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ABSTRACT

This report describes the effect of integrating math and science and employing technology to bridge the gap. The targeted population consisted of primary and secondary students in a diverse, blue-collar, rural community located in northeast central Illinois. The problem of low-test scores and errors on assignments in mathematics was evident and documented through daily work, student portfolios, and teacher generated tests. Analysis of probable cause data revealed that low student achievement in math skills was evident in the daily work, portfolios of students, and tests by teachers. Students were not motivated to learn math and science skills in a traditional classroom setting. Teaching strategies utilized technology, thematic units, and an integrated math and science course in order to make learning relevant to the students. A review of solution strategies such as literary articles, surveys, and an analysis of the problem setting resulted in the creation of an integrated math and science course, the utilization of thematic units, and increased usage of technology. These strategies were implemented to improve student motivation and achievement. Post intervention data indicated strengthened mathematical computation skills, increased problem solving skills, and increased student interest. (Contains 36 references.) (Author/ASK)

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# INTEGRATING MATH AND SCIENCE WITH TECHNOLOGY



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An Action Research Project Submitted to the Graduate Faculty of the School of Education in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Teaching and Leadership

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This report describes the effect of integrating math and science and employing technology to bridge the gap. The targeted population consisted of primary and secondary students in a diverse, blue-collar, rural community located in northeast central Illinois. The problem of low-test scores and errors on assignments in mathematics was evident and documented through daily work, student portfolios, and teacher generated tests.

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Post intervention data indicated strengthened mathematical computation skills, increased problem solving skills, and increased student interest.

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# CHAPTER 1

## PROBLEM STATEMENT AND CONTEXT

### General Statement of the Problem

The students of the targeted group, grades 1 through 9, exhibited difficulties with making connections between different curriculum areas. Students experienced difficulty transferring knowledge, thinking, reasoning, and using problem solving skills across the curriculum. This difficulty interfered with their success in school. According to the Illinois Standards Achievement Test (ISAT), there were curriculum gaps in physical science and mathematics, including pre-algebra. Site C of this school district, as evidenced by a 1998-99 in-school report, indicated that 80% of pre-algebra students received a grade of D or F at the high school level. Furthermore, 50% of life-science students received a grade of D or F. In addition, math grades for Sites A and B in the 1999/2000 school year have declined or showed no improvement as compared to math grades in the previous year.

The following demographic information was taken from the 1999 School Report Card. Targeted sites A and B, were located in an elementary school, and site C was in a high school. The elementary school was a one-story building with a total of 20 self-contained classrooms and 10 pullout classrooms. The total student population of the elementary school was 398 students. The major racial-ethnic groups in the elementary school were 66.8% Caucasian, 21.9% African-American, and 11.3% Hispanic.

The low-income rate for the elementary school was 51.3%. There was a free lunch program available for low-income children. The student attendance rate for the elementary school was 95.4%. The mobility rate for the elementary school was 31.3%, and students limited in English proficiency were 2.5%.

In this school, the teachers were divided between 89% females and 11% males. At this site, 59% of teachers had a bachelor's degree, and 41% had a master's degree.

The faculty and staff at the elementary school focused on hands-on math activities varied learning strategies, reading for comprehension, computer-assisted instruction, and relationship skills. There was a gifted program for first through fourth grades, which totaled approximately 10% of the student body. For the first grade, there were three trained reading recovery teachers who instructed four students one on one for 30-minute class periods, four times a week. A Title I program was provided for first through fourth grades that included push-in and pull-out times within self-contained classrooms, four times a week in 30-minute periods. For the at-risk students, this site had a learning resource teacher and three special education teachers with two teacher assistants. As a regular part of the curriculum at this site, there was a music program and a physical education program three times a week for all classes.

The high school was a three story, 22 classroom, building that was built in 1936 through the resources of the Works Progress Administration. Two of the classrooms in the basement were remodeled storage rooms. The total number of students at the high school was 403 students. The major racial ethnic group configuration was 72% Caucasian, 20.3% African-American, 6.5% Hispanic and 0.5% Asian/Pacific Islander. The high school had 49.6% low-income students. The student attendance rate was 92.5% with a mobility rate of 25.8%. The drop out rate was 4.5% and the chronic truancy was 5.0%.

The staff at the high school had an average of 17 years of experience. Of the 24 teachers, 45% were male and 55% were female; furthermore, 100% of the teachers were Caucasian. There were two special education assistants and one Title I aid. The education of the staff was 44.4% with a Bachelor's Degree and 55.6% with a Master's degree or higher according to the School Report Card, 1999.

The curriculum at the high school was mostly directed toward general education since only 12% of the graduates went on to higher education. The curriculum included honors, community service, workplace, advanced placement, and vocational courses. The school operated on a Block-8 schedule, 82-minute periods and alternating days, with an average class size of 21.4 students. The athletics available were baseball, basketball, cheerleading, cross-country, football, golf, soccer, softball, track, and volleyball. Other extracurricular activities included theater, choir, band, and various scholastic teams. There were two computer labs in the building that had Internet access. One classroom lab had 25 computers while the other, located in the library, had 29 computers. There were also six sets of Computer Based Laboratories (CBL II's) including sound, temperature, and light sensors. Calculator availability included 20 Texas Instruments TI-30X IIS's and 20 Texas Instruments TI-92's.

The integration of mathematics and science along with technology at site C became possible through efforts involving a grant from the Illinois School Board of Education titled "Challenging Traditions". This work was done from 1998 to 2000. Money from this grant made staff development, new materials, and school visitations possible. Furthermore, the creation of a new course titled "Integrated Math and Science" was a direct result of this grant. This course will be referred to as class 1 as because of two sections of pre-algebra, and classes 2 and 3, that were offered at site C. The main objective of the district was to determine if this method of instruction was more effective than the traditional methods that were currently in place. The integrated mathematics and science course was designed to explain pre algebra level mathematics and physical science to incoming freshmen that were considered to be at risk students. Teacher recommendations from the junior high school mathematics and science departments were taken into consideration along with course grades and test scores to determine which students would experience this new course. Fifteen students started the course but, by the end of the semester, the number had declined to twelve due to students moving out of the district.

Along with being the only integrated course in the building, this course had two more unique features. This course was the only noncollege preparatory double-blocked class. This meant that the course met for 82 minutes every day rather than the usual 82 minutes every other day schedule. This course was also unique in the fact that it was the building's only regular teacher team taught class. The mathematics teacher was with the students every day while the science teacher was present every other day, due to scheduling conflicts. Furthermore, on the days that the science teacher was teaching another course, a Title One aid was present in the integrated math and science classroom.

The textbooks that provided a science curriculum guidance were the Transportation and Predictions volumes of Active Physics, published by It's About Time, Incorporated. The textbook that was utilized as a supplement for mathematics was, The University of Chicago School Mathematics Project Transition Mathematics, published by Scott, Foresmann and Company.

The Surrounding Community

This "blue collar" community of 3000 residents, that contained sites A, B, and C, was located in northeast central Illinois. The community was 76 square miles with the Kankakee River winding through this border town.

There were four schools in the consolidated school district. A school board presided with a superintendent and three principals. The average administrative salary was $59,378. The total numbers of teachers in this consolidated school district totaled 86. The average teacher salary for the district was $40,464. The district served 1,350 students, pre-k through 12. The racial/ethnic population was 70.3% Caucasian, 21% African-American and 8.4% Hispanic. Due to a growing number of migrant workers, there was a growing Hispanic population that was evident in sites A, B, and C. The instructional expenditure per pupil was $3,190 and operating costs reached $4,961 per student. While the state expenditure per pupil was $3,990 and the operating expenditure per pupil was $6,882.

The mission statement for the targeted sites, A, B, and C was to educate all students in basic knowledge and life-long learning skills that promote continuous growth in their academic, occupational, civic, and personal lives. This has been accomplished through a partnership of students, family, staff, and community within a climate of mutual respect.

The goals for the targeted sites, A, B, and C were as follows:

1. To improve the quality of instruction through engaged learning.
2. To improve student achievement in reading instruction a priority in all curriculum areas.
3. Incorporate technology into instructional practices.

The educational philosophy of sites A, B, and C was that the district be child-centered. The district has viewed its responsibility as providing every student, who resides within the district, with equal access to the greatest educational development that, the individual can attain.

## National Context of the Problem

According to the National Research Council (1989), Students need to become better prepared for today's world. They need a higher level of mathematical, scientific, and technical literacy than they have ever needed in the past. The work place demands that students acquire problem solving, communication, and reasoning skills that are not being provided in the typical high school program. The high school curriculum has changed very little in the last century despite the fact that society has changed and technological advances have been made.

The Third International Mathematics and Science Study (TIMSS) reported disturbing findings about the performance of U.S. secondary school students in science and mathematics, ranking them will below the international average. The TIMSS achievement results paint a disappointing picture. "It is a picture of decline in our relative standing internationally from grade 4 through grade 8 to grade 12. This pattern holds in both science and mathematics (Schmidt & Wang, 1999, p.2).

"No nation can afford to tolerate what prevails in American schooling: generally low expectations and low performance in mathematics and science, with only pockets of excellence at a world-class level of achievement...If we do not arm our children with appropriate tools, we fail them" (National Science Board, 1998, p. 98). The National Science Board further stated that world class achievement in science and mathematics education is of critical importance to our nation's future. "The National Science Board urges all stakeholders in our vast grass-roots system of K-12 education to develop a nation-wide consensus for a common core of knowledge and competency in mathematics and science" (National Science Board, 1998, p.98).

In The Nation's Report Card, (Mitchell et al.1999), presented evidence that suggests when a Theme Study was administered at the fourth-grade level, most students attempted to answer the questions posed, even though large percentages produced responses that were scored as "incorrect". Although not definitive, this may be evidence that the thematic context of the block of questions encouraged students' attention to the task of solving problems, even ones that proved to be difficult for most students. At grade 8, unlike grade 4, many students did not attempt to answer the more complex questions that required them to write explanations or apply concepts in problem settings. In addition, at all grade levels, many students seemed to lack the mathematical knowledge needed to solve problems. Further research has revealed that although students can perform arithmetic computations adequately, they are not able to use their skills to solve problems. The Nation's Report Card (Mitchell et al.,1999) concluded that students are lacking in the areas of mathematics that require higher-level cognitive skills and understanding to solve problems beyond routine, step-by-step situations.

There was substantial evidence that many students experience difficulty in transferring knowledge of subjects across the curriculum, many times causing deficiencies in learning. According to S. Willis:

> Because our lives require us to integrate what we have learned in an interdisciplinary manner, teaching children through merged disciplines better prepares them for applying new knowledge and understandings. Additionally, when students view their learning as having personal relevance, they put more effort into their schoolwork and achievement (Willis, 1995, p. 1-8).

In other words, when students can see connections across different content areas, they develop an increased understanding of subjects as an integrated whole.

"Numerous scientific studies have shown that traditional methods of teaching mathematics not only are ineffective but also seriously stunt the growth of students' mathematical reasoning and problem-solving skills" (Battista & Larson, 1994, p. 178). Traditional methods ignore recommendations by professional organizations in mathematics education, and they ignore modern scientific research on how children learn mathematics. Yet traditional teaching continues, taking its toll on the nation and on individuals. According to the National Research Council (1989), 60% of college mathematics enrollments are in courses ordinarily taught in high school and 75% of Americans stop studying mathematics before they complete career or job prerequisites. "The mathematical ignorance of our citizenry seriously handicaps our nation in a competitive and increasingly technological, global marketplace" (Battista, 1999, p.2).

# CHAPTER 2

## PROBLEM DOCUMENTATION

### Problem Evidence

The students of the targeted group, grades 1 through 9, exhibited difficulties with making connections between different curriculum areas. Students experienced difficulty transferring knowledge, thinking, reasoning, and using problem solving skills across the curriculum. The fact that they were not experiencing success in school was apparent in low math and science test scores in targeted groups.

In site A, math grades in the 1999-2000 school year showed 47% of the students scored below a C average.

In site B, math grades in the 1999-2000 school year showed 15% of the students scored below a C average. However, the average unit test score for the school year was a 79% on a 92-85-75 grading scale.

In site C, math grades in the 1998-1999 school year showed 80% of the students in pre-algebra earning a letter grade of a D or a F. The 1999-2000 school year, showed that 59% of the pre-algebra students earned a letter grade of a D or an F. In addition, on the most recent testing for the state of Illinois, 51% of grade 10 students scored in the “below standards” or received an “academic warning” in mathematics.

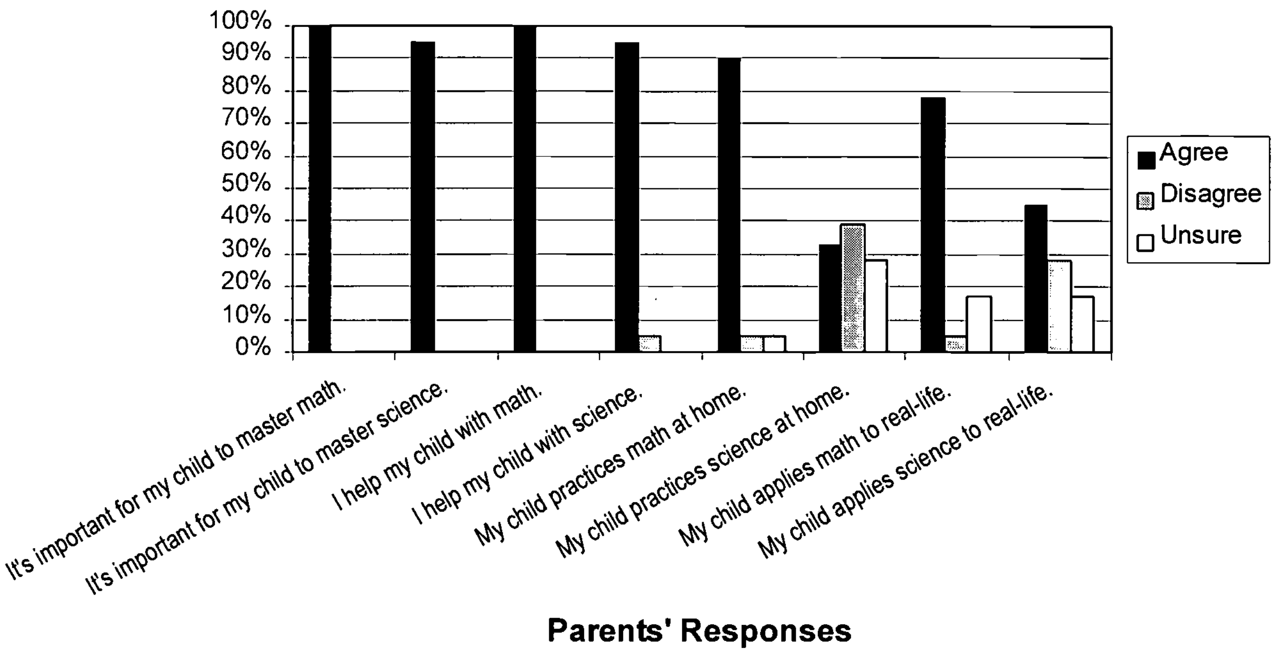



Figure 1. Site A: Parent Survey Results.

Parent surveys were administered in September (Appendix A-4). Survey results in Site A (Figure 1) showed that 100 % of parents thought it was important for their children to master basic math skills and felt comfortable helping their children with math. Ninety-five percent thought it was important for their child to master basic science skills and were comfortable helping their children with science; 5% disagreed. Ninety percent of the parents surveyed reported that their children practiced basic math skills at home, while 5% disagreed and 5% were unsure. Thirty-three percent of the parents surveyed reported that their children practiced basic science skills at home, 39% disagreed and 28% were unsure. Of the parents surveyed, 78% believed that their children applied basic math skills to real-life situations, 5% disagreed, and 17% were unsure. The results of the survey showed that 45% of the parents believed that their children applied basic science skills to real-life situations, 28% disagreed and 17% were unsure.

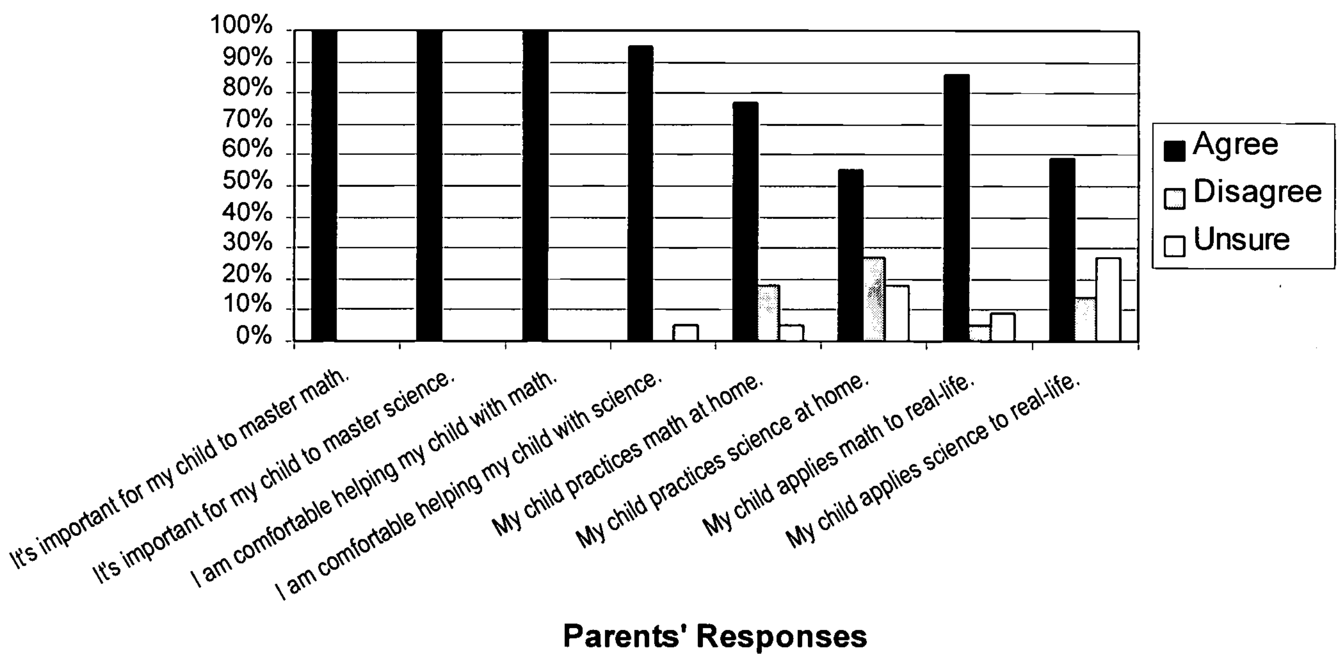



Figure 2. Site B: Parent Survey Results.

Survey results in Site B (Figure 2) showed that 100 % of parents thought it was important for their children to master basic math skills and felt comfortable helping their children with math. One hundred percent thought it was important for their child to master basic science skills and 95% were comfortable helping their children with science; 5% were unsure. Seventy seven percent of the parents surveyed reported that their children practiced basic math skills at home, while 18% disagreed and five percent were unsure. Fifty five percent of the parents surveyed reported that their children practiced basic science skills at home, 27% disagreed and 18% were unsure. Of the parents surveyed, 86% believed that their children applied basic math skills to real-life situations, five percent disagreed, and nine percent were unsure. The results of the survey showed that 59% of the parents believed that their children applied basic science skills to real-life situations, 14% disagreed and 27% were unsure.

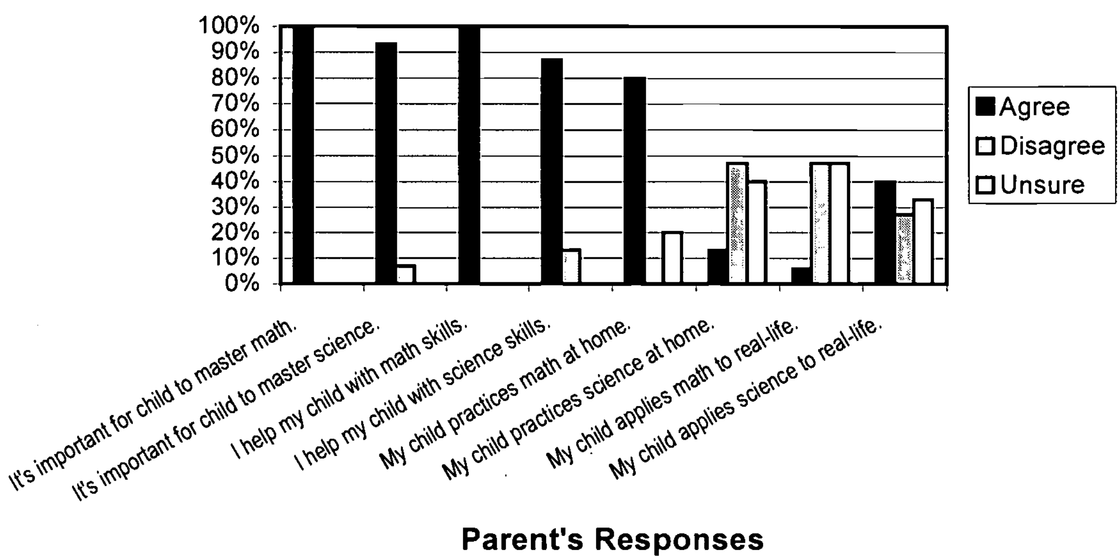
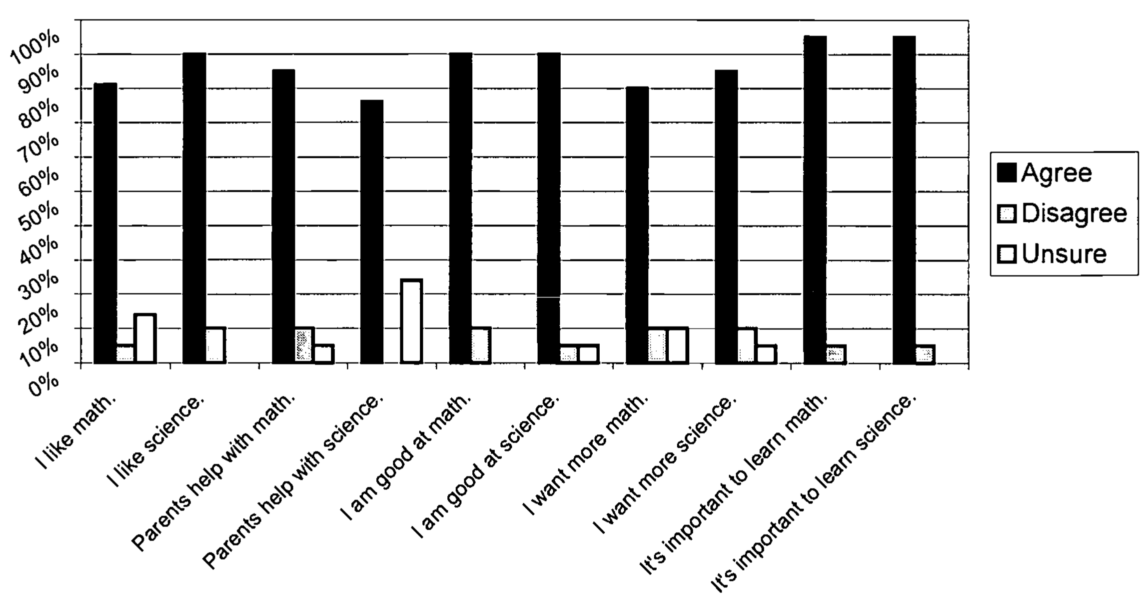



Figure 3. Site C: Parent Survey Results.

Survey results in Site C, Figure 3, showed that 100% of parents thought it was important for their children to master basic math skills and felt comfortable helping their children with math. Ninety three percent thought it was important for their child to master basic science skills, while 7% disagreed. Eighty seven percent were comfortable helping their children with science, the other 13% percent were unsure. Eighty percent of the parents surveyed reported that their children practiced basic math skills at home, while 20% percent were unsure. Thirteen percent of the parents surveyed reported that their children practiced basic science skills at home, 47% disagreed, and 40% were unsure. Of the parents surveyed, 6% believed that their children applied basic math skills to real-life situations, 47% disagreed, and 47% were unsure. The results of the survey showed that 40% of the parents believed that their children applied basic science skills to real-life situations, 27% disagreed, and 33% were unsure.




**Students' Responses**

Figure 4. Site A: Student Survey Results.

The student surveys were administered in September (Appendix B-1 and B-2). Survey results in Site A (Figure 4) showed that 81% of students liked math, five percent did not, and 14% were unsure. Ninety percent of students liked science, whereas 10% did not. Of the students surveyed, 85% reported that their parents helped them with math, 10% did not, and 5% were unsure. Seventy six percent of the students reported that their parents helped them with science, and 24% were unsure. Ninety percent of students believed they were good at math, while 10% thought they were not good at math. Of the students surveyed, 90% believed themselves good at science, 5% believed themselves to be poor at science, and 5% were unsure. Eighty percent of students wanted to do more math at school, 10% disagreed, and 10% were unsure. Eighty five percent of students surveyed wanted to do more science at school, 10% disagreed, and 5% were unsure. Ninety five percent of students in this survey thought that math and science were important to learn, and 5% disagreed.

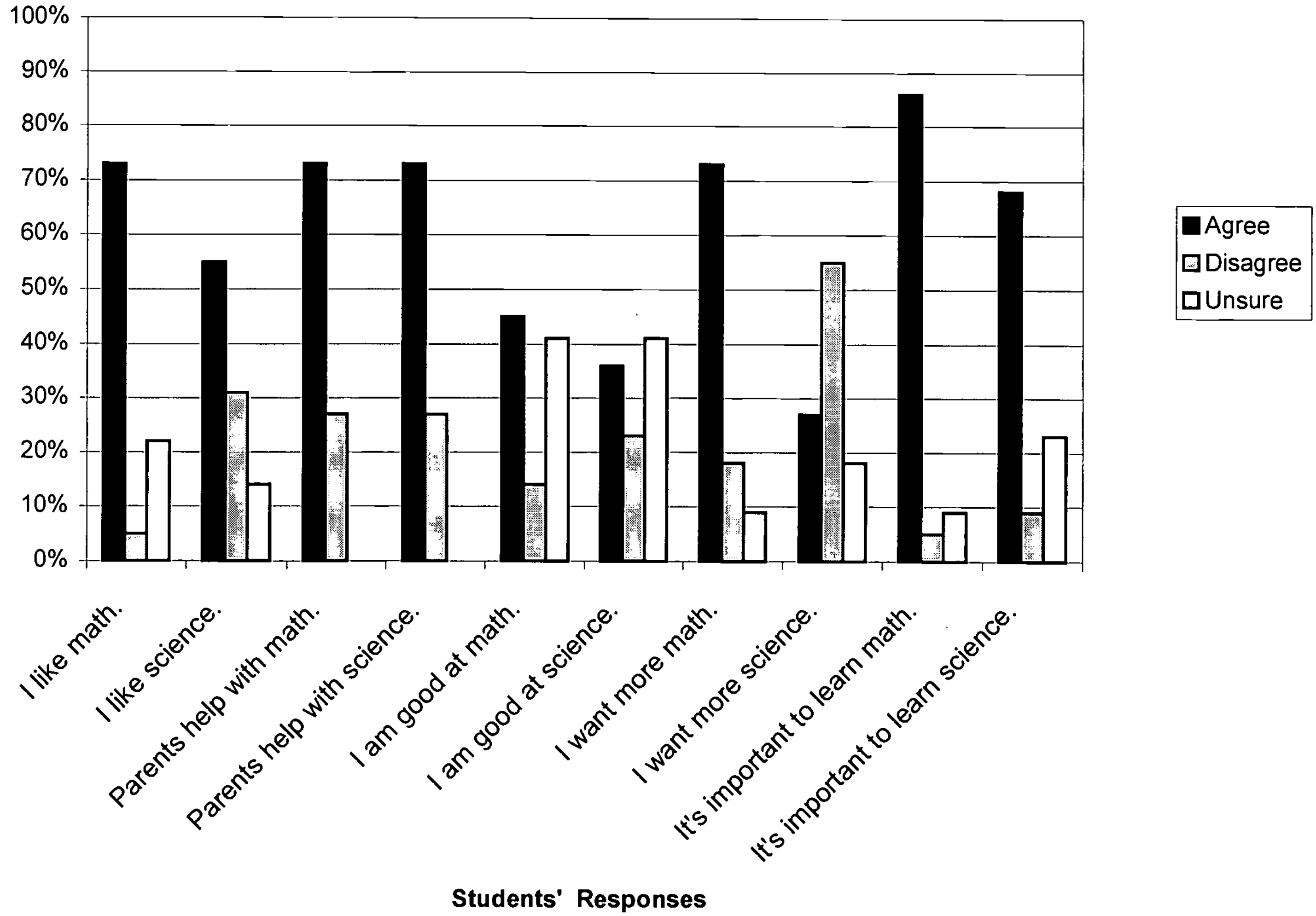



Figure 5. Site B: Student Survey Results.

A summary of the student survey at Site B is presented in Figure 5. Survey results in Site B showed that 73% of students liked math, 5% did not, and 22% were unsure. Fifty five percent of students liked science, whereas 31% did not, and 14% were unsure. Of the students surveyed, 73% reported that their parents helped them with math and 27% did not. Seventy three percent of the students reported that their parents helped them with science and 27% disagreed. Forty five percent of students believed they were good at math, while

14% thought they were not good at math, and 41% were unsure. Of the students surveyed, 36% believed themselves to be good at science, 23% believed themselves to be poor at science, and 41% were unsure. Seventy three percent of students wanted to do more math at school, 18% disagreed, and 9% were unsure. Twenty seven percent of students surveyed wanted to do more science at school, 55% disagreed, and 18% were unsure. Eighty six percent of students in this survey thought that math was important to learn, 5% disagreed, and 9% were unsure. Sixty eight percent of students thought that science was important to learn 9% disagreed, and 23% were unsure.

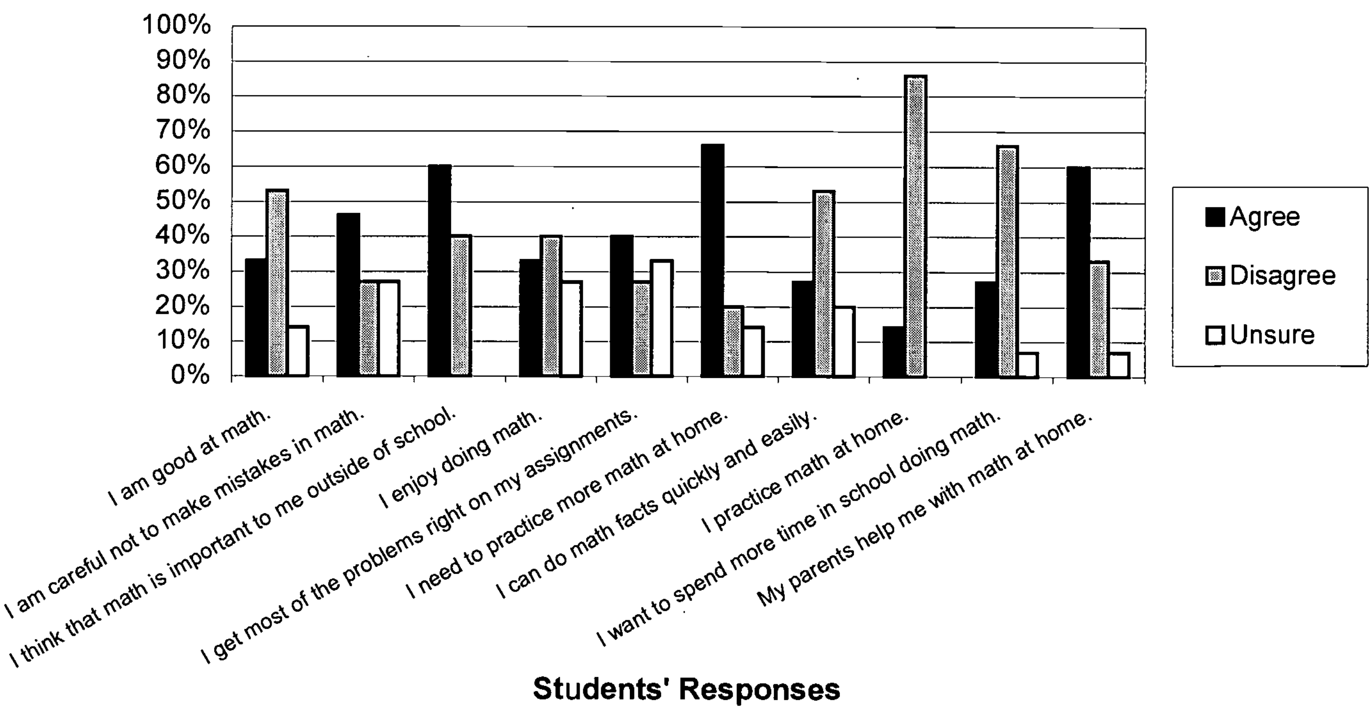



Figure 6. Site C: Student Math Survey Results.

The students' survey results for mathematics at site C are depicted in Figure 6. The graph shows that 33% of students liked math, 53% did not, and 14% were unsure. Forty six percent of students surveyed thought themselves careful to not make mistakes in math, 27% disagreed, and 27% were unsure. Of the students surveyed, 60% reported that math was important to them outside of school, 40% of students disagreed. Thirty three percent of students surveyed enjoyed doing math, 40% did not enjoy doing math, and 27% were not sure. Of the students surveyed, 40% thought they had most of the problems correct on their math assignments, 27% disagreed, and 33% were unsure. The student survey indicated that 66% of students needed to practice more math at home, 20% disagreed, and 14% were unsure. Twenty seven percent of students surveyed thought they could do math facts quickly and easily, 53% disagreed, and 20% were unsure. Of the students surveyed, 14% practiced math at home, and 86% did not practice math at home. Twenty seven percent of the students surveyed wanted to spend more time during school doing math, 66% disagreed, and seven percent were unsure. Of the students surveyed 60% stated that their parents helped at home with math, 33% stated that they did not receive help at home with math, and 7% were unsure.

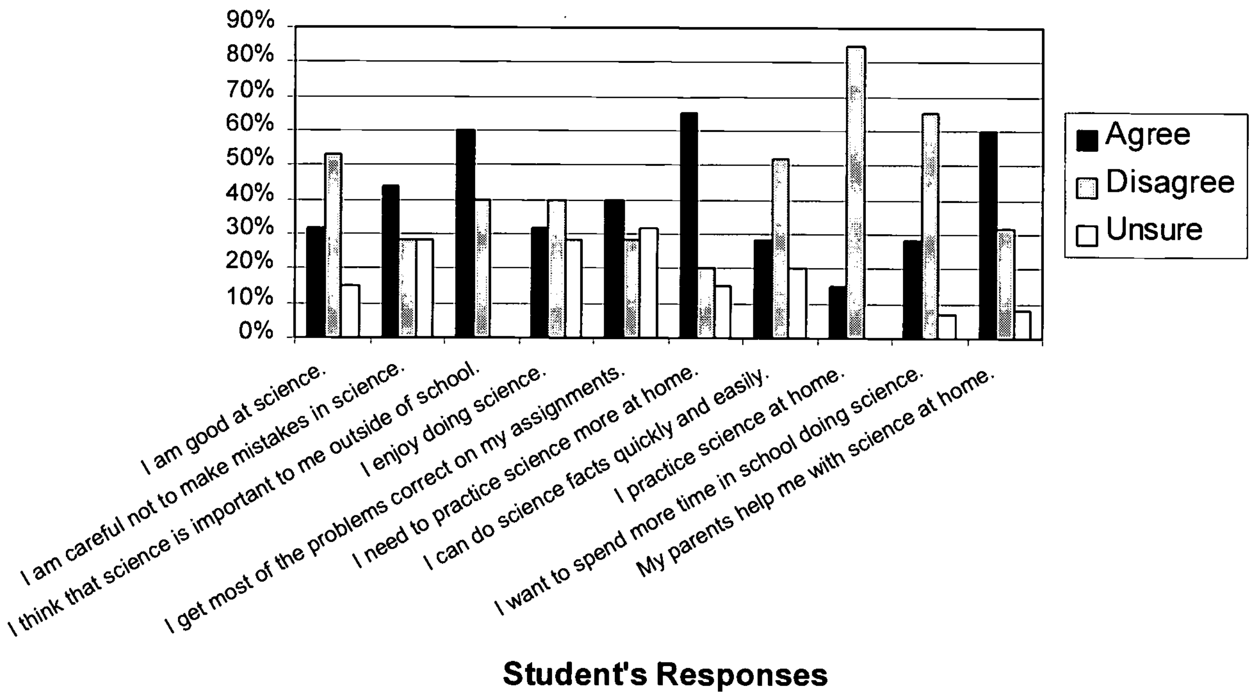



Figure 7. Site C: Student Science Survey Results.

The student's survey results for science at site C, Figure 7, showed that 20% of students liked science, 47% did not, and 33% were unsure. Twenty percent of students surveyed thought that they were careful to not make mistakes in science, 33% disagreed, and 47% were unsure. Of the students surveyed, 47% reported that science was important to them outside of school, 40% of students disagreed, and 13% were unsure. Twenty six percent of students surveyed enjoyed doing science, 67% did not enjoy doing science, and 7% were not sure. Of the students surveyed, 7% thought they had most of the problems correct on their science assignments, 60% disagreed, and 33% were unsure. The student survey indicated that 33% of students needed to practice more science at home, 47% disagreed, and 20% were unsure. Twenty percent of students surveyed thought they could do science problems quickly and easily, 47% disagreed, and 33% were unsure. Of the students surveyed, 7% practiced science at home, 86% disagreed, and 7% were unsure. Seven percent of the students surveyed wanted to spend more time during school doing science, 80% disagreed, and 13% were unsure. Of the students surveyed 40% stated that their parents helped at home with science, 47% stated that they did not receive help at home with science, and 13% were unsure.

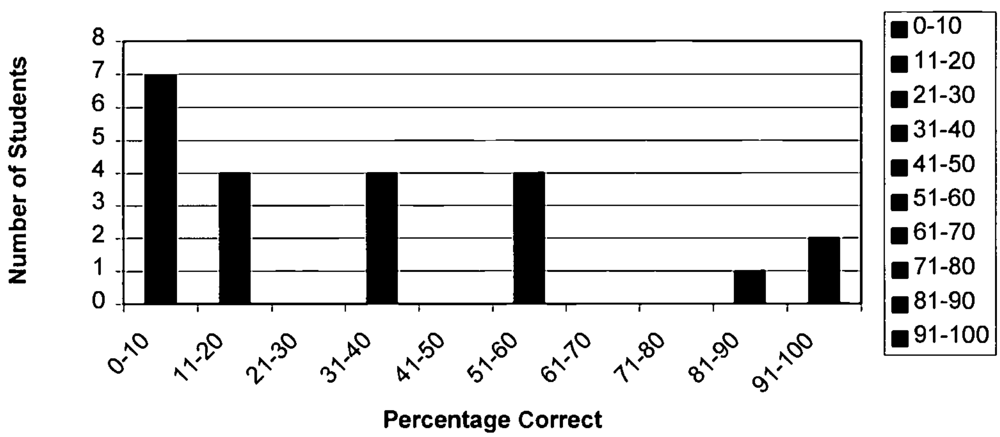
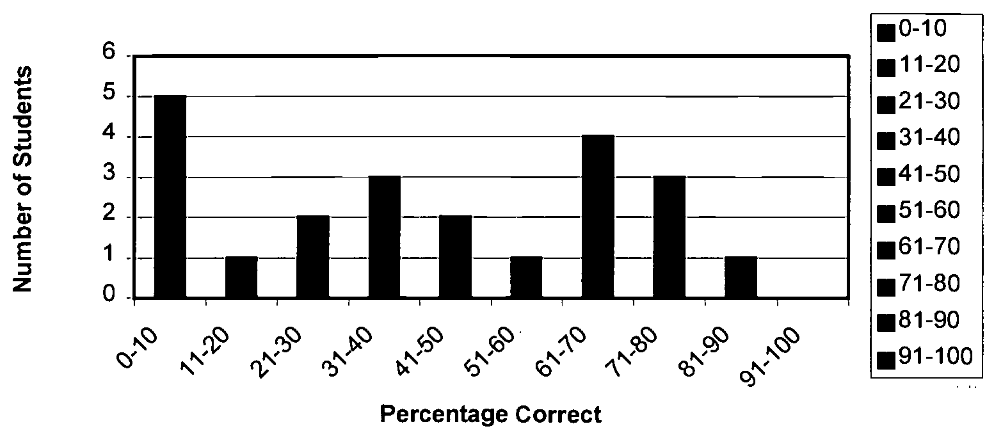



Figure 8. Site A: Math Pretest

The Essential Skills Screener, by Slosson Educational Publications, was the pretest that was administered to site A students. The test is designed to screen or identify children equivalent to 3-11 years of age who may exhibit problems in math. These scores are based on a national average. After administration, a student is given a raw score and compared to a criterion standard or norm group of students of the same chronological age. Survey results indicated that over half of the students in site A scored below 50% on their math pretest. Only 7 students out of a total of 22 scored above 50% on their test. This test was administered before the action research was started in early September.




<u>Figure 9.</u> Site B: Math Pretest

The Essential Skills Screener, by Slosson Educational Publications, was also administered to students in site B. The test was administered in early September before the action research was started. Over 50% of the students in site B scored below 50% on their pretest. Nine students out of 15 scored above 50% compared with the national average of students that were in the same norm group. This norm group consisted of children that were in the same grade (or chronological age). The following are interpretative ranges of the Essential Skills Screener:

Below Average – 25th %ile and below

Average – 26th to 75th %ile

Above Average – 76th %ile and above

Both of these tests, pretest and posttest, can be used in a criterion-referenced capacity set by the evaluator.

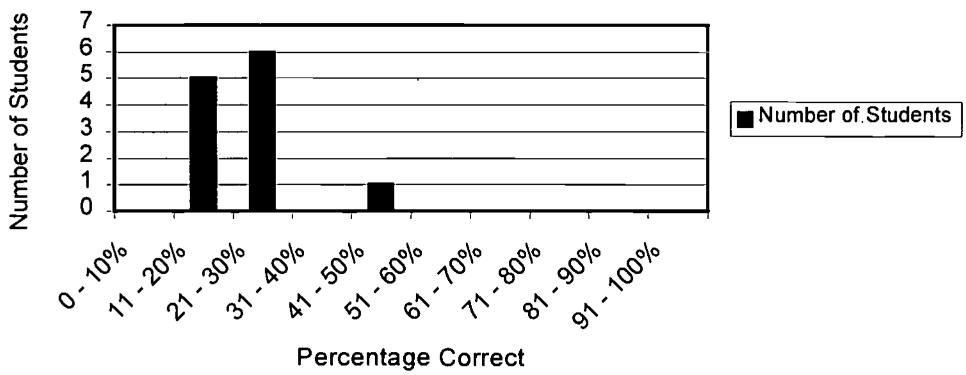



Figure 10. Site C: Science Pretest.

A teacher written test comprised of physical science fundamentals was administered to the students of site C. The test was a 50 question multiple-choice exam designed to assess the content knowledge of a complete year of freshmen level physical science. The results of this test, Figure 10, showed that five students answered 11-20% of the questions correct, six received 21-30% answers right, and one student received a score of 41-50% of the questions correct.

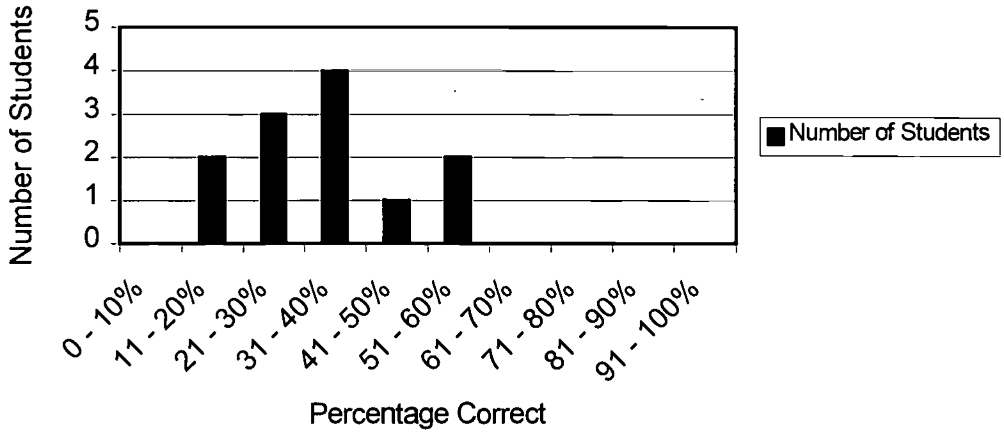



Figure 11. Site C: Math Pretest, Class 1.

The assessment that was utilized to test the students at site C was the Comprehensive Test, Chapter 1-13, from The University of Chicago School Mathematics Project Transition Mathematics textbook, published by Scott, Foresmann and Company. This textbook presented pre-algebra content for this mathematics series. The results of this test, Figure 11, show that two of the integrated math and science students had 11-20% of the 25 questions correct. Three of the students had 21-30% of the questions correct. Four of the students had 31-40% correct, while one student had 41-50% correct, and two students had 51-60% of the questions correct.

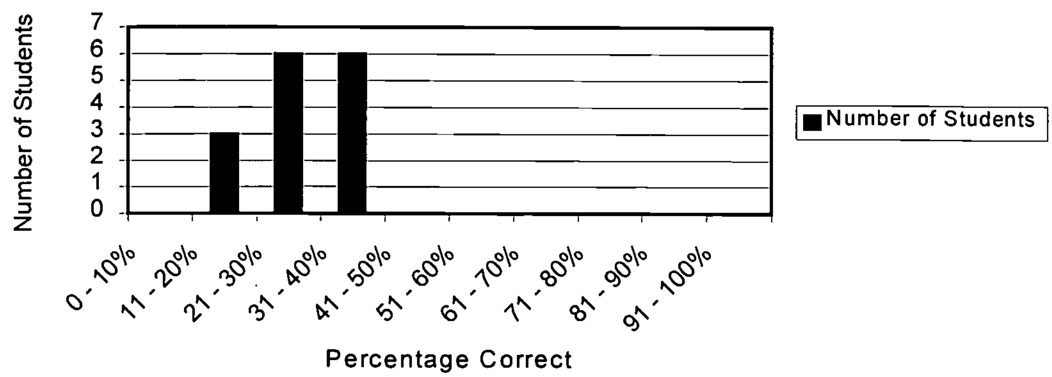



Figure 12. Site C: Math Pretest, Class 2.

A summary of test scores in class 2 of the pre-algebra class is shown in Figure 12, which represents the overall mathematics situation of site C. The test that was used was the same utilized by class 1 at site C. Three students had 11-20% of the 25 questions correct, while six students had 21-30% of the questions correct, and six students had 31-40% of the questions correct.

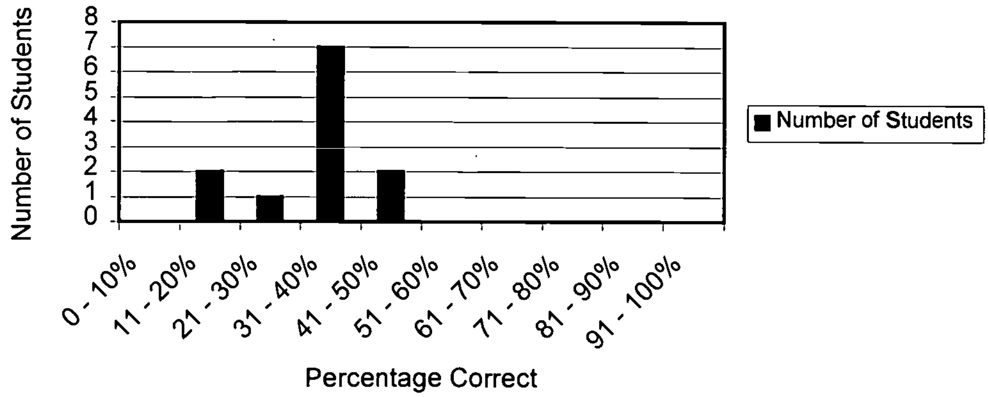



Figure 13. Site C: Math Pretest, Class 3.

Figure 13 displays the results of the pretest given to the students of class 3 located at site C, which was also a pre-algebra class. The assessment administered was the same one offered to classes 1 and 2. Two students had 11-20% of the 25 questions correct, while one student had 21-30% correct, and seven had 31-40% correct. Two students had 41-50% of the questions correct.

## Probable Causes

Analysis of probable cause data revealed that low student achievement in math skills was evident in daily work, portfolios of students, and tests by teachers of the targeted schools. Students were not motivated to learn math and science skills in a traditional classroom setting.

According to the 1996 Third International Mathematics and Science Study (TIMSS; Schmidt & Wang, 1999), American school students were ranked well below the international average. Also, the National Council of Teachers of Mathematics (NCTM, 2000) indicated in the Principles and Standards for School

Mathematics that there was a learning gap in mathematics and the effectiveness of math education can be improved significantly. In addition, the Nation's Report Card (1996) assessment showed students, at all grade levels, had difficulty with multi-step problems. The students also demonstrated that they seemed to lack the necessary mathematical knowledge to solve problems (Mitchell, 1999).

Often, students were reluctant or unable to recognize and use knowledge they already possessed to help them solve new problems or understand new, related topics. According to Carla Mathison and Cheryl Mason (1989), this concept could be directly related to the ways students originally comprehend information. Teaching subjects that are not connected hinders students from identifying important interconnections within the subjects they study.

In traditional mathematics instruction, the teacher demonstrated how to solve a certain type of problem and then had the student practice this method in class and as homework. The National Research Council (1989) has dubbed the "learning" produced by such instruction as "mindless mimicry mathematics" (The National Research Council, 1989, p.44). Furthermore, the focus on computation was so myopic that few students developed any understanding of why the computations worked or when they should have been applied.

Michael T. Battista stated:

> For most students, school mathematics is an endless sequence of memorizing and forgetting facts and procedures that make little sense to them. Though the same topics are taught and retaught year after year, the students do not learn

> them. Numerous scientific studies have shown that traditional methods of teaching mathematics not only are ineffective but also seriously stunt the growth of students' mathematical reasoning and problem-solving skills (Battista, 1999, p.3).

Low-income students are disadvantaged in the public school system. Carta (1991) cited several sources indicating that low socioeconomic status (SES) children are much more likely to have "educationally damaging circumstances as part of their life experiences" (Cohen, 1993, pp. 4-5). The United States has a much higher incidence of child poverty than do other Western nations, and the percentage of impoverished children in the population has continued to increase during the past two decades.

Federal, state and local programs have designs implemented in an effort to offset the profound difficulties children from economically and socially disadvantaged backgrounds encounter when they enter public schools. The idea, of course, is to educate these students beyond their poverty, that is, to give them the intellectual tools and social skills necessary to become productive, working adults (Renchler, 1993).

Just as high poverty rates in a school lowers achievement, schools with high mobility rates do not succeed either (Sewell, 1982). Students who attend the same school for their whole career are most likely to graduate, whereas the most mobile of the school populations-migrant students have the highest rates of school failure (Lunon, 1986). Also, in the Journal of the American Medical

Association's study (1993), children in families that move frequently are 50 to 100% more likely to repeat a grade, or experience a delay in growth or development, behavioral problems, or a learning disorder. High mobility affects the whole social and learning environment of the school and makes heavy demands on staff time and resources, with implications for the non-mobile students, too (Dobson, 1999).

Evidence from a variety of sources indicates that many students are not learning what they need or are expected to learn. Some reasons for this may be that students have not had the opportunity to master mathematics skills. In some cases, the curriculum offered does not engage students. Sometimes students lack a commitment to learning. Also, the quality of mathematics teaching is highly variable (NCTM, 2000).

# CHAPTER 3

# THE SOLUTION STRATEGY

## Literature Review

In a study of an integrated mathematics curriculum, Edgerton (1990) found that after one year 83% of the teachers involved preferred to continue the integrated program rather than return to the traditional curriculum. MacIver (1990) found that teachers appreciated the social support of working together and felt that they were able to teach more effectively when they integrated across subjects and courses. In addition, teachers discovered new interests and teaching techniques that revitalized their teaching.

Technology in schools has an impact on how well a student learns. A large-scale study called "Does it Compute?" (Wenglinsky, 1996) conducted by the Educational Testing Service on how computers affect the learning of mathematics in American classrooms, found that when used selectively by trained teachers in middle schools they can significantly enhance academic performance (Ethan Bronner, 1998). The study took the scores of thousands of fourth and eighth graders on the 1996 math portion of the National Assessment of Educational Progress and examined them based on surveys of students and teachers regarding classroom computer use. Among eighth graders, it found that when students use computers for more complex mathematics like simulations, which measure changing variables, or application, where data are manipulated and analyzed, gains of more than a third of an academic year were registered.

With fourth graders using computers for mathematical games, the gain was a tenth of an academic year. Harold Wenglinsky concluded the report by stating:

> When computers are used to perform certain tasks, namely applying higher order concepts, and when teachers are proficient enough in computer use to direct students toward productive uses more generally, computers do seem to be associated with significant gains in mathematics achievement (Wenglinski, 1996, p.2).

In a report for the U.S. Congress Office of Technology Assessment, Pea and Soloway stated that technology might be the factor to help "bridge the ever-widening gaps between schools and society" (Pea, 1987, pp.33-34).

It has also been noted that computers were used successfully in a deliberate attempt to raise student test scores. Kulik and Kulik (1991) found that educational software improved learning outcomes (speed of learning and achievement) by a consistent 20%.

"One thing is crystal clear: The advance of technology makes constructing new and richer contexts for teaching and learning ever more tenable and more necessary" (Kinnaman, 1995, p.86).

D.N. Perkins advocates teaching for transfer and thoughtful learning when he states, "A concern with connecting things up, with integrating ideas, within and across subject matter, and with elements of out-of-school life, inherently is a concern with understanding in a broader and a deeper sense" (Perkins, 1991, pp. 4-8).

This view supports the idea of curriculum integration as a means of making education more meaningful. Concerns about national achievement levels and high dropout rates have put the spotlight on any educational change that can lead to increased student success. In addition to the realization that curriculum integration may be an effective element in making education both manageable and relevant, there is a body of research related to how children learn that supports curriculum integration. In support of this concept, Brandt (1991) felt that integrated curriculum taught concepts that would often help students approach any situation or problem, rather than facts which had limited applications.

Integrated curriculum has an impact on student attitudes. MacIver (1990) found that integrated program students developed team spirit and improved their attitudes and work habits. Vars (1995) also reports that motivation for learning is increased when students work on "real" problems, a common element in integrated programs. When students are actively involved in planning their learning and in making choices, they are more motivated- reducing behavior problems. Furthermore, Jacobs (1989) found than an integrated curriculum is associated with better student self-direction, higher attendance, higher levels of homework completion, and better attitudes toward school. Students are engaged in their learning as they make connections across disciplines and with the world outside the classroom.

The research of Lipson also supported the positive effects of curriculum; the following is a list of those findings:

1. Integrated curriculum helps students apply skills.
2. An integrated knowledge base leads to faster retrieval of information.
3. Multiple perspectives lead to a more integrated knowledge base.
4. Integrated curriculum encourages depth and breadth in learning.
5. Integrated curriculum promotes positive attitudes in students.
6. Integrated curriculum provides for more quality time for curriculum exploration (Lipson, 1993, pp. 252-264).

When researching how children learn, Cromwell (1989) looked at how the brain processes and organizes information. The brain processes many things simultaneously, and holistic experiences are recalled quickly and easily. This view supports the idea of curriculum integration as a method of making education both meaningful and relevant to real life. Included in this research, Shoemaker stated that, "The human brain actively seeks patterns and searches for meaning through these patterns" (Shoemaker, 1989, p.13).

Caine and Caine (1991) also supported this research finding when they connected neuro-psychology and educational methods and stated that the search for meaning and patterns is a basic process in the human brain. Consequently, the brain may resist learning isolated facts out of context. Learning is believed to occur faster and more thoroughly when presented using real life experiences. To meet these diverse needs means providing choices for students. In fact, when implemented in the classroom, the brain research points toward curriculum-integrated learning, thematic units, real life experiences, and teaching that is conducive to student learning styles (Shoemaker, 1991).

Fogarty (1997) has stated in, The Brain Compatible Classroom, that many times students learn best when the curriculum is connected. Even though students may have different learning styles, exposing them to real life experiences through thematic units helps stimulate the brain, thus helping them to make connections.

Perkins and Salomon (as cited in Bellanca, Costa, & Fogarty, 1992) wrote that in a traditional classroom setting, students often may acquire skills and knowledge in one subject area, but fail to make a connection in other subject areas, in which those skills and knowledge could also be useful. If transfer of learning does not happen, this could be a major problem in education.

In agreement with integration, instead of supplying students with fragmented and irrelevant isolated facts, give them knowledge that they can relate to personally as a useful tool for learning (Lipson, 1993).

Hiebert (1994) believed that teachers who used thematic units created active readers and writers by engaging the students in their work. Learning extends beyond the classroom walls. When students were engaged, they began collaborating with each other, there was also an opportunity for a variety of reading and writing activities built upon the student's interests, abilities, background, and language development.

Perkins (1991) wrote that effective learning coincides with a stimulating curriculum that interests children while capturing their imaginations. The article went on to say that when students and teachers are engaged and have an interest in the subject matter, nothing else matters. Integration and context are the keys to designing a curriculum that will meet the needs of this criterion.

## Project Objectives and Processes

As a result of increased instructional emphasis on integrating technology with curriculum, during the period of September 2000 to December 2000, the students of the targeted sites will increase their abilities in math and science, as measured by diagnostic tests, rubrics, teacher made tests, student portfolios, and daily work.

The following processes will be used to accomplish the project objectives:

1. Integrating computer software with math and science will be utilized.
2. Thematic units involving learning activities that include technology will be implemented.
3. Internet activities will be integrated with math and science.

## Project Action Plan

I. Week 1

A. Compose Parent Consent letter

B. Identify classes as A, B, or C for research documentation

C. Administer Slosson Essential Skills Screener PreTest in sites A and B

D. Administer science test and Comprehensive Test (Chapters 1-13) from UCSMP Transition Mathematics in site C

II. Week 2

A. Send parent letter of Consent to Participate in Research Study

B. Score Slosson Essential Skills Screener Test, science test, and Comprehensive Test (Chapters 1-13) from UCSMP Transition Mathematics

C. Send Parent Survey prepared in Week 1

D. Give Student Survey

E. Develop five separate two week thematic unit plans in sites A and B

F. Teach math/science lessons using technology in site C

G. Develop assessment profiles

III. Week 3

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Compile and analyze survey data

E. Develop graphs for survey results

F. Students write in reflection journals

G. Collect students' weekly reflection journals

H. Write weekly entry in implementation journal

IV. Week 4

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

V. Week 5

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

VI. Week 6

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

VII. Week 7

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journals

VIII. Week 8

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

IX. Week 9

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

X. Week 10

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

XI. Week 11

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

XII. Week 12

A. Teach math/science lessons using technology

B. Give weekly math assessment and score assessment

C. Collect weekly artifacts for student portfolios

D. Students write in reflection journals

E. Collect students' weekly reflection journals

F. Write weekly entry in implementation journal

XIII. Week 13

A. Administer Slosson Essential Skills Screener Post Test in sites A and B

B. Administer science test and Comprehensive Test (Chapters 1-13) from UCSMP Transition Mathematics site C

C. Students write in reflection journals

E. Write weekly entry in implementation journal

XIV. Week 14

A. Score math and science unit post tests

B. Compare and analyze math and science unit pretests to posttests

C. Compile data taken from the math science pretests and posttests for graphs

## Methods of Assessment

To assess the effects of the interventions, the Slosson Essential Skills Screener Test in computation, concepts, and problem solving was administered in the fall to targeted first and fourth graders. The Comprehensive Test, Chapters 1 through 13, from University of Chicago School Mathematics Project Transition Mathematics, published by Scott, Foresmann and Company, was administered to the integrated math and science classes at site C. The test was also administered to two sections of pre-algebra classes at site C. The integrated math and science class also took a 50 question, multiple choice, teacher written science test that included fundamental physical science concepts. These test results were used in comparison with testing done later in the semester. Student portfolio work and weekly math assessments were evaluated for increased computational accuracy.

# CHAPTER 4

## PROJECT RESULTS

### Historical Description of the Intervention

After the administration of parent and student responses, there was a marked difference between math and science responses. Parents had high expectations for their children in math, but the same was not true for science. Most parents surveyed agreed that their children practiced math at home but significant fewer students practiced science at home in all sites. In sites B and C, most students reported they did not like science or think it was important to learn.

From grade 4 on, science is taught on a regular basis throughout the school year. Since there was such a decline in students' attitudes towards science, intervention was definitely needed. In relation to research on integration, it was found that many students' attitudes positively changed towards curriculum when there was a connection. Motivation for learning a subject is often increased when students work on "real" problems such as in an integrated math and science lesson.

Most students enjoyed doing math but not science. Research showed that possibly combining the two subjects would help students to become more engaged and interested in doing science.

The objective of the action research project was to increase student motivation and achievement in math by integrating math and science with technology. The intervention procedure had the following components: teaching math and science lessons using technology, integrating curriculum by implementing thematic units, and collecting weekly artifacts for student portfolios. Teaching math and science lessons using technology was selected to motivate students in mathematics. Implementing thematic units were used to integrate subjects across the curriculum. Collecting weekly artifacts for student portfolios was used as an authentic form of assessment.

The research team consisted of four people. Two researchers taught in self-contained elementary classrooms. The third researcher taught computer technology to first through fourth grades. The fourth researcher taught an integrated mathematics and science course to ninth grade students. All students in the targeted classrooms participated in the interventions.

Surveys were administered to students and their parents in the targeted classrooms. The purpose of the surveys was to determine attitude and involvement in connection with the subjects of math and science. Surveys were administered to targeted groups during week two of the action research.

Computer software from the targeted school's computer lab was used during school to help increase computational mathematics skills and to motivate students. A specific software program used with targeted students was MECC. This software consisted of whole numbers, symmetry, and geometry. The Learning Company software, Ultimate Writing and Creativity, incorporated research skills used to make science collages. Math Rabbit was also used for students to practice basic math skills. Software by Tom Snider, Graph Club, was used to create various graphs on the computer. TableTop Jr., by Broderbund software, was used to teach sorting to the first grade classes. Fourth grade students made charts for their weather units on Microsoft Excel.

The targeted sites A and B used Mathkeys by MECC software. It is an innovative software series designed to provide a rich learning environment in which our students explored math concepts such as whole numbers, symmetry and geometry using manipulatives. Mathkeys provided open-ended tools that enabled students to construct meaning from their experiences. Some of the major goals of using this software were to:

1. Support mathematics instruction for all children
2. Follow the guidelines developed by the NCTM
3. Provide powerful tools that support instruction throughout the mathematics curriculum
4. Assist children in linking physical objects to abstract mathematical concepts
5. Provide a risk-free environment for the exploration of mathematical ideas
6. Support children in the construction of mathematical models

The Learning Company software, Ultimate Writing and Creativity Center, was used for students in sites A and B to make science collages. It was a powerful tool that helped students use creative and independent thinking skills. Students were allowed to visually create collages to express what they had been studying in a science lesson.

Site A used the software, Math Rabbit, by The Learning Company, to practice basic math skills. Math Rabbit appealed to the many different learning styles of our students. A math program such as Math Rabbit combined animation, graphics, sound, color, and interaction with the computer. It was a rich resource as we tried to address our students' varied intelligences. Math Rabbit encouraged children to explore math concepts and see numbers in new ways. The programs were designed to help students predict, explore, seek alternative solutions, and justify those solutions. The students explored math concepts and connected them to real-life problems. Our students developed critical thinking skills as they progressed from memorizing by rote to creating connections to patterns.

For making graphs in their integrated science and math lessons, sites A and B used the Graph Club, by Tom Snyder Productions. This software provided a motivating, manipulative environment within the classroom, which structured our entire graphing units. It was designed to help students in both sites develop the ability to read and interpret graphs and use their graphs to communicate information, answer questions, and solve problems. The Graph Club assisted children in making the transition from graphing with manipulatives to graphing in the abstract and helped them understand the relationship between different graphs of the same data – e.g., picture graph, bar graph, line graph, circle graph, and table. This program was designed to support the NCTM standards and encouraged cooperative learning, problem solving and cross-curricular integration. Our students were able to determine that data came from many sources and that it can be used for a variety of purposes. The students collected information from class surveys, reading, interviews, and other research. They were able to use data to organize and communicate information, answer questions, make decisions, and solve problems. The Graph Club was primarily used in targeted sites A and B because it was a flexible resource. It was also a powerful, open-ended technology tool, which was used to support and enhance graphing activities in the integration of science and math.

Site A used the software, TableTop Jr. by Broderbund, to help teach sorting. This software also helped the targeted class explore and apply fundamental principles of logic, information, graphing, and data analysis. For our technology purpose, we used TableTop Jr. to set up an environment for the students to do many different mathematical games, puzzles, and challenges. This software helped first grade students make and arrange various objects according to different characteristics. Some of these characteristics included sorting by facial features, color, hair, shapes, and different feet.

To chart their information about weather, students in site B used Microsoft Excel. After recording rainfall and temperatures for a one-week period, students were able to make charts on Excel using this information. Excel is a highly sophisticated word processing program. The students learned word processing, formatting, and layout skills to make their charts. Excel's standard chart types provided students a way to interpret and organize their data. Excel helped students manipulate numerical data in rows and columns of cells.

Students, for research purposes, used various Internet sites. In site B, weather.com was used by students to look at weather maps, record temperatures and various weather information. Students looked at a map of the

United States and recorded temperature ranges. They learned about isotherms and which colors on the map represented the coldest and hottest isotherms throughout the United States. They graphed their information, which showed an estimation of the low temperatures from west to east across the middle of the United States map. The students in site B used this Internet site to also learn how they could check the weather in their area on a weekly basis. The temperature information they received was recorded on a daily chart.

The Internet site, usatoday.com/weather/, was used by students in site B, in conclusion to their weather unit. They learned about weather forecasts and how forecasts were predicted. They also had to find the definition of a jet stream. This lesson was used in conjunction with the U.S. Olympics and had the students record the temperature in Sydney, Australia. Students then compared and contrasted the temperature in Australia to the temperature in their area.

For a light and color unit, sites A and B used explorescience.com. In this site, students predicted what the outcomes would be when mixing 3 color combinations together. After predicting, the students were able to mix those colors on the computer. They experimented with additive (red, blue and yellow) colors and subtractive (yellow, cyan, magenta) colors.

Another site used only for site B was kapili.com. In this site, students were able to gather information about prisms, reflection, refraction, lenses, visible light, lasers, and wavelengths. This was a supplemental activity that reinforced what was taught from the fourth grade science textbook.

To complete the light and color unit in site B, students learned about the human eye and optical illusions. The site that was used for studying the human eye was tqjunior.thinkquest.org/3750/sight.html. In this site, students gathered information about the eye. Then the students had to explain how the different parts of the eye worked and why those parts are important for vision. The site that was used for optical illusions was sciencecentre.sk.ca/science/optical.htm. Here the students were shown various optical illusions. They had to explain what they saw and why they thought their mind deceived them.

In a unit on space, fourth graders used library.thinkquest.org/15215/ to learn about the sun. In this site, students gathered specific information about the sun, compared the sun to other stars, and figured out how many times Earth could fit across the diameter of the sun.

Technology used in Site C was integrated through software, websites, calculator exercises, and calculator based lab activities. The software used was Inventor Labs, Divide and Conquer, The Incredible Laboratory, and Introductory Algebra.

The Inventor Labs, by Sunburst Communications, was an interactive program, which allowed students to become familiar with three inventors and their inventions through exploratory activities. The inventors were Thomas Edison, Alexander Graham Bell, and James Watt. This program was implemented to make significant connections between math and science. Furthermore, it taught important scientific and historical concepts while engaging the students at a visual level by allowing them to investigate principles behind the inventions.

Divide and Conquer, by Sunburst Communications, was a code-breaking game that involved ten symbols which represented the numbers 0 through 9. The students formed hypotheses, thought about relationships among numbers, looked for patterns, reasoned logically, and exchanged positions on an issue while discovering which symbol represented which number. Students progressed through the levels of difficulty during the course of two classes in the Patterns and Classifications unit.

Introductory Algebra, by Boxer, was used as a self-paced, individual practice tool for algebra problems of the types ax = c and ax + b = c. The program combined innovative graphs with interactive illustrations of mathematical concepts through the use of the computer. This program was used as an individual practice activity during the later part of the semester.

The Incredible Laboratory, by Sunburst Communications, focused on cognitive control strategies involved in problem-solving skills. This program paralleled Divide and Conquer in the sense that students were trying to solve a particular code. Students took notes, made organized lists, gathered information, looked for patterns or sequences, analyzed the problem, scanned for hints and clues, and made decisions in order to break the code. This program was also used in the Patterns and Classifications unit.

One of the websites that were used at site C was fourmilab.ch/earthview/satellite.html. This website gave the students the opportunity to look at any region of Earth, at actual time, from different satellites and as seen from different distances above Earth. The students were instructed to find certain items such as polar ice caps, sunrise, sunset, shallow coastal regions, and the seven continents. This was part of the Forces, Angles, and the Universe unit.

Another website that was utilized was explorescience.com/activities/Activity_page.cfm?ActivityID=29. This site was an interactive activity that allowed students to use a scale to measure the mass and to use a graduated cylinder to find the volume of certain objects. The students then ranked them from lowest to highest according to their density. They then needed to determine whether or not if each object would float in various fluids. This was a segment of the Formulas unit.

The last on the list of websites was disonsmith.com/stars/htm. This website allowed the students to choose and print out constellations that they were to draw to a larger scale. The students strengthened their knowledge of measurement, angles, and drawing to scale. This was implemented in the Forces, Angles, and the Universe unit.

Calculator exercises revolved around TI-30X IIS and TI-92 calculators. Aside from activities that developed a familiarity with each calculator, exercises included those that explored indirect and inverse variation, indirect measurement, probability, functions and their graphs, including linear and quadratics, solving equations, and rewriting literal expressions. Types of lessons included lecture, worksheets, and exploratory.

The class also included a number of calculator based laboratories. While in this class, students worked in pairs in the science lab. These labs incorporated light, sound, and temperature sensors. Students studied acceleration, density, different methods of insulation, and sound waves.

Presentation and Analysis of Results

In the targeted sites A and B, the overall success of the interventions was such that most of the students demonstrated increased enthusiasm towards the math and science units that were taught.

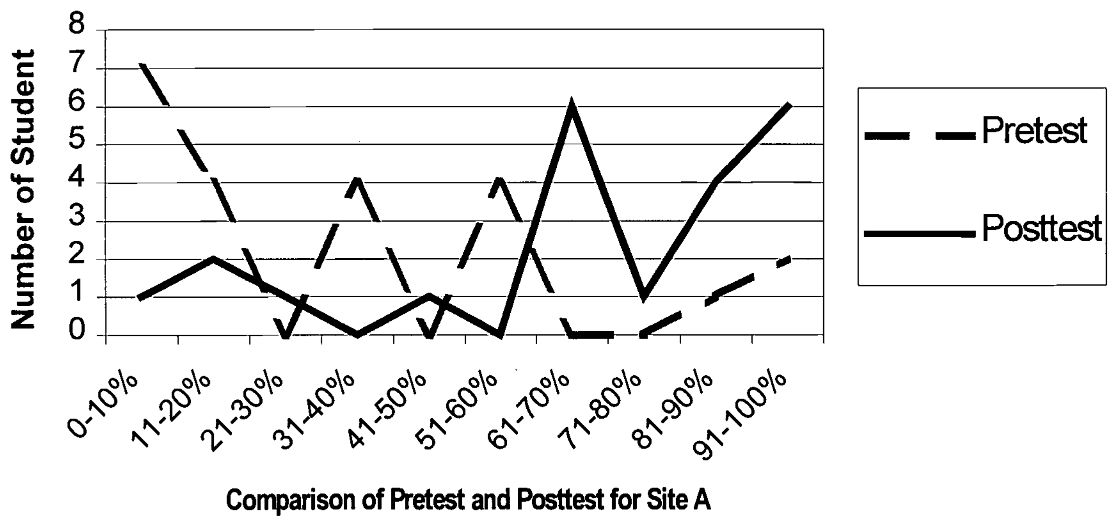



Figure 14. Comparison of Pretest and Posttest for site A.

The Slosson posttest was administered to students in site A in the first week of December. This graph, Figure 14, shows the pretest results in comparison to the posttest results. There was a substantiated difference between the two tests. In the pretest over half of the students scored below 50% of the national percentile. In the posttest it was the opposite. Over half of the students in site A scored above 50% of the national percentile. Only 3 students out of 17 who took the test scored below 50%. Fourteen students out of 17 scored above 50%.

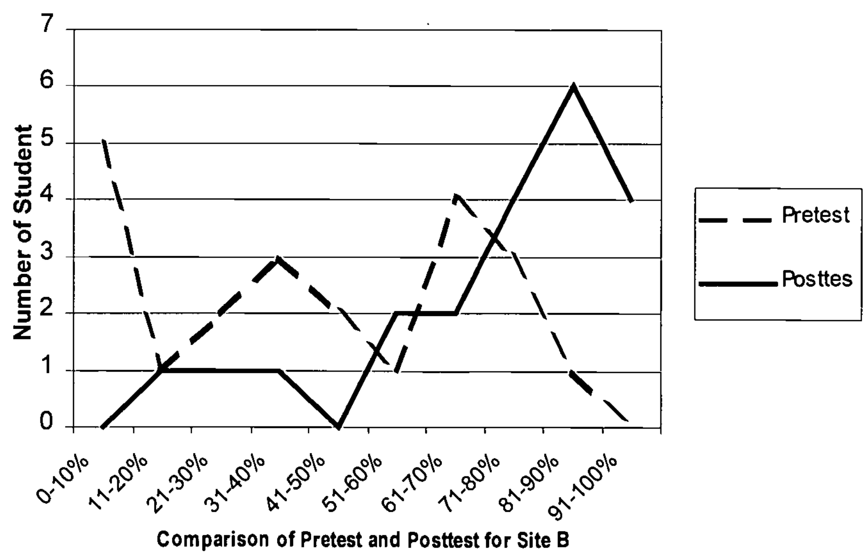



Figure 15. Comparison of Pretest and Posttest for site B.

The Slosson posttest was also administered to students in site B the first week of December. In comparison with the pretest, Figure 15, students in site B scored much higher on the posttest. On the pretest, over half of the students in the fourth grade class scored below 50% of the national percentile. However, on the posttest, over half of the students scored over 50%. Only 3 students out of 21 total in site B score below 50%. Eighteen students out of 21 had scores that were above 50%. These scores were based upon a national average.

Most students also had improved math test scores. As a result of working extensively with the computer, almost all the students demonstrated increased proficiency with word processing skills. Another area of improvement for students was the ability to use rubrics and portfolios for authentic and self-assessment purposes.

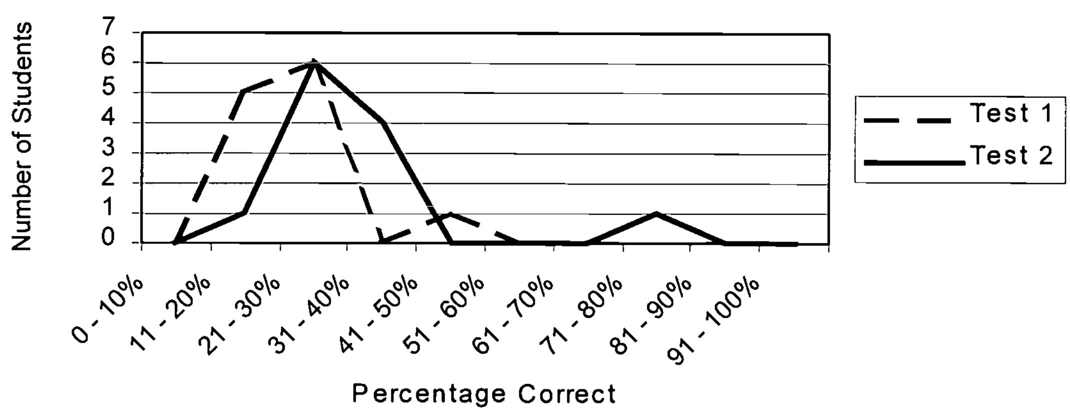



Figure 16. Site C: Comparison of Science Scores.

The science test that was utilized was a teacher-constructed test containing basic physical science concepts. On the science test, 100% of the students improved their scores from the first test to the second test. The graph of the comparisons, Figure 16, shows that the graph shifts to the right. The average score rose from 11.42 to 15.58, out of a possible 50 points, improving 4.17 points. The highest score improved from a 25 to a 36 as the lowest score improved from 6 to 7 points. The median score bettered from a score of 11 to a 14 on the second test while the median amount of improvement was 4 points.

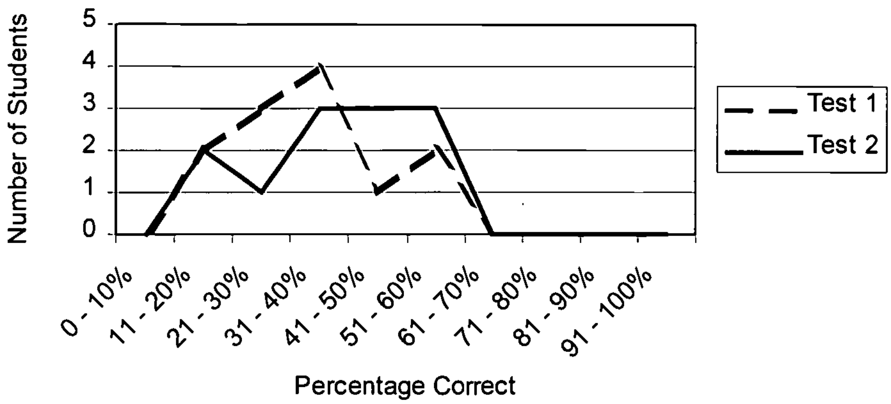



Figure 17. Site C: Math Scores for Class 1.

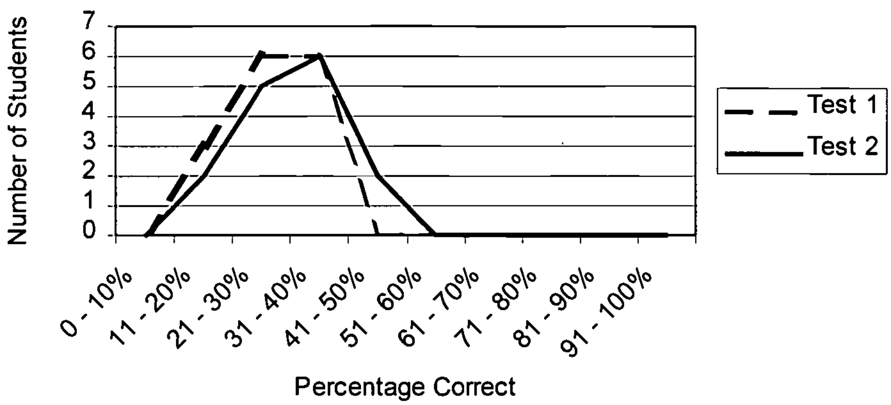



Figure 18. Site C: Math Scores for Class 2.

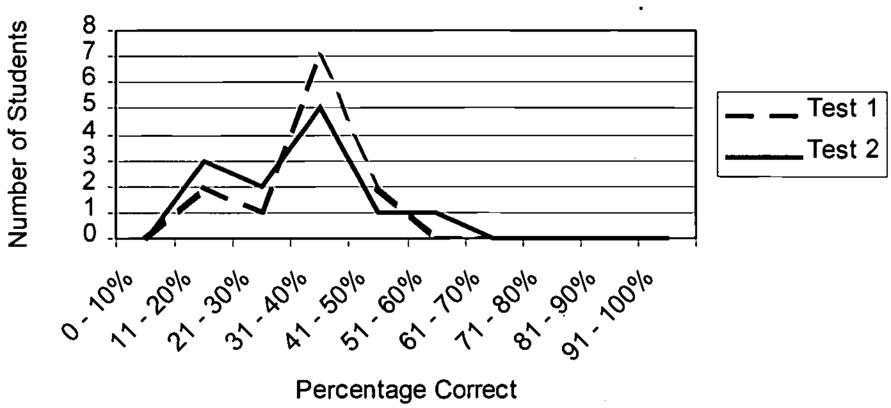



Figure 19. Site C: Math Scores for Class 3.

The math scores for the integrated math and science class were compared against two other pre-algebra classes that were also located at site C. Class 1 is the integrated math and science class. Classes 2, and 3, were pre-algebra groups that were taught by the same teacher, but not that of the integrated math and science class. The test that was implemented was the Comprehensive Test, Chapters 1 through 13, from the University of Chicago School Mathematics Project Transition Mathematics textbook published by Scott, Foresmann and Company.

The graph depicting the results of the pretest and posttest for class 1, Figure 17, shows that the range of score intervals did not change but the overall graph does appear to have a significant shift to the right. The graph for class 2, Figure 18, shows that the range of scores stayed constant at the low end but increased one interval at the top end. Furthermore, it appears that the overall graph has a slight shift to the right. Figure 19 represents the scores for class 3. The lower end of the graph stays constant but the top end increases one interval. However, there appears to be a shift to the left of the entire graph.

## Conclusions and Recommendations

The action research team's objective was to improve student motivation, computational skills, test grades, and daily work in mathematics by integrating math and science with technology.

Researchers of the action research project in targeted sites A and B found results of the integrating math and science with technology to be successful. Over half of the students' math test scores in both sites A and B were above the

50th percentile. This showed that in a time of period of less than 4 months, students showed tremendous growth in their knowledge of math. These test results were based on comparisons of August and December Slosson test scores. Teachers in both sites A and B also noticed students' daily math scores increased. Researchers observed that students had an increased interest level in science. Many times when science thematic units were being taught, students were not aware that they were doing science. Several times students in site B wanted to work through their lunch and not wait 2 days to finish their unit. After doing the KWL charts, students were excited about the new things they learned. Researchers also noticed from students' journals how much they enjoyed working on their math and science units.

One area that researchers in sites A and B observed that changed the most was student motivation. Students really enjoyed working with a computer, which enabled them to progress at their own pace and receive immediate feedback. As a result, the students remained engaged and motivated to learn. Another aspect of increased motivation was the students' pride in their own technological competence. When the students performed a learning activity on a computer, the researchers observed that they were willing to devote more time and energy to it. The researchers' conclusion was that most students' attention span or concentration was greater when they used technology than when they were in a traditional setting using traditional resources.

In addition, giving students opportunities to explore interconnections among the subject areas of math and science had many advantages.

Interdisciplinary instruction added meaning and relevancy to learning as students discovered fascinating and interesting relationships between subjects. New perspectives were developed which helped students construct a more integrated web of knowledge. This integrated approach to math and science demonstrated to students the interconnectedness of subjects, which increased their understanding of the thematic unit being taught.

Another advantage of teaching with computers was the authentic learning assessment that took place. Using computer software allowed students to draw, analyze, interrelate, record, and represent data, which was used as assessments of students' work in extended, authentic learning activities. This technology allowed students' work to be reviewed as often as necessary, and allowed students, as well as the teacher, to keep a copy. The students kept their work samples in their portfolios for self-assessment purposes when writing in their journals. As a result, students were aware of their own progress.

Another interesting aspect the researchers discovered was when the computer was used to teach, the researchers tended to work with small groups of students or individual students rather than with the class as a whole at any given time. This allowed the researchers to develop a much more accurate and realistic impression of what students did and did not understand. Researchers in sites A and B came to the conclusion that when they taught in the computer lab, they concentrated more on students who needed help, who were usually the weakest, while in the traditional classroom, the researchers tended to give priority to the average to strongest students.

Students in Site B became very independent learners. They would come into the computer room, get their assignments, and begin working on their units of study immediately. This was not true with the students of site A. At the beginning of the action research, the students of site A were just emergent readers, so researchers had to do most of the reading and work with them. It was hard for them to work independently. The researchers viewed this as a minor problem.

One disturbing aspect that the researcher in site A found when using technology was the poor selection of computer software for younger students. In order for students to successfully benefit from using technology, a wide variety of computer software must be available for their use. The researcher in Site A did not have this advantage, as compared with the researchers in Sites B and C, who have older students.

The data from site C implies that there was some level of success concerning science. The motivation and confidence of the students in the integrated math and science class appeared to increase as the course progressed. The scores on the posttest improved from those of the pretest. The quality of the student's daily work also improved as the semester advanced.

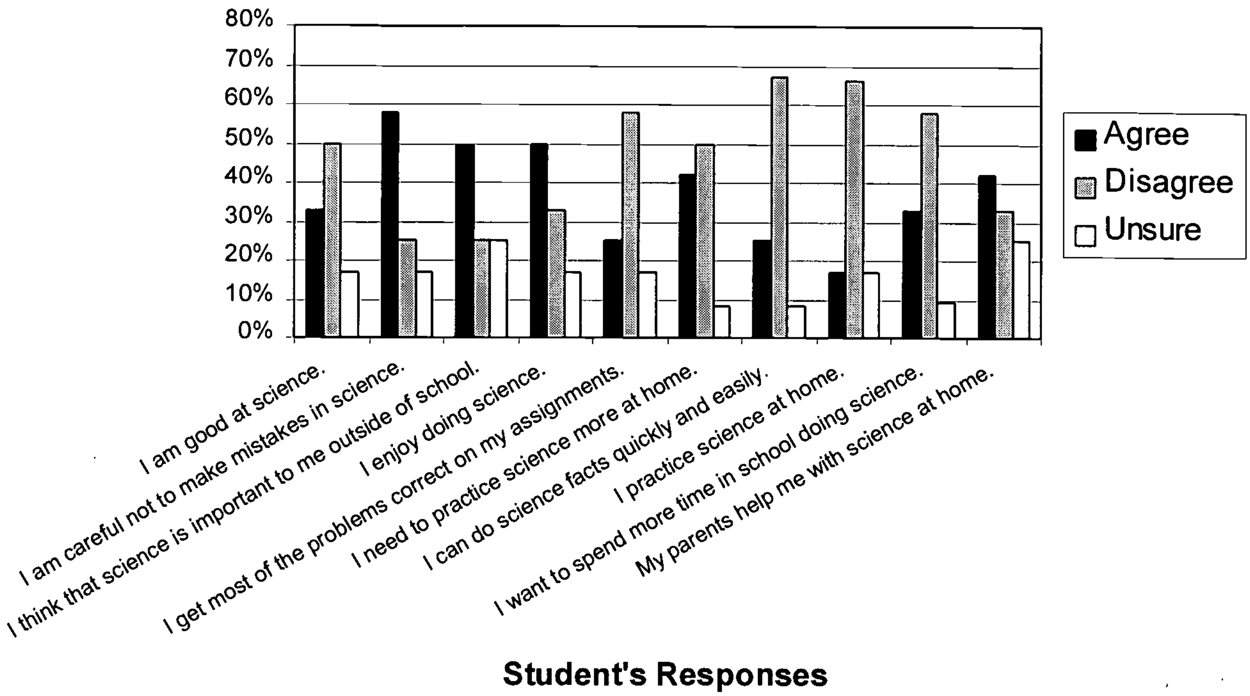



Figure 20. Site C: Student Science Survey Results, December.

The second application of the student survey implies that even though the student body felt the same about their performance in science, they were more careful about what they were doing. Seventeen percent more indicated that they enjoyed science than when did the survey was given in August.

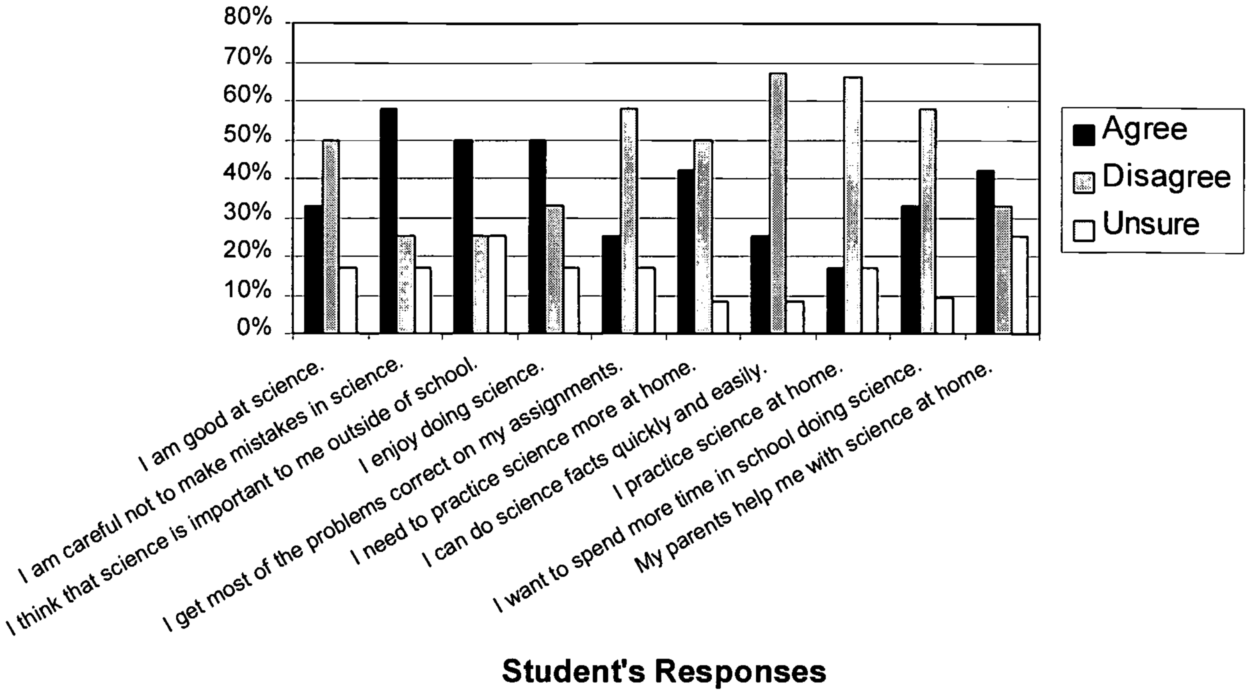



Figure 20. Site C: Student Science Survey Results, December.

The second application of the student survey implies that even though the student body felt the same about their performance in science, they were more careful about what they were doing. Seventeen percent more indicated that they enjoyed science than when did the survey was given in August.

| SCIENCE | Site C |
|---|---|
| Total Possible | 50 |
| Average of Test 1 | 11.42 |
| Average of Test 2 | 15.58 |
| Average Increase | 4.17 |
| Highest Score of Test 1 | 25 |
| Highest Score of Test 2 | 36 |
| Lowest Score of Test 1 | 6 |
| Lowest Score of Test 2 | 7 |
| Median Score of Test 1 | 11.00 |
| Median Score of Test 2 | 14.00 |
| Median Score Change | 4.00 |
| Number of Students | 12 |
| Number Inclined | 12 |
| Percentage Inclined | 100.00% |
| Average Increase | 4.17 |

Figure 21. Site C: Statistical Breakdown of the Pretest and Posttest for Science

Skills in science also seemed to improve according to the results of the posttest, Figure 21. The science scores show an improvement from an average score of 11.42 to 15.58, an increase of 4.17 points. However, there is still room for improvement as the test included 50 questions. It should be mentioned that this test was created for diagnosing scores from August to May. However, this test was given at midterm rather than at the end of the year. Nevertheless, every student improved his or her score from the first application to the second.

The highest score for the second test is 11 points higher than that of the first test; however, the difference of the lowest scores is only 1 point. The median score of the first test was 11, while it was 14 on the second test. This indicates that the lower end of the scores improved. The median for the amount of score change was 4, which converts to 8% of the total possible points.

The daily work for the students improved throughout the semester but was still unsatisfactory. The students were very good at getting work in class completed with acceptable quality. However, any homework that needed to be done over a period of time had a very poor chance of being turned in or completed. As an end result, however, the students showed improvement with the skills necessary to successfully work in groups.

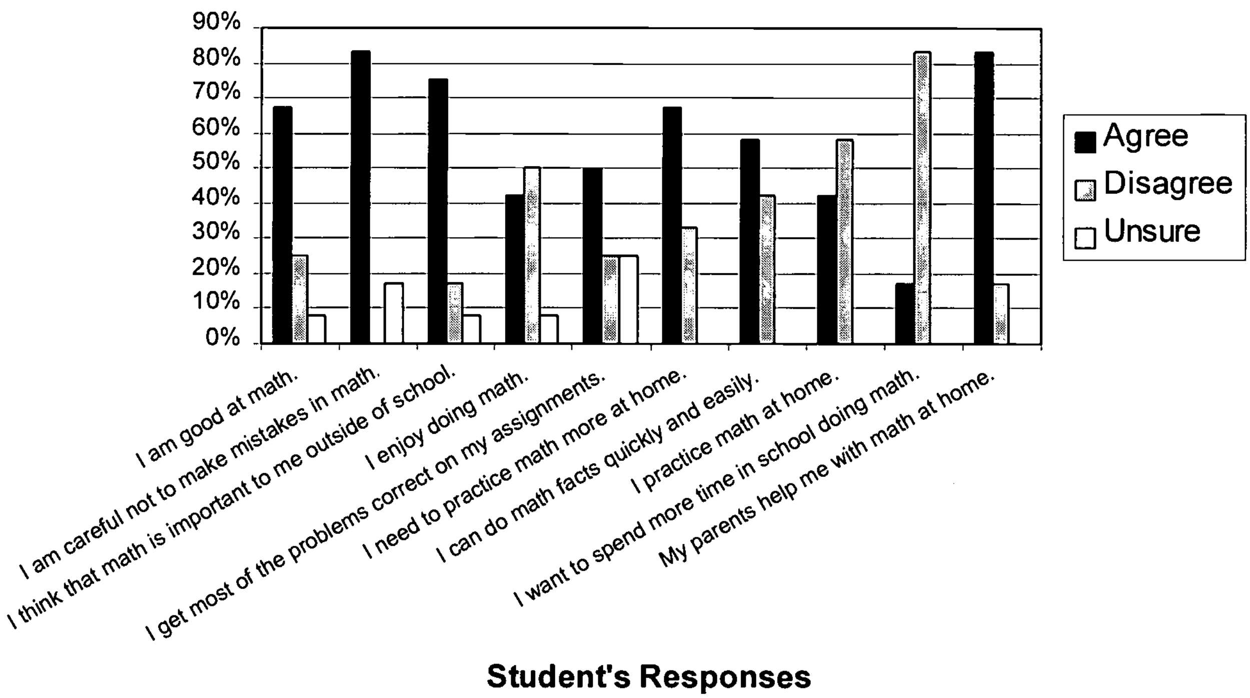



Figure 22. Site C: Student Mathematics Survey Results, December.

The results for the math surveys for site C, Figure 22, showed a significant improvement in the students' attitudes toward mathematics. According to the graph, 33% more students said they were good at mathematics and 40% more said they were careful not to make mistakes in math. Nearly 10% more of the students said they enjoyed mathematics more than on the first survey. Another significant increase was that 23% more said their parents helped them at home with mathematics.

| **MATHEMATICS** | Site C Class 1 | Site C Class 2 | Site C Class 3 |
|---|---|---|---|
| Total Possible | 25 | 25 | 25 |
| Average of Test 1 | 8.75 | 6.87 | 8.46 |
| Average of Test 2 | 9.83 | 8.00 | 8.31 |
| Average Increase | 1.08 | 1.13 | -0.15 |
| Highest Score of Test 1 | 15 | 10 | 11 |
| Highest Score of Test 2 | 15 | 12 | 13 |
| Lowest Score of Test 1 | 4 | 4 | 5 |
| Lowest Score of Test 2 | 5 | 5 | 4 |
| Median Score of Test 1 | 8.50 | 9.00 | 7.00 |
| Median Score of Test 2 | 10.50 | 8.50 | 7.00 |
| Median Score Change | 1.50 | 1.00 | -0.15 |
| Number of Students | 12 | 15 | 13 |
| Number Inclined | 8 | 10 | 6 |
| Percentage Inclined | 67.00% | 67.00% | 46.00% |
| Average Increase | 3.38 | 2.50 | 2.33 |
| Number Declined | 3 | 4 | 6 |
| Percentage Declined | 25.00% | 27.00% | 46.00% |
| Average Decrease | 4.67 | 2.00 | 2.67 |
| Number Unchanged | 1 | 1 | 1 |
| Percentage Unchanged | 8.00% | 6.00% | 8.00% |

Figure 23. Site C: Statistical Breakdown of the Pretest and Posttest for Math

The chart above, Figure 23, represents a statistical breakdown of the testing results for site C. The computational skills of the students in class 1 appeared to have improved. They showed an improvement for the average score, lowest score, and median score. Eight of the 12 students made an improvement from test 1 to test 2, while 3 students showed a decline, and 1 student's score remained the same.

A comparison of the average scores for the first and second tests of classes 1, 2, and 3, indicated that class 1 appeared to be more successful.

However, further examination showed that even though class 1 had the highest beginning and ending scores, class 2 had the largest improvement. It can not be ignored that the scores were extremely low since there were 25 points possible on the multiple-choice exam. This could be attributed to the fact that the second test was given before the first semester ended, and the test is intended for assessing performance over the course of the entire year. Also, some students experienced a decline in performance. This could be due to apathy, poor test taking skills, or the fact that the first test was given in August and the second test was administered a few days before the anticipated winter break.

The median scores for the tests showed some interesting points. These scores for class 2 were higher than its average scores for both tests, while the complete reverse is true for class 3. This indicated that a few students skewed the average scores by testing to one extreme or the other. The median score for class 1 was higher than that of the other two classes, and it had the largest improvement in this category.

Through this analysis of data, class 1 was observed to have improved more significantly than classes 2 or 3, so one may have considered that it underwent a more appropriate teaching strategy. However, since the average scores are so low, below 40%, and the improvement of these scores rotated around an average of only one point, it can not be concluded that any one method is better.

The science and the math grades for the integrated math and science class were blended together as many of the assessments overlapped in content.

The grades were encouraging as only 42% of the students earned a letter grade of D or F for the first semester, compared to 80% and 50% in previous years. However, 58% of the students earned a C, meaning that none of the students earned a letter grade of A or B. The test scores and the homework assignments were a negative factor in many of the students' grades.

The problems encountered in mathematics were parallel to those in science. Students performed well in class but had trouble remembering assignments that needed to be done outside of class. Also, it was noticed that the students did not have a lot of confidence in their ability with basic math operations involving whole numbers, fractions, and decimals. The students were very dependent on their calculators, which made activities involving high-order thinking skills difficult. Nevertheless, improvement was observed from August to December in computation and problem-solving skills.

Possible reasoning for the overall progress in math and science might be related to the real life situations that were brought into the classroom in order to reinforce mathematics and science. Students learned about insulation, forces, and acceleration through situations that related to them. In addition to the relevance of the content, technology allowed the students to learn by way of circumstances that were unique to them. For the first time in their educational careers, students were using Computer Based Laboratories (CBL II's), the accompanying sensors, and graphing calculators in order to test the quality of assorted insulation materials, graph direct and inverse variation, and to explore the properties of gravity.

Another theory regarding the overall improvements in math and science could be linked to the fact that each science concept was reinforced by the mathematics behind it. One procedure utilized was that the students were given a science concept and were to explore the mathematics behind it. The students then investigated the concept in a lab setting. Another procedure utilized involved mathematics being presented first, then a science activity or hands on project was introduced to incorporate the math. By using these methods, the students were given numerous processes to learn the material. The material was made relevant to them and had meaning outside of the classroom.

Recommendations for such actions are broken down into two categories. The first being team teaching and the second being integrating math and science using technology.

Considering team teaching, it is recommended that the teachers involved have a common time frame during school in order to prepare the lessons. This was initially the plan but a late discovery of a scheduling problem caused this to change. It was difficult to coordinate lesson plans, write integrated tests and quizzes, and discuss time frames needed to teach topics. Also, it is suggested that both teachers be in the classroom every time that the class meets. The fact that the math teacher was in the class every day and the science teacher could only be in every other day gave an unwanted impression that it was a math class that incorporated science. The students started using the words "math day" and "science day". This demonstrated that the split schedule interfered with the integration concept.

It is recommended to implement the integration of mathematics and science through the use of technology wherever possible. The teaching of mathematics and science was very natural and technology was an avenue for this union to occur. Many new teaching strategies were learned and applications for concepts were observed.

Problems that occurred involved space, time, and familiarity with manipulatives. Changes in scheduling, topics, and activities were occasionally made due to the demand of the lone computer lab that was available for noncomputer based courses. Also, some of the units were so involved that assessments were separated from the content by a large amount of time. This meant that review sessions were needed in order to refresh the students' memory of the content to be learned. Furthermore, since this was a new experience for both teachers involved, a lot of self-teaching on how to use certain software, programs, and hardware was necessary. Difficulties also resulted because some of the material arrived in late August and some of the units were designed as they progressed, since the only time that the teachers had to plan was during assessments.

The school district has chosen not to continue the integrated math and science course as it was introduced this year. The school's population continues to grow and the teachers are in too much demand to offer a double-blocked course or a team-taught course. However, the innovative curriculum created through this course will be utilized by the pre-algebra courses in years to come.

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Appendix A -1

Parent Survey Cover Letter Site A

August 29, 2000

Dear Parents,

We are starting another school year at Je-Neir Elementary School. We are excited because we are going to try something new and interesting for your child. This will include integrating math and science with technology. You can help us by filling out the attached Math and Science Attitude Survey. Your cooperation is greatly appreciated.

Sincerely,

Mrs. Vogel - First Grade Teacher
Mrs. Garcia - Computer Teacher

Appendix A -2

Parent Survey Cover Letter Site B

August 29, 2000

Dear Parents,

We are starting another school year at Je-Neir Elementary School. We are excited because we are going to try something new and interesting for your child. This will include integrating math and science with technology. You can help us by filling out the attached Math and Science Attitude Survey. Your cooperation is greatly appreciated.

Sincerely,

Mrs. Mullinax - Fourth Grade Teacher
Mrs. Garcia - Computer Teacher

# Appendix A -3

## Parent Survey Cover Letter Site C

August 29, 2000

Dear Parents,

We are starting another school year at Momence High School. I am excited because I am going to try something new and interesting for your child. This will include integrating math and science with technology. You can help me by filling out the attached Math and Science Attitude Survey. Your cooperation is greatly appreciated.

Sincerely,

Mr. Blume

# Appendix A -4

## Parent Survey - Sites A, B, & C

Circle the best choice. 3 = agree 2 = disagree 1 = not sure

1. I think it is important for my child to master basic math skills.

   3 2 1

2. I think it is important for my child to master basic science skills.

   3 2 1

3. I am comfortable helping my child with basic math skills.

   3 2 1

4. I am comfortable helping my child with basic science skills.

   3 2 1

5. My child practices basic math skills regularly at home.

   3 2 1

6. My child practices basic science skills regularly at home.

   3 2 1

7. My child applies basic math skills to real-life situations.

   3 2 1

8. My child applies basic science skills to real-life situations.

   3 2 1

# Appendix B-1

## Student Math & Science Attitude Surveys Sites A and B

Circle the best choice…3=Agree 2=Disagree 1=Unsure

| | | | |
|---|---|---|---|
| 1. I like to do math. | 3 | 2 | 1 |
| 2. I like to do science. | 3 | 2 | 1 |
| 3. My parents help me do math at home. | 3 | 2 | 1 |
| 4. My parents help me do science at home. | 3 | 2 | 1 |
| 5. I am good at math. | 3 | 2 | 1 |
| 6. I am good at science. | 3 | 2 | 1 |
| 7. I want to do more math at school. | 3 | 2 | 1 |
| 8. I want to do more science at school. | 3 | 2 | 1 |
| 9. I think math is important to learn. | 3 | 2 | 1 |
| 10. I think science is important to learn. | 3 | 2 | 1 |

Appendix B - 2

## Student Math Attitude Survey Site C

Circle the best choice…3=Agree 2=Disagree 1=Unsure

| | | | |
|---|---|---|---|
| 1. I am good at math. | 3 | 2 | 1 |
| 2. I am careful not to make mistakes in math. | 3 | 2 | 1 |
| 3. I think that math is important to me outside of school. | 3 | 2 | 1 |
| 4. I enjoy doing math. | 3 | 2 | 1 |
| 5. I get most of the problems correct on my assignments. | 3 | 2 | 1 |
| 6. I need to practice math more at home. | 3 | 2 | 1 |
| 7. I can do math facts quickly and easily. | 3 | 2 | 1 |
| 8. I practice math at home. | 3 | 2 | 1 |
| 9. I want to spend more time in school doing math. | 3 | 2 | 1 |
| 10. My parents help me with math at home. | 3 | 2 | 1 |

Appendix B - 3

Student Science Attitude Survey Site C

Circle the best choice…3=Agree 2=Disagree 1=Unsure

| | | | |
|---|---|---|---|
| 1. I am good at science. | 3 | 2 | 1 |
| 2. I am careful not to make mistakes in science. | 3 | 2 | 1 |
| 3. I think that science is important to me outside of school. | 3 | 2 | 1 |
| 4. I enjoy doing science. | 3 | 2 | 1 |
| 5. I get most of the problems correct on my assignments. | 3 | 2 | 1 |
| 6. I need to practice science more at home. | 3 | 2 | 1 |
| 7. I can do science problems quickly and easily. | 3 | 2 | 1 |
| 8. I practice science at home. | 3 | 2 | 1 |
| 9. I want to spend more time in school doing science. | 3 | 2 | 1 |
| 10. My parents help me with science at home. | 3 | 2 | 1 |

# Appendix C

## Lesson Plans *for Thematic Unit on Nutrition using Math and Technology*

## Site A

Integrated curriculum using, science, math and technology.

Goal 1: Students will learn about nutrition, food groups, what foods are most nutritious to eat etc.

Technology used: Ultimate Writing and Creativity Center

Lesson 1: Before students work on their collages, they will learn how to use Ultimate Writing and Creativity Center. *Teacher will show by example using the Gateway computer. (put on computer, apple – cake – candy – bread)* students will do the same. Students will circle which foods are the healthiest to eat.

After students have brainstormed and discussed healthy foods, they will make their collages of only nutritious foods.

Appendix D

Site A

Lesson 2: Nutrition unit continued. Integration of science and math with technology unit.

Fractions and Apples

Students will learn about fractions using an apple as an example.

Software used: Ultimate Writing and Creativity Center

Show example of half using a real apple. Cut the apple in half, show equal parts. Explain that Mrs. Garcia and Mrs. Vogel each want an equal piece. Ask…"Where can I cut this apple to give each of us the same piece?" Ask students to show you on the computer. Also, work on 1/3 and 1/4. Have students show on the computer where they could divide an apple to make 3 and 4 equal parts.

Students will make predictions:

*Predict how many seeds are in the apple. After students make predictions, we will cut the apple to see how many seeds are in the apple.*

# Appendix E

## Site A

## Integrated Science and Math with Technology unit, continued.

Lesson 3: This will be an introduction to graphing for first graders. They will have an apple taste test. Once they have tasted each kind of apple, they will put their favorite apple on the chart under its name.

Science & Math Unit…Apples

Taste test…What kind of apples taste the best…choices are, Macintosh, Granny Smith, Golden Delicious, or Jonothan?

Students will taste the apples and after they are done tasting they will vote for their choice of the best tasting apple and then make a graph.

Appendix F

Site A

<u>Lesson 4:</u> Graphing Unit – Using the Graph Club software is an excellent way to introduce students to graphing. This is a very easy program for students to use. This unit will culminate the unit on science (nutrition) and math.

*What is class 105's favorite fruit to eat?*

Technology used: Graph Club

Students will learn the necessary components to graphing. Students will vote for their favorite fruit. We will do a table first, and then students will learn how to put information into a graph. We will learn the difference between bar graph, pie graph, and picture graph.

# Appendix G

## Lesson plan for Site B

*This was part of an integrated science and math lesson on using light. This was a science lesson on light that taught students to use the Internet as a source of information.*

Name____________________

Type in address: ***Kapili.com***

Click on "Research Labs".

Click on "physics".
Click on "light".

- Who started to break light up with a prism? ________________
- What is the definition of *refraction*?______________________

________________________________________________________

On the left side of your screen, click "reflection".
- What is the definition of *reflection*?______________________________

Click on "lenses".
- What is the definition of *lenses*?______________________________

- What are the 3 basic shapes that lenses can have?

_______________ _______________ _______________

- Prisms are a special type of________________________.

- For visible light, the colors that you can see are(in order):

______________________________________________________

Click on "lasers".

- What is the definition of *lasers*?______________________________________________

Laser is not a word. It is an acronym. It stands for:

L____________________
A____________________
S____________________
E____________________
R____________________

- Where could you find lasers being used?__________________________________________________

______________________________________________________

Click on "structure".

- What is a wavelength?

______________________________________________________

____________________________________________

- All of the wavelengths of light together are called the_______________________________________.

# Appendix H
## Site B

Time for some fun with optical illusions!

Type http://www.sciencecentre.sk.ca/science/optical.htm into the address bar.

Go through the optical illusions shown and explain what you see for each one.

1. The flag:

2. The tallest soldier:

3. Perfect circle?

You may now travel down the Online Hall of Optical Illusions!
Use the bottom and the back of this paper to explain the illusion and what you see.

Appendix I

Lesson Plan for Sites A & B

## Spiders & Symmetry Unit with Internet and MECC Software

*Lesson 1: Before this lesson begins students will do a KWL chart. In this lesson students will get an introduction to the spider unit by learning all about certain spiders. After they are finished with this worksheet they will explore other spiders and share some interesting things they learned with the class. This first lesson is to teach students to research spiders using the Internet as a source of information.*

Website: **enature.com**

American House Spider (click)

1. What area(s) can we find the American House spider living in? (Range)

___

2. Give a brief description of their webs.

___

3. Where does this spider usually spin its web?

___

Daddy Long Legs (click on 2nd row 4th box) question 1.

1. How many legs do Daddy Long Legs have?___

(click on 3rd row 1st box for DDLL)

2. What areas do you usually find Daddy Long Legs living in? (Range)

___

3. What place can you usually find Daddy Long Legs living in? (Habitat)

Black Widow (click on Black Widow)

1. What area(s) can we find most black widow living in? (Habitat)

2. Why is the black widow the most feared spider?

3. How did the black widow get her name?

# Appendix J

## Integration of science (spider unit) with math (symmetry unit)

## Sites A & B

This lesson is designed to teach students the concept of symmetry. *Before the lesson begins...*students will play the mirror game with partners. Everything their partner does, they will mirror them. Teach concept of mirror images. Show and explain the line of symmetry. Put several shapes on computer, show line of symmetry for different shapes. Have students put several shapes on their computer and find the line of symmetry. After students have found the lines of symmetry in several shapes they work on their assignment. Students will make a symmetrical spider on the computer using the symmetry program. This spider must have at least 5 parts listed on it. The final project will be used for their assessment.

# Appendix K

## Spider Unit Test for sites A & B

Name______________________________________

1. Spiders have _________ legs.

    a. 3

    b. 5

    c. 8

2. Most spiders eat _____________

    a. cheese

    b. bugs

    c. vegetables

3. Draw a line to match the parts of a spider. (students will have a picture of a spider).

    Leg

    Eye

    Fang

    Spineret

4. Why do spiders spin webs?

   a. To catch insects

   b. To keep warm

   c. They are bored

5. What spider eats the male?

   a. House spider

   b. Black Widow spider

   c. Tarantula

6. Are spiders insect?

   a. yes

   b. no

7. Where do most spiders keep their eggs?

   a. Spinnerets

   b. Egg sacks

   c. Feelers

# Appendix L

Site B – September 28, 2000

Integrated science (weather) and math (subtraction, measuring, graphing)

with Technology unit, (Internet and Microsoft Excel).

In lesson 1, students will learn to use the Internet as a source of information to learn about weather.

1. Open Internet
2. Type in address bar – usatoday.com
3. Answer the following questions about weather forecasts.
    1. What is the limit (how many days?) of useful day-to-day forecast? (look in 1st paragraph) ___________________
    2. What do they use to see how weather is doing all over the world?

    ____________________________________________________________

Type in address bar – usatoday.com/weather/wjet

4. What is the jet stream? Explain briefly.

____________________________________________________________

____________________________________________________________

5. Look at the map. What area is favorable for storm development according to the jet stream?

Circle one: North South

Type in address bar – weather.com

6. Right underneath the map there is a Browse all cities/countries area. Click on arrow and find Australia and then click on GO. Scroll down and find Sydney. Double click on Sydney. What is the temperature in Sydney today?

8. Go back to weather.com's home page. At the top of the page look for, (Choose an Outlook), click on local outlook and (Enter city or zip), put in Momence's zip code 60954.

Find out what Momence's temperature is today, and then find the difference between its temperature and the temperature in Sydney.

# Appendix M

Site B Integrated math (measuring) and science (weather) Unit with Technology (the Internet)

Lesson 2: Students will record average rainfall and temperatures for a one week period. They will use the Internet (weather.com) as their source of information. They will find out what the average temperature of Momence was for a whole week. This information will be put on a chart using Excel. (see appendix N for sample). After temperatures and rainfall has been recorded, students will figure out the averages for the week, and put these on a chart using Excel.

1. Open Internet
2. Go to weather.com
3. On home page near the top, find (Choose an Outlook) click on local outlook, and find (Enter city or zip) type in Momence zip code, 60954.
4. Record temperatures and rainfall for the week.

Close internet.

Go to Microsoft Excel.

*Show on Gateway and have students follow along.* Click on 1 and you should see an arrow. Move column 1 down to 20. Move column 2 down to

30. On the top row, click on the A and do the same. Widen the columns for A-E to a width of 18. On the top row, type in Monday-Friday. Just below in the next row of boxes type in temperatures for the week.

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# Appendix N

## Weather Chart

Sept. 25 – Sept. 29

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| 55*F | 69*F | 60*F | 60*F | 76*F |