DOCUMENT RESUME

ED 465 533 SE 066 142

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TITLE	Improving Mastery of Basic Mathematics Facts in Elementary School through Various Learning Strategies.
PUB DATE	2002-05-00
NOTE	165p.; Master of Arts Action Research Project, Saint Xavier University and IRI/SkyLight Professional Development Field-Based Masters Program.
PUB TYPE	Dissertations/Theses (040) -- Tests/Questionnaires (160)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Elementary Education; Intervention; Mathematics Education; Numeracy; *Teacher Attitudes; *Testing
IDENTIFIERS	Basic Facts (Mathematics); Testing Time

ABSTRACT

This report describes the intervention programs used to improve student proficiency in learning, recalling, and retaining basic mathematics facts. The targeted population consisted of first, second, third, and fifth grades in four suburban midwestern schools. The problems of recalling basic mathematics facts is documented through teacher surveys, parent surveys, student surveys, and scores obtained on timed pretests. Research of probable causes indicated lack of time given to practicing mathematics facts in school, inconsistent at home practice, and little emphasis of mathematics facts within the textbook. This research also indicated an ambivalence among teachers pertaining to the importance of practicing math facts in school. Because the literature review of solutions named pro position, con position, and ambivalent position on teaching basic mathematics facts, the researchers focused on the solutions of the pro position, specifically using music or game interventions daily. Students, parents, and teachers were given surveys to record attitudes about learning mathematics facts. A timed pretest of mathematics facts was administered to experimental and control groups to establish baseline data. Weekly two minute timed tests were given to the experimental groups. A Timed posttest was given to the groups to determine improvement in speed and accuracy. Based on the presentation and analysis of data on mastering basic mathematics facts, the results indicated an increase in the test scores from the pretest to the posttest for the targeted first, second, third, and fifth grade levels. This was true regardless of using the games or music as the intervention. Experimental and control group pretest and posttest scores were also compared. (Contains 50 references.) (Author/MM)

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IMPROVING MASTERY OF BASIC MATHEMATICS FACTS IN ELEMENTARY SCHOOL THROUGH VARIOUS LEARNING STRATEGIES

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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

Saint Xavier University & IRI/Skylight Professional Development

Field-Based Masters Program

Chicago, Illinois

May, 2002

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TABLE OF CONTENTS

CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

The students of the targeted first, second, third, and fifth grade classes exhibit difficulty in retaining basic mathematics facts. Evidence includes miscalculations on tests of basic facts, results of teacher surveys, parent surveys, and student surveys.

Immediate Problem Context

This study will be conducted at four sites. All are located in suburban communities of a large midwestern city. Each school has a multi-ethnic population of students whose parents are predominately blue collar workers. Each of the four sites is an elementary school. The sites will be designated as Sites A, B, C, and D.

Site A

Site A is a public school that is located on approximately three acres of land. The one-story school was built in 1961 and contains 18 classrooms within the building and two mobile classrooms behind the school. There was a building addition in 1995, which added a computer lab and learning center to the school. Grades kindergarten through sixth are represented at this school. Thirteen regular education classes, five

English as a Second Language (ESL) classes, and two special education classes are at this site. The ESL classes represent over 21 primary languages other than English. Although many students from Hispanic backgrounds enrolled at Site A are eligible for bilingual instruction, their parents have refused the services. Those students would need to be bused to another school since Spanish bilingual is not offered at this site. Children from ESL classrooms are mainstreamed into the regular education classes, usually for either language arts or math when the teacher feels that children have attained proficiency in these areas. This usually occurs no sooner than third grade. In addition, 12 students in afternoon kindergarten are enrolled in the Project Accelerated Literacy (PAL) program. They are designated as students at risk who do not possess adequate literacy skills for kindergarten. They attend morning kindergarten at another school in the district and attend afternoon kindergarten at Site A.

Enrollment at Site A is 450 students. Students live in three communities and 56% of the students are bused. The ethnic mix of the student population is 53% White, 6% Black, 20% Hispanic, and 20% Asian-Pacific Islander. Low income families comprise 31% of the population and 30% of the school population is limited- English proficient (LEP). Attendance at Site A is 95%. The mobility rate is 25% and chronic truancy is 2%.

Classroom enrollment averages 19 students. Each classroom is equipped with a computer that is linked to the Internet. In addition, all classrooms have a television monitor and videocassette recorder mounted on the wall.

Reading and language arts instruction are taught 120 minutes each day. Mathematics is taught 60 minutes each day, and science, health and social studies are also taught on a rotating basis throughout the week. This year character education has been added to the curriculum, and is taught approximately 60 minutes each week at each grade level.

Students at Site A have music and physical education for 30 minutes each week, art for 45 minutes each week, and library time for 30 minutes each week. A computer lab is available to each class for 60 minutes each week. Band, orchestra, and chorus are offered at Site A. Band and orchestra lessons are 30 minutes each week for grades four, five, and six. Chorus is offered for interested fifth and sixth grade students for 30 minutes each week. Speech, social work and learning disabilities resource are available for students who qualify for these services. A nurse is on the school premises for two and one half days each week. The school also has one full-time custodian and a night cleaning crew.

Site A has a multicultural population and teachers are cognizant of this when working within the curriculum. The emphasis of the curriculum throughout the building has been placed on improving reading performance resulting in the adoption of a new assessment based reading program. Staff development in the area of reading has been a priority. Reading specialists have conducted workshops, classroom visits and demonstrations to help support the efforts of the staff. Mathematics is taught using the Heath Mathematics Connections series, which has been used in the building since August 1994. At this time, there are no plans to pilot another mathematics series.

There is a total of 49 employees at this school. The site has 13 regular education teachers, five ESL teachers, and two special education teachers. The staff ratio is 92% female and 8% male. The racial/ethnic background of the staff includes 80% White, 0% Black, 4% Hispanic and 16% Asian-Pacific Islander. Seventy-one percent of the staff is certified. Of those staff members, 62% have a bachelor's degree, 36% have a master's degree and 2% have a doctorate degree. The office staff includes one administrator, one full-time secretary, one secretary who divides her duties between secretarial and clerical work, and one home-school ESL liaison.

An active parent group at Site A promotes two major fundraisers each year. Money earned from these fund-raisers has provided the school with library books, computer software, playground equipment and funds for teachers to use in their classrooms. The parent group sponsors a family reading night in the fall, a fun fair at Halloween time, a Valentine's Day sweetheart social, and two book fairs. At the fall book fair, children are allowed to choose one book, which is paid for by the parent group. School/community relations are enhanced by a family night held once each month at a local fast food restaurant. About one per cent of the profit the restaurant earns on these nights is given to the school. In addition, the school also earns money from a local gas station which contributes one half cent per gallon of gasoline sold on each Tuesday of the month.

Site B

Site B is a public elementary school that houses kindergarten through sixth grade with an early childhood facility on site. This school is a new brick building

constructed on approximately 10 acres. There is a creek, within a wooded area, that runs behind the school. The building houses 27 classrooms. In addition, there is a learning center, a computer lab, a gymnasium, and a commons area that is used for lunch and special activities.

The school opened in August 1998, with an initial enrollment of 459 students compared to 585 students as of September 1999 (2000 School Report Card). The early childhood facility houses approximately 200 students between the ages of three and five. This school is comprised of three sections at each grade level, K-6, with the exception of fifth grade, which has two sections. There are two self-contained special education classes, primary and intermediate. Students attending these classes have multiple and more involved learning needs. This school also houses 13 sections of early childhood classes. These classes utilize the district's blended model: each class is made up of special education students, at risk students, and typically developing students.

Site B is predominately a middle class, neighborhood school. The number of students within walking distance to the school accounts for 88% of the student population. The student ethnic background, as reported in the 2000 School Report Card, consists of 62% White, 11% Black, 21% Hispanic, 6% Asian/Pacific Islander, and 1% Native American. Eighteen percent of the student population comes from low-income families, and 8% are LEP. The school attendance rate is 96%, 0% truancy, and has a 23% mobility rate.

The staff is stable and well educated with current teaching practices and participates in a variety of professional growth opportunities in the area of reading, writing and technology. The staff participates in a reading initiative with the National Council of Teachers of English (NCTE), a local university, and with an internationally known reading specialist in order to strengthen teacher skills and strategies. They also have a partnership with a local college that provides a tutoring program for the students. The staff consists of a principal, two secretaries, three custodians, and twenty-eight teachers; 86% are female, and 14% are male. The ethnic background of the staff is 85% White and 15% Hispanic. Of the classroom teaching staff, 32% have a bachelor's degree and 68% have their master's degree. One staff member is Nationally Board Certified.

With an average class size of 25 students, each classroom is equipped with a computer, television, and a device that connects the computer to the television. Classroom teachers teach the basic curriculum of mathematics, reading, writing, social studies, and science. Students have weekly instruction in music, physical education, and art, each for 45 minutes a week. The support staff consists of a reading support teacher for all grade levels, a speech pathologist, two learning disabilities resource (LDR) teachers, band and orchestra teachers, a school nurse, and a school social worker. There are also other itinerant staff that come into the school on an as-needed basis.

Site B encourages the support of all staff to being involved in a variety of committees, both internally and district-wide. There is a technology committee that addresses the hardware and software concerns in the building. A Partnership for Excellence in Learning (PEL) Site council consists of a group of parents, teachers, and building administrator who meet to discuss educational and school related issues, and devise ideas for school improvement. There is also an active Parent Teacher Organization (PTO) which supports the efforts of the school.

Site B also has committees, which include the students as well. The school climate committee is comprised of student representatives and the principal. Together, they address social, emotional and behavioral issues regarding the school population. Student Council is a group of student representatives from each classroom who meet with faculty advisors to discuss service related projects. The peer tutor program is a group of students trained to provide one-on-one assistance to students having difficulty with reading and basic mathematics facts.

Site C

Site C is a public school that has provided educational service to this community since 1971. The school is in a residential area, and is located on 12 acres of land. Within the property, there is a faculty parking lot, playground and a field. A bridge connects the school grounds and field to the residential area behind the school. The residential street where the school is located has houses on each side as well as across the street from the school. The building itself is a one-floor brick structure with trees and plants in front. Sidewalks are placed in front and on each side of the school. This

school building is constructed in the open-school design. Classrooms are set up in pods with open walls and curtains between the rooms. Besides the 30 classrooms, this site also has a gymnasium, computer lab, learning center, and a commons, which is used as a lunchroom and for various functions throughout the day.

The school houses kindergarten through sixth grade. In addition, it has a developmental preschool on site, as well as classes for primary behavior disorders, intermediate behavior disorders, educably mentally handicapped, visually impaired, all-day gifted classes for intermediate grades, and a before and after school daycare program for currently enrolled students. Bus transportation is required for 21% of the students.

The enrollment at this site is 567 students. Racial/ethnic enrollment is: 78% White; 7% Black; 8% Hispanic; 8% Asian/Pacific Islander; 0% Native American. Average daily attendance at this site is 96%, with chronic truancy at 1%. The student mobility rate is 19%. The socio-economic status is 10% low income; 5% of the students come from LEP households. (State School Report Card 2000).

Each of the 30 self-contained classrooms has a computer. A television and videocassette recorder are mounted on the wall within each room. The average class size is 23 students. Students spend approximately 60 minutes a day on math, 40 minutes on science, 30minutes on social studies, and two hours on language arts. Each child has physical education, art, music weekly and use of the computer lab. Each of these sessions is 40 minutes long. Students visit the learning center weekly for 30 minutes. The students have the following resources available to them on an as-

needed basis: reading resource, speech, learning disability resources, and social work. Available to the intermediate students are 30 minute music lessons in chorus, band, and orchestra. The school offers after school activities in art, reading, science, and working on a spring musical.

There are 55 staff members at Site C. This includes an administrator, 2 secretaries, a custodian, a nurse, 35 teachers and 18 teachers' assistants. Seven percent of the staff members are male, 92% are female. Sixty percent of the certified staff earned degrees beyond their bachelor's degree. The racial/ethnic composition of staff is as follows: 96% White, 2% Black, and 2% Hispanic. Sixty-seven percent of the staff members are certified. Itinerant staff work at the school as needed.

Site C has an active PTO. They sponsor various fundraisers throughout the year. In addition, they provide funds to individual staff for supplemental classroom supplies, sponsor all student assemblies, organize a fun fair, two book fairs, bingo night, and a Santa's Workshop where students may purchase inexpensive gifts for family members. The PTO presents students with books as birthday presents, sponsors a monthly family night at a local fast food restaurant, purchases t-shirts for each Drug Abuse Resistance Education (D.A.R.E.) graduate and helps financially with a community Wheel of Wisdom game for each D.A.R.E. graduate. They have organized support people to come assist in the computer lab. They have planned various speakers to come speak with parents at evening meetings. Besides obtaining the speakers, they have also organized babysitting for children. The speakers have discussed such topics as gangs, parent discipline, and upcoming referendums. The

PTO also organizes picture days, and sponsors the school yearbook. They collect boxtops and soup can labels to purchase additional software and materials for the computer lab. "Daddy/Daughter" and "Mother/Son" dances are sponsored yearly by the PTO.

Site C has monthly read-ins during the school day. Each month has a different theme. It also sponsors evening read-ins where students and their families may eat pizza and read together. The whole school participates in a program called "Rainbow of Respect." Each month there is a specific focus on positive behavior. Each time children are caught demonstrating that specific behavior, they earn a raffle ticket. At the end of the month, there is a drawing to see which students have won. Prizes include certificates and prizes from local community fast food restaurants and stores. The school also has a yearly musical, all-school sing, a yearly fine arts festival, and field day.

The school has a good relationship with the fire department and the police department. A fireman comes in yearly and meets with each class. The D.A.R.E. officer has organized a special "lunch with a cop" as one of the prizes for the Rainbow of Respect Program. In addition, he participates in the field day activities. There is a local pizza restaurant that has formed a partnership with Site C. They sponsor monthly pizza parties as one of the Rainbow of Respect prizes. They also offer discounts on purchases for any school and/or staff activities.

Site D

Site D is a public K-8 single school district with an enrollment of 537 students. The school was founded in 1893. The school is located on approximately five acres of land. Site D is a two-story brown brick building. In the fall of 1999, an addition was built which added 17,000 square feet to the school. It included a new gym, stage, locker rooms, washrooms, and a physical education office. The old gym was renovated to add eight new classrooms to the school, which was completed in spring, 2001. The school contains 34 classrooms including the art room, computer lab, reading resource room, gifted room and two special education classrooms. A resource center and a computer lab are located in the center of the school. Available to the students on the school grounds are a baseball field, a soccer field, two large blacktop areas with basketball hoops and a playground.

The student racial/ethnic composition is made up of 30% White, 49% Black, 17% Hispanic, and 3% Asian/Pacific Islander. There are 19% low-income families and 1.3% LEP families in the district. The mobility rate of the school is 12%. The average daily attendance rate is 96% and the school has no problem with chronic truancies. The number of students within walking distance to the school accounts for 88% of the student population. One group of students that receives bus services resides in a low income, high-risk neighborhood, of which 93% of its residents are minorities. (State School Report Card 2000)

Site D has an average class size of 23 students. Each classroom houses two computers. Students spend 50 minutes a day on mathematics. All of the students are split into a high level and low level performing mathematics class. Students spend 40 minutes daily on both social studies and science, and one hour on language arts. Students go to both the computer lab and music class twice a week. Each student has art, library, and weekly self-esteem lessons with the guidance counselor. The D.A.R.E. officer comes once each week during the first semester, and works with all fifth grade students. Students in intermediate grades attend industrial arts and home economics first semester. Students receive 30 minute Spanish lessons twice a week. Students who participate in band have a 30 minute practice during the school day, along with weekly lessons before school. The students have the following resources available to them on an as-needed basis: reading resource, speech, learning disability resources, and social work. The school offers before and after school activities in drama and a homework help program called Project Idea. The after school program is offered to students who are in danger of failing a subject.

The ethnic background of the staff at Site D is 95% White and 5% Black. There are 83% female and 17% male teachers at the school. The staff consists of 38 full-time teachers, seven aides, six custodians, a nurse, three secretaries, and three administrators, with 38% of the staff being certified. Of the staff members, 30% have a bachelor's degree, and 70% have a master's degrees or higher.

The Surrounding Community

Site A

Site A is located 25 miles west of a major midwestern city. The population of the community is 35,579 and the median selling price for homes in the area is $100,900. The median family income in this community is $46,335. It is largely a residential community with many nearby places to shop. A major expressway borders this community and a railroad provides transportation for commuters who work in other towns. The community has its own police and fire protection and provides residents with numerous baseball and soccer fields as well as a large indoor recreational facility. The community opened a new outdoor aquatic park in 1999 and also offers a branch library.

Site B

Site B's community is approximately 38 miles from a major metropolitan city. The current population is over 85,000. The median income is $46,679 with the median price of a home at $144,000. The community has highway and commuter rail transportation access to the entire metropolitan area. The community has hundreds of businesses including retail, small manufacturing companies, major corporations, and a riverboat casino. This community also has a cultural arts center that hosts a symphony orchestra and nationally known entertainment. The police and fire departments have become an integral part of the school community. The police department supports the D.A.R.E. program, and the fire department provides instruction in fire safety to all classrooms. The park district offers many programs for all ages and 100 acres of park

land, which are available for the many baseball, football, and soccer teams. There are over 4,000 acres of forest preserves nearby. The library offers many programs for children and adults. It provides activities on holidays and during the summer, such as reading clubs, crafts, and puppetry.

Site C

Site C's community is approximately 25 miles from a major city. The current population is 35,000. The median price for a home is $148,000. In addition to single-family homes, this community also has apartments, townhouses, and duplex housing. The median household income is nearly $75,000. There are over 600 businesses within this community. There are incentive packages to assist commercial and industrial businesses within the community. Two highway systems and a commuter railroad system are located near Site C and its community.

Within this community sports is an important activity for children and adults. The park district facilities include 34 playgrounds, seven ball fields, eight basketball courts, seven picnic shelters, three recreation buildings, three tennis courts, a swimming pool, an ice-skating rink, 22 bike paths, a golf course, and two fishing ponds. The park district sponsors soccer, baseball, basketball, football, and cheerleading. The public library sponsors summer reading incentive programs. They also host chess meets, reading competitions, and toddler/pre-school reading programs throughout the year.

The school district for Sites A, B, and C are located in the second largest school district in the state. The district serves 11 different communities, covering 90 square

miles, and extends into three counties. The total student enrollment for this district is 36,575. The average enrollment increase over the last four years is 1,173 students per year. Due to the rapid growing enrollment, this district is currently embarking on an aggressive construction plan. This construction plan consists of building six new elementary buildings, one new middle school and one new high school. A warehouse/plant operation center will also be built. Renovation and expansion will be done in 49 schools within the district. The construction time line ranges over a four-year period (District web site).

The administrative structure includes one superintendent, five area superintendents, and one curriculum director. The average administrator salary is $73,799. The district spends 70% of its budget on education; 6% on bonds and interest; 5% on operations and maintenance; 4% on transportation expenditures; 2% on municipal retirement and social security; 0% on fire prevention and safety; and 12% on site and construction/capital improvements. The total operating expenditure per pupil is $6,953. The average teaching salary within the district is $42,428.

Site D

Site D is located 14 miles west of a major midwestern city. The median price for a home is $105,000. The community is 50% residential, 50% business, and has a population of 9,000. The median income of its community members is $38,679. The school is located near a major expressway. There is a major cemetery directly across the street from the school. A police station is next to the school. The local library is fewer than six blocks from the school. The library offers a summer reading program for

the students. There is a popular zoo near the community. A major airport is just 15 miles from this community. The local high school is within sight of the school. The community is multi-cultural with over 17 languages spoken among the students and their families.

Community members are involved with the school in numerous ways. A D.A.R.E. officer comes in and the students create a "Say No to Drugs" poster, which is displayed in the local businesses. The police station also offers contests and guest speakers throughout the school year. The PTO participates in numerous fundraisers for the school. They participate in Market Day food pick up once a month. They also hold a breakfast with Santa and a craft show. The PTO also plans the book fairs and sponsors numerous activities on weekends such as ice-skating, roller-skating, bowling, and family dances. The park district offers youth soccer and baseball in the summer, and the local pool offers swimming lessons near the school.

Site D draws most of its students from its own midwestern suburban area, but also receives students from three neighboring communities. The expenditures by fund in 1998-1999 were 50% on education, 8% on operations and maintenance, 3% on transportation, 3% on bonds and interest, 2% on municipal retirement/social security, 1% on fire prevention and safety, and 34% on site and construction/capital improvement. The total operating expenditure per student is $8,748. Site D, being a one-school district, has one superintendent, one principal, and one assistant principal, with the average administrator salary being $74,493. The average teaching salary is $48,761.

National Context of the Problem

When teachers begin teaching double-digit addition, subtraction, multiplication, or division and students do not know their basic mathematics facts, it becomes a serious problem. "Students who lack mastery on basic facts will continue to experience failure as subsequent math instruction is provided" (Miller, 1997, p.1). Students who have not mastered their basic mathematics facts at the elementary level have generated concern at the state as well as national levels. Many studies agree that basic mathematics fact knowledge is the building block of complex mathematical skills, but that time must be spent on mathematics fact practice if students are to reach a level of "automaticity" (Cooke & Reichard, 1996). Current literature shows that some experts feel that too much time is spent on rote learning and not enough on meaningful problem solving activities. What experts do agree on is that "...having the facts committed to memory is a huge asset" (Burns, 1999, p.2).

"Parents, teachers, and the public expect the school to teach the basic facts" (Isaacs & Carroll, 1999, p. 2). However, questions still remain as to how students best acquire memorization of their facts. "Although most teachers agree that students' mastery is important, many are unclear about how to seek it in ways that are consistent with the National Council of Teachers of Mathematics (NCTM) Standards" (Isaacs & Carroll, 1999, p. 1). The State Standards require mental math for estimation, computation, and problem solving. However, neither the NCTM nor the State Standards specify the means by which students should learn their basic facts. Studies agree that

when properly approached, the basic facts offer excellent opportunities for teaching children to think mathematically (Isaacs & Carroll, 1999).

Best practice approaches vary from researcher to researcher, but the goal of mathematics mastery remains solid. Traditional approaches to learning mathematics facts have included teaching strictly from the textbook versus using mathematics in everyday life experiences. In addition, using flash cards, timed tests, worksheets, counters (such as beads), and programmed sequential mathematics materials are all components of this traditional approach. More recently, experts have advocated the use of calculators, manipulatives and computer software to help with the memorization of mathematics facts. Furthermore, with the emergence of the mathematics reform movement, proponents are stressing a strategy-based approach to learning mathematics facts. Students are encouraged to explain several ways to solve problems. The belief is that with repeated use of basic facts in these problems, students will eventually learn them. Proponents believe that the ability to reason about mathematics is more important than simply memorizing the facts.

It is the job of the teacher to make sure that students obtain the information to master basic mathematics facts. Why is it that, "U.S. students drop out of mathematics at alarming rates, averaging about 50 percent each year after mathematics becomes an elective subject" (Steen, 1989, p. 1)? It is the job of educators to reduce students' frustration levels and teach them the basic mathematics facts so well that they can recall them in a matter of seconds. Knowing the basic mathematics facts is the foundation for success. As long as a debate persists as to whether traditional or reform

methods should be used to help students learn their mathematics facts, the students' progress may actually be hindered.

ERIC

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

The teacher-researchers created and administered a teacher survey (Appendix A) for the purpose of determining how well teachers felt students knew their basic mathematics facts. The teacher-researchers administered the survey to all teachers of mathematics in grades one through six at each of the four sites during the first week of school. There were 12 teachers at Site A, 16 teachers at Site B, 15 teachers at Site C, and 17 teachers at Site D, for a total of 60 teachers who responded to the survey.

The teacher survey consisted of seven questions. Figure 1 focuses on question five, which asked teachers to state how well students knew their basic mathematics facts at the beginning of each school year. The survey requested a yes, or a no answer. Figure 1 shows the percent of responses for all 60 teachers from all sites. In this survey, 18% of the teachers replied that yes, the students knew their basic mathematics facts and 82% replied no, they did not know their basic mathematics facts. The majority of the teachers surveyed overwhelmingly responded that most students were not prepared and had not mastered their basic mathematics facts before entering school in the fall.

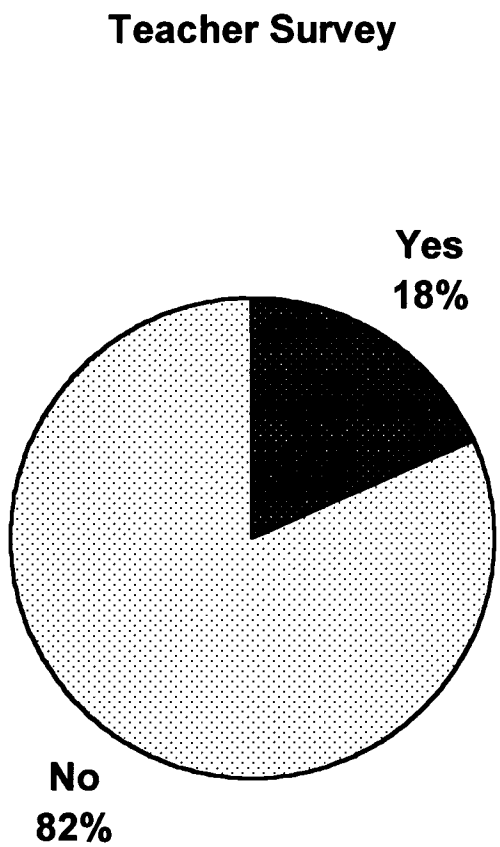

Figure 1. Percentage of teachers' opinions on students' possession of grade level entry skills in basic mathematics facts.

During the first week of school, the teacher-researchers created and administered a parent survey of four questions (Appendix A) asking parents how well they thought their children knew their basic mathematics facts. The three choices for this question were: knew all, knew some, and didn't know their basic mathematics facts. The teacher-researchers administered the parent surveys to the parents of the 16 first grade students, 45 second grade students, 26 third grade students, and 16 fifth grade students, across the four sites. This was a total of 103 parental surveys.

Parent Survey

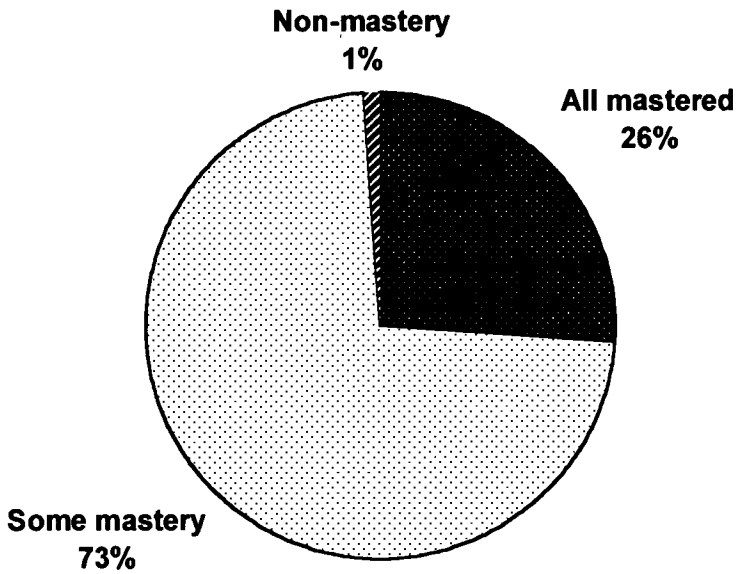

Figure 2. Percentage of parents' opinions on their children's knowledge of basic mathematics facts.

Figure 2 shows the results of the parent survey. The question asked was: "How well do you think your child knows his/her basic mathematics facts?" In this survey, 26% of the parents felt their children knew all their basic mathematics facts; 73% of the parents felt their children knew some of the basic mathematics facts; 1% of the parents felt their children knew no facts at all. Overall, over 99% of the parents thought that their children knew some or all of their basic mathematics facts.

The teacher-researchers created and administered a student self-assessment survey of five questions (Appendix A) during the first week of school for the purpose of determining how well students felt they knew their basic mathematics facts. Students were asked to identify the facial graphic that best indicated their perceived degree of mastery. The teacher-researchers administered the survey to 16 first grade students, 45 second grade students, 26 third grade students, and 16 fifth grade student across the four sites. This was a total of 99 students.

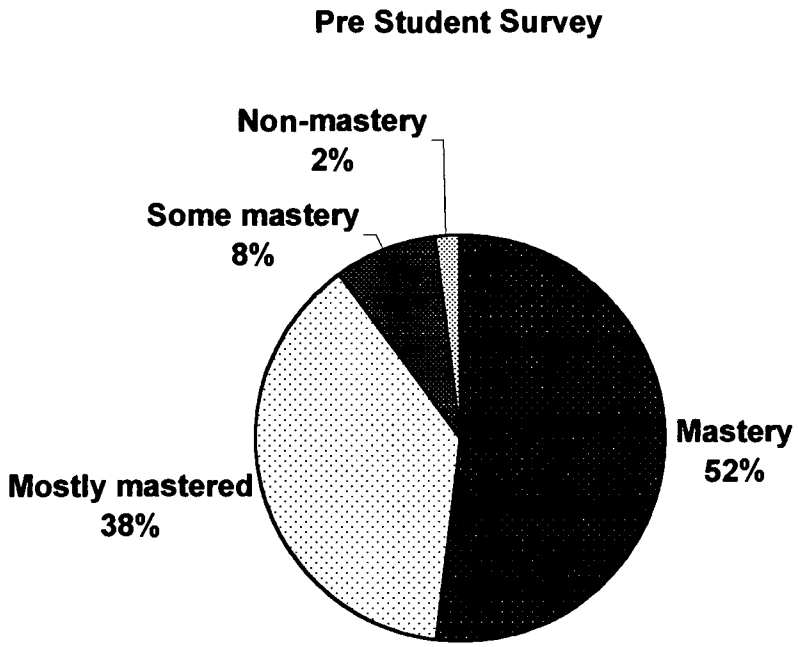

Figure 3. Percentage of students from the first, two seconds, third, and fifth grades self-assessment on knowledge of basic mathematics facts.

Figure 3 shows the results of the student survey to the question, "How well do you feel you know your math facts by heart?" Of those surveyed, 52% of students said they knew all their basic mathematics facts; 38% of students said they knew most of their facts; 8% of students said they knew some of their facts; and 2% of the students said they did not know any of their facts. Overall, 90% of the students felt that they had mastered or mostly mastered their basic mathematics facts.

The teacher-researchers created and administered a teacher-made pretest (Appendix A) consisting of 30 addition, subtraction and/or multiplication problems which the students had to complete in two minutes. During the first week of school the teacher-researchers administered the test to all the students at Site A in the first and second grade classes, at Site B in the second grade classes, at Site C in the third grade classes, and at Site D in the fifth grade classes. Thus, 53 students at Site A, 47 students at Site B, 53 students at Site C, and 32 students at Site D took the two-minute timed pretest. This was a total of 96 students in the experimental group and 89 students in the control group. Mastery level is measured at 90% or better, mostly mastered is 80-89%, some mastery is 70-79%, while non-mastery is for all scores below 70%. Figure 4 shows the percent of responses for all sites.

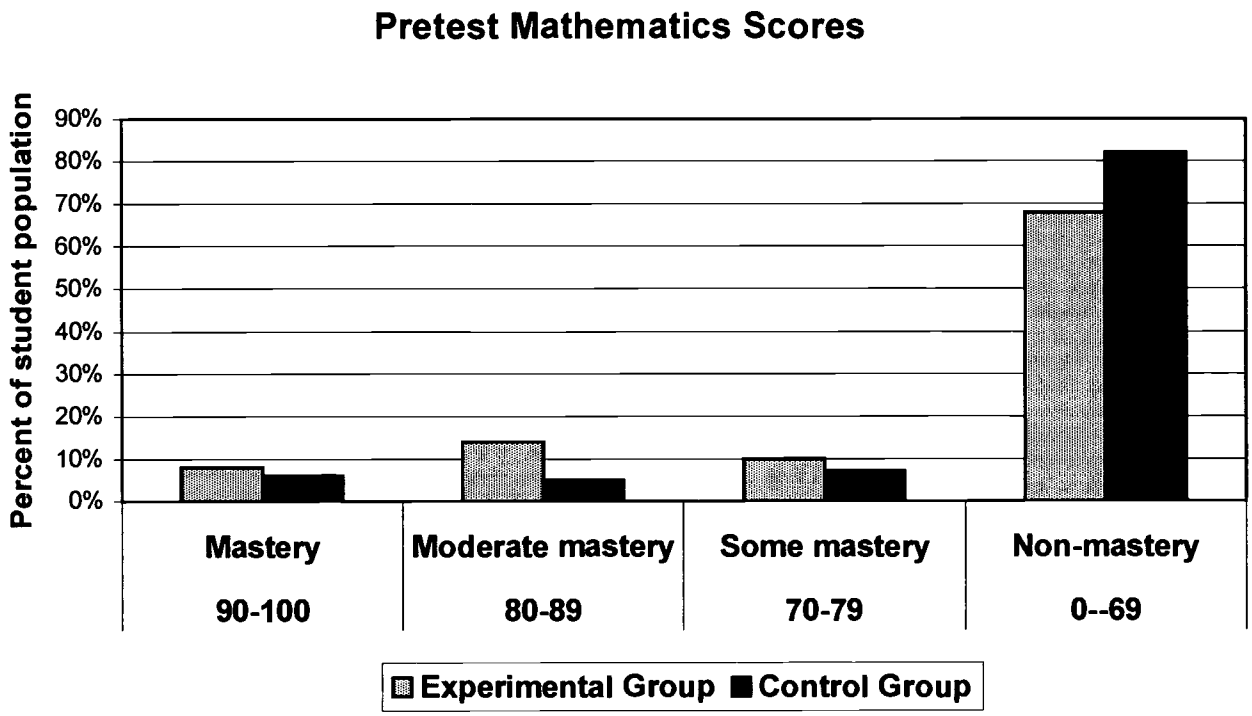

Figure 4. Percent of student population in both experimental and control group achieving various mastery levels in timed pretest of mathematics at the beginning of the school year.

Figure 4 shows the results of the scores the experimental and control groups received on a two-minute mathematics timed pretest of basic facts. On this test, 8% of the experimental group scored between 90%-100%, indicating mastery; 14% scored between 80-89%, indicating moderate mastery; 10% scored between 70-79%, indicating some mastery; and 68% scored between 0-69%, indicating non-mastery. Of the control group scores, 6% scored between 90-100%, indicating mastery; 5% scored between 80-89%, indicating moderate mastery; 7% scored between 70-79%, indicating some mastery; and 82% scored between 0-69%, indicating non-mastery.

In summary, both the students' perceptions of their knowledge of basic mathematics facts and the parents' opinions of their children's degree of mastery did not correspond to the actual scores on the pretest. Ninety-nine percent of the parents and 98% of the students felt they had mastered all or some of their basic mathematics facts. The pretest results indicated that only 22% of the students either mastered or moderately mastered their facts. The teachers' opinions about basic mathematics were more closely aligned to the pretest scores. Over 80% of the teachers felt that children did not have their facts mastered at the beginning of the school year.

Probable Causes

Based on data collected from teacher, parent, and student surveys, as well as a review of current literature on teaching children mathematics, there appears to be an ambivalence towards the importance of mastering basic mathematics facts.

Mathematics education has been undergoing changes since the 1950s. During World War II, both educators and the public have recognized that more technical and mathematical skills were needed to push forward the developing technological age (Herrera & Owens, 2001). The decade of the 1960s promoted "new math" and the decade of the 1970s was the "back to basics" movement. Finally, in 1989 the National Council of Teaching Mathematics (NCTM) produced a set of standards for school mathematics in grades K-12. The 1989 NCTM Standards recommended increased emphasis on using manipulatives and technology while decreasing emphasis on rote memorization. Some teachers found themselves abandoning sound practice for a more exciting style of mathematics instruction (Education, 1998). This caused teachers to

interpret the standards differently. According to (Brinkman, 1999, p.1), "Teachers are spending too much time on concepts and not enough on multiplication drills." In contrast, the National Assessment of Educational Progress (NAEP) criticized United States mathematics as dominated by paper and pencil drills on basic computation (Bowen, 1988). Different opinions like these were the cause of ambivalence towards the memorization of basic facts.

The pro position asserts that the basic mathematics facts are the foundation on which other math skills and knowledge are built. Without the ability to recall these facts quickly, other mathematical progress will be hindered. "Problem solving and thinking may be fine, but certain things, such as math facts and multiplication tables, must be memorized" (Wakefield, 1997, p.1). Leutzinger (1999) believes that teaching basic mathematics facts has always been a central part to any successful mathematics program. Mental mathematics and estimation are difficult without a mastery of basic facts (Leutzinger, 1999). Some veteran math teachers, concerned that students are not mastering their basic mathematics facts, have resorted to using outdated textbooks in an effort to teach the basics (Christian Science Monitor, 1997). Even parents have voiced their concerns about the lack of basic mathematics facts being taught. They contend that teachers are spending too much time on concepts and not enough on multiplication drills (Brinkman, 1997).

The opposing view to the pro position asserts that while knowing basic mathematics facts has its place, it should not be the focus of schools' mathematics curriculums. Instead, the emphasis should be placed on applying mathematics

concepts to everyday life. "Although performing calculations quickly and accurately is useful, effective instruction emphasizes skills development in the context of meaningful applications to real world situations . . ." (Cornell, 1999, p.5).

Critics of rote memorization, such as Cornell (1999), believe that "Rote memorization exercises should be de-emphasized. . .students' dependence upon rote memory should be viewed as a possible sign of gaps in understanding" (Cornell, 1999, p. 5). Similarly, in the field of children's learning of arithmetic, there is significant research to show that the direct instruction of computational procedures is harmful. Furthermore the emphasis on mathematics computation, as advocated in the back to basics movement, did not show significant gains in student performance on national tests. In fact, the scores declined or remained the same (Herrera & Owens, 2001).

The NCTM's Curriculum and Evaluation Standards for School Mathematics was published in 1989 as a response to the dissatisfaction with the back to basics movement, which emphasized computation over problem solving. The focus of these NCTM Standards was to stress problem solving, estimation, logical reasoning, and the use of calculators and computers at all grade levels (Herrera & Owens, 2001).

The 1989 Standards were not without its critics. According to the Standards for grades five to eight curriculums, the NCTM recommended "decreased attention" for memorizing and practicing. Quirk (1997, p.7) criticized the NCTM by stating that by ". . .decreased attention they really mean no attention. They would throw away our primary tool, the unbelievable power of human memory." Criticism has come from parents regarding the overuse of calculators, the utilization of manipulatives, and the

fact that basic skills are not being taught (Nelson, 1996). In response to the critics, the NCTM solicited feedback from educators in order to clarify its controversial 1989 guidelines. "If you ever want to get beyond basics and attain more sophisticated levels of knowledge, the basics are non-negotiable" (Auster, 2000, p. 1). The 2000 Standards insisted on learning mathematics with understanding, but also strongly supported the need for students to be proficient in computation (NCTM.org).

In summary, a contradiction seems to exist regarding the perception students, parents, and to some degree, teachers, have about student knowledge of basic mathematics facts. Based on data from student, parent, and teacher surveys, and results of timed pretests, there seems to be a disparity between the perception of what students think they have mastered, and the actual mastery itself. Also, 99% of the parents who responded to the survey felt that students had either some or all of the basic mathematics facts mastered. Teacher perception of fact mastery, on the other hand, was more closely aligned to the scores on the pretests. Finally, an ambivalence was evident on the part of experts in the field of mathematics education who are in disagreement over the importance of basic fact memorization versus a more conceptualized approach to learning mathematics.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

Three viewpoints on how children can best learn, recall, and retain their mathematics facts, have emerged from the literature. First is the belief that specific mathematics games or strategies should be implemented at school to help students learn their facts. Second is an endorsement of a family component whereby parents encourage the use of mathematics in everyday life even before the child begins school. Third is the opinion by educators that memorization will follow conceptual understanding. In other words, children need to understand the meaning of arranging, counting, and manipulating through meaningful experiences, before memorization should occur.

Mathematics Games/Strategies

Experts advocate using regimented math programs, teaching through multiple intelligences, or using games and strategies, to help students succeed in learning their mathematics facts. Reingold (1990) recommends using a regimented approach to help acquire mastery. He endorses a Japanese system of teaching mathematics called Kumon, which was developed to help increase speed and accuracy in calculating. Students compete with themselves rather than others to complete worksheets. They

must score 100% within a given time before advancing to the next level. Parents and teachers whose children have used Kumon noticed a positive change in attitude. A former president of the NCTM, Shirley Frye says, "We are looking for all of the methods that will help make students successful. Kumon certainly seems to be one of them" (Reingold, 1990, p. 2).

Another regimented program, recommended by Miller and Mercer (1997), is the Strategic Math Series. It is a program consisting of seven leveled books that contain approximately 20 instructional lessons in each level. The students need to score 90% mastery before passing to the next level. "Teachers and students involved in the field tests [of the Strategic Math Series] and research studies reported high levels of satisfaction with the program" (Miller and Mercer, 1997, p. 9).

Other experts of a strategic approach advocate helping children learn mathematics through multiple intelligences. Howard Gardner theorizes that all individuals possess different learning styles. He believes that people have many intelligences based on problem solving and creating products. While Gardner's predecessors believed there were only two components to measure intelligence, language and mathematics, Gardner's research revealed the existence of at least eight intelligences. The eight intelligences named thus far are: verbal linguistic, musical rhythmic, logical/mathematical, visual/spatial, bodily kinesthetic, naturalist, intrapersonal, and interpersonal.

Because the learning styles of children vary, teachers should employ a variety of activities to enhance learning. The quality of learning can be improved when educators focus on children's varying abilities. Willis and Johnson (2001), in discussing multiple intelligences, recommend learning mathematics facts to familiar tunes. "Each child may use a variety of these intelligences to learn mathematics concepts and skills, not just logical-mathematical" (Adams, 2000, p. 2).

A fourth group of researchers advocate using games to teach and reinforce mathematics facts. Krech (2000) recommends games with objects such as colored beans to physically illustrate math facts. Williams (2000) found that students practicing multiplication puzzles on the computer scored higher on tests than did their paper and pencil student counterparts. Checkley (1999, p. 3) believes that "...when practice is embedded in a game situation, they're more likely to learn the math." In addition, he says that children need to use as many manipulatives as possible to "cement" their understanding of numbers. Bailey (2001) encourages teachers to drill their students in ways that are fun. He finds math baseball a motivating and enjoyable means to accomplish this. May (1997) uses games and activities with both flash cards and playing cards to help her students practice finding answers without using their fingers.

Family Component

The second viewpoint of possible solutions on how children learn their mathematics facts is the family component. "Building on the experiences that children bring to school is where teaching basic skills begins" (Goodloe, 1999, p. 5). Isaacs and Carroll believe that children have a base of knowledge of "informal mathematical

knowledge" (Isaacs and Carroll, 1999, p. 1). This means that children, even in the pre-school years, possess this "natural thinking." Current reform of mathematics curriculum would encourage teachers to recognize this natural thinking and build on it once children begin their formal education (Isaacs and Carroll, 1999).

Once students have started school, families still play an important role in their child's mathematical success. Communication with children is an important part of their learning. Parents need to convey in a positive manner the significant role that mathematics has in children's everyday life. Once students realize the importance of math, parents can further guide them to be confident and successful in their approach to mathematics. This will enable students to have more success in application of mathematics within their daily lives (Teaching Children Mathematics, 2000). When a family offers opportunities for activities such as games that reinforce math facts, they are aiding their children in developing mathematical skills (Wakefield, 2001). Another benefit of families working with children is the success that children feel when showing their parents what they have learned. When parents and children do math activities at home, families can see the progress their children are making. (Leutzinger, 1999).

Conceptual Understanding

The third viewpoint of possible solutions on how children learn their mathematics is conceptual understanding. "Memorization has an important role in computation. Memorization should follow, not lead, instruction that builds children's understanding. The emphasis of learning in mathematics must always be on thinking, reasoning, and making sense" (Burns, 1999, p. 2).

Experts such as Leutzinger (1999) and Waite-Stupiansky and Stupiansky (1998) are in agreement that children need to develop thinking strategies before they can successfully achieve memorization. Learning the mathematics facts is a process that consists of repeated practice, which confirms that there is consistency in the number facts. Through this repeated practice, children will develop patterns such as knowing doubles and doubles plus one. Waite-Stupiansky and Stupiansky call this, "...building a solid knowledge base developed through repeated experiences and logical reasoning" (1998, p. 83). Leutzinger agrees, and furthermore believes that repetition of fact activities is also necessary because repetition leads to fluency in the use of these strategies, which in turn leads to mastery of basic facts (Leutzinger, 1999).

In summary, researchers have found three components necessary to learn, recall, and retain the basic mathematics facts. These components are: that teachers should use games and other strategies, that families need to encourage the use of mathematics in everyday situations, and that conceptual understanding should come before memorization.

Project Objectives and Processes

As a result of incorporating ten minutes of mathematics fact games daily, during the months of September 2001 to December 2001, the targeted first and second grade students at Site A will increase their abilities to recall mathematics facts to a minimum mastery level of 85%, as measured by weekly timed tests and a final timed posttest. This target group, the experimental group, will perform as well or better than their peer control group.

As a result of incorporating ten minutes of mathematics facts to music daily, during the months of September 2001 to December 2001, the targeted second, third, and fifth grade students at sites B, C, and D will increase their abilities to recall mathematics facts to a minimum mastery level of 85%, as measured by weekly timed tests and a final timed posttest. This target group, the experimental group, will perform as well or better than their peer control group.

In order to accomplish the project objective, the following processes are necessary:

1. Teachers will choose a series of mathematics games to be used after the concept has been taught, that will reinforce the basic mathematics facts.
2. Teachers will restructure the schedule to include time daily for ten minute interventions using mathematics games at the first and second grade levels.
3. Teachers will purchase music tapes or compact discs that will reinforce the basic mathematics facts and use these after the concept has been taught with second, third, and fifth graders.
4. Teachers will restructure the schedule to include time for daily ten minute interventions using music.
5. Teachers will establish control groups and experimental groups for each intervention.
6. Teachers will administer a two minute pre test to both the control and experimental groups.

7. Teachers will administer a weekly two minute timed test to the experimental groups.
8. Administer a two minute timed post test to both the control and experimental groups.

Table 1 shows the plan for implementing the action research project.

Project Action Plan

Table 1.

Action Plan for Research Project

Project Objective	Intervention	Targeted Group Behavior	Teacher/ Researcher Behavior	Materials	Time Fre-quency and Duration
To establish control and experimental groups at each site	Choose the control group for each grade level within each site	Control group teachers will agree not to implement experimental groups' interventions	Researchers will communicate with control teachers regarding scheduling of pre and post tests	Pre and post tests	Week of August 27, 2001
To increase students' abilities to learn, retain, and quickly recall basic math facts	Administer pretest to control and experimental groups	Control and experimental groups will take pretests	Researchers administer and correct pretests	Timed tests	Week of August 27, 2001

Project Objective	Intervention	Targeted Group Behavior	Teacher/ Researcher Behavior	Materials	Time Fre-quency and Duration
To increase students' abilities to learn, retain, and quickly recall basic math facts	Purchase math music tapes and develop math games that foster basic learning of math facts	None	Researchers will review samples of music tapes and collect materials for math games	Math fact tapes, supplementary text book of math games and support materials	August 2001
To increase students' abilities to learn, retain, and quickly recall basic math facts	Administer parent, teacher, and student surveys and permission slips	Teachers, principals, parents, and experimental groups of students fill out surveys	Researchers will pass out and collect completed surveys and signed permission slips	Parent, teacher, and student surveys and signed student permission slips	Due by August 31, 2001
To increase students' abilities to learn, retain, and quickly recall basic math facts	Begin inter-vention of mathematics music or mathematics games for 10 minutes daily for 14 to 16 weeks	Teacher-Researchers and experimental groups of students will participate	Researchers will use strategy with their classes for 10 minutes daily	Mathematics music, mathematics games	Ten minutes daily for 14 to 16 weeks, September through December 2001
To increase students' abilities to learn, retain, and quickly recall basic math facts	Administer weekly timed tests to experimental group	Teacher-Researchers will administer weekly timed tests to experimental groups of students	Researchers will administer and correct weekly timed tests	Timed tests	Last day of the week for 14 to 16 weeks, September through December 2001

Project Objective	Intervention	Targeted Group Behavior	Teacher/ Researcher Behavior	Materials	Time Fre-quency and Duration
To increase students' abilities to learn, retain, and quickly recall basic math facts	Keep daily log and journal	Teacher-Researchers will keep daily log and journal	Researchers will record intervention used and time spent on the intervention strategy	Log, journal	Logs-daily Journals -weekly
To increase students' abilities to learn, retain, and quickly recall basic math facts	Posttest	Control group teacher and researchers will administer posttests to control and experimental groups	Researchers and teachers will administer and correct posttest	Posttest	Early Decem-ber 2001
To increase students' abilities to learn, retain, and quickly recall basic math facts	Post student surveys	Teacher-Researchers will administer post student surveys to experimental group	Researchers will administer and collect post survey	Post student survey	Early Decem-ber 2001

Methods of Assessment

To assess the quality of these interventions, the teacher-researchers will use a total of four methods to monitor the process. Each teacher-researcher will administer a 30 problem, two minute timed test to monitor progress (Appendix B). A final two minute timed test, at the end of the interventions, will be used to identify the students' progress during the full 12 weeks of the interventions (Appendix B). A weekly journal will be kept by each teacher-researcher throughout the interventions. This document will describe the weekly interventions along with each teacher-researcher's reflections (Appendix B). These reflections will consist of the "positive," "negative," and "interesting" observations made each week by the teacher-researcher. At the conclusion of the intervention period, students in the experimental groups will take a post student survey on their attitudes and interest toward mathematics (Appendix B).

In summary, three viewpoints on how children can best learn, recall, and retain their mathematics facts have been discussed. First is the belief that specific mathematics games or mathematics to music should be implemented to help students learn their facts. A second belief is that parental encouragement about using mathematics in everyday life is necessary. The third belief, held by some educators, is that memorization will follow conceptual understanding. Of those discussed, the interventions that will be used consist of using mathematics games and mathematics facts to music to help students learn basic mathematics facts.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to have students achieve a minimum of 85% mastery of their mathematics facts. The implementation consisted of the following: establishing a control and experimental group for each group of students involved in the research; determining which researchers would use games and which researchers would use music for the intervention; collecting data from parent, teacher, and students surveys; administering a pretest to the control and experimental groups; incorporating ten minutes of daily practice of mathematics facts by the teacher-researcher for a period of 12 weeks; testing the students in the experimental groups weekly using a two minute timed test; administering a posttest to both the control and experimental groups; and re-administering the student survey at the conclusion of the intervention period for the purpose of noting any change in student attitudes towards mathematics. This research was conducted over a period of 13 weeks, during which time the researchers kept a weekly journal of the interventions used with comments on specific student behaviors or attitudes as the interventions were implemented.

The first and second grade students at Site A, practiced their mathematics facts using a variety of games for their interventions. These games consisted of using

manipulatives in order to reinforce addition facts 0 through 10 for first grade and 0 through 20 for second grade. The teacher- researcher for first grade used dice, dominoes, flash cards and a teacher directed game while the teacher-researcher for second grade used dice, dominoes, flash cards, playing cards, teacher made games, individual dry erase boards, and teacher directed games. Both researchers designed their lesson plans so that the first ten minutes of each mathematics class would begin with a game. The decision as to what game would be played each week was decided by the individual researcher. However, in both cases the researchers chose games that were done at the students' desks, such as dice and dominoes for the early weeks of the intervention. The first grade students, who were just learning their mathematics facts, played desktop games with dice or dominoes for the first six weeks. To incorporate some competition into the intervention, the researcher introduced the teacher directed game "Around the World" during week eight (Appendix C), addition math Bingo during week nine, and flash card games during week ten.

The second grade teacher-researcher at Site A similarly used games played at students' desks, with partners or in small groups, using dice, dominoes and playing cards for the first four weeks. Starting with week five, the students began playing games that were designed for whole class participation such as "Around the World," flash card team competitions, large group teacher-made games, or competitions using dry erase boards (Appendix C).

The music intervention at Sites B, C, and D consisted of listening to, and singing along with, commercially produced cassette tapes and compact discs. Site B, second

grade, utilized a rap cassette tape for addition facts 0 through 20. Site C, third grade, incorporated addition and subtraction facts on light rock compact discs to reinforce the facts 0 through 18. Site D, fifth grade, listened to a multiplication rap cassette tape reinforcing the facts 0 through 12. The researchers designed their lesson plans so that the first ten minutes of each mathematics class would begin with mathematics practice to music.

The researchers at each grade level indicated that all students were eager to participate in their respective interventions when they were told what they would be doing during week one. However, the researcher for second grade using games noted that about 25% of the students would drop their dice on the floor while trying to roll them and would lose some intervention time because of this. The second grade researcher using music observed that the majority of the class enjoyed hearing the music, but did not respond with answers because they did not know them. The third grade researcher noted enthusiasm on the part of the students, but indicated in the journal that the music tape was too wordy and would need modification to incorporate more problems into the ten minute intervention period. The first and fifth grade researchers noted no problems during the first week.

During the second week, about 95% of the students were still enthusiastic. At all three music sites the teachers made modifications to their music. The second grade teacher allowed students to look at a sheet with answers in order to facilitate answering the problems. The third grade teacher had the words to the music printed on an

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overhead transparency, highlighting the facts in red and the chorus in blue. The fifth grade teacher also modified the wordy music to help keep the students motivated.

In the third week, the first grade teacher observed that students were beginning to have trouble answering harder facts, but in general the speed at which they were answering the facts was increasing. The second grade teacher at the game site noticed that about 20% of the students did not follow rules for the game. Complaints about partners started to emerge. At the music sites, student behaviors ranged from still enjoying the music, students starting not to answer the problems (second grade), reluctance to learn a new song (third grade), to about 25% of the class appearing distracted (fifth grade). There was also a decline in test scores for both second grades during the third week, but an increase in scores for first and third grades and no change in scores for fifth grade.

During week four, the researchers at grades three and five implemented new methods to increase student interest and participation. The third grade teacher had students help write a new song, which was overwhelmingly well received by the class (Appendix D). The fifth grade teacher deviated from the plan of using only music for the intervention and introduced a game intervention at the same time: having races at the chalkboard to do mathematics problems while listening to music (Appendix D). This was done in an attempt to keep students interested in participating. The researcher for the second grade music group noticed that about 75% of the class needed to be encouraged to keep participating, and for the next four weeks of the intervention period this researcher commented on student boredom, teacher discouragement with the

intervention, and the need to try to keep the students motivated. Despite lack of enthusiasm on the part of the students, the weekly test scores continued to increase at this site.

For weeks five, six, and seven, the music intervention groups experienced boredom on the part of the students unless modifications were made. The third grade group wrote a second original song, while the fifth grade group changed to a rock and roll cassette tape. The second grade group using games played "Around the World," which proved to be very popular with the students. More than half of the students seemed to enjoy the competition, although two to three minutes could pass before a student would get another turn. The same opinion of this game was echoed by the first grade teacher who introduced it during week eight. Student test scores increased or remained consistent at all sites during these weeks except for the third grade site, which experienced a small decrease during week seven. During weeks five, six, and seven, average student scores exceeded or nearly exceeded 70% mastery at all grade levels and exceeded 90% mastery at the fifth grade level.

During week eight, the fifth grade teacher alternated rap music and rock and roll and had students write answers to the problems on paper while listening to the music. The third grade teacher noted that the majority of students were pleased to be reviewing the songs they had previously learned, but were having trouble learning their tables of nine.

By week nine of the intervention, first grade had consistently maintained an interest in the games and more than half of the students were recalling their facts more

quickly. The second grade games group reached a mastery level of nearly 90%, but the researcher noted that during any of the game interventions about 25% of the children displayed off-task behaviors. These off-task behaviors included dropping materials such as dice and playing cards, excessive talking, and non-participation by some students. The fifth grade researcher commented that during week nine the students requested to play math races on the chalkboard during a class party.

By weeks ten and eleven, the first grade teacher recognized that about 75% of the students were relying less on fingers to help them add. The second grade teacher using games introduced a team game with dry erase boards. The entire class enjoyed the game, but the teacher noted that each team needed an adult to monitor answers. The second grade teacher for the music group wanted to change to other music and commented that students' lack of participation created a need for the teacher to monitor those who were not participating. Similarly, the third grade teacher found a lack of student participation during the music intervention and an unwillingness on their part to write another original song. The fifth grade teacher continued to get student requests to do mathematics chalkboard races, but for the first time the researcher complained that the math intervention was taking too much time from the regular 40 minute math period. Student scores by weeks ten and eleven had reached or exceeded 85% mastery at all sites and nearly reached mastery at the third grade music site. At this point, the researchers chose to end the interventions two weeks earlier than what was stated in the action plan because four of five research groups had achieved mastery of their mathematics facts.

Presentation and Analysis of Results

Upon completion of the interventions, data were gathered and analyzed to determine the effectiveness of the interventions. The two interventions were mathematical games and mathematics facts to music, for ten minutes daily. The measurements that were used to analyze progress were student pre and post student attitudes toward mathematics and pre and post test scores from each research group.

Post Student Survey

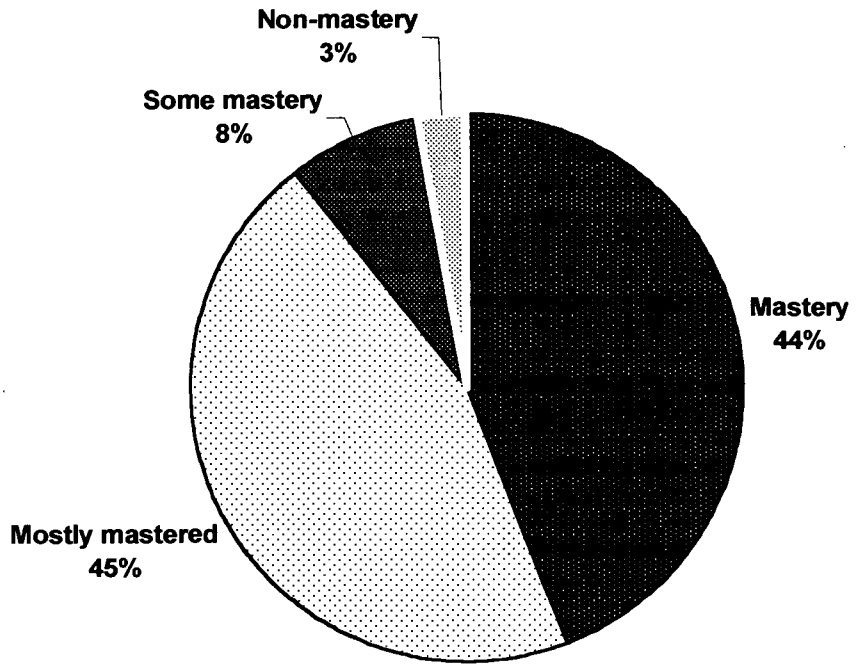

Figure 5. Percentage of first, second, third, and fifth grade students' self-assessed knowledge of basic mathematics facts.

The teacher-researchers administered a post student survey at the conclusion of the interventions. Figure 5 shows the results of the post student surveys. The question asked was, "How well do you feel you know your math facts by heart?" Of those surveyed, 44% of the students said they knew all their basic mathematics facts; 45% of the students said they knew most of the facts; 8% of the students felt they had some mastery of their facts; and 3% of the students said they did not know any of their facts. Overall, 89% of the students felt they had mastered, or mostly mastered, their basic mathematics facts.

The teacher–researchers compared the data from both the pre and post student surveys for the purpose of noting any changes in student attitudes about mathematics. The results in figure 6 showed that the percentage of students who felt they had mastered their mathematics facts decreased from 52% to 44%. The percentage of students who felt they had mostly mastered their basic mathematics facts increased from 38% to 45%. Eight percent of students felt they had some mastery, which was consistent with results from the pre student survey. The percentage of students who felt they had not mastered their basic mathematics facts increased from 2% on the pre student survey to 3% on the post student survey.

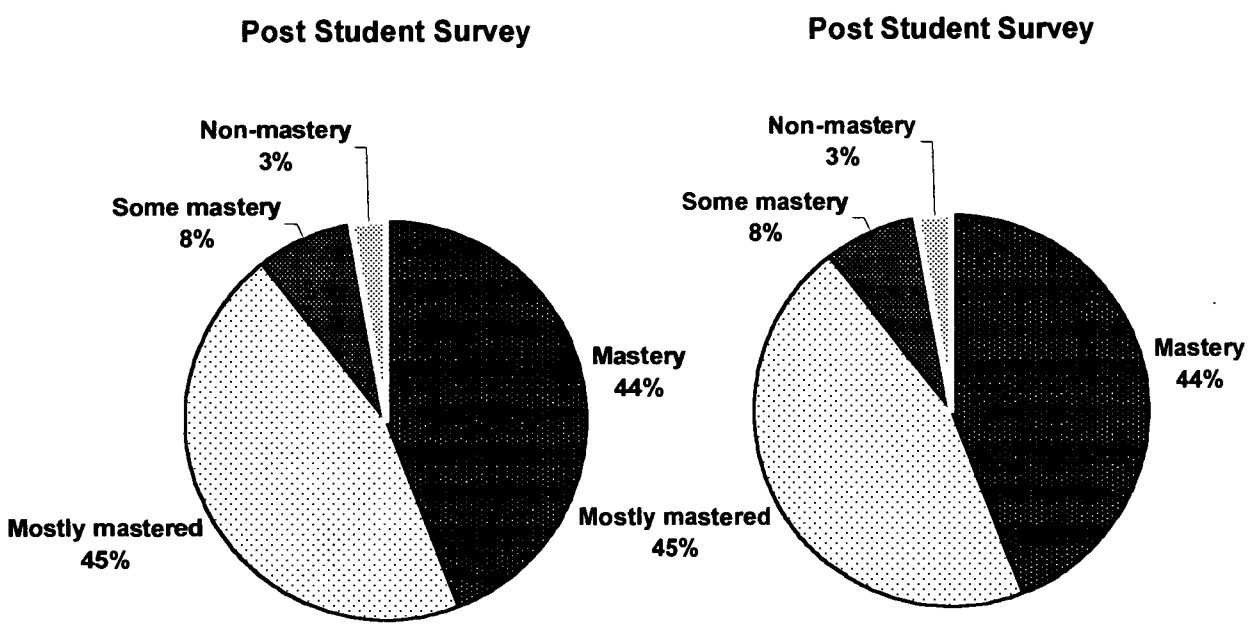

Figure 6. Pre and post student survey results.

Table 2 shows the pre and the post attitudes of the students in the experimental group.

Attitude Survey

Table 2.

Pre and Post Attitude Student Survey Regarding Grades One and Two

Attitude	Gr. 1 Pre	Gr. 1 Post	Difference +/-	Gr. 2 Pre	Gr. 2 Post	Difference +/-
Highly Like	80%	80%	0%	66.7%	87.4%	+20.7%
Like	6.7%	20%	+13.3%	27%	6.3%	-20.7%
Somewhat Dislike	13.3%	0%	-13.3%	2.1%	6.3%	+4.2%
Highly Dislike	0%	0%	0%	4.2%	0%	-4.2%
Intervention	Games			Games and Music		

Table 3 shows the pre and the post attitudes of the students in the experimental group.

Attitude Survey

Table 3.

Pre and Post Attitude Student Survey Regarding Grades Three and Five

Attitude	Gr. 3 Pre	Gr. 3 Post	Difference +/-	Gr. 5 Pre	Gr. 5 Post	Difference +/-
Highly Like	34.6%	23.1%	-11.5%	43.8%	56.2%	+12.4%
Like	50.1%	57.7%	7.6%	56.2%	37.5%	-18.7%
Somewhat Dislike	11.5%	0%	-11.5%	0%	6.3%	+6.3%
Highly Dislike	3.8%	0%	-3.8%	0%	0%	0%
Intervention	Games			Games and Music		

Tables 2 and 3 show students' attitudes about mathematics at each grade level prior to and following the interventions. Those students who indicated they enjoyed mathematics to a very high degree increased at grade two and grade five. Those who said they enjoyed mathematics to a very high degree remained the same at grade one, and decreased at grade three. Students at grades two and three indicated a dislike of

mathematics to a high degree prior to the interventions. Following the interventions, no students at any grade level indicated a dislike of mathematics to a high degree.

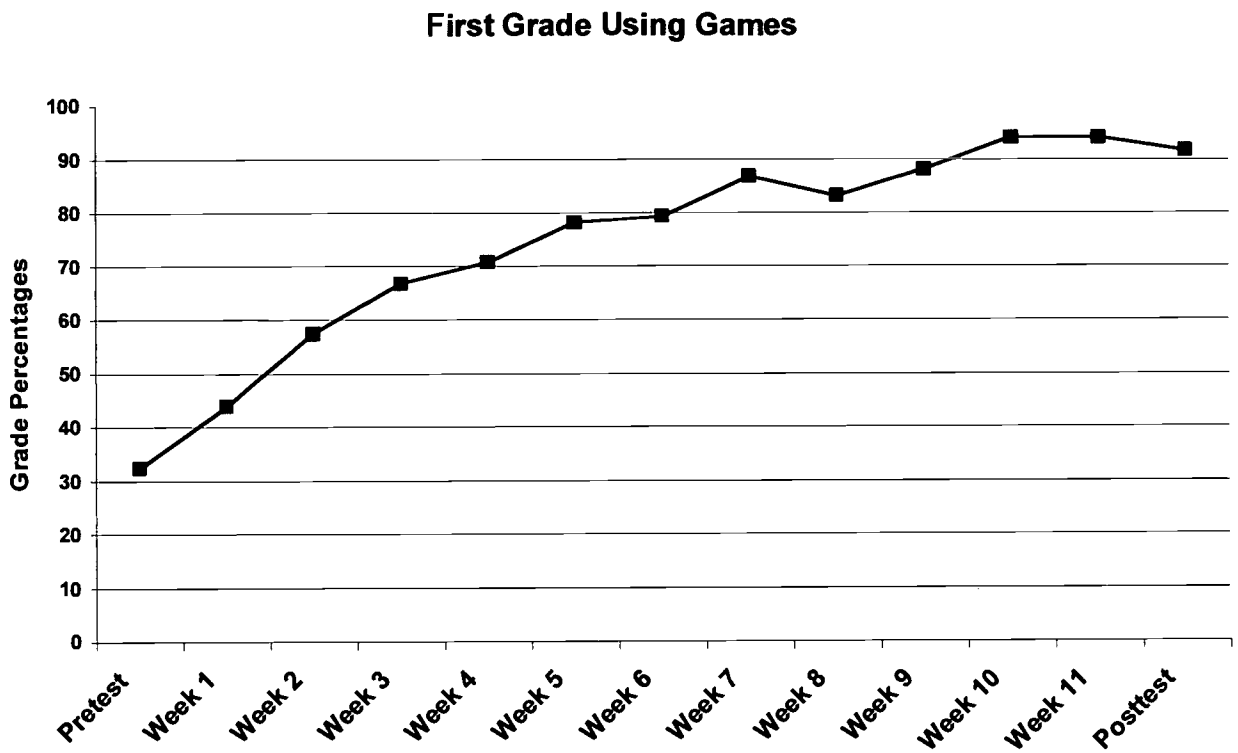

Figure 7. First grade weekly mathematics test averages after using games.

Figure 7 shows the first grade weekly averages of timed tests using games as an intervention. The average pretest score was 32.3%. The average timed test score for week one was 43.8%. There was a gradual increase of timed test scores each week, with the exception of week eight. The highest scores came in week ten and week eleven, averaging 94%. The posttest score averaged slightly lower, at 91.5%. Overall, test scores from the pretest to the posttest increased 59.2%.

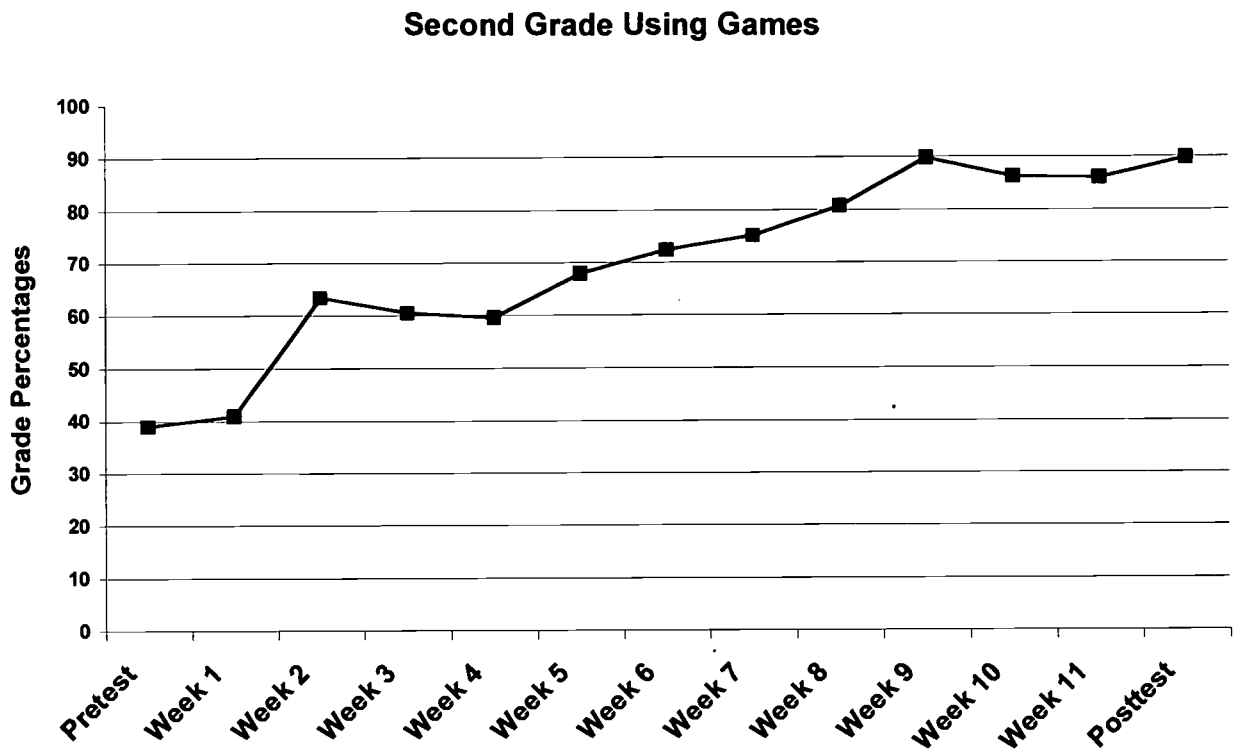

Figure 8. Second grade weekly mathematics test averages after using games.

Figure 8 shows the results of the weekly tests of the second grade classroom which incorporated games as their intervention. It shows a pre-test average of 39%. With the exception of week two, where there was about a dramatic 20% increase, there was a gradual increase in grade averages over the 13-week period. Average test scores decreased during weeks ten and 11, but increased again for the posttest, with an ending score of 90%. Overall, test scores from the pretest to the posttest increased 51%.

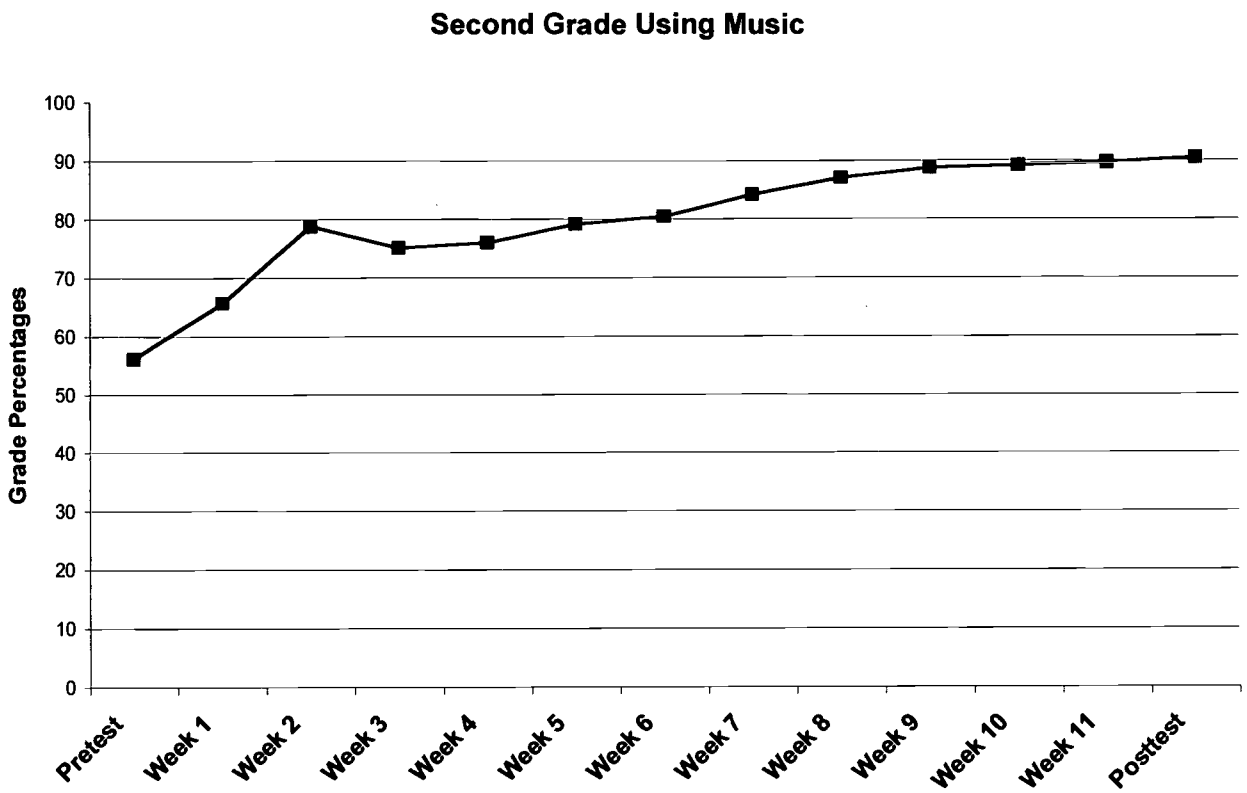

Figure 9. Second grade weekly mathematics test averages after using music.

Figure 9 shows the results of the weekly tests of the second grade classroom, which incorporated music as their intervention. It shows a pretest average of 55%. The biggest increase was shown in the first two weeks of the intervention. After that, there was a slight decrease in scores in week three before they began to increase for the rest of the intervention. Overall, test scores from the pretest to the posttest increased 35% for a final test score of 90.4%.

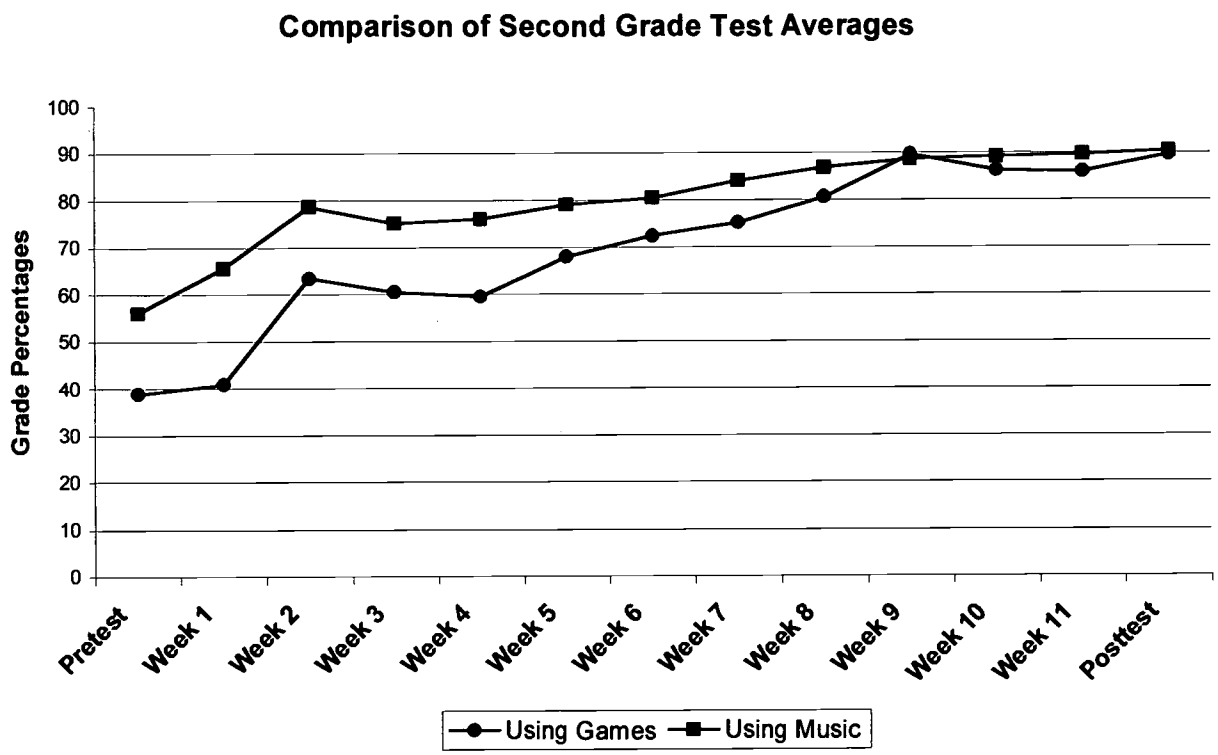

Figure 10. A comparison of the second grade classes using games or music interventions.

Figure 10 shows the comparison of the two second grade classrooms' weekly mathematics tests. It compares the mathematics scores of the second grade classroom using games as its intervention, with the second grade classroom using music as its intervention. The pretest average for the games intervention was 39% and the pretest average for the music intervention was 55%. The scores in both classrooms increase and decrease at about the same time throughout the 13 weeks of intervention.

The graph indicates that at both sites student test scores increased between the pretest and the second week. Scores decreased at both sites during the third week, and decreased slightly again at the game intervention site during the fourth week. Scores continued to increase at both sites from week five through week nine, where the same percentage was recorded on the ninth week. Scores decreased slightly at the game intervention site during weeks ten and eleven, whereas they increased slightly at the music intervention site. The posttest average at both sites was 90%. Overall, the test scores from the pretest to the posttest at the games intervention site increased 51%, and the test scores from the pretest to the posttest at the music intervention site increased 35%.

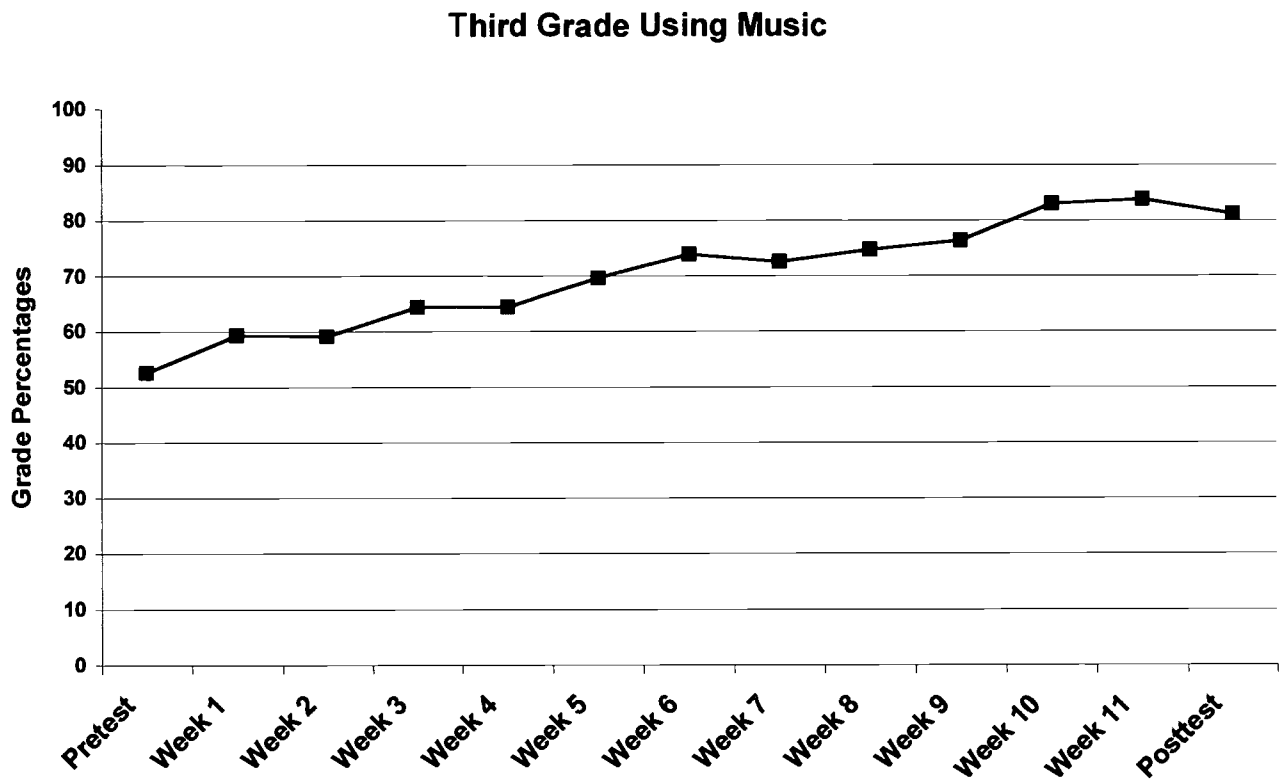

Figure 11. Third grade weekly mathematics test averages after using music.

Figure 11 shows the results of the third grade weekly average test scores of two minute timed addition and subtraction tests, incorporating music for ten minutes daily. The students' pretest scores averaged 52%. By week one, compared to the pretest, the scores jumped up 8%. The scores steadily increased through week eleven with the exception of week seven, where the average dropped a few percentage points. The students received an average of 81% on the posttests. Overall, test scores from the pretest to the posttest increased 29%.

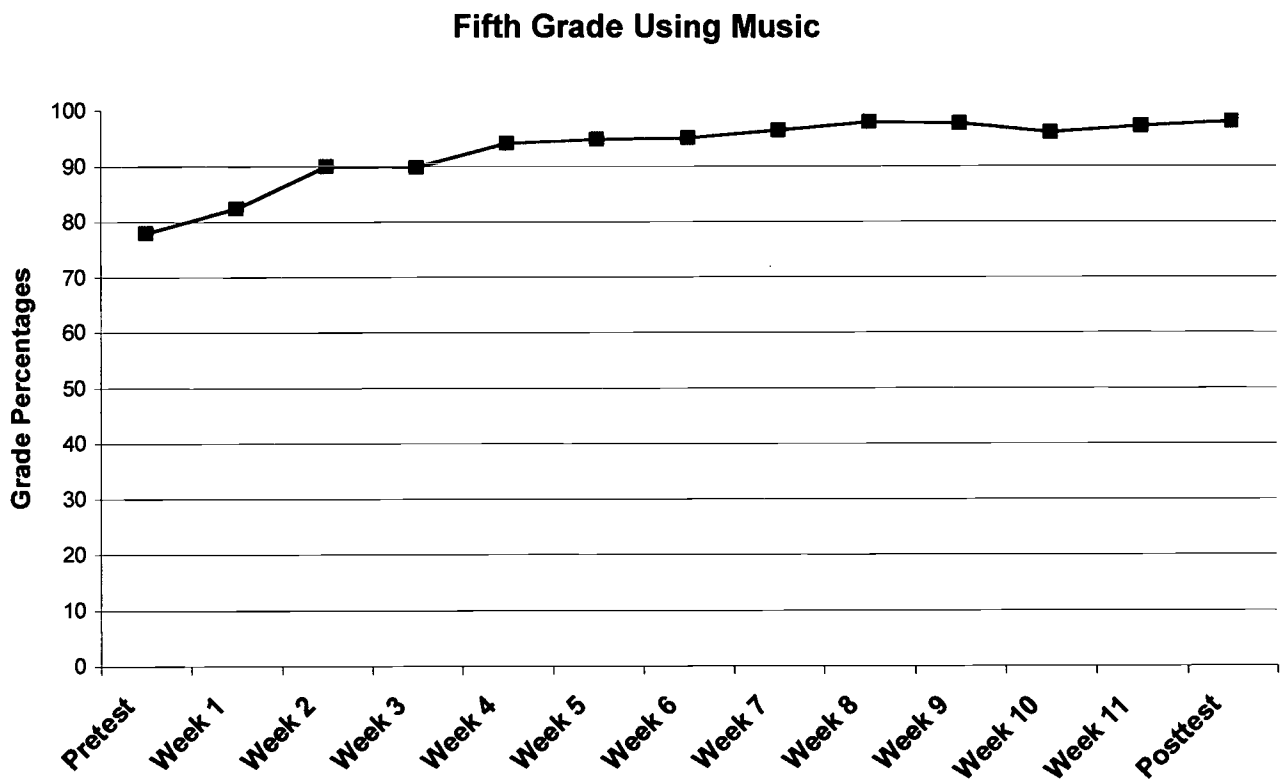

Figure 12. Fifth grade weekly mathematics test averages after using music.

Figure 12 shows the results of the fifth grade weekly averages of two minute timed tests in multiplication that incorporated listening to music for ten minutes daily. The students' pretest average was 78%. The scores increased weekly with only two exceptions. Week two and week three averages were the same and week ten averages dropped. The average for the posttests was about 98%. Overall the increase in scores was 20%.

Fifth grade students at Site D were administered a 30 problem, two minute timed mathematics facts test. The same students were administered the identical test 12 weeks later. One group, the experimental group, used music as an intervention, and the other group, the control group, used no intervention. The experimental group showed a 20% increase in scores from the pretest to the posttest and the control group showed a 24.9% increase from the pretest to the posttest.

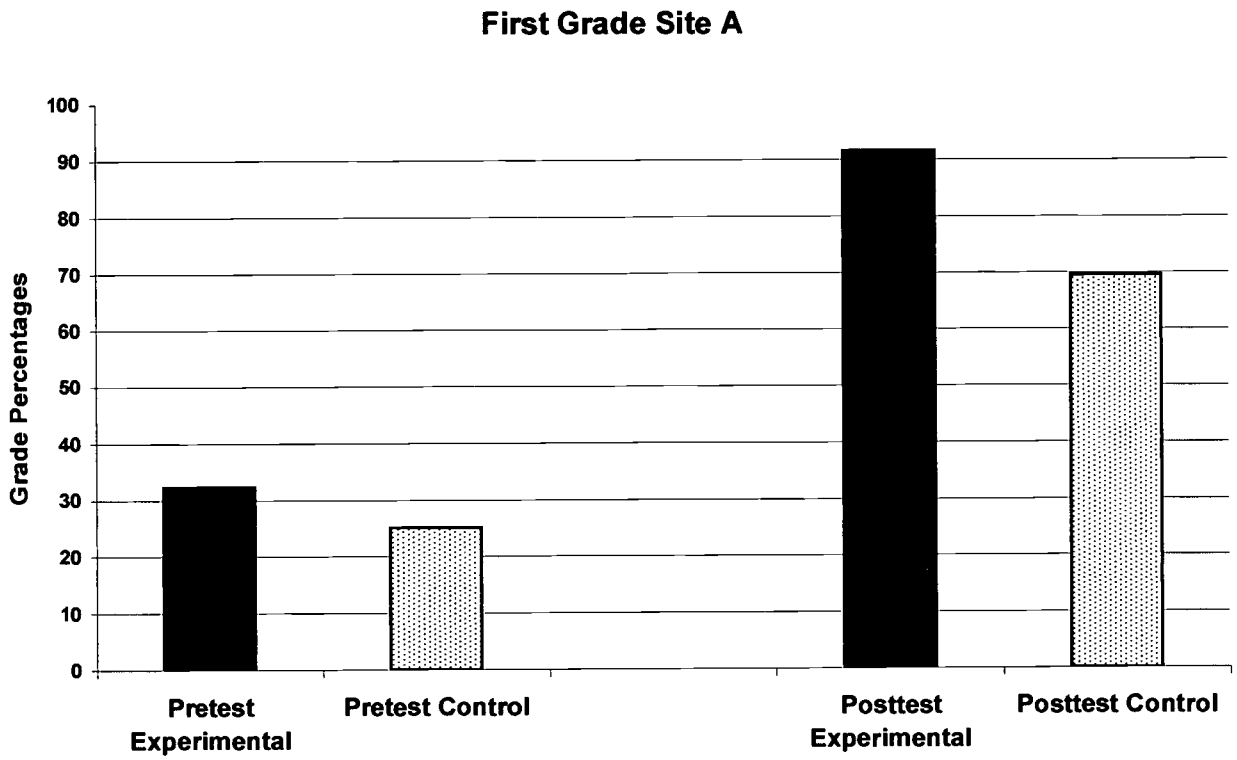

Figure 13. First grade experimental and control group pretests and posttests.

Figure 13 shows the comparison of the first grade's pretest and posttest average scores of the experimental and control groups. The average pretest scores of the experimental group were 32.3%. The average pretest scores of the control group were 25.1%. The average posttest scores of the experimental group were 91.5%. The average posttest scores of the control group were 69.6%.

First grade students at Site A were administered a 30 problem, two minute timed mathematics facts test. The same students were administered the identical test 12 weeks later. One group, the experimental group, used games as an intervention, and the other group, the control group, used no intervention. The experimental group showed a 59.2% increase in scores from the pretest to the posttest and the control group showed a 44.5% increase from the pretest to the posttest.

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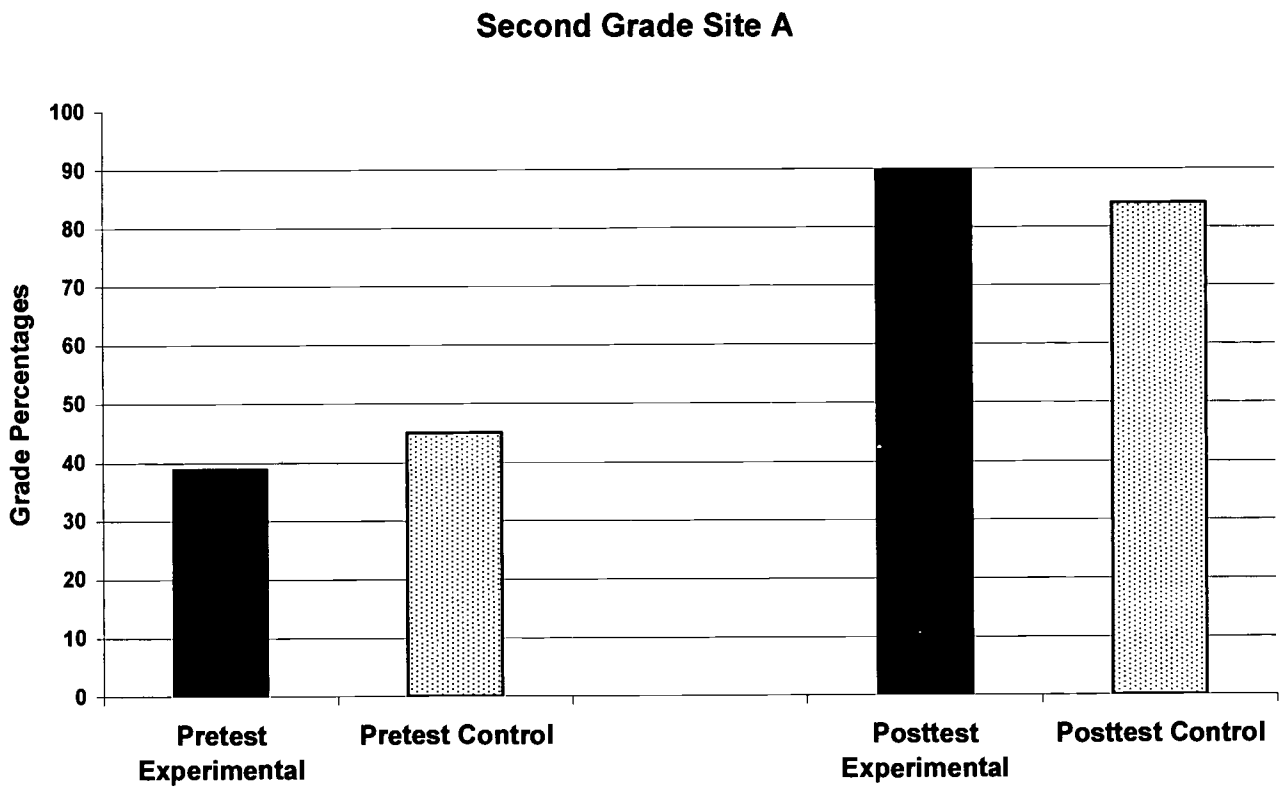

Figure 14. Second grade, Site A, experimental and control group pretests and posttests.

Figure 14 shows the comparison of the second grade's pretest and posttest average scores of the experimental and control groups. The average pretest scores of the experimental group were 38.9%. The average pretest scores of the control group were 45.1%. The average posttest scores of the experimental group were 89.7%. The average posttest scores of the control group were 84.1%.

Second grade students at Site A were administered a 30 problem, two minute timed mathematics facts test. The same students were administered the identical test 12 weeks later. One group, the experimental group, used games as an intervention, and the other group, the control group, used no intervention. The experimental group showed a 50.8% increase in scores from the pretest to the posttest and the control group showed a 39% increase from the pretest to the posttest.

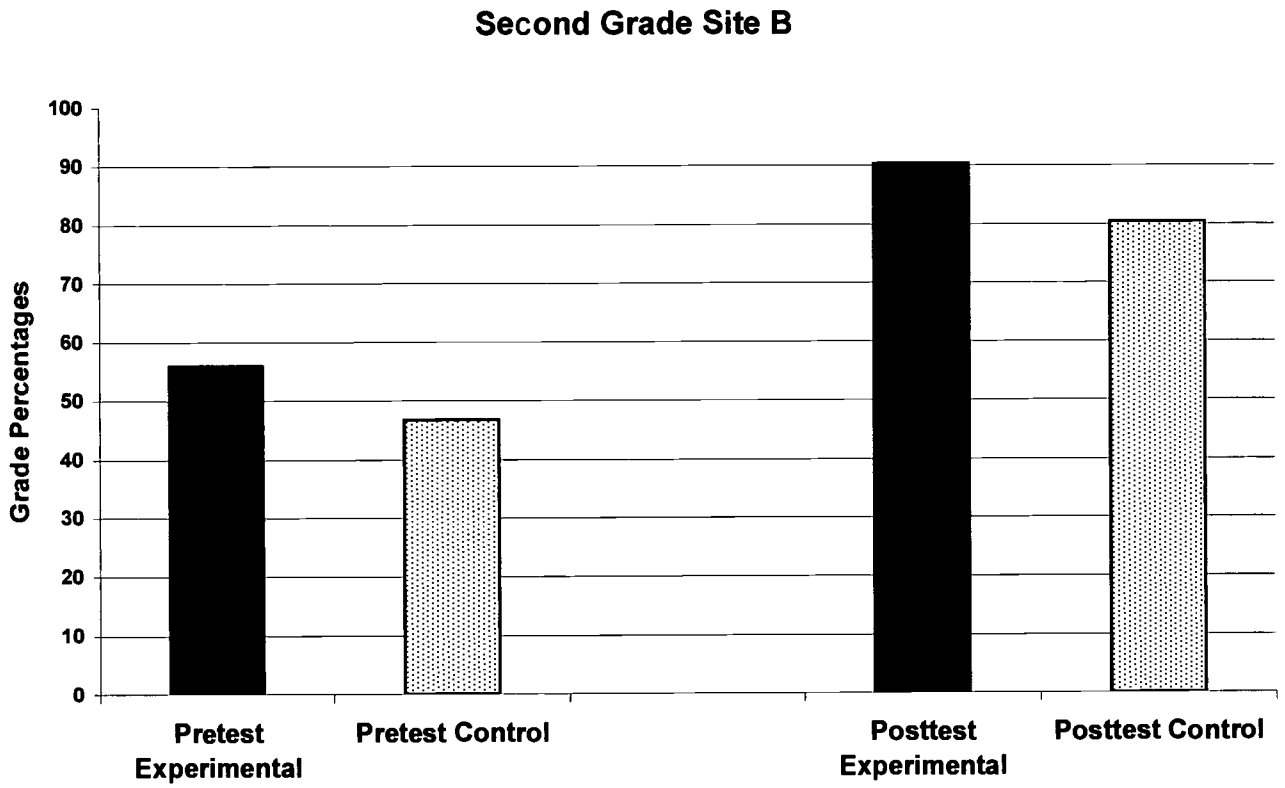

Figure 15. Second grade, Site B, experimental and control group pretests and posttests.

Figure 15 shows the comparison of the second grade's pretest and posttest average scores of the experimental and control groups. The average pretest scores of the experimental group were 56%. The average pretest scores of the control group were 46.8%. The average posttest scores of the experimental group were 90.4%. The average posttest scores of the control group were 80.4%.

Second grade students at Site B were administered a 30 problem, two minute timed mathematics facts test. The same students were administered the identical test 12 weeks later. One group, the experimental group, used music as an intervention, and the other group, the control group, used no intervention. The experimental group showed a 34.4% increase in scores from the pretest to the posttest and the control group showed a 33.6% increase from the pretest to the posttest.

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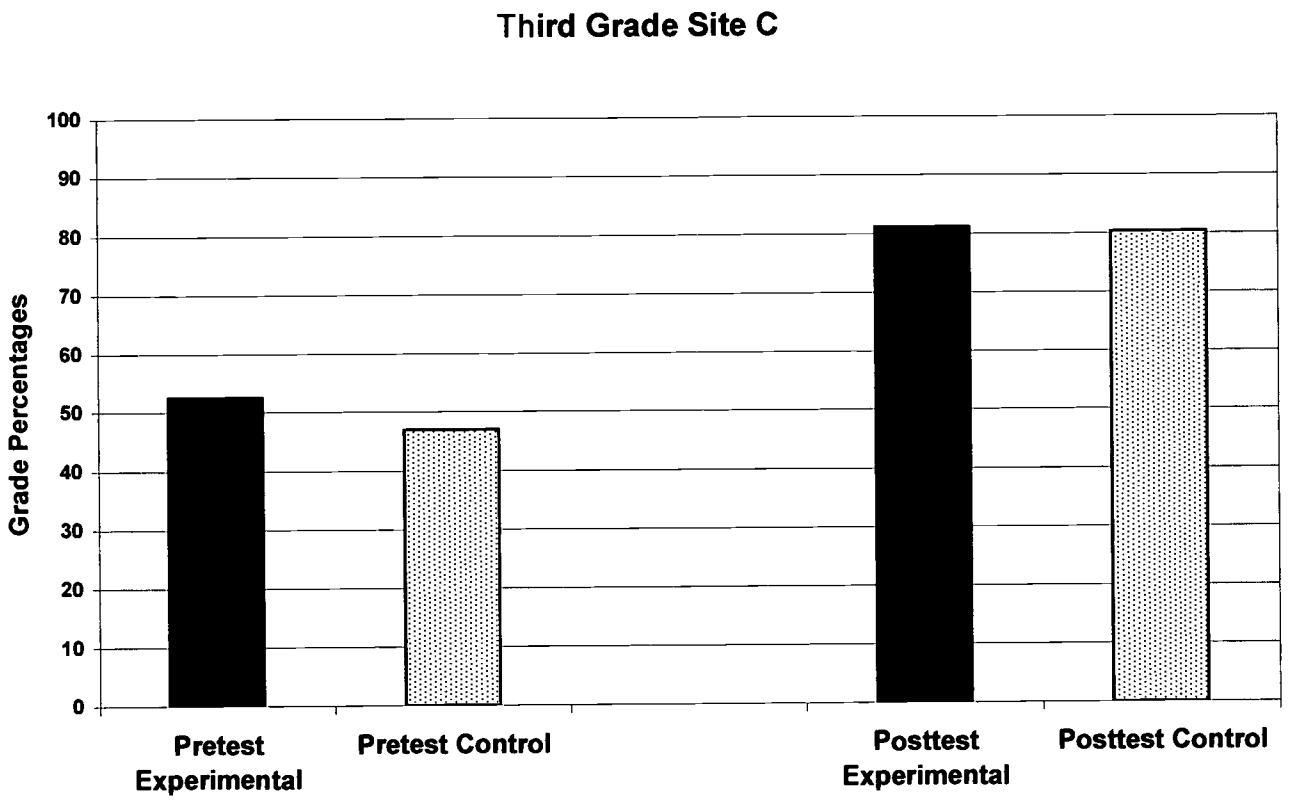

Figure 16. Third grade experimental and control group pretests and posttests.

Figure 16 shows the comparison of the third grade's pretest and posttest average scores of the experimental and control groups. The average pretest scores of the experimental group were 52.6%. The average pretest scores of the control group were 47%. The average posttest scores of the experimental group were 81.2%. The average posttest scores of the control group were 80.3%.

Third grade students at Site C were administered a 30 problem, two minute timed mathematics facts test. The same students were administered the identical test 12 weeks later. One group, the experimental group, used music as an intervention, and the other group, the control group, used no intervention. The experimental group showed a 28.6% increase in scores from the pretest to the posttest and the control group showed a 33.3% increase from the pretest to the posttest.

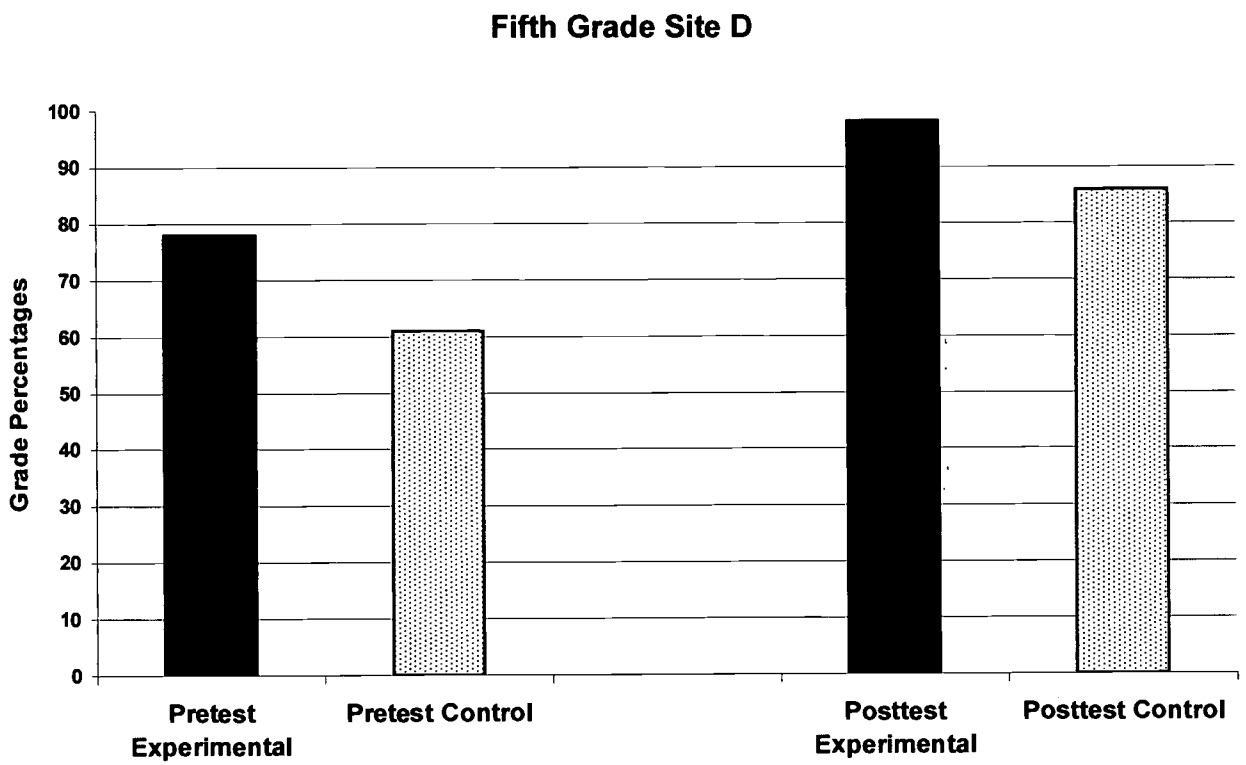

Figure 17. Fifth grade experimental and control group pretests and posttests.

Figure 17 shows the comparison of the fifth grade's pretest and posttest average scores of the experimental and control groups. The average pretest scores of the experimental group were 78%. The average pretest scores of the control group were 60.9%. The average posttest scores of the experimental group were 98%. The average posttest scores of the control group were 85.8%.

Fifth grade students at Site D were administered a 30 problem, two minute timed mathematics facts test. The same students were administered the identical test 12 weeks later. One group, the experimental group, used music as an intervention, and the other group, the control group, used no intervention. The experimental group showed a 20% increase in scores from the pretest to the posttest and the control group showed a 24.9% increase from the pretest to the posttest. Calculations to determine the practical significance of the intervention were done, and they yielded an effect size of 1.4.

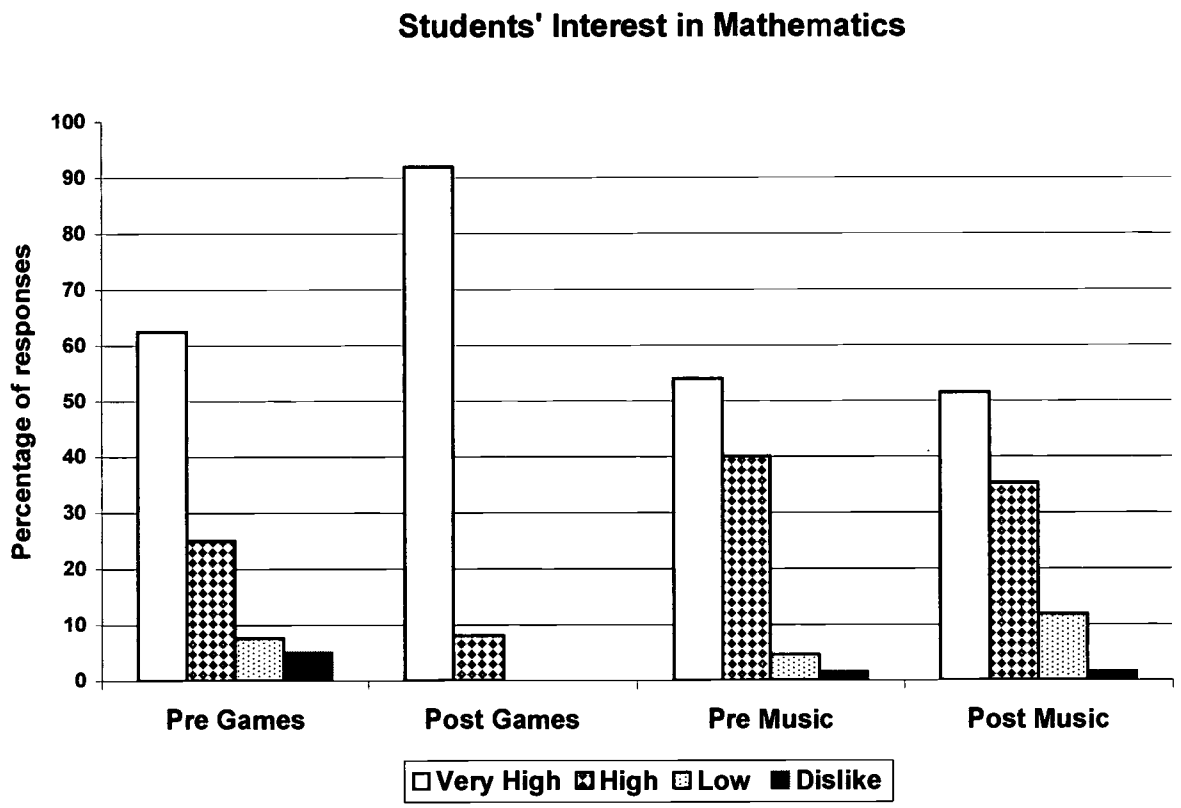

Figure 18. Experimental group students' interest in mathematics before and after intervention.

Figure 18 shows the results of the students' interest in mathematics as recorded on their student surveys before the games or music intervention as well as their interest in mathematics following the games or music intervention.

The teacher-researchers administered student surveys to determine to what degree the students enjoyed mathematics. Students were given these surveys prior to the intervention and at the conclusion of the intervention period. On the pre-student survey, students who would be using games reported that 62.5% of them liked mathematics to a very high degree, 25% of them liked mathematics, 7.5% of them somewhat disliked mathematics, and 5% of them disliked mathematics to a high degree. On the post-student survey, students who used games reported that 91.9% of them liked mathematics to a very high degree, and 8.1% of them liked mathematics. No students reported a dislike of mathematics. On the pre-student survey, students who would be using music as an intervention reported that 53.9% of them liked mathematics to a very high degree, 40% of them liked mathematics, 4.6% of them somewhat disliked mathematics, and 1.5% of them disliked mathematics to a high degree. On the post - student survey, students who used music reported that 51.4% of them liked mathematics to a very high degree, 35.3% of them liked mathematics, 11.8% of them somewhat disliked mathematics, and 1.5% of them disliked mathematics to a high degree. Further analysis indicated that students using games as an intervention reported a 29.4% increase in liking mathematics to a high degree from the pre survey to the post survey. A similar comparison of the music intervention groups indicated a 2.5% decrease in liking mathematics to a high degree from the pre survey to the post survey.

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Conclusions and Recommendations

In an effort to increase student test scores on basic mathematics facts test, the teacher-researchers chose to implement a daily ten minute intervention of mathematics games or mathematics to music. Based on the presentation and analysis of data on mastering basic mathematics facts, the results indicated an increase in the test scores from the pretest to the posttest for all targeted grade levels. This was true regardless of the intervention used. The first, second, third and fifth grade experimental groups all showed an increase in test scores from the pretest to the posttest. The greatest was a 59% increase at the first grade level and the least was a 20% increase at the third grade level. Additionally, the first, second and fifth grade experimental groups exceeded the 85% mastery level. The third grade experimental group did not exceed that level, but did score an 81.2% on the posttest, which indicated moderate mastery.

The researchers were encouraged by the results of the weekly timed tests and the fact that most of the student scores reached or nearly reached mastery level by the end of the intervention period. An exception was at Site C, the third grade group, which did not show a significant effect size when the data was analyzed. The teacher-researcher at Site C attributed this to two possible factors. The first factor was that the teacher of the control group at Site C used daily timed tests with the students, which in itself is an intervention. The second factor was that the teacher of the control group at Site C had recently completed the chapter in the mathematics textbook on addition and subtraction facts, whereas the teacher-researcher at that site had completed that

chapter at an earlier time. This led the researchers to wonder if working on mathematics facts through intervention while simultaneously studying addition and subtraction in the textbook would help students learn their facts. A similar concern was stated by a teacher-researcher at Site A. Control group scores on the posttest exceeded the 85% mastery level. The teacher of the control group agreed not to implement any intervention but was not pleased with the textbook presentation of mathematics facts. To help students learn their facts, the teacher of the control group used additional materials supplied by a publishing company. This took the place of the textbook instruction for the basic mathematics facts. Again, this was another type of intervention used with a control group.

Student scores on the posttest were higher if the students used games as interventions as opposed to music. This led the researchers to conclude that the games intervention was more popular with the students than the music intervention. The researchers concluded from that data that in the games intervention groups students had a variety of activities to do and did not become bored with the routine. On the other hand, students using music for the intervention appeared bored with the music after a while. They also appeared less eager to do the intervention each day. This may also be the reason why more students who used games as their intervention responded on the post surveys that they enjoyed mathematics to a very high degree. This was true at Sites B and C. The student responses from Site D, a music intervention group, reported a very high degree of mathematics enjoyment on their post survey. The researcher at Site D sensed the lack of enthusiasm on the part of the students and incorporated a

game (mathematics facts races at the chalkboard) while listening to the music tapes. Perhaps this helped to alleviate the apparent boredom that the students experienced.

The use of weekly timed tests was a critical component of the interventions in the opinion of the researchers. Students seemed motivated to do well on their weekly tests. Additionally, they seemed to enjoy the competition that timed tests provided. This led the researchers to speculate that perhaps the timed tests themselves were responsible for increased student scores. A further study could be conducted to determine if that were true. A second possible study could have games intervention scores compared to weekly timed test scores to see if there was a significant difference.

A side effect of this research brought an increase in interest towards mathematics instruction on the part of the researchers' peers. Teachers inquired about the interventions being used and seemed impressed that student test scores had increased.

Because the researchers who used music interventions were aware of a lack of student enthusiasm, they recommend that future interventions include a combination of music on cassette tapes or compact discs. Basic mathematics facts video tapes, which are commercially available, could also be incorporated into this intervention.

Finally, the researchers strongly recommend that teachers use mathematics games to help students learn basic mathematics facts. The researchers did not

believe that eliminating music as an intervention was necessary, even if students seemed less motivated. However using a combination of games and music might facilitate student learning of mathematics facts. The final recommendation would be to use either weekly timed tests or short daily timed tests as part of the intervention.

Although in the literature there is a lack of agreement regarding the importance of memorizing basic mathematics facts, nevertheless, the opinion among teachers at the research sites is that learning these facts still has its place in the classroom. The debate over the need to memorize mathematics facts may not be settled soon. However, based on the research conducted in this study, the mastery of basic mathematics facts appears to be possible when ten minutes of daily intervention of games in combination with music are included in the teaching of mathematics.

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Appendices

ERIC

Appendix A

Saint Xavier IRB Forms
Teacher Survey
Parent Survey
Pre Student Survey
Journal Form
Calendars

ERIC

SAINT·XAVIER·UNIVERSITY

Institutional Review Board

Consent to Participate in a Research Study
Improving Mastery of Basic Mathematics Facts in Elementary School Through Various Learning Strategies

Dear Parent or Guardian,

I am currently enrolled in a master's degree program at Saint Xavier University. This program requires me to design and implement a project on an issue that directly affects my instruction. I have chosen to examine strategies for learning math facts.

The purpose of this project is to find the best strategies for learning math facts. It will help your student learn their math facts.

I will be conducting my project from early September till early December. The activities related to the project will take place during regular instructional delivery. The gathering of information for my project during these activities offers no risks of any kind to your child.

Your permission allows me to include your student in the reporting of information for my project. All information gathered will be kept completely confidential, and information included in the project report will be grouped so that no individual can be identified. The report will be used to share what I have learned as a result of this project with other professionals in the field of education.

Participation in this study is completely voluntary. You may choose to withdraw from the study at any time. If you choose not to participate, information gathered about your student will not be included in the report.

If you have any questions or would like further information about my project, please contact me at

If you agree to have your student participate in the project, please sign the attached statement and return it to me. I will be happy to provide you with a copy of the statement if you wish.

Sincerely,

PLEASE RETURN THE ATTACHED STATEMENT TO ME BY Friday, August 31.

3700 West 103rd Street · Chicago, Illinois · (773) 298-3000 · FAX (773) 779-9061

SAINT·XAVIER·UNIVERSITY

Institutional Review Board

Consent to Participate in a Research Study
Improving Mastery of Basic Mathematics Facts in Elementary School through Various Learning Strategies

I, _____, the parent/legal guardian of the minor named below, acknowledge that the researcher has explained to me the purpose of this research, identified any risks involved, and offered to answer any questions I may have about the nature of my child's participation. I freely and voluntarily consent to my child's participation in this project. I understand all information gathered during this project will be completely confidential. I also understand that I may keep a copy of this consent form for my own information.

NAME OF MINOR: _____

_____

Signature of Parent/Legal Guardian Date

3700 West 103rd Street · Chicago, Illinois · (773) 298·3000 · FAX (773) 779·9061

Teacher Survey

1. What grade do you teach? _____

2. Do you feel it is important for students to memorize math facts?

   Yes No

3. When you were in school did you have a hard time memorizing your math facts?

   Yes No

4. When teaching your students math facts, do you use the same methods you were taught as a student?

   Yes No

5. Do you feel that when your students come to you in the fall, that the majority of them have memorized their facts appropriate at your grade level?

   Yes No

6. What methods do you use to help your students learn their math facts? Please check all that apply.

   _____ Flash Cards

   _____ Workbooks/worksheets that accompany the text

   _____ Workbooks/worksheets supplements

   _____ Computer software, please specify

   _____

   _____ Games

   _____ Oral quizzing

   _____ Other, please explain

   _____

7. If there is one method that you have tried that you feel is highly successful, please elaborate.

First/Second Grade Parent Survey

1. Do you think that knowing basic addition facts is important for your child to have memorized?

Yes No

2. How well do you think your child knows his/her addition facts? Please check one.

_____ Knows all _____ Knows some _____ Doesn't know

3. Do you do anything to assist your child in learning their math facts at home?

Yes No

4. If you do work with your child, what do you do? Please check any that applies.

_____ Flash Cards

_____ Store bought workbooks, please specify

_____

_____ Computer software, please specify

_____

_____ Games

_____ Oral quizzing

_____ Other, please explain

_____

Third Grade Parent Survey

1. Do you think that knowing basic addition and subtraction facts is important for your child to have memorized?

Yes No

2. How well do you think your child knows his/her addition and subtraction facts? Please check one.

_____ Knows all _____ Knows some _____ Doesn't know

3. Do you do anything to assist your child in learning their math facts at home?

Yes No

4. If you do work with your child, what do you do? Please check any that applies.

_____ Flash Cards

_____ Store bought workbooks, please specify

_____

_____ Computer software, please specify

_____

_____ Games

_____ Oral quizzing

_____ Other, please explain

_____

Fifth Grade Parent Survey

1. Do you think that knowing basic multiplication facts is important for your child to have memorized?

Yes No

2. How well do you think your child knows his/her multiplication facts from 1 to 12? Please check one.

_____ Knows all _____ Knows some _____ Doesn't know

3. Do you do anything to assist your child in learning their math facts at home?

Yes No

4. If you do work with your child, what do you do? Please check any that applies.

_____ Flash Cards

_____ Store bought workbooks, please specify

_____

_____ Computer software, please specify

_____

_____ Games

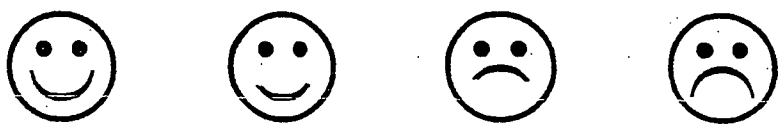
_____ Oral quizzing

_____ Other, please explain

_____

Pre Student Survey

1. How much do you like math? Circle one.



2. How much do you practice your math facts at home? Circle one.

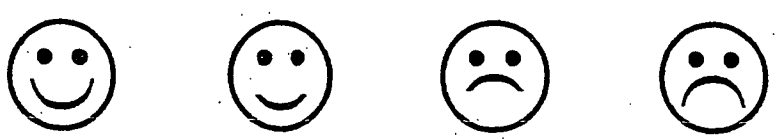
   Every day Almost every day Once in a while Never

3. Does anyone at home help you practice your math facts? Check those that are true.

   _____ Mother _____ Father _____ Brother

   _____ Sister _____Grandparent _____ Other

4. How well do you feel you know your math facts by heart? Circle one.



5. Do you feel that you will do better in math if your math facts are memorized? Circle one.

   Yes No I don't know

Journal Form

Week of

Actions Taken:

Reflection:

PLUSES (+)	MINUSES (-)	INTERESTING (?)

ERIC

September 2001

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

October 2001

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

November 2001

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

December 2001

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Appendix B

Timed Tests
Post Student Survey

ERIC

First Grade Timed Test

3 + 3	0 + 2	2 + 5	6 + 1	0 + 3	4 + 3	1 + 4	3 + 2	7 + 2	5 + 4
1 + 3	4 + 5	5 + 2	3 + 4	1 + 2	6 + 3	1 + 5	8 + 1	4 + 2	0 + 4
0 + 5	4 + 4	5 + 1	2 + 3	7 + 1	2 + 2	2 + 4	6 + 2	3 + 5	5 + 3

First Grade Timed Test

1 + 3	4 + 5	5 + 2	3 + 4	1 + 2	6 + 3	1 + 5	8 + 1	4 + 2	0 + 4
3 + 3	0 + 2	2 + 5	6 + 1	0 + 3	4 + 3	1 + 4	3 + 2	7 + 2	5 + 4
0 + 5	4 + 4	5 + 1	2 + 3	7 + 1	2 + 2	2 + 4	6 + 2	3 + 5	5 + 3

First Grade Timed Test

0 + 5	4 + 4	5 + 1	2 + 3	7 + 1	2 + 2	2 + 4	6 + 2	3 + 5	5 + 3
1 + 3	4 + 5	5 + 2	3 + 4	1 + 2	6 + 3	1 + 5	8 + 1	4 + 2	0 + 4
3 + 3	0 + 2	2 + 5	6 + 1	0 + 3	4 + 3	1 + 4	3 + 2	7 + 2	5 + 4

Second Grade Timed Test

6 + 6	2 + 2	8 + 8	5 + 5	3 + 3	9 + 9	7 + 7	4 + 4	1 + 1	5 + 0
4 + 8	3 + 9	4 + 6	8 + 2	3 + 8	1 + 2	3 + 6	2 + 9	6 + 5	9 + 8
1 + 6	3 + 2	6 + 9	2 + 6	2 + 8	0 + 9	5 + 2	1 + 8	4 + 2	4 + 5

Second Grade Timed Test

3 + 3	9 + 9	7 + 7	4 + 4	1 + 1	5 + 0	6 + 6	2 + 2	8 + 8	5 + 5
3 + 8	1 + 2	3 + 6	2 + 9	6 + 5	9 + 8	4 + 8	3 + 9	4 + 6	8 + 2
2 + 8	0 + 9	5 + 2	1 + 8	4 + 2	4 + 5	1 + 6	3 + 2	6 + 9	2 + 6

Second Grade Timed Test

4 + 8	3 + 9	4 + 6	8 + 2	3 + 8	1 + 2	3 + 6	2 + 9	6 + 5	9 + 8
1 + 6	3 + 2	6 + 9	2 + 6	2 + 8	0 + 9	5 + 2	1 + 8	4 + 2	4 + 5
6 + 6	2 + 2	8 + 8	5 + 5	3 + 3	9 + 9	7 + 7	4 + 4	1 + 1	5 + 0

111

112

Second Grade Timed Test

1 + 6	3 + 2	6 + 9	2 + 6	2 + 8	0 + 9	5 + 2	1 + 8	4 + 2	4 + 5
1 + 2	3 + 6	2 + 9	6 + 5	9 + 8	4 + 8	3 + 9	4 + 6	8 + 2	3 + 8
3 + 3	9 + 9	7 + 7	4 + 4	1 + 1	5 + 0	6 + 6	2 + 2	8 + 8	5 + 5

113

114

Third Grade

Add

4	4	1	2	6	3	9	6
+5	+2	+8	+6	+9	+2	+8	+5

3	2	3	3	4	7	5
+8	+9	+6	+9	+8	+7	+5

Subtract

11	10	7	6	14	11	8	9
- 7	- 9	- 4	- 1	- 8	- 9	- 3	- 9

15	10	13	8	13	10	16
-8	- 8	- 9	- 6	- 8	- 7	- 9

Third Grade

Add

7	3	6	2	3	2	4	5
+7	+9	+5	+9	+2	+6	+2	+5

4	3	3	9	6	1	4
+8	+6	+8	+8	+9	+8	+5

Subtract

10	8	10	9	11	6	10	16
- 7	- 6	- 8	- 9	- 9	- 1	- 9	- 9

13	15	13	8	14	7	11
-8	- 8	- 9	- 3	- 8	- 4	- 7

Third Grade

Add

5	4	3	3	9	6	1	4
+5	+8	+6	+8	+8	+9	+8	+5

7	3	2	3	6	2	4
+7	+9	+9	+2	+5	+6	+2

Subtract

16	13	15	13	8	14	7	11
- 9	- 8	- 8	- 9	- 3	- 8	- 4	- 7

10	8	10	9	11	6	10
-7	- 6	- 8	- 9	- 9	- 1	- 9

Third Grade

Add

4	6	6	3	7	1	3	3
+2	+9	+5	+6	+7	+8	+2	+8

3	5	2	9	2	4	4
+9	+5	+6	+8	+9	+8	+5

Subtract

10	14	9	13	10	7	11	15
- 9	- 8	- 9	- 9	- 7	- 4	- 9	- 8

8	16	6	8	10	13	11
-6	- 9	-1	- 3	- 8	- 8	- 7

Third Grade

Add

4	2	9	2	4	5	3	3
+8	+9	+8	+6	+5	+5	+9	+8

3	1	7	3	6	6	4
+2	+8	+7	+6	+5	+9	+2

Subtract

13	10	8	6	11	16	8	15
- 8	- 8	- 3	- 1	- 7	- 9	- 6	- 8

11	7	10	13	9	14	10
-9	- 4	- 7	- 9	- 9	- 8	- 9

Third Grade

Add

4	2	3	6	2	3	7	4
+2	+6	+2	+5	+9	+9	+7	+5

1	6	9	3	3	4	5
+8	+9	+8	+8	+6	+8	+5

Subtract

10	6	11	9	10	8	10	11
- 9	- 1	- 9	- 9	- 8	- 6	- 7	- 7

7	14	8	15	13	13	16
-4	- 8	- 3	- 8	- 9	- 8	- 9

Third Grade

Add

2	6	3	4	6	3	4	4
+6	+5	+9	+5	+9	+8	+8	+2

3	2	7	1	9	3	5
+2	+9	+7	+8	+8	+6	+5

Subtract

10	9	8	11	14	15	13	10
- 9	- 9	- 6	- 7	- 8	- 8	- 8	- 9

11	10	10	15	8	13	16
- 9	- 8	- 7	- 8	- 3	- 9	- 9

Third Grade

Add

4	2	6	3	2	7	3	4
+2	+6	+5	+2	+9	+7	+9	+5

1	6	9	3	3	4	5
+8	+9	+8	+8	+6	+8	+5

Subtract

10	6	11	9	10	8	10	11
- 9	- 1	- 9	- 9	- 8	- 6	- 7	- 7

7	14	8	13	15	13	16
- 4	- 8	- 3	- 9	- 8	- 8	- 9

Third Grade

Add

5	3	9	1	7	2	3	4
+5	+6	+8	+8	+7	+9	+2	+2

4	6	3	4	3	6	2
+8	+9	+8	+5	+9	+5	+6

Subtract

16	13	8	15	10	10	11	10
- 9	- 9	- 3	- 8	- 7	- 8	- 9	- 9

13	15	14	11	8	9	10
- 8	- 8	- 8	- 7	- 6	- 9	- 9

Third Grade

Add

4	5	3	9	3	6	1	4
+8	+5	+6	+8	+8	+9	+8	+5

7	3	2	6	3	2	4
+7	+9	+9	+5	+2	+6	+2

Subtract

13	16	13	15	8	14	7	11
- 8	- 9	- 9	- 8	- 3	- 8	- 4	- 7

10	8	10	9	11	6	10
- 7	- 6	- 8	- 9	- 9	- 1	- 9

Third Grade

Add

4	4	2	9	2	5	3	3
+5	+8	+9	+8	+6	+5	+9	+2

3	7	1	3	6	6	4
+8	+7	+8	+6	+5	+9	+2

Subtract

11	13	10	8	6	16	8	15
- 7	- 8	- 8	- 4	- 1	- 9	- 6	- 8

11	7	10	13	9	14	10
- 9	- 4	- 7	- 9	- 9	- 8	- 9

Third Grade

Add

4	6	6	3	7	1	3	3
+2	+9	+5	+6	+7	+8	+2	+8

3	5	4	2	9	2	4
+9	+5	+5	+6	+8	+9	+8

Subtract

10	14	9	13	10	7	11	15
- 9	- 8	- 9	- 9	- 7	- 4	- 9	- 8

8	16	11	6	8	10	13
-6	- 9	- 7	- 1	- 3	- 8	- 8

Third Grade

Add

7	9	5	9	2	6	2	5
+7	+3	+6	+2	+3	+2	+4	+5

8	6	8	8	9	8	5
+4	+3	+3	+9	+6	+1	+4

Subtract

10	9	6	16	10	11	8	10
- 8	- 9	- 1	- 9	- 7	- 9	- 6	- 9

8	7	13	11	15	13	14
-3	- 4	- 8	- 7	- 8	- 9	- 8

Third Grade

Add

5	8	9	8	6	8	5	8
+4	+1	+6	+9	+3	+3	+5	+4

2	6	2	9	5	9	7
+4	+2	+3	+2	+6	+3	+7

Subtract

14	13	15	11	13	7	8	10
- 8	- 9	- 8	- 7	- 8	- 4	- 3	- 9

8	11	10	16	6	9	10
-6	- 9	- 7	- 9	- 1	- 9	- 8

Nam _____

Multiplication Timed Test
(2 minutes)
5th grade

7 x 6	3 x 9	12 x 4	5 x 5	5 x 4	5 x 3	12 x 8	8 x 5	2 x 8	6 x 4
9 x 8	4 x 1	6 x 5	1 x 8	4 x 9	12 x 7	1 x 9	2 x 2	2 x 7	2 x 9
3 x 7	6 x 5	1 x 3	2 x 4	4 x 3	5 x 1	5 x 5	4 x 7	12 x 6	12 x 12

Name_____

Multiplication Timed Test
(2 minutes)
5th grade

3 x 7	2 x 8	12 x 4	5 x 5	5 x 4	5 x 8	12 x 8	3 x 3	6 x 4	8 x 5
7 x 5	2 x 7	6 x 5	1 x 8	4 x 9	12 x 7	1 x 9	4 x 1	2 x 9	2 x 2
9 x 9	12 x 5	1 x 3	2 x 4	4 x 3	5 x 1	5 x 5	6 x 5	12 x 12	4 x 7

Name_____

Multiplication Timed Test
(2 minutes)
5th grade

2 x 9	2 x 2	9 x 8	12 x 6	1 x 3	2 x 4	4 x 3	5 x 1	5 x 6	6 x 6
6 x 4	8 x 5	7 x 6	2 x 7	6 x 5	1 x 8	4 x 9	12 x 7	1 x 9	4 x 1
12 x 12	4 x 7	3 x 7	2 x 3	12 x 4	5 x 5	5 x 4	5 x 8	12 x 8	3 x 8

Name _____

Multiplication Timed Test
(2 minutes)
5th grade

7 x 6	3 x 9	12 x 4	5 x 5	5 x 4	5 x 8	12 x 8	8 x 5	2 x 8	6 x 4
9 x 8	4 x 1	6 x 5	1 x 8	4 x 9	12 x 7	1 x 9	2 x 2	2 x 7	2 x 9
3 x 7	6 x 6	1 x 3	2 x 4	4 x 3	5 x 1	5 x 6	4 x 7	12 x 5	12 x 12

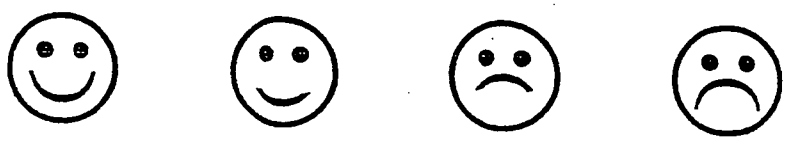
Name_____

Multiplication Timed Test
(2 minutes)
5th grade

2 x 9	2 x 2	9 x 8	12 x 5	1 x 3	2 x 4	4 x 3	5 x 1	5 x 5	6 x 6
6 x 4	8 x 5	7 x 5	2 x 7	6 x 5	1 x 8	4 x 9	12 x 7	1 x 9	4 x 1
12 x 12	4 x 7	3 x 7	2 x 3	12 x 4	5 x 5	5 x 4	5 x 8	12 x 8	3 x 3

Post Student Survey

1. How much do you like math? Circle one.



2. How much do you practice your math facts at home? Circle one.

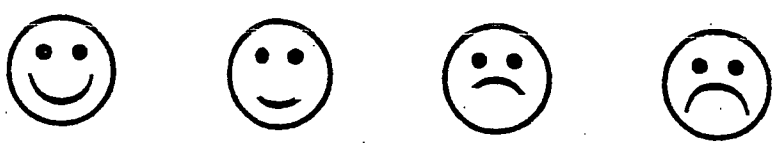
   Every day Almost every day Once in a while Never

3. Does anyone at home help you practice your math facts? Check those that are true.

   _____ Mother _____ Father _____ Brother

   _____ Sister _____Grandparent _____ Other

4. How well do you feel you know your math facts by heart? Circle one.



5. Do you feel that you will do better in math if your math facts are memorized? Circle one.

   Yes No I don't know

Appendix C

Lesson Plans

ERIC

Lesson Plan - First Grade
First 10 minutes of Math Class

Name of Game Intervention: Dice Addition

Targeted Group: Whole Class

Objective: Students will increase knowledge of addition facts through a game format.

Procedure:

1. Teacher passes out two dice to students, paired with a partner
2. Students alternate rolling dice on desktop and call out sums.
3. Play continues with partners for ten minutes, each checking each other's answers.

ERIC

Lesson Plan - First Grade
First 10 minutes of Math Class

Name of Game Intervention: Dominoes

Targeted Group: Whole Class

Objective: Students will increase knowledge of addition facts through a game format.

Procedure:

1. Teacher passes out two or more dominoes to students paired with a partner.
2. Students alternate adding two dominoes together and call out the sums.
3. Students check each other's sums.
4. Play continues for ten minutes. When time permits, procedure may be repeated with two new dominoes.

ERIC

Lesson Plan - First Grade
First 10 minutes of Math Class

Name of Game Intervention: Group Flashcards

Targeted Group: Whole Class

Objective: Students will increase knowledge of addition facts through a game format.

Procedure:

1. Students are divided into groups of four students, one student as a captain.
2. Each group is given flashcards with sums of ten or less.
3. The captain holds one flashcard up for the students to see. The students try to say the correct answer first.
4. The game continues for ten minutes. Captains may change during this time.

ERIC

Lesson Plan - First Grade
First 10 minutes of Math Class

Name of Game Intervention: Addition Bingo

Targeted Group: Whole Class

Objective: Students will increase knowledge of addition facts through a game format.

Procedure:

1. Each student receives a bingo card with sums of ten or less.
2. Teacher calls out an answer. If the student has a problem that equals the answer, he/she puts a marker on it.
3. Students are allowed to use counters.
4. The student who has bingo first is the winner.
5. The bingo game is played for ten minutes.

ERIC

Lesson Plan - First Grade
First 10 minutes of Math Class

Name of Game Intervention: Around the World

Targeted Group: Whole Class

Objective: Students will increase knowledge of addition facts through a game format.

Procedure:

1. Teacher uses flashcards with sums of ten or less.
2. Two students are shown the same flashcard. The student that says the correct answer first, moves on to the next student.
3. I have the student stop at six students, to give more an opportunity to participate. Adjustments can be made, according to class size.
4. Students may say only one answer.
5. If both students say the answer at the same time, another flashcard is given.
6. The game continues for ten minutes.

2nd Grade
Lesson Plan (first ten minutes of math class)

Name of game intervention: Addition Facts with playing cards
Targeted Group: Whole class
Objective: Students will increase knowledge of addition facts through game format
Procedure:
1. Teacher passes out 1/2 deck of cards to every two students.
2. Students take turns turning over two cards at a time, showing them to partner. Partner must add up the value of the cards. Face cards = 10 Ace=1
3. Play then goes to the partner, who then turns over two cards to other player.

Alternate game:
Teacher tells partners to keep turning over cards until a certain value is reached, such as 16 or 18. If cards total over that number, discard that card and continue turning over cards until 16 or 18 is reached.

2nd Grade
Lesson Plan (first ten minutes of math class)

Name of game intervention: Ball toss
Targeted Group: Whole class
Objective: Students will increase knowledge of addition facts through game format

Procedure:
1. Teacher uses plastic or other soft ball (such as a nerf ball) about the size of a softball. Using a marker teacher writes numbers all over the ball from 0 to 12.
2. Students sit on desktop and the first student with the ball tosses it to classmate.
3. Classmate should catch ball with two hands. Student looks at the two numbers that right and left thumb are covering. Student adds those two numbers together then tosses ball to another classmate.

Alternate game:
Students sit in circle and roll the ball across circle to classmate. Divide class into two groups, using two balls. More students get turns.

2nd Grade
Lesson Plan (first ten minutes of math class)

Name of game intervention: Math fact races
Targeted Group: Whole class
Objective: Students will increase knowledge of addition facts through game format

Procedure:

1. Teacher passes out dry erase boards,marker, and eraser to each student.

2. Students are divided into two teams

3. Teacher calls out a math fact, such as 8 + 6. Students writes answer on white board and quickly hold up the board for checking.

4. Teacher predetermines how many students need to have it correct before the winning team is awarded a point. For example, if there are 8 people on a team, teacher may want 5 students to have the correct answer in order to win the point.

5. Team with the most points at the end of the 10 minutes wins.

6. This game is best played with two adult judges since it is difficult to look at both teams at the same time.

ERIC

Lesson Plan - First Grade
First 10 minutes of Math Class

Name of Game Intervention: Around the World

Targeted Group: Whole Class

Objective: Students will increase knowledge of addition facts through a game format.

Procedure:

1. Teacher uses flashcards with sums of ten or less.
2. Two students are shown the same flashcard. The student that says the correct answer first, moves on to the next student.
3. I have the student stop at six students, to give more an opportunity to participate. Adjustments can be made, according to class size.
4. Students may say only one answer.
5. If both students say the answer at the same time, another flashcard is given.
6. The game continues for ten minutes.

ERIC

2nd Grade
Lesson Plan (first ten minutes of math class)

Name of game intervention: Dice addition
Targeted Group: Whole class
Objective: Students will increase knowledge of addition facts through game format

Procedure:

1. Teacher passes out two dice to students paired up with a partner.

2. Students alternate rolling dice on desktop and call out the sum.

3. Play continues with partners for ten minutes.

2nd Grade
Lesson Plan (first ten minutes of math class)

Name of game intervention: Flash card practice
Targeted Group: Whole class
Objective: Students will increase knowledge of addition facts through game format

Procedure:

1. Teacher divides class into two groups, who stand in two lines.

2. Two students come forward and are shown a flash card with addition fact.

3. First student with right answer gets to keep the card.

4. Play continues for ten minutes.

Alternate pairings:
girls vs. boys
tables 1, 2, 3 vs. tables 4, 5, 6

Second Grade Lesson Plans

Lesson Plans for Math Lessons for the Week of:_____

12:00-12:10 Math Intervention- use math addition tape to practice math facts

12:10-12:45 Math Lesson

ERIC

Third Grade Lesson Plan

The intervention was implemented from 8:30 to 8:40 daily. It was a part of the opening activities for each day.

Monday-Review one previously learned song
-Introduce two new songs

Tuesday-Review the two new songs that were learned on Monday
-Introduce one more new song

Wednesday-Review the three new songs for the week

Thursday-Review the three new songs for the week

Friday-Review songs from this week and from last week

ERIC

Friday 5th grade

8:45-9:00	OPENING ACTIVITIES pledge attendance D.O.L.
9:00-9:45	READING
9:45-10:23	SPELLING/WRITING
10:25-11:00	P.E.
11:03-11:38	SCIENCE
11:40-12:15	MATH warm-up Listen to 10 min. of multiplication tape.
12:18-12:53	LUNCH
1:00-1:30	CURRENT EVENTS/TIME MAGAZINE.
1:30-2:00	CREATIVE WRITING
2:00-2:30	GUIDANCE
2:35-3:05	SPANISH
3:03-3:18	CLOSING Mailboxes Assignment notebooks

Appendix D

Fact Power Table
Modified Lesson Plans

ERIC

Date Time

Fact Power Table

0 + 0	0 + 1	0 + 2	0 + 3	0 + 4	0 + 5	0 + 6	0 + 7	0 + 8	0 + 9
1 + 0	1 + 1	1 + 2	1 + 3	1 + 4	1 + 5	1 + 6	1 + 7	1 + 8	1 + 9
2 + 0	2 + 1	2 + 2	2 + 3	2 + 4	2 + 5	2 + 6	2 + 7	2 + 8	2 + 9
3 + 0	3 + 1	3 + 2	3 + 3	3 + 4	3 + 5	3 + 6	3 + 7	3 + 8	3 + 9
4 + 0	4 + 1	4 + 2	4 + 3	4 + 4	4 + 5	4 + 6	4 + 7	4 + 8	4 + 9
5 + 0	5 + 1	5 + 2	5 + 3	5 + 4	5 + 5	5 + 6	5 + 7	5 + 8	5 + 9
6 + 0	6 + 1	6 + 2	6 + 3	6 + 4	6 + 5	6 + 6	6 + 7	6 + 8	6 + 9
7 + 0	7 + 1	7 + 2	7 + 3	7 + 4	7 + 5	7 + 6	7 + 7	7 + 8	7 + 9
8 + 0	8 + 1	8 + 2	8 + 3	8 + 4	8 + 5	8 + 6	8 + 7	8 + 8	8 + 9
9 + 0	9 + 1	9 + 2	9 + 3	9 + 4	9 + 5	9 + 6	9 + 7	9 + 8	9 + 9

Modified Third Grade Lesson Plan

The intervention was implemented from 8:30 to 8:40 daily. It was a part of the opening activities for each day.

Monday-Review two previously learned song
-Discuss melodies that would be good to use for creating our own class song

Tuesday-Begin to write the words for the song

Wednesday-Finish creating the words for the song
-Sing the newly created song

Thursday-Sing the newly created song
-Review the songs learned from last week

Friday-Review the new song
-Review songs learned last week

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Thursday 5th grade

8:45-9:00	OPENING ACTIVITIES pledge attendance D.O.L.
9:00-9:45	READING
9:45-10:23	LANGUAGE ARTS
10:25-11:00	P.E.
11:03-11:38	SCIENCE
11:40-12:15	MATH warm-up 10 min. of listening to mult. tape while 4 students at a time race to write the answers on the board
12:18-12:53	LUNCH
1:00-1:20	Guided Reading
1:20 –1:57	SOCIAL STUDIES
2:00-3:00	ART
3:05-3:13	CLOSING Mailboxes Assignment notebooks

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