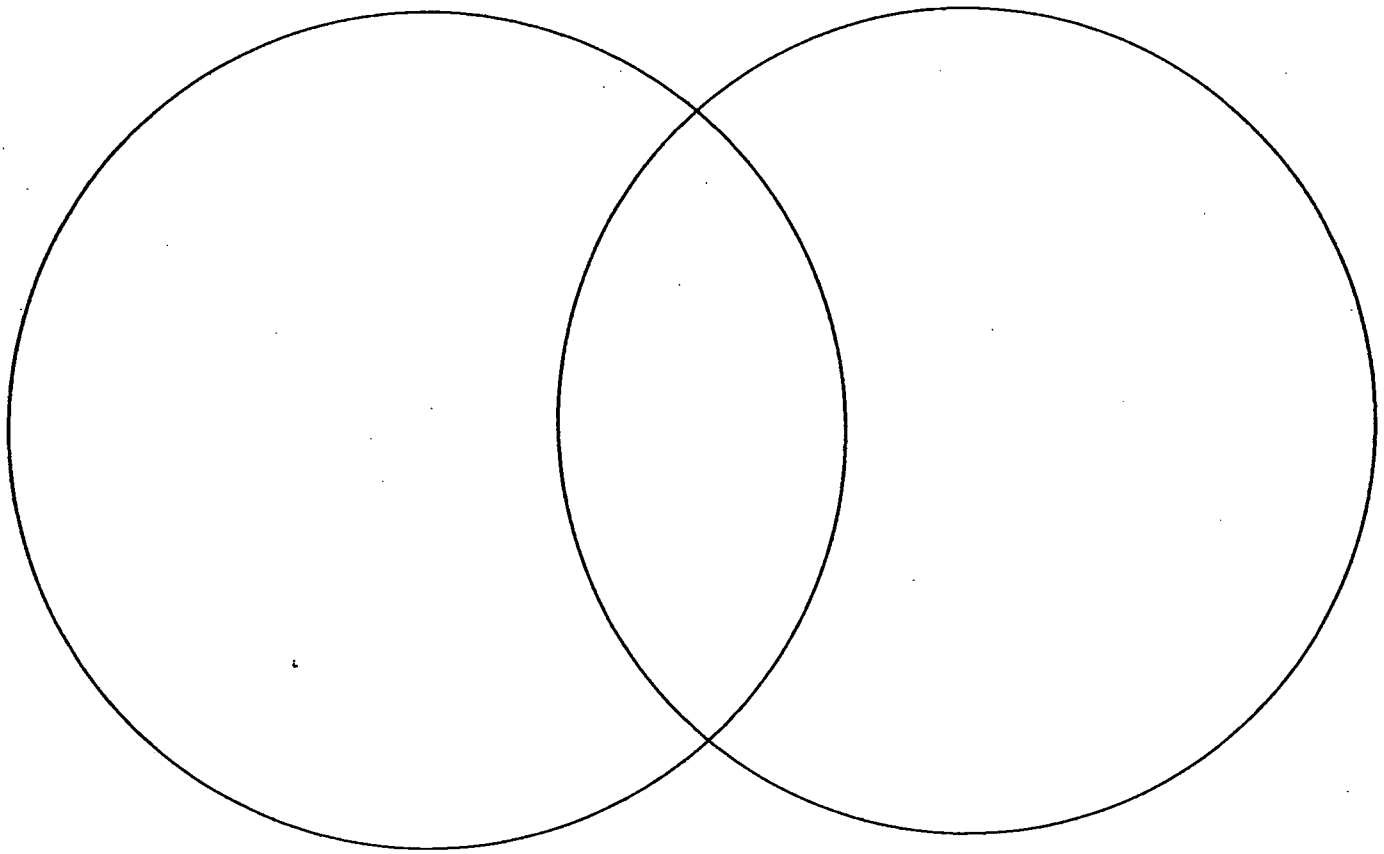
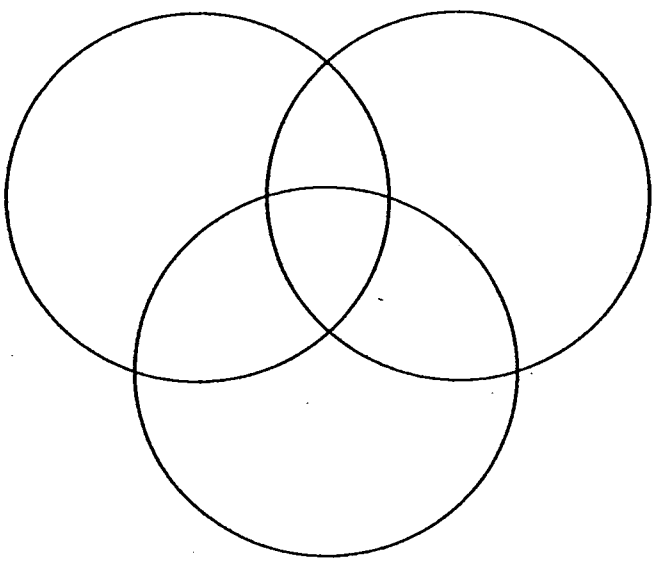
Appendix V

Venn Diagram



Use to compare or contrast two ideas, concepts, pictures, stories, objects, or other. Venn diagrams provide the opportunity to use compare/contrast questions. Ask students how two things are alike and how they are different. The differences are recorded in the outer circles. The similarities are recorded in the center. When comparing three ideas, use a triple Venn diagram.



Appendix W

What Is In A Name?

Objective: To provide practice in comparing, developing vocabulary that describes the comparison, and forming compare/contrast questions.

Materials: Interlocking cubes, name cards, Chrysanthemum by Kevin Henkes

Procedure: Introduce the lesson by reading the book Chrysanthemum. Follow the reading with a discussion about names. Ask the students to estimate how many letters were in Chrysanthemum's name and to compare that to their own names.

Distribute name cards to the students and ask them to count the letters in their own names. After the number of letters is determined, ask each student to count out the same number of interlocking cubes and join the cubes together.

The students are then asked to locate other students in the class with the same cube length as their own. This activity is done by comparing cubes lengths and using vocabulary as shorter, longer, the same.

Application: When the students have formed groups according to cube lengths, additional comparisons are made by creating a real graph using the cube lengths to determine the different name lengths of the entire classroom. The instructor initiates a discussion by asking compare/contrast questions about the graph.

Appendix X

Anno's Counting Book Lesson

Objective: To provide practice using opinion questions, to make visual observations and predictions, and to develop own counting book-using ideas gathered from the discussions.

Materials: Anno's Counting Book by Mitsumasa Anno. A stapled pre-made book with a cover page and a page for each number 1 – 6. Drawing materials as crayons, markers, or colored pencils.

Procedure: Display the book called Anno's Counting Book. Ask the following types of questions in order to encourage the students to share their opinions:

By looking at the cover and title, "What do you think this book will be about?"

"What number do you think will be on the first page?" (Show the first page). "Why do you think the author may have started with a zero rather than the numeral one?" "If zero means nothing, why did the author draw some things in the picture?"

Continue to display and discuss the rest of the pages in the book. Use similar opinion questions. Encourage the students to look at the details in the illustrations for each page. When the students begin to notice groups of objects and elements that go with the number on each page, ask questions that will encourage the students to predict what will be found on the next page.

When the book is finished, reflect on the details by reviewing the pages. "What made Anno's book special or different?"

Application: To transfer the ideas that the students discussed, explain that they will now make their own counting books. Brainstorm different options in which the pages may be illustrated. A list of ideas may be generated in the class. Provide a variety of drawing tools and the pre-made books to create the individual books.

Appendix Y

I Love Spiders

I love spiders.

_____spiders, _____spiders,

_____spiders, _____spiders,

_____, _____ spiders.

I think they're great!

Appendix Z

Affinity Diagram

Fall Things
(Main topic, concept, or idea goes here)

Weather: specific ideas or concepts	Harvest: specific ideas or concepts	Animals: specific ideas or concepts
Cool Changing leaves Rainy Sunny	Apples (Orchard) Pumpkins (Patch) Squash Nuts and acorns	Squirrels Owls Bears (getting ready to hibernate)
Clothing: specific ideas or concepts	**Holidays: specific ideas or concepts**	**Activities: specific ideas or concepts**
Jackets Long pants Sweaters	Halloween Thanksgiving Columbus Day	Raking leaves Hayrack rides School starts

- Use to generate ideas and related concepts and topics.
- Use to associate ideas and related concepts and topics.

Appendix AA

Fat and Skinny Questions

FAT	Skinny
Fat questions are those that require more thought than just giving a simple obvious answer or a yes/no answer. Fat questions often require expressing one's feelings and applying previous knowledge or experiences in order to answer. Fat questions often trigger a lot of discussion, require time to be thought out, and may offer a variety of solutions.	Skinny questions are answered usually by a single right answer, a yes/no answer, or a simple gesture of yea or nay. Skinny questions do not usually initiate a lot of discussion and are generally answered by simple recall.
Samples:	Samples:
Can you think of a different plan for saving the turkeys?	How did the students save the turkeys?
If you were a character in the story, who would you want to be, a student, a turkey, or the farmer? Why?	Who were the characters in the story?

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Appendix BB

Measurement Lesson

Name_____

I estimate I am _____**gingerbread men**  **tall.**

I am _____ gingerbread men  tall.

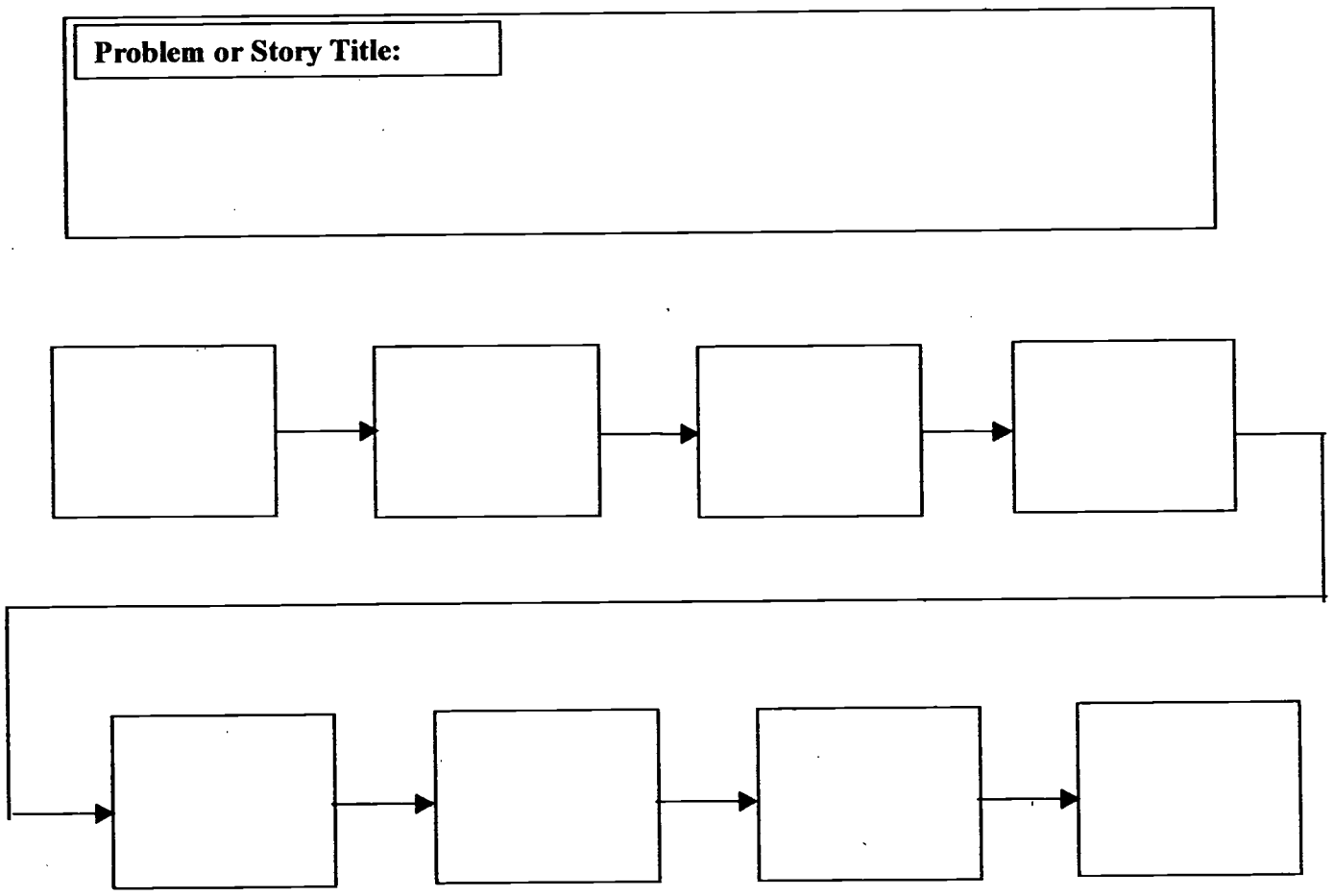
Name_____

I estimate I am _____**gingerbread men**  **tall.**

I am _____ gingerbread men  tall.

Appendix CC

Flow Chart



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Appendix DD

KWL Chart

What do you Know?	What do you Want to know?	You Learned?

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