The Outcome of Implementing a Math Tutorial Program for Second Graders Struggling with Procedures for Solving Problems

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Abstract

The purpose of this study is to determine whether participation in afterschool math tutoring program would positively enhance the performance of selected 2nd graders invited to participate. The measurement tool used was the Benchmark Assessment. This study involved the use of a pretest and posttest to compare data from the winter of 2010 (before the intervention was administered) to data from Spring 2011 (after the intervention was completed). There were no statistically significant findings.

CHAPTER I

INTRODUCTION

Second graders are required to understand and apply a vast array of mental processes in which to properly solve mathematical problems. In an attempt to problem solve, the student must read and identify the information given and what is being asked of them to do. Then, they must make a plan to solve the problem, deciding on what operation to use based on the information given, and find a solution that may or may not require a number of systematic steps. Therefore, students must be equipped with the knowledge of what to do in a given situation and follow the necessary steps in a sequential order to demonstrate mastery. However, it can be challenging for students to retain math processes when they are required to learn more and more skills to accommodate timelines and pacing guides. In addition, students have to maintain prior math knowledge to prevent confusion and misperceptions. As a teacher of second mathematics, the investigator is aware of challenges many students face in mastering mathematics. The investigator has observed that many students struggle with problem solving and particularly using a problem solving strategy. The teacher attempts to address these needs with flexible grouping. For many of these students, an additional intervention is needed.

Problem Statement

The purpose of the study is to determine the effectiveness of afterschool tutoring upon the problem-solving skills of second grade students.

Hypothesis

The null hypothesis states that there will be no difference in pretest to posttest gain scores for students who receive after-school math tutoring compared to similar students who do not participate in tutoring.

Operational Definitions

The independent variable was participation in the afterschool math tutoring program. It was operationally formed into two groups. One group consisted of students who were not eligible for the program and the other group was of students who qualified for the Title One program. The dependent variable was math performance measured with the Benchmark Assessment scores.

CHAPTER II

LITERATURE REVIEW

The main purpose of learning mathematical processes is not merely to derive a correct answer, but also to promote mathematical reasoning, to encourage exploration, and to equip students with skills to apply problem solving techniques in most real-life circumstances. This review of the literature contains three major sections. The first one explores methods of promoting mathematical reasoning. The second section explains the types of mathematical exploration available for students, and the third section discusses methods of equipping students with mathematical skills that equate with real-life situations.

Promoting Mathematical Processes

Math is everywhere. Therefore, problem solving should mimic real life situations. Strategies should reveal more ways than one to justify mathematical thinking. Motivation in teaching mathematics using technology is an important factor for getting students actively engaged in learning. According to one study pre-service teachers should be exposed to technological tools that will help them in their future teaching. They should first be exposed to these tools as learners, so they appreciate them as tools that facilitate learning, and to teach, they will introduce these tools to their students as objects with which they can learn. Technological tools can have various functions in the mathematics classroom; one function is to solve mathematical problems with them, which is an important aspect of the students' mathematical activity (Daher, 2009).

Word problems can be difficult if not challenging for students if problem-solving strategies are not put into place. Students benefit from step-by-step processes that engage and direct their thinking when solving math problems. Problem solving does not have to be the standard pencil and paper method. One researcher found that problem-solving can be fun – especially if it means playing games and discovering “secret strategies” that make young students winners every time they attempt to solve problems. Like the TV game show “Jeopardy,” contestants are given the answer and must come up with the correct question. Hence, the question is the most important part of a word problem. Students of all ages must learn to read the question first before they tackle the whole problem (May, 1995).

Students need to be able to express their mathematical thinking. Many students as early as first grade are required to write brief constructed responses (BCR). In these they must explain or justify how they solve a particular math problem. BCRs require students to explain using not only words but numbers, illustrations, and relational symbols (<, >, =, +, -, x, etc…). Many students will write responses step-by-step to validate that their answer is correct. A recent article suggests using math journals to enhance second graders’ communication of mathematical thinking. It is important for students to be able to demonstrate their mathematical thinking process as well as their methods of solving a problem (Kostos and Shin, 2010).

Students who have mastered their basic math facts are more inclined to solve problems successfully. According to current research, mathematical skill deficits affect a wide range of students. Inventions are needed to prevent and/or remedy math skill deficits and to increase skills needed to efficiently solve math problems by having students memorize the basic math facts (Poncy, Duhon, Lee, & Key, 2010). Teachers should also consider related facts or number combinations when teaching basic math facts because students can often make connections. Research believes that competent number combination performance involves a mix of strategies, with counting strategies and decomposition strategies serving as back-ups for primary reliance on memory-based retrieval. In fact, individuals, including adults, use various strategies at different times to solve the same number combinations (Fuchs, Powell, Seethaler, Fuchs, Hamlett, Cirino, & Fletcher, 2010).

Mathematical Exploration

As teachers seek to introduce, develop, and maintain mathematical skills and concepts, consideration should be given to age appropriateness. Students do not all begin school at the same exact age. There are age gaps as well as achievement gaps and teachers should gather this information shortly after the school year begins. Research indicates that there is a significant relationship between children's season of birth and measures of their academic success (i.e., the season of birth effect). Whereas most of the studies performed were cross-sectional, the current study used growth curve modeling to analyze longitudinal data on 3,187 children in Flemish primary education. The results indicated season of birth effects on both grade retention and mathematics achievement during the first two years of primary school. Because the Flemish cut-off date is December 31, children born in the fourth quarter (October-November-December) invariably were among the youngest in their grade age group. Almost 20% of these children were found to have been retained or referred to special education by the end of Grade 2, whereas for children born in the first quarter (January-February-March), showed only 6.34% (Verachtert, De Fraine, & Onghena, 2010. Students never enter school with equal amounts of knowledge. Therefore, it is up to the teacher to investigate where students are in terms of age in years as well as months to ensure that the concepts and skills are age appropriate.

Another issue to consider is students' written communication skills in mathematical processing. Students have different ways of expressing or explaining the same idea. Learning how to effectively communicate ways to solve a problem in writings and drawings is a great tool for assessing understanding. Along with enhancing mathematical thinking, math journaling can also assist with developing math concepts as well. Kostos and Shin (2010) also agree that math journaling can benefit the teachers as well as the students. The information gathered helps teachers gain insights, develop their reflective practice and improves the students' math practice in a second grade classroom. With their regular math teacher, students are able to utilize the insights that can only be obtained when an instructor who knows them well can capture the students' thinking process more closely, and gather and analyze the data more in-depth.

To further build math strategies and teacher practices, professional development and training is a must. In a world that is ever-changing and poses new ideas on society rapidly, technology in the classroom is a growing trend. Students seem to be born computer literate and teachers must catch up and/or stay on board with the use of technology to solve math problems in the classroom. It should be viewed as another tool for building mathematical strategies. Substantial evidence indicates that teacher-delivered schema-based instruction (SBI) facilitates significant increases in mathematics word problem solving (WPS) skills for diverse students; however research is unclear whether technology affordances facilitate superior gains in computer-mediated (CM) instruction in mathematics WPS when compared to teacher-mediated (TM) instruction particularly for low-performing students (Leh, 2011).

Another factor to consider for building math strategies is the teacher's level of confidence when attempting to teach a math strategy. A case study provided teacher feedback for increasing teachers' mathematical knowledge for teaching and strategies for building students' math self-efficacy revealed that teachers felt "In Bloom's taxonomy, students must have the underlying understanding and knowledge before they can move to deeper levels of thinking, such as application and analysis" (Stevens, Harris, & Cobbs, 2009, p 905). It is important to build the students' comfort level as they learn math strategies. Teachers should steer from simply announcing that the student's response is "wrong". However, they should encourage students to explain their thinking and rework the problem. Many times students will find their own mistakes.

Maintaining math concepts is important because students need prerequisites before going on to the next unit. Oftentimes, teachers will assist with maintaining skills by incorporating them in daily drills. Some teachers even work with students in small groups. Teachers also create math workshops to reinforce skills previously taught. Students also benefit from the use of cooperative learning. This strategy allows small groups of students of different levels of ability to use an assortment of learning activities to improve their understanding of math concepts and problem solving. Groups members are expected to help each other and promote an atmosphere of achievement within their group. The positive side to this is students work together to achieve a common goal. In fact, according to Tarim's study "preschoolers in the experimental groups experienced larger improvements in their problem-solving abilities than those in the control group". Findings also revealed that the cooperative learning method can be successfully applied in teaching verbal mathematics problem-solving skills during the preschool period. The preschoolers skills regarding cooperation, sharing, listening to the speaker and fulfilling individual responsibilities in group work also improved (Tarim, 2009).

The use of math manipulatives allow students to physically act out a problem solving situation. Burns (2005) agrees that manipulatives provide concrete objects for children to describe and learn math more easily. She supports the use of manipulatives in the classroom. She writes, "I've used manipulative materials at all levels for 30 years, and I'm convinced I can't—and shouldn't --teach without them" (Burns, 2005, p. 31). She encourages teachers to first talk with students about why manipulatives help them learn math. These discussions are essential for first-time users and useful refreshers to refocus from time to time. She recommends preceding discussions by giving children time to explore a manipulative. Then talk about what students noticed and then introduce the concepts they will learn with the material (Burns, 2005)

Mathematical Difficulties

Students often encounter challenges in math when prerequisites are quickly glossed over. Teachers are required to follow timelines designed by bureaucrats whose main agenda is "*racing to the top*". Many wonder how we can expect students to improve academically when they are scuttled from skill to skill.

Since solving word problems is a lot like "Jeopardy" because the question is the most important part of a word problem, students of all ages must learn to read the question first before they tackle the whole problem (May, 1995). In addition, multiple skills are used when solving math problems. For example, listening and processing problems are often the root of poor performance in problem solving. Research suggests that, listening requires students to focus on key elements, interpret what information is being given, and understand the question that is being asked. Only then can they determine which route to take for solving the problem (Pennequin, Sorel, Nanty, & Fontaine, 2010). May's study also suggested the use of games to make problem solving fun (May, 1995).

Teachers have to also consider students with disabilities in preparation for math instruction because goals have been published to meet their individual needs. Whatever the disability, a range of strategies can assist these students to develop proficiency.

A strong case can be made that special education teachers need both content knowledge and sophisticated instructional planning skills to be effective in collaboration and in extending the instruction that children with disabilities require to be successful in meeting performance expectations (Meyen & Greer, 2009). More content knowledge will better equip teachers to raise the bar for all students. Therefore, the key to decreasing mathematic achievement gaps may be increasing teachers' content knowledge, instructional planning skills, and preparation in research based instructional practices in mathematics.

For students with disabilities to reduce the sizable deficits that characterize many of their profiles as learners, their instruction must be well coordinated in terms of the short- and long-term goals specified in their Individual Education Plan (IEPs), as well as how the instruction is implemented and reinforced across teacher and settings alike. If the instruction is not clearly focused, carefully orchestrated, and precisely planned, the gains may be significantly reduced (Mainzer, Deshler, Coleman, Kozleski, & Rodriguez-Walling, 2003).

After a recent study was performed, key findings indicated that implementing reading comprehension strategies was effective in improving Title I school students' math comprehension skills (Gresens, 2011). Students who have problems comprehending text will frequently speculate whether to add or subtract and use all of the numbers in the problem. For instance, the problem will read: *Johnny counted birds on 2 days. On Wednesday, he counted 10 birds. On Thursday, he counted 7 birds. How many more birds did he count on Wednesday than on Thursday? A low reader will often add 2+10+7=19.* In this particular problem, the student would have subtracted 10-7 if they understood the clues in the problem.

In addition to reading comprehension, listening for important information (clue words) can also have an impact on problem solving.

The lack of opportunity to practice and develop the skills acquired can lead to skills being lost or diminished from their short-term memory. Students need to revisit and practice skills as often as possible. Not only do students need time to practice at school, they need to reinforce what they've learned on a daily basis (http:www.math-drills.com). However, Kohn recommends that daily practice should not resemble homework packets full of worksheets (Kohn, 2007). According to Kohn, parents accept the premise that more homework is good. The amount of homework for 6-9 year olds has increased since the 1980s. For this reason, many do not understand how learning happens. Homework should be driven by problems and questions that peak children's curiosity and desire to know about the world in which we live. Real learning comes when children have a reason for learning.

Effective teacher training is essential for building the students' mathematical framework. One study reveals that a teacher's own mathematical knowledge has a substantial impact on student learning even at the first-grade level, a finding that left even the researchers themselves "modestly surprised"(Jerald, 2006). Teaching mathematics effectively depends on a solid understanding of the material. Teachers must be able to do the mathematics they are teaching **(**Jerald, 2006). This leads me to the next point.

Equipping Students

Teachers need professional development periodically to improve techniques for teaching math strategies and consistent awareness of learning styles. No matter how much teaching experience an individual has, there is always more to learn and share with others. In one particular study teachers were encouraged to learn and articulate math vocabulary along with what they already know and teach in their curriculum. The use of math language enables students to recognize the math concepts as they appear on standardized tests. One teacher reflected by saying the professional development forced her to re-evaluate curriculum from a different perspective, which meant professional growth from that perspective (Pearson, 2004). The inclusion of a focus on content in professional development activities is seen to vary across four dimensions. These are the degree of emphasis on subject matter and teaching methods, the specificity of change in teaching practice encouraged, the degree of emphasis on goals for student learning, and the degree of emphasis on the ways students learn (Unal, 2011).

The way students learn impacts on how well the teacher can capture and hold their attention. Each child has his or her individual learning style. It is up to the teacher to find out which method(s) works best for each student. Many people recognize that each person prefers different learning styles and techniques.

The overview on learning styles suggest that students benefit from knowing whether they are a visual learner (prefers to use pictures, images, and spatial understanding), an auditory-musical learner (uses sound and music), a verbal or linguistic learner (prefers to use words in speech and writing), a physical or kinesthetic learner (uses the body, hands, and sense of touch), Logical or mathematical learner (uses logics, reasoning, and systems), a social or interpersonal learner (works best in groups or with other people), or solitary or intrapersonal learner who prefers to work alone and benefits best from self-study (Learning Styles Online, 2010). In addition, Learning styles group common ways that people learn. Everyone has a mix of learning styles. Some people may find that they have a dominant style of learning, with far less use of the other styles. Others may find that they use different styles in different circumstances. There is no right mix. Nor are styles fixed. Individuals can develop ability in less dominant styles, as well as further develop styles that they already use well (Learning Styles Online, 2010).

As teachers plan using the state's Common Core Standards, they need to also keep in mind these various learning styles to engage all students. The Common Core Standards aids the teacher by addressing what math skills students are supposed to know from last year, what they are going to be learning this year, and what they will learn the following year. It is in a sense a roadmap for driving the instruction from state to state (MSDE, 2011).

Interventions

Interventions are supposed to help ensure the needs of struggling students as soon as the teacher foresees potential problems. Interventions need to be proactive in every sense. One way that teachers can assist students is by pre-assessing students before teaching a particular skill as this will allow teachers to pinpoint the student's strengths and weaknesses. It enables teachers to prescribe what is needed as opposed to everyone receiving the same exact treatment.

Another type of intervention has to do with assembling small groups of students who have similar math issues and re-teach that certain challenging skill. On the flip side, small groups can also be used as an enrichment tactic for students who more than excel in a particular math skill. In all, small groups can allow the teacher to offer one-on-one support.

Teaching math skills through the use of games can serve as a useful tool. Games motivate and elevate a level of competiveness among students. Games can be used to tackle almost any math skill and cause students to shift ahead. At the same time, it encourages peer interactions when expectations are specified and activities are monitored closely (McNelly, personal communication, September 4, 2012).

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Tutoring can take the form of one-on-one help or small group instruction. Tutoring can be implemented by an adult as well as a student peer. Oftentimes, peer tutors can be just as effective as a teacher. Tutoring can be organized within the school day (school based intervention) and during after school hours. Some schools offer afterschool math clubs for a nominal fee. Tutors who operate outside the school often charge a fee that can range from modest to expensive for their service. Many times, parents utilize the help of organizations such as *The Huntington Learning Center* and *Silvan Learning Center* to help the child meet or exceed their academic goals. When structured in a way that meets the needs of the individual, tutoring can be very successful.

CHAPTER III

METHODS

The purpose of this study is to examine changes in student performance on word problems involving multi-step addition and subtraction after the implementation of an afterschool tutoring program.

Design

A pre-test post-test control group design was selected to determine the effects of participation in an after-school mathematics tutoring program on student skill in solving word problems.

Participants

A total of 10 students participated in the study. Of those 10 students, five were females and five were males. Three of the male subjects received math tutoring after school and two of the female subjects. Two of the male subjects did not receive afterschool tutoring and three of the female subjects did not as well. All subjects were second graders, between the ages of 7 and 8. The researcher selected these subjects because they are enrolled in the school's regular homework afterschool program. Five students who promptly returned a permission slip received the treatment. The five control students were selected randomly from the after school homework class roster. All treatment students attended a total of 16 tutoring sessions, which were offered four days each week for four weeks.

Instrument

The Benchmark Test is Baltimore City's quarterly assessment designed to provide teachers with data they can use to update instruction (http:// baltimorecityschools.org). The results of the Benchmarks are posted on a web page that analyzes the data at the district, area, school, class, and student levels. The Benchmark helps teachers analyze the data gathered from the tests to determine their students' strengths and weaknesses, thus tailoring their instruction to meet the needs. No information about the reliability and validity of this instrument was available.

The students received the Benchmark Test C to evaluate their progress. This was used as a pretest for the experiment. There was a total of 50 selected response items on the test. Students receive two points for each correct response. The test covered an assortment of problems involving whole number concepts, computations, and word problems. The total population consisted of 24 students in the class during the regular school day. None of the students required special accommodations or were excused from taking the test. At this time, none from the total population of the students scored less than 60 percent. However, as a whole the data revealed that students needed to improve in solving word problems based on addition or subtraction situations with no more than two-digits. This data was also used to plan and implement instruction for the afterschool tutoring program. Only students who returned the permission slips were allowed to participate in the afterschool tutoring program. At the end of the afterschool tutoring program, the same students were given the Benchmark Test D and the test consisted of a total of 60 questions. There were the same types of questions and the same addition and subtraction word problems. However, the latter test required students to solve some three-digit computations in addition to the other math skills.

Procedure

During February of 2011, ten low-income, low-performing students enrolled in the investigator's class were selected by the school's title 1 specialist to participate in the study. Five students were assigned to an afterschool tutoring program in addition to their regular instruction. The five remaining students received regular math instruction only. The tutoring program began immediately following dismissal from 3:00p.m. to 4:00p.m. The teacher began with drilling basic math facts each day. Next, the teacher instructed the skill to be learned for that particular day by modeling the steps and procedures. Students worked independently and sometimes with other students. The weekly schedule for these students was as follows:

Mondays -Thursdays – 5 minutes of drilling math facts, 10 minutes of instructions and directions, 25-30 minutes of implementing a skill or strategy, 5-10 minutes of journaling, and 5-10 minutes of follow-ups and reflections.

The participants engaged in an array of math activities which required them to use their written and oral thinking skills. They worked with partners and in groups of three. The researcher observed students working in pairs to solve a problem by reading the information given and the question that was being asked of them. Students discuss and highlighted words that they thought were clues to decide how they would solve the problem. They had to refer back to a chart that explained what to do for general clues. The chart was divided into two parts. The left side read: "Clues for Addition" and the right side read: "Clues for Subtraction". The students had to decide whether to add or subtract. Afterwards, they reread the story and discussed whether their answer made sense and why. The students did so by writing a BCR and sharing what they had written. They got a chance to construct possible arguments and critique the reasoning of others. In addition, to writing BCRs, the students were given opportunities to respond to journal topics regularly. Examples included: "What did I do today in math?", "What did I not understand in math today?", "What did I dislike about working the problem?", and "Draw a picture of yourself teaching the math class?"

The students also played math games related to problem solving in which they were given a scenario and they had to physically act out the events. The students did not use manipulatives such as ones and tens models. I would like to have seen the use of some manipulatives. This may have been due to the fact that the instructor normally worked with third graders and the push is to get rid of manipulatives by third grade. During reflection times students got a chance to discuss "glows" and "grows". These were things that they learned and needed to work on.

CHAPTER IV

RESULTS

The hypothesis that students who received intervention would not demonstrate greater improvement in whole number operations than a peer group who did not receive the intervention was supported.

Figure 1. Mean Score on the Benchmark Assessment

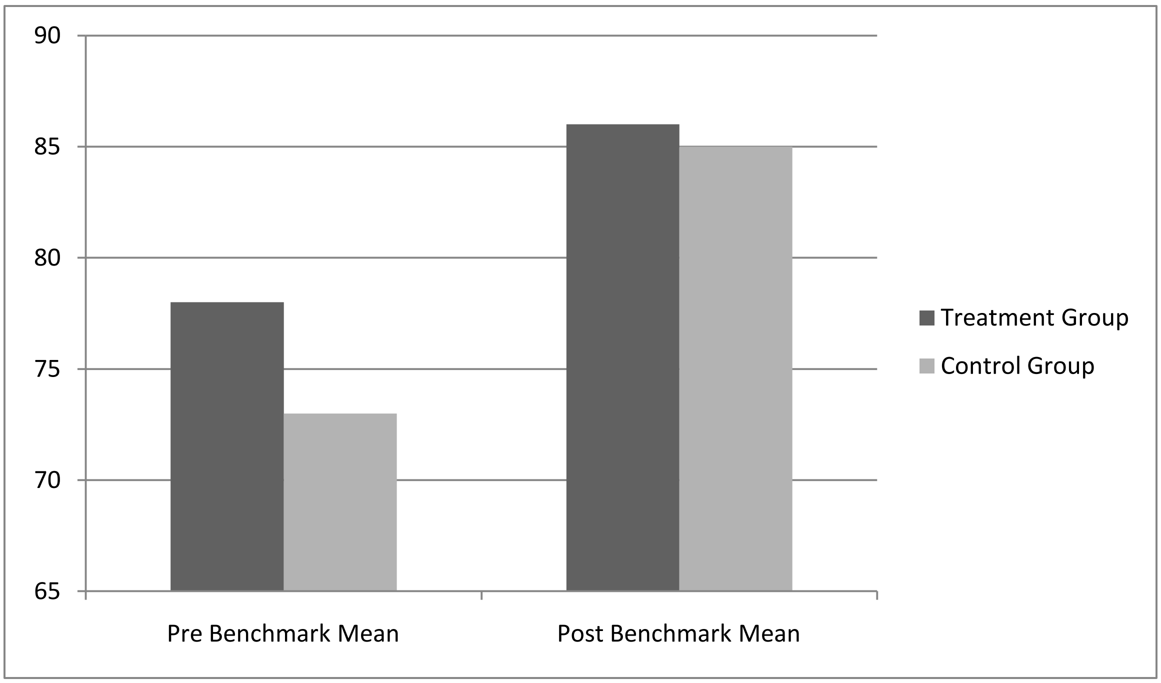

Table 1: Performance of Intervention and Non-Intervention Students on Pre and Post Measures of the Benchmark

Statistic	Treatment	Control
Pretest Mean	77.66	72.50
Pretest SD	11.27	1.91
Pretest Median	80.00	73.00
Pretest Range	62-94	70 – 74
Posttest Mean	86.13	85.40
Posttest SD	8.78	6.97
Posttest Median	86.70	88.30
Posttest Range	71-95	75- 90

As Table 1 describes, treatment participants out scored control participants by approximately 5 points on the pretest. The range of performance, however, was significantly greater among treatment than control participants. On the posttest, control participants slightly out-performed treatment participants; however, the ranges of performance were much closer. Because of the small size of each group and the differences in the distributions of scores, the researcher applied the Independent Samples Median Test to determine the significance of differences between pretest and posttest performance for the two groups. A Fisher Exact Significance test applied to both the pretest and posttest medians suggested that the null hypothesis of no significant difference in median scores for the treatment and control groups was not rejected in either case. Overall, across all students, the difference between average pretest and posttest scores was 10.24 (sig<.001), suggesting that the performance of all students improved. However, results of the median tests suggested that the pretest to posttest change was not significantly different across groups.

CHAPTER V

DISCUSSION

The hypothesis that students who received intervention will demonstrate greater improvement in whole number operations than a peer group who did not receive the intervention was not supported. The results show that the performance of all students improved.

Implications of the Results

Students who received the additional instruction benefited from it, but their progress was not on the whole significantly different from the Control group. However, the range of scores earned by treatment students on the pretest decreased on the posttest: the bottom of that range was 62 on the pretest compared to 71 on the posttest. Whereas the size of the treatment group makes it difficult to draw conclusions about the effects of the program, it does appear to have raised the performance of the lowest scoring students. These results bear further study.

Theoretical Consequences

Whereas all students can benefit from intervention, the content and more time allotted for instruction is needed. Carefully consideration needs to be given to identify and take account of students in need of interventions.

Threats to Validity

Threats to the validity of the study included the small number of students, the selection process, and the short term of the program. In terms of generalizability, the small number of students who received the intervention and the manner of selection suggests that these students were not necessarily representative of the true range of performance of second grade students in mathematics. Not only the duration of the study--four weeks--but also the scheduling of the intervention--after students had experienced a full day of school--may have limited the effects. Finally, the match between the content of the tests and the content and focus of the program requires further study. Even though there were improvements gained, there needed to be an array of low to high scores from the pretest. The selection process was limited to Title One students in the treatment group. Students not listed under Title One were not given the option to attend. The instrument did not include any length of time that would show significant impact.

Connections to Previous Studies and Existing Literature

Similar ideas about providing after school help was connected to a guide called Beyond the Bell (Diedrich, 2005). It reinforces the idea that students need extra opportunities to learn, develop, explore, and have fun beyond the normal school day. Linking the afterschool program to the school day is a good bond to drawing on needs. However, making such linking does not imply replicating the school day. It should provide an alternative learning environment for students who are not experiencing success in a traditional setting. It also provides opportunities for collaborative relationships between the staff in both settings.

Implications for Future Research

If the program is run again, collecting data from students and teachers might be helpful. The selection process and the amount of time also should be considered. The research might consider using another selection process that is not connected to Title One. In addition, future research on this topic needs to be followed over a longer period of time.

Summary

The results of a four-week intervention program did not offer strong support for the benefits of such a program for second-graders struggling with mathematics problem-solving. Compared to a similar group of students who received only regular mathematics instruction, students receiving both instruction and intervention did not demonstrate significantly greater growth although the test scores of the very lowest performers did improve. This promising result suggests that further try-outs of the program with a larger number of students representing a wide range of abilities would be useful. Understanding that many students struggle with mathematics problem-solving for a variety of reasons, the investigator intends to continue to investigate the effects of different types of intervention programs on students' growth in mathematics skills.

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