The Effects of Using Distributed Practice on Math Performance

By Lynn Lesneski

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Dr. Donald L. Platz

The Graduate School

University of Wisconsin – Stout

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The Graduate College

University of Wisconsin-Stout

Menomonie, Wisconsin 54751

ABSTRACT

Lesneski	Lynn	A.	
(Writer)(Last Name)	(First)	(Initial)	

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As a result of the federal No Child Left Behind Act that requires all states to test all students in reading and mathematics in grades 3 through 8 and once in high school, schools are looking for ways to increase their students' math performances. Student math performances on these tests will determine the adequate yearly progress on students in school, district, and state levels. If schools do not show adequate achievements on these tests, they will not get the funding that is needed. The purpose of this group comparison/quasi experimental study was to determine the level of difference in test scores on a mathematical division posttest administered to two fifth grade multi-categorical math groups that differed in the math instruction administered prior to the posttest. Previous literature showed that there was a link between using the distributed practice in teaching mathematics and an increase in retention of material. Studies have also shown that distributed practice has produced higher levels of student learning. Therefore, the null hypothesis for this study that there is no statistically significant difference between academic achievements for fifth grade students in the multi-categorical classroom for those students who received distributed practice methods of instruction as compared to those who received regular practice methods. The null-hypothesis was tested and it was accepted.

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Chapter I: Introduction

We live in a time of extraordinary and accelerating change. New knowledge, tools, and ways of doing and communicating mathematics continue to emerge and evolve. The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase. The authors of *Principles and Standards* believe in this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. A lack of mathematical competence keeps those doors closed (NCTM, 2000).

Beginning in the 2005-2006 school year, the federal No Child Left Behind Act requires all states to test all students in reading and mathematics in grades 3 through 8 and once in high school. Student performances on these tests will be used to determine the adequate yearly progress on students in school, district and state levels according to the Wisconsin Student Assessment System which has provided Wisconsin schools with an informational paper that provides objectives and sub-skills for districts to follow. The No Child Left Behind Act of 2001 stems from the Elementary and Secondary Education Act (ESEA) of 1965. According to the Wisconsin Department of Public Instruction, congress completed a major reform of the ESEA and as a result the No Child Left Behind Act of 2001 (NCLB) was passed into law on January 8, 2002. The NCLB has changed the role the federal government plays in K-12 education, which is supposed to help with the achievement gap between disadvantaged and minority students and their peers. The No Child Left Behind Act presents real obstacles for many school districts and has left many districts struggling to find ways to fund this program due to decreasing budgets.

According to the book, *Adding It Up: Helping Children Learn Mathematics*, one area in which research evidence is consistent is the weaknesses in the mathematical performances of U.S. students. State, national, and international assessments conducted over the pass 30 years indicate that U.S. students tend to have limited understanding of basic mathematical concepts. They are also deficient in their ability to apply mathematical concepts (2001). The Center for Education that published *Adding It Up* do recognize that performance in mathematics is generally low, there are signs from national assessments that it has been improving over the past decade. They also mention that a number of schools and states have students' mathematical performances that are among the best in the world. The evidence suggests, however, that many students are still not being given the educational opportunities they need to achieve at high levels.

Schools are struggling because they know that if students' test scores do not improve, they will not get the funding that is needed. Many districts are looking at reevaluating their curriculum. They are looking for ways to increase their math and science excellence. Schools are looking for ways to develop instruction that is aimed at developing proficiency in mathematics and science. In the book, *Adding It Up: Helping Children Learn Mathematics,* they discuss what much of the research has shown on teaching mathematics. They discuss ways schools can develop instruction that leads to math proficiency. One area they focus on is the research that can be found about effective instruction and what is known about learning. They look at ways of teaching that will promote learning over time so that it yields mathematical proficiency.

A common practice that is used in U.S. mathematics classroom is the practice of using the textbook and worksheets that provide students with frequent and repeated opportunities to practice what they have learned. Usually the practice is directly related to the topic of the lesson. Students usually continue their practice until they have mastered the lesson (Adding It Up, 2001). This type of practice is not reliable to insure successful long-term learning. Practicing a skill over a few days or even weeks is no guarantee of long-term learning. An great example that shows this is when you look at how few people can recall and recite the opening phrase of the preamble to the Constitution, which only has 52 words, but most of us can remember the "Pledge of Allegiance" that we recited daily for many of years (Dempster, 1991). Research shows that practice is most effective when repetition is distributed over time. The National Research Council discusses such a practice in which they call this distributed practice. They state that on any one day, only a few of the exercises assigned might address the lesson topic, and the rest would address topics studied earlier in the year. They believe that such practice is based on the principle that mastery is achieved gradually and once achieved is maintained through regular practice (2003).

So how does one increase accuracy and increase retention in mathematics for the multi-categorical classroom? A review of the literature showed that there was a link between using the distributed practice in teaching mathematics and an increase in retention of material. Studies have also shown that this distributed approach has produced significantly higher levels of student learning. Therefore, the research hypothesis for this study was that students who were taught with distributed practice techniques would demonstrate academic achievement that was at least comparable to students who were not taught with the distributed practice in teaching mathematics.

Statement of the Problem

With the recent passage by the federal government of the No Child Left Behind Act, school districts have been struggling to find ways to improve their math performance due to the high stake testing brought forth by this NCLB. Schools are under pressure because they know that if students' test scores do not improve, they will not get the adequate funding that is needed.

Purpose of the Study

The purpose of the study was to determine the level of difference in test scores as measured by the Scott Foresman - Addison Wesley Grade Five Achievement Test on Two Digit Divisors in Division for two Grade 5 multi-categorical math groups in a rural Northern Wisconsin school, who differ in the math instruction administered prior to the posttest. This study will look at two different methods for teaching Grade 5 students mathematics to see if one specific method of instruction, the distributed practice, can address some of the problems schools are having with low test scores verses the standard way of teaching mathematics in which instruction has been shaped under the assumption that most students can learn things quickly, and once they have demonstrated this learning, further practice is unnecessary.

Research Hypothesis

The following null hypothesis was tested. There is no statistically significant difference between academic achievements for fifth grade students in the multi-categorical classroom for those students who received distributed practice methods of instruction as compared to those who received the regular classroom teaching methods.

Definition of Terms

For clarity of understanding, the following terms need to be defined.

Distributed practice method - A practice schedule in which sessions are separated by other learning activities. Often used interchangeable with the term spaced practice.

Multi-categorical – classroom containing regular education students, Title I Math, Learning Disabled, and Speech and Language students.

Learning Disability – A disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations (U.S. Office of Education, 1977).

Assumptions

It was assumed that the classroom instructor did carry out the lesson plans as dictated for this study.

Limitations

Limitations that may be evident in this study were:

1. The small sample number of the two classrooms that were used.
2. There may be a difference in the multi-categorical classrooms in terms of ability and achievement levels.
3. Students may also have felt they were rushed through posttest due to time constraints of only having 48 minutes to complete test. Students may have been able to finish more problems more thoroughly if time was not an issue.

4. The duration of the study limited the amount of time the students were exposed to the distributed practice of instruction.

Summary

Educators need to make some reforms in curriculum and in their approach to teaching mathematics if they want their students to keep up with the ever-changing world. With the recent No Child Left Behind Act, school districts need to ensure the adequate yearly progress on student achievement if they want to continue their funding in this time of decreasing budgets. The distributed practice method for teaching mathematics is one way that educators can help improve student achievement in their classroom.

The following chapters will include a review of the literature, methodology used for this study, and finally, results and a discussion of this study will be presented.

Chapter II: Review of Literature

The mathematics that students need today is not the same mathematics that their parents and grandparents needed to learn. In a book written by the NCTM, they believe that all young Americans must learn to think mathematically, and they must think mathematically to learn. The Council expresses concerns that too few students in elementary and middle schools are not successfully acquiring the mathematical knowledge, the skill, and the confidence they need to use the mathematics they have learned (2001).

In the recent publication of *Principles and Standards for School Mathematics*, they believe that those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Being mathematically competent can open doors to a more productive future. The council believes the need to understand and be able to use mathematics in everyday life and in the workplace have never been greater and will continue to increase (2000).

In an article written by the U.S. government in which they discussed findings from the 2000 National Assessment of Educational Progress (NAEP), they report that only a quarter of our fourth and eight graders are performing at or above proficient levels in math. Twelfth-grade math scores have not improved since 1996. From these scores, the NAEP found that the biggest drop in scores came from the lower level achievers. These are the students who most need our help and cannot lose any more ground in mathematics. With these findings, it becomes important to examine why our mathematics curriculums are struggling in the United States and how this affects students learning outcomes.

This study will investigate methods of instruction in mathematics, concentrating on the method of distributed practice in teaching math. Distributed practice is a method in which the teacher develops a practice schedule where math sessions are separated by other learning activities. Research has shown that if educators make learning more memorable, students would show greater long-term retention of knowledge and skills. This study will look at three areas in which distributed practice can play a role in creating a learning environment where learning is taking place and with greater long term retention of knowledge and skills; they are reducing the size of curriculum, understanding how students learn, and types of practice to help students enhance learning outcomes.

Reduce Size of Curriculum

Dempster stated that the sheer size of the curriculums being taught in the United States is too overwhelming. He discusses three types of curriculums that are predominate in American schools today and how they base their curriculum on three beliefs about human learning. First, curriculum is driven on the basis that "more is better," and the more that can add meaning to a lesson the more it will assist learning. Second, there seems to be a belief among educators that if we expose students to information, with little or no risk to overload, that knowledge cannot hurt. Third, curriculum has been shaped under the assumption that most students can learn things quickly, and once they have demonstrated this learning, further practice is unnecessary (1993).

Dempster believes that textbooks present an abundance of material and encourage educators to address a wide range of topics. He says that teachers are looking to textbooks to help guide them when they decide what to teach. Textbooks are packed with information that often takes away from the real point of the lesson. They are packed with dates, names, and details that offer what researchers call "elaborations," which is material that takes away from the central information (1993).

The NCTM discusses the importance of curriculum developers who are responsible for establishing curriculum frameworks need to focus on important mathematics. They believe schools should focus mathematics content and processes that are worth the time and attention to students and that will be useful in solving problems within or outside of mathematics. They believe that curriculum needs to be clearly articulated across all grades, and gives teachers guidance regarding important ideas or major themes. The NCTM believes curriculums should also give guidance about depth of study warranted at particular times and when closure is expected for particular skills or concepts (2000). With this guidance, educators can eliminate much of the extra, or abundance of material that is not necessary to achieve specific goals.

The NCTM compares curricula in the United States with countries achieving well on international comparisons, and the U.S. curriculum in mathematics has been characterized as "shallow, undemanding, and diffuse in content coverage." They also compare U.S. math textbooks to other countries and in the U.S. they show that textbooks cover more topics more superficially than other countries do. The Council also says the instruction that U.S. students are given continues to emphasize paper and pencil skills (2001).

In order for effective learning to take place, curricula and textbooks need to focus on providing relevant information and should not digress too far from the point that the teacher is trying to make. In order to promote classroom learning, scholars and educators believe that decreasing the size of the curriculum will benefit students. "Exposing students to less material but in more depth will lead to greater learning than the current practice of exposing students to a large amount of often disconnected information. In order for effective learning to take place, in addition to exposing students to less material, educators need to frequently distribute practice over time. Reducing the amount of material covered by curriculums and textbooks can only do this (Dempster, 1993). "Distributed practice is based on the principal that mastery is achieved gradually and once achieved is maintained through regular practice (National Research Council, 2001)."

Understanding How Students Learn

In order for educators to better understand how students learn, we need to take a look at memory. Memory is important for educators to understand, and the role it plays in the teaching and the learning process. Alison Banikowski, states, "If we cannot commit knowledge or skills to memory, even briefly, how can we know they have learned the knowledge or skill?" Banikowski goes on to say, in order for educators to ensure that students attend to learning, attach new learning to previous learning, and actively engage students in learning in order to construct meaning and demonstrate their learning, educators need to help learners be able to organize, store, and retrieve knowledge and skills. This all requires memory (1999).

Richard L. Bucko called, talks about cognitive psychologists that have identified two types of memory systems that we possess. The "what" memory system and the "how-to" memory both store information in the short-term holding area. The "what" memory holds facts such as faces, names, and dates. The "how-to" preserves skills such as reading. Both of these memory systems are held in the short-term holding area for only a few moments. Some of the memories are converted to long-term storage and may last for years. The "what" memory tends to fade quickly, but the "how-to" memory can last a lifetime. The article continues to discuss certain memory-enhancing strategies, such as repetition and association as effective ways to make growing connections between neurons in your brain. Actual changes are made in the brain depending on the experience and type of practice that will lead to greater long-term retention. Over time, when students are given opportunities to think and speak about topics and then do hand-on activities, this will help with long-term retention (1997). "Frequent distributed practice helps students maintain and develop concepts and skills early on and it gives them the time needed to find appropriate and meaningful ways of integrating information from a variety of sources (Dempster, 1993). Which will lead to greater long-term retention of concepts being learned.

S.A.S Crawford and D. Baine found that distributed practice has been shown to be effective in increasing retention in elementary, middle school, and special education, and students who possessed severe handicaps. Their study used distributed practice in a variety of educational settings and was used with teaching a variety of subject matter such as teaching sound-symbol correspondence, to enhance spelling performance, and teaching life-skills. Crawford and Baine found that distributed practice has been successfully used to increase long-term retention. This method is also sensitive to the individual differences and can be an effective method for increasing retention for students with a variety of learning abilities (1992).

Types of Practice

The most common kinds of practice used in the United States mathematics classroom are the textbook and worksheet exercises to reinforce material. Often the practice is directly related to the topic of the lesson. Students practice the material until they can perform independently (National Research Council, 2001). Another approach that has been discussed throughout this paper is the use of the distributed practice.

Dr. Carolyn Hopper offers a Study Skills Help Page in which she uses the principal of distributed practice to help students remember things and to optimize their learning. She believes distributed practice allows time for you to build basic background knowledge and can be used to optimize learning. She offers a few tips on how to use the distributed principal to help students study materials in an effective way where learning will take place and knowledge will be stored in memory (2005).

The Saxon Math Series also uses the distributed practice approach as a basis for their math series. Saxon math has designed its series on the foundation that each increment of learning builds on the foundation of earlier increments, which leads to a deeper understanding of mathematical concepts. "The authors of *Saxon Math* began developing the series by first breaking complex concepts into related increments, recognizing that smaller pieces of information are easier to teach and easier to learn. Then they systematically distributed the instruction, practice and assessment of those increments across a grade level." They use this as a basis of their series, instead of the massed presentations that are found in programs that have chapter-based approach. Authors of *Saxon Math* have completed research on this idea of distributed practice. Through research and further studies, authors of *Saxon Math* have confirmed that distributed practice is more effective in a variety of subjects including mathematics. They believe that continual, distributed practice continually across each grade level ensures that concepts are committed to students' long-term memory (Saxon Publishers, 2002-2003).

Summary

Having reviewed the literature on these three points, it is evident that educators need to make some reforms in curriculum and in their approach to teaching mathematics. In order for students to be successful in maintaining and using the knowledge they have gained, educators need to ensure students are attending to learning, and are able to organize, store, and retrieve knowledge and skills. The distributed practice method for teaching mathematics is one way that educators can help improve student achievement in their classroom.

Chapter III: Methodology

Introduction

This chapter will describe the subjects under study and how they were selected for inclusion in this study. In addition, the instruments being used to collect information will be discussed as to their content, validity, and reliability. Data collection and analysis procedures will then be presented.

The following null hypothesis was tested. There is no statistically significant difference between academic achievements for fifth grade students in the multi-categorical classroom for those students who received distributed practice methods of instruction as compared to those who received the regular classroom teaching methods.

The purpose of the study was to determine the level of difference in test scores as measured by the Scott Foresman - Addison Wesley Grade Five Achievement Test on Two Digit Divisors in Division for two Grade 5 multi-categorical math groups in a rural Northern Wisconsin school, who differ in the math instruction administered prior to the posttest. This study will look at two different methods for teaching Grade 5 students mathematics to see if one specific method of instruction, the distributed practice, can address some of the problems schools are having with low test scores verses the standard way of teaching mathematics in which instruction has been shaped under the assumption that most students can learn things quickly, and once they have demonstrated this learning, further practice is unnecessary.

Subjects

The subjects of the study were students from a rural school in Northwest Wisconsin. The community school has a school population of 185 students in Pre K through sixth grade. The students for this study were chosen from two multi-categorical fifth grade classrooms in the fall of the 2004-2005 school year. Both classrooms "A" and "B" contained students with varying abilities. Students were randomly placed in either Group A or Group B. Neither the researcher nor the classroom teacher had anything to do with the way each group was set up.

There was one teacher for both groups "A" and "B" and has taught for 19 years. Group "A" students were in a class of 12 students (six boys and six girls). This class included two speech and language students, one learning disabled student in mathematics, and one OHI (Other Heath Impairment) student.

Group "B" had a class size of 14 students (eight boys and six girls). This group of students included six Title I mathematics students and two speech and language students.

Before students took part in the study, a written consent form was sent home to all student participants (Appendix A). With 100% approval from parents and guardians, the study was ready to be administered.

Instrumentation

The Chapter Five Division Pretest and Posttest were taken from the *Scott Foresman-Addison Wesley* Fifth Grade Math Series (Appendix C and D). The tests were modified only to eliminate the problems that dealt with using algebraic expressions, which would have distracted from the study. Both Groups A and B were administered the same pretest and posttest and both groups had to the same problems and identical number of problems to complete for each test (Appendix E and F).

Daily instructional materials were also taken from the *Scott Foresman-Addison Wesley* Fifth Grade Math Series either from the textbook or resource workbooks

(Appendix G-M). The independent variable was the method of instruction given to control group (Group A) and the experimental group (Group B).

This rural school district in Northwest Wisconsin has adopted the *Scott Foresman-Addison Wesley* math program as the core tool through which math curriculum is implemented for grades K-6. The pretest and posttest used are standard publications by a recognized publishing company.

Data Collection-Procedure

Since the focus of the study was to determine if the multi-categorical classroom students performed equally as well on a math test as a function of the mathematics instructional method to which they have been exposed, it was essential to identify any initial differences between the two groups' math ability.

Prior to the study, students from both multi-categorical classrooms, Group A and B, were given the same pretest. The results of the pretest where analyzed and used to determine initial group equivalence by means of a t-test for independent means. See Table 1 below. A list of pretest scores can be found on Appendix B.

The results indicated that there was no statistically significant difference between Groups A and B. Group A had a mean score of 5.75, while Group B's mean score was 5.607. Table 1 shows the pretest means and standard deviations. The t-test score for the independent means (.084) indicated that there was no statistically significant difference in pretest scores between Group A and Group B. See Table 1 below for Pretest Data Analysis.

Table 1

Pretest Data Analysis for Equality of Variances

Group	Scores
A	
Mean	5.75
Standard Deviation	3.9629
Participants	12.0
B	
Mean	5.067
Standard Deviation	4.6292
Participants	14.0
Both	
t	.084
df	24.0
Significance	.934

Since the groups were compatible, the students remained as two intact groups for this group comparison/quasi-experimental study. The classrooms were then randomly assigned a method of instruction, and the teacher for both classes was given the weekly lesson plans.

For Group A the classroom teacher followed lesson plans that consisted of ten consecutive days of teaching long division with two digit divisors (Appendix C). Each lesson took between 30-40 minutes. Each lesson was introduced by modeling several pre-determined problems on the board taken from the *Scott Foresman – Addison Wesley* Fifth Grade Textbook. Following the teacher directed modeling, the students were given several of the same guided practice problems from the student textbook. The students worked out each problem on either paper or using their individual chalkboard. The teacher reinforced the students' practice by modeling the same problem on the board. Time was provided during each session for questions and answers.

After each introductory mini-lesson, the students were assigned problems from worksheets taken from the *Scott Foresman – Addison Wesley* Fifth Grade Mathematics Practice or Review Workbook (Appendices G-M). The Control Group (Group A) worked out the problems given on the worksheets. These students worked during the remainder of class time on these worksheets, and any problem not completed by the end of the class period was assigned as homework. At the end of this unit, Group A was given the posttest provided by the *Scott Foresman – Addison Wesley* Fifth Grade Math Series.

The same classroom teacher also taught the Experimental Group (Group B). Group B followed the same lesson plans for Group A. Both Group A and B received the same amount of days learning long division with two digit divisors. Group B, however, did not do division for ten consecutive class periods (Appendix D). Group B worked over a 14-day period of time. Four out of the fourteen classroom math periods were designated for something other than long division was being taught. Group B experienced the distributed practice method of instruction. At the end of this unit, Group B was also given the same posttest as Group A.

Data Analysis

After math lessons were taught for both Group A and B, the posttest was given to determine whether the independent variable caused changes in the dependent variable. The results of the posttests were analyzed and used to determine if there was a difference between the two groups in this comparison study by the use of a t-test for independent means.

Summary

We will discuss the results of the posttest in the next chapter. One needs to consider that this study was done using a small sample of students in a small, rural school district in Northwest Wisconsin. The duration of the study also limited the amount of time the students were exposed to the distributed practice method of instruction.

Chapter IV: Results, Discussion, and Recommendations

The purpose of this group comparison/quasi experimental study was to determine the effects of different math instruction with the use of pretest and posttest scores. Pretest and posttest scores were used to find the level of difference between two fifth grade multi-categorical math groups that differed in the math instruction administered prior to the test.

Results

The null hypothesis stated that there is no significant difference between academic achievements for fifth grade students in the multi-categorical education classroom for those students who received distributed practice methods of instruction as compared to those who did not receive the distributed practice methods.

Data was computed using a t-test statistical procedure to analyze the difference between means in a group comparison study. The results were used to determine which instructional method produced significant academic achievement. See Table 2 for posttest data analysis. A list of posttest scores can be found in Appendix B.

Table 2

Posttest Data Analysis for Equality of Variances

Group	Scores
A	
Mean	17.667
Standard Deviation	4.7546
Participants	12.0
B	
Mean	16.000
Standard Deviation	8.5642
Participants	14.0
Both	
t	.624
df	20.0
Significance	.539

The t-test score for independent means (0.624) indicated that there was no statistically significant difference in posttest scores between the control Group A, whose mean score was 17.667, and experimental Group B whose mean score were 16.000. The standard deviation (the approximate average amount by which each score in a set of scores differs from the mean) for Group A was 4.7546, while the standard deviation for

Group B was 8.5642. This indicated that both groups had comparable mean scores, however, Group B's standard deviation was a larger range than Group A.

Based on these results, the null hypothesis was accepted. There was no significant difference between Group A and Group B.

Discussion

As hypothesized, students who were taught by the distributed teaching method performed at the same academic level as students without the use of this teaching method.

This group comparison study was designed to examine how the method of instruction effects academic achievement. The statistical data indicated that there was no significant difference in achievement for students who differ in the type of instruction they received.

According to the literature, the sheer size of curriculums being taught in the United States is too overwhelming. Many curriculums have been shaped under the assumption that most students can learn things quickly, and once they have demonstrated this learning, further practice is unnecessary. Given this information, it is fair to say that Group A, who were given information over a shorter period of time may have experienced this. If you look at Group B posttest scores, although their mean score was 1.667 lower than Group A, if you compare the standard deviation of each group, Group B had a larger range of scores with a standard deviation of 8.5642. Group A's standard deviation was 4.7546, which is not as far apart from the mean score as Group B. If you take a look at the multi-categorical classroom of Group B, you find they have a wide range of ability levels. Out of the fourteen students in this classroom, six were Title I math students, which could account for the larger standard deviation for this group. Whereas Group A had only one learning disabled student in mathematics. If you look at the posttest scores for both groups (Appendix B), you will see higher scores from Group B, but you will also see four of the lowest scores from the same group. One could assume from this data, that Group B had a wide range of abilities compared to Group A. Even with the wide range of scores from Group B, this group did have three of the top four highest test scores.

If we take a look at understanding how students learn, which was another area the review of the literature looked at, we may find another underlying influence on the study. Research has been able to show us that educators need to help learners organize, store, and retrieve knowledge and skills. This all requires memory. In order to do this effectively, researchers have found that the distributed practice method shows an increase in retention among students, which will lead to greater long-term retention of concepts and skills being learned. Although Group A had a slightly higher mean score, it was not significantly different from Group B; Group B had three out of the four highest posttest scores. This could be attributed to the distributed practice method that was applied to Group B. Group B was given practice spaced over more time, which may have allowed them more time to process information, which enabled them to achieve some of the highest scores.

Finally, the review of the literature identified types of practice as another area of concern in many mathematic programs. Group B was taught using the distributed method of instruction. It is possible upon further study, that the reason Group B received three out of the four top scores on the posttest was that the distributed practice method allowed students to remember things and to optimize student learning because Group B was given the opportunity to learn division over a longer period of time, intermitted with other skills not related to division. Although this study did not support this, further study is still needed to see if the distributed practice method would allow students to absorb information if given the opportunity to learn skills over a longer period of time verses the more traditional ways of teaching mathematics as Group A received. Group A did spend the same amount of time learning division, but without the intermittence of other material. Group A had ten consecutive days of learning to divide. It is possible that repetition led to boredom and students became less motivated to learn.

In addition to these three factors addressed in the literature, it is important to recognize that even though there was one teacher for both groups, overall presentations may have differed and may have influenced students and their learning outcomes.

It is also important to review the make-up of both of the multi-categorical classrooms when comparing the outcomes. While both groups were randomly selected at the beginning of the year by the school administrator, and placed in two intact multi-categorical classrooms, there were wide differences in student's individual abilities, which may have had a significant difference on the results of this study. Group A had one learning disabled student, one OHI student, and two speech and language students, while Group B had six Title I math students.

One other area to consider that may have influenced this study is the time frame in which the study took place. Group A was given ten days to complete the study and Group B was given fourteen days. This was a short amount of time to indicate whether there were significant differences between the two teaching methods.

Recommendations

This study examined the effects of using distributed practice as a method of instruction to teach a multi-categorical group of fifth grade students in math. Even though there was not a significant difference in scores between the groups, it was interesting to look at the standard deviation for Group B. Group B's standard deviation scores were wider in range than it was for Group A. This may have been a result of the varying ability levels in that group compared to Group A. It would be interesting to perform the same study on a more homogeneous group such as exceptional educational needs students, or gifted students to see the effects of the distributed practice methods.

Another possibility to adapt this study would be to experiment with different math skills such as multiplication and subtraction to see if similar results would be experienced with the distributed practice method..

It would also be interesting to examine the long-term effects on retention if this study were to be conducted over a longer period of time to see the true effects of distributed practice. A follow-up posttest could be administered to the two groups at the end of the year, approximately six months after the original posttest was given to see how well the two groups retained the information.

Another variation would be to increase the time students would be exposed to the distributed practice methods to see the true effects of this teaching method. This study was only over a 14-day period of time. Possibly starting the year with the two groups and conducting a comprehensive mathematics test. Collecting data for the entire school year from these two different groups, with one group being taught with the distributed practice methods and the other group would not receive this method of instruction. At the end of the year, give the comprehensive posttest to see which group was able to retain the skills necessary to succeed on the test.

Summary

Having reviewed the literature and examined all other external influences, students who were taught using the distributed method of instruction achieved at the same level as those students who did not receive this method. Although there was no significant difference found in this study, further study is needed in this area. With increasing demands on school districts to increase students' achievement levels, it is more important than ever that educators meet these demands by using methods of instruction that can increase a child's long-term retention. Upon further study, the distributed practice method for teaching mathematics is one way that educators might consider to be a way that can help improve student achievement in their classroom.

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Appendix A: Parent Consent Form

October 4, 2004

Dear Parents/Guardians,

Your child's fifth grade class has the opportunity to take part in a math pilot study. The study will investigate whether using distributed practice when teaching long division will provide greater achievement among math students. Distributed practice is a method in which math sessions are separated by other math activities other than long division in this case.

The University of Wisconsin-Stout along the School District of Solon Springs have fully approved of this study. I am now asking your permission for your child to be included in this study. The study will occur during regular classroom hours and will last approximately 45 minutes for two weeks.

The study will have no affect on your child's grade whether they participate or not. The data collected will be kept strictly confidential, and no individual names or any other identifying information will be reported at any time. Your child may withdraw from the study at anytime.

If you have any questions about the study, please call me either at school (378-2263) or at home (374-2791). Please sign the attached form indicating whether or not you have agreed to have your child participate in the study and return by October 15, 2004.

*NOTE: Questions or concerns about participation in the research or subsequent complaints should be addressed first to the researcher (715) 374-2791 or research advisor, Dr. Donald Platz, (715) 232-1224, and second to Sue Foxwell, Director, Research Services, 152 Vocational Rehabilitation Bldg., UW-Stout, Menomonie, WI 54751, phone (715) 232-2477, email address; foxwells@uwstout.edu.

Sincerely,

Lynn A. Lesneski
Classroom Teacher And Researcher

I have read the above and do_____ do not_____ (check one) give my consent to participate in the study about to take place.

______________________________ ______________________

Parent/Guardian Signature Date

______________________________ ______________________

Student Signature Date

Appendix B: Group A & B Pretest Scores

	Group A	Group B
Value #1	21	8
Value #2	12	12
Value #3	24	40
Value #4	10	24
Value #5	13	6
Value #6	8	3
Value #7	8	47
Value #8	29	8
Value #9	44	12
Value #10	21	3
Value #11	0	28
Value #12	12	8
Value #13		21
Value #14		10

Group A & B Post-test Scores

	Group A	Group B
Value #1	35	24
Value #2	50	47
Value #3	82	76
Value #4	47	85
Value #5	41	15
Value #6	53	50
Value #7	53	82
Value #8	53	35
Value #9	65	71
Value #10	68	15
Value #11	41	62
Value #12	35	29
Value #13		53
Value #14		18

Appendix C: Group A Lesson Plans

Day 1

Pretest Chapter 5 Test – Form A

Day 2

Objective: Students will explore division with multiples of 10.

Introduce: TE222 Review 1-3

Model: Work together problems 1 a-f; 2 a-f

Guided Practice: Even numbers 2-12 (Each student will complete problems of small individual chalk boards)

Assign: Worksheet Practice 5-1

Day 3

(Collect WS Practice 5-1)

Objective: Students will find high and low estimated quotients.

Introduce: TE224 Review problems 1-3

Model: Read and discuss TE224 together. Complete problems 1-5 together. Discuss word compatible.

Guided Practice: TE225. Students will complete even problems 6-12 using individual chalkboards.

Assign: Worksheet Practice 5-2 Problems 1-10. Students may work with partners.

Day 4

(Collect WS Practice 5-2)

Objective: Students will estimate quotients using basic facts and compatible numbers.

Introduce: TE226. Read over page together and discuss. Review the word compatible.

Model: TE226. Go over example in book and check problems 1-3 on the board.
Guided Practice: Students will complete the odd number problems 19-35 on TE227 using individual chalkboards.

Assign: Practice Worksheet 5-3

Day 5

(Collect Worksheet 5-3)

Objective: Students will divide greater numbers with two digit divisors.

Introduce: Read TE234-235 together and discuss.

Model: Check odd problems 1-7 on TE235.

Guided Practice: Students will work together to complete even problems 20-28; 44-46; and 49 and 50 on TE236 using individual chalkboards.

Assign: Practice Worksheet 5-5

Day 6

(Correct Worksheet 5-5 together in class.)

Objective: Students will divide whole numbers with zeros in the quotient.

Introduce: Read together TE242. Discuss Learn problems and examples.

Model: TE243. Complete odd problems 1-9.

Guided Practice: Students will work together on even problems 14-26 on TE242.

Assign: Another Look Worksheet 5-7

Day 7

Objective: Students will divide money.

Introduce: Read and discuss examples on TE250-251.

Model: Check problems 1-5 on TE251.

Guided Practice: Students will complete problems 6, 8, 10, 14, 21, 22.

Assign: Practice Worksheet 5-10.

Day 8

(Collect Worksheet 5-10.)

Objective: Students will explore division of decimals by 10, 100, 1000.

Introduce: Use introduce/review problems 1-3 and Build on Prior Knowledge problem on TE254.

Model: Work Together Problems 1-3 on TE254.

Guided Practice: Read Connect Together on TE255. Students will use chalkboards to do odd problems 9-19 and 21-25.

Assign: Practice Worksheet 5-12.

Day 9

(Correct Worksheet 5-12 together.)

Objective: Students will review for Posttest.

Assign: Students will complete Review/Test on TE262 1-3; evens 4-32. Students will check answers in Teacher Manual when they complete review.

Day 10

Posttest on Chapter 5 – Form B

Appendix D: Group B Lesson Plans

Group B will follow same lesson plans for group A. Both groups will spend the same amount of days learning division. Group B, however, will not do division on the consecutive 10 days that group A will.

Day 1

Follow Group A lesson plans for Day 1.

Day 2

Follow Group A lesson plans for Day 2.

Day 3

Do something other than division.

Day 4

Follow Group A lesson plans for Day 3.

Day 5

Follow Group A lesson plans for Day 4.

Day 6

Do something other than division.

Day 7

Follow Group A lesson plans for Day 5.

Day 8

Follow Group A lesson plans for Day 6.

Day 9

Do something other than division.

Day 10

Follow Group A lesson plans for Day 7.

Day 11

Follow Group A lesson plans for Day 8.

Day 12

Do something other than division.

Day 13

Follow Group A lesson plans for Day 9.

Day 14

Follow Group A lesson plans for Day 10.