International Journal of Education in Mathematics, Science and Technology (IJEMST)

www.ijemst.com

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ISSN: 2147-611X

To cite this article:

Haynes, K. B. & Brendle, J. (2019). Cross-age math tutoring of kindergarten and first grade students by middle school tutors. *International Journal of Education in Mathematics, Science and Technology (IJEMST), 7*(3), 238-250.

International Journal of Education in Mathematics, Science and Technology
Volume 7, Number 3, 2019 ISSN: 2147-611X

Cross-age Math Tutoring of Kindergarten and First Grade Students by Middle School Tutors

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Article Info

Article History

Received:
08 December 2018

Accepted:
21 June 2019

Keywords

Mathematics education
Math remediation
Cross-age tutoring
Explicit instruction

Abstract

To address the problem of low achieving math students, a cross-age math tutoring intervention paired middle school tutors with kindergarten and first grade students with low math skills. This instrumental group case study explored the effects of the intervention on the math skills of the students through teacher interviews and the testing program of *Aimsweb Plus* (Pearson, 2017) before and after the tutoring intervention. Most of the teachers of the tutees reported measurable math gains possibly from the tutoring and most of the teachers observed improved attitude towards math work for the young tutees. Most teachers of the tutors did not report any measurable math gain from tutoring young students. All the teachers of the tutors recommended the cross-age tutoring experience as the middle school students seemed to show increased leadership skills, confidence, or found helping others a positive experience.

Introduction

Researchers note that a child's early math skills predict later math achievement finding that students who struggle with math in early grades often struggle with later math performance (Sonnenschein, Galindo, Metzger, Thompson, Huang, & Lewis, 2012). How can educators improve students' math performance? Research indicates that few studies have focused on math skill deficits even though these issues create potential life-long difficulties at school and in the workplace (Re, Pedron, Tressoldi, & Lucangeli, 2014). Clarke, Doabler, Nelson, and Shanley (2015) note that early elementary grades may prove a pivotal time to improve student outcomes, especially in math deficits. Current research on cross-age tutoring focuses on improving reading and generally targets older students for cross-age tutoring. This study strives to determine the effectiveness of using middle school students as change agents for tutoring math skills to low math-achieving kindergarten and first grade students. The National Mathematics Advisory Panel Report (2008) indicates a low U.S. student achievement in mathematics which emphasizes the need for early interventions in math instruction to minimize math difficulties for students (Gersten, Beckmann, Clarke, Foegen, Marsh, Star, & Witzel, 2009). Vaughn, Wanzek, Murray, and Roberts (2012) discuss the need for intensive instructional programs for students with significant learning difficulties involving small learning group size and one-on-one instruction to foster a more successful learning environment. One-on-one tutoring has been shown to improve academic performance skills (Allen & Chavkin, 2004; Slavin, Lake, Davis, & Madden, 2011), but many schools still use small group or whole group instruction, often calling it tutoring, instead of the research proven one-on-one tutoring approach (Slavin et al., 2011).

Positive Effects of Tutoring

Developing mathematical competency becomes an important goal for the rapidly developing and technologically-driven workplace highlighting the need to address the educational concerns for children who exhibit math disability or low math achievement (McQuarrie et al., 2014). One-on-one instructional grouping is viewed as highly effective for students with disabilities, but it is rarely implemented in schools for students with learning disabilities and usually for only a few minutes if it is accomplished (Vaughn, 2001). A structured math tutoring program study identified a significant effect for math skill attainment only when used in a cross-age condition where older students tutored younger students (Topping, Miller, Murray, Henderson, Fortuna, & Conlin, 2011). Shenderovich, Thurston, and Miller (2016) reviewed cross-age tutoring programs for kindergarten and elementary schools and found that highly structured programs were more effective than unstructured programs, but the type of tutor, whether adult volunteers, university students, or older school

children, did not make a significant difference in the effect analysis. Therefore, a highly structured approach for math skill acquisition is important to improve the effectiveness of the tutoring, particularly when using middle school students as tutors. One meta-analysis of tutoring studies demonstrated the greatest effect size for tutoring was accomplished in the cross-age tutoring of a teen working with a younger elementary student (Won Jun, Ramirez, & Cumming, 2010). Programs that support cognitive processing through academic instruction and which provide explicit and systematic instruction in math may accelerate academic progress for students struggling with math skills (Vaughn et al., 2012).

Kohli, Sullivan, Sadeh, and Zopluoglu (2015) note that the gap in mathematics achievement is apparent when students enter school tending to either remain constant or grow farther apart through the school years. Kindergarten and first grade students who score below grade level in math achievement testing may struggle with a variety of issues or only math solving challenges. Of the students with low math achievement, Wei, Lenz, and Blackorby (2012) explain that students with disabilities have math performances that are "significantly poorer than that of students without disabilities" (p. 154).

The National Mathematics Advisory Panel Report (2008) indicates a low U.S. student achievement in mathematics emphasizing the need for interventions to prevent math difficulties (Gersten et al., 2009). "Interventions that target memorization and fluent recall of basic number" facts may produce the strongest results as knowing math facts frees up students' cognitive resources for more complex problem solving (Clarke et al., 2015, p.262). Kurz, Elliot, Lemons, Zigmond, Kloo, and Kettler (2014) concluded that some students, especially students with disabilities, may need more opportunity-to-learn experiences to succeed academically than other students suggesting that additional instructional opportunities may help these students to increase their academic skills.

Studies have found that individualized tutoring is one of the most effective ways to improve educational outcomes and can be effectively done with non-professional peer tutors (Shenderovich, Thurston, & Miller, 2016; Paterson & Elliott, 2006). The National Reading Panel (2000) has concluded that early intervention is more effective for student success than remediation later in school, and Banard-Brak, Lan, and Yang (2017) note that increasing the opportunities to learn math corresponds to positive achievement outcomes validating the implementation of a math tutoring intervention.

Tutoring has been shown to improve academic skills without the use of certified teachers (Mokhtari, Neel, Kaiser, & Hong-Hai, 2015; Allen & Chavkin, 2004). Peer tutoring utilizes two students near the same age while the even more effective cross-age tutoring uses one older student and one younger student (Korner & Hopf, 2014). Shenderovich, Thurston, and Miller (2016) conducted a meta-analysis of studies using cross-age tutoring for kindergarten and elementary students finding significant standardized mean differences for cross-age tutoring especially in mathematics. The study noted that "effect sizes for cross-age tutoring were significantly greater than for same-age tutoring" (Shenderovich et al., 2016, p. 204). Focusing on peer and cross-age tutoring in math, research by Robinson, Schofield, and Steers-Wentzell (2005) found benefits such as students being more likely to show improvement in math performance, improved classroom behavior, and being less likely to be placed in special education programs resulted from peer and cross-age tutoring programs. The length of the intervention did not always correspond to effect sizes as programs as short as six weeks showed large positive effects for academics and students improved their academic self-concept (Robinson et al., 2005; Paterson & Elliott, 2006).

Cross-age tutoring programs allow tutors to recognize their power of influence, reflect on their own academic potential, and see their potential to make a difference including improved academic attitudes, increased motivation, and positive academic performance for the role of the teen tutors (Paterson & Elliott, 2006). Re, Pedron, Tressoldi, and Lucangeli (2014) note that "students' attitudes toward math are closely related to their achievement" (p.338).

Tutoring Intervention Design

Some tutoring interventions employ a relaxed format, often with little tutor training, while other tutoring programs utilize a highly structured format with tutor training and supervision (Shenderovich et al., 2016). From their review of the tutoring studies, Shenderovich, Thurston, and Miller (2016) found that "highly structured interactions between tutor and tutee is important" for improving academic achievement (p. 206). Highly structured cross-age math tutoring programs seem to yield the greatest positive results (Topping et al., 2011).

Vaughn, Wanzek, Murray, and Roberts (2012), supported by the U.S. Department of Education, created a practice guide for working with low achieving students explaining that the highest effects for intensifying instruction are from these components of direct instruction: teaching of strategy instruction, explicit instruction utilizing clear modeling procedures, systematic instruction incorporating the breaking of complex skills into smaller chunks of learning, and opportunities for student response and feedback where students practice with remedying errors.

The type of curriculum used affects the outcome of the tutoring program. Remediation intervention should include work with "visual representations of mathematical ideas" and include building math facts each day (Gersten et al., 2009, p. 12; Jitendra, et al., 2013). Teachers realize that many students "who struggle academically also have poor memory" which negatively affects their mathematics performance (Vaughn et al., 2012, p. 10). These researchers recommend integrating training these processes into academic instruction (Vaughn et al., 2012).

Conceptual Framework

The conceptual framework used to guide this research was based on three ideas. First, early intervention for low achieving students is more effective than remediation later in school (Won Jun et al., 2010) suggesting the need for schools to offer tutoring in math for primary grades to be effective in math skill attainment (Topping et al., 2011). Second, most students may benefit from one-on-one tutoring which has been shown to improve performance skills (Allen & Chavkin, 2004; Won Jun et al., 2010). Third, using trained student volunteers to deliver highly structured math tutoring allows for a larger population to be targeted for increasing academic performance as cross-age tutoring has a favorable effectiveness rating for younger students (Robinson et al., 2005). This instrumental group case study of cross-age math tutoring should observe improved math skills and improved attitudes towards math work for the tutees and possibly the tutors.

Method

This qualitative study explored an instrumental group case study for the math intervention for both primary student tutees and middle school student tutors as a result of the math tutoring. All students underwent math assessment testing and all the teachers were interviewed about their observations of their students during the tutoring period. The results were verified and validated in this study.

Participants

Students were recruited for the tutoring study from ten elementary schools and a homeschool community by posting recruitment notifications on email flyer services for the elementary schools of two school systems, website notices for the homeschool community, and printed bulletin notices for community groups. The study offered twenty-five-minute math tutoring sessions twice a week after school for ten weeks for kindergarten and first grade students. To be included in the study, kindergarten and first grade students had to test at 50% or below on a math subtest of the Fall Individual Benchmark curriculum-based assessment from *Aimsweb Plus* (Pearson, 2017) or have been retained from the previous year. Fifteen kindergarten and first grade students were screened and tested for inclusion in the afterschool cross-age tutoring study. One student was repeating her kindergarten year and three students were identified with a disability: Intellectual Disability, ADHD, and Speech Impairment. The student identified with ADHD and another student attended only one tutoring session in the first three weeks and withdrew from the study. Thirteen kindergarten and first grade students who met the criteria completed the tutoring study and the post-test for inclusion in the study. Ten of these students were from ten different public elementary schools in West Texas and three students were homeschooled. Each of the thirteen tutees comprising of nine girls and four boys had a different math teacher who was interviewed about her observations concerning her kindergarten or first grade student.

To tutor the kindergarten and first grade students, middle school students were recruited by posting recruitment notifications on the homeschool community website offering an opportunity to volunteer one day a week for less than two hours each time. Six sixth grade, one seventh grade, and two eighth grade homeschool students were screened and tested to volunteer as tutors for the cross-age math tutoring study. The nine middle school

tutors of three boys and six girls included a researcher's son. One of the sixth-grade tutors withdrew before the final weeks of the study. Seven math teachers were interviewed about their observations of their students.

The research included testing of each student for math skill performance using curriculum-based measures through the *Aimsweb Plus* by Pearson system (Pearson, 2017). This curriculum-based assessment evaluated the math skill development over the ten-week instructional period for both the primary and middle school students. Using the Individual Benchmark Testing for the Fall as a pre-test and then the Winter Individual Benchmark as a post-test allowed the researcher to compare the scores as an evaluation of the instructional intervention for math skill acquisition. The evaluator tested the primary students individually using the *Aimsweb Plus* Fall Individual Benchmark Early Numeracy (Pearson, 2017) assessment asking each math question by using visual prompts for response on the assessments. The pre-test and later the post-test (after ten weeks of intervention) took approximately 15 to 20 minutes to administer individually for each kindergarten and first grade student. Kindergarten students completed a timed Number Naming Fluency subtest, a timed Quantity Total Fluency subtest, and an untimed Concepts & Applications subtest. These subtests created a Total Early Numeracy Composite which also corresponded to a national percentile score. First grade students completed a timed Math Facts Fluency subtest, a timed Number Comparison Fluency Pairs subtest, and an untimed Concepts & Application subtest. These subtests created a Total Early Numeracy Composite which also corresponded to a national percentile score. Pearson determined the percentile scores for the math-based assessment on their testing of a large, representative national sample of at least 11,000 kindergarten students and 12,000 first grade students (Pearson, 2012). Table 1 lists the grade, gender, special considerations, and composite scores and percentiles on the Fall Individual Benchmark assessment by *Aimsweb Plus* (Pearson, 2017) for each tutee.

Table 1: Characteristics of the Tutee Participants

			Score	%	
1	K	M	40	66%*	
2	K	F	36	54%*	
3	K	F	43	75%	Retained
4	K	F	19	9%	
5	K	F	40	66%*	Teacher Suggested
6	1	M	27	13%	SPED Speech Impairment
7	1	F	15	1%	SPED Intellectual Disability
8	1	F	57	70%*	
9	1	F	33	20%	Teacher Suggested/RTI
10	1	M	53	62%*	
11	1	M	16	2%	RTI
12	1	F	51	57%*	
13	1	F	40	31%	
			36.2	40.5%	

Note. *Subtest score(s) of 50% or less Teacher Suggested Tutoring
SPED = Identified in Special Education program,
RTI = Response to Intervention program

The middle school students took the *Aimsweb Plus* Fall Individual Benchmark Math (Pearson, 2017) assessment completely online on a laptop computer. No paper-and-pencil was used. The math composite percentiles on the Fall Individual Benchmark assessment for the middle school students ranged from 6% to 92% with four of the students having composite percentiles over 50% and four students having math composite percentiles at 50% or less. Table 2 lists the grade, gender, and composite scores and percentiles on the Fall Individual Benchmark assessment by *Aimsweb Plus* (Pearson, 2017) for each tutor.

The teachers of each of the students were asked if they observed math skill, math attitude, or math work ethic improvement after the ten-week intervention. After the ten-week tutoring intervention, the math teachers were emailed again and asked to respond to four questions. Three teachers of the tutees were interviewed face-to-face while the other ten teachers chose to respond to the questions via email. Two teachers of the tutors were interviewed face-to-face while five of the teachers responded by written personal communication from emailed questions.

The thirteen teachers of the kindergarten and first grade students responded and seven of the tutors' teachers also responded. Ten of the thirteen tutees' teachers teaching in ten different elementary schools were composed of nine teachers in regular classrooms and one teacher in a self-contained intellectual disability classroom.

Three of the tutees' teachers home school their students, and all seven of the tutors' teachers home school their students.

Table 2. Characteristics of tutor participants

Student	Grade	Gender	Composite	
			Score	%
1	6	F	181	6%
2	6	F	195	19%
3	6	F	240	79%
4	6	M	251	88%
5	6	M	261	92%
6	7	F	218	50%
7	8	F	208	28%
8	8	F	237	70%
			223.9	54%

Data Sources

The research included the testing of each student for math skill performance using curriculum-based measures through the *Aimsweb Plus* by Pearson system (Pearson, 2017). This curriculum-based assessment evaluated the math skill development over the 10-week instructional period for both the primary and middle school students. Using the Individual Benchmark Testing for the Fall as a pre-test and then the Winter as a post-test allowed the researcher to compare the scores as an evaluation of the instructional intervention for acquisition of grade level math skills. The evaluator tested the primary students individually using the *Aimsweb Plus* Fall Individual Benchmark Early Numeracy (Pearson, 2017) assessment asking each math question by using visual prompts for response on the assessments. The middle school students took the *Aimsweb Plus* Fall Individual Benchmark Math (Pearson, 2017) assessment completely online. No paper-and-pencil was used for either type of test.

At the beginning of the intervention, the teachers of each of the students were emailed and told they would be asked if they observed improvement in math skill or attitude towards completing math work after the 10-week intervention. After the ten-week tutoring intervention, the math teachers were emailed again and asked to respond to four questions: 1) Have you seen any documented math gains for this student and what type of documentation shows that (overall grades, homework grades, test grades, test scores, etc.)? 2) What types of math gains have you seen? (number identification, basic addition facts, basic subtraction facts, number sense, problem solving, etc.) 3) Does the student exhibit more positive attitudes in attempting math work? How have you seen this? 4) Would you recommend the cross-age math tutoring program for other students? Why?

The teachers were asked to respond to the four questions either by email, phone, or a face-to-face interview. Five of the twenty teachers chose to answer the four questions face-to-face in person and have the researcher record their oral responses, but fifteen of the teachers responded by written personal communication from email. The thirteen teachers of the kindergarten and first grade students responded and seven of the tutors' teachers also responded. Ten of the thirteen tutees' teachers teach in different elementary schools in large-size urban public school districts in Texas. Nine of these teachers teach in a regular classroom, and one teacher teaches in a self-contained intellectual disability classroom. Three of the tutees' teachers home school their students, and the seven tutors' teachers home school their students.

The thirteen responses from the math teachers of the tutees were compiled for each of the four questions using Microsoft Word. The data were then reduced and highlighted for color-coding to analyze the categorized responses. Themes emerged from the patterns of responses across the data sets as emergent category designation was used to color-code the unitized data. This process was repeated for the seven responses from the math teachers of the tutors. After the color-coded data were analyzed to determine the themes, the raw data responses of both sets of teachers were line numbered and downloaded into the MAXQDA 2018 (VERBI GmbH, 2018) software program. The transcripts were coded in the qualitative research analysis program and evaluated for patterns and percentages of responses. Summary reports were printed for both sets of teacher responses noting the codes and coded segments. The analysis summaries for both the color-coded emergent category designation using Microsoft Word and the MAXQDA Summaries Confirmation sets were compared for verification and trustworthiness of findings.

Procedures

Training volunteers to understand both the aspects of the instruction and the right of privacy for students with special needs was crucial for a successful and respectful program and to ensure fidelity of the study (Johns & McGrath, 2009). The middle school tutors were trained for three and a half hours in confidentiality, working with young children, mentoring skills, and the practice of the math instruction. In addition to covering these topics, the instructor provided tutor training in the areas of number writing and how to teach math facts more effectively.

The math curriculum used for tutoring combined aspects of research-based programs. Since visual representation in mathematics is a strongly recommended practice for instruction, especially for low achieving students (Garderen, Scheuermann, Poch, & Murray, 2018), the math curriculum incorporated systematic instruction and visual representations inspired by *Visual Circle Math* (Bedell, 2005). Tutors must use visual supports when teaching all math problem-solving levels explaining how they attempt the problem and allowing for student responses. Tutors immediately provide systematic error correction to prevent students from continuing to practice incorrect math solving steps as "feedback is more effective when given during or immediately after a task is completed" (Vaughn et al., 2012, p. 21).

The twenty-five-minute math tutoring intervention conducted twice a week for ten weeks included several activities. First, the tutors engaged the tutees with conversations based on the nine "Mentoring Questions/Comments" listed by the researcher. Using math flash cards, the tutor reviewed the set of flash cards and taught the five fact cards for that day. The tutors practiced short term visual memory using single digit cards for two minutes. Next, the tutor reviewed previously covered math skills with the tutee using a printed review sheet where the tutor and tutee took turns answering math questions. Then, the tutor taught new math skills to the tutee and had the tutee practice for a total of fifteen minutes. The tutor reviewed the math facts taught earlier with the tutee for the next two minutes. After that, the tutor practiced short term auditory memory using digit cards for two minutes. Finally, the tutor used laminated number reading pages for the tutees to practice counting by multiples. Tutors gave the tutees a variety of verbal praise as the researcher supervised each tutoring session and offered help to the tutors in working with their students.

Studying the effects of cross-age math tutoring with the instrumental group case study design examined the qualitative case study interviews of the math teachers along with the mathematical assessment data of the students. Using Microsoft Word, the thirteen responses from the math teachers of the tutees were compiled for each of the four questions. The data were then reduced and highlighted for color-coding to analyze the categorized responses. Themes emerged from the patterns of responses across the data sets as emergent category designation was used to color-code the unitized data. This process was repeated for the seven responses from the math teachers of the tutors. After the color-coded data were analyzed to determine the themes, the raw data responses of both sets of teachers were line numbered and downloaded into the MAXQDA 2018 (VERBI GmbH, 2018) software program. The transcripts were coded in the qualitative research analysis program and evaluated for patterns and percentages of responses. Summary reports were printed for both sets of teacher responses noting the codes and coded segments. MAXQDA Analytics Pro 2018 (VERBI GmbH, 2018) added another way to interpret the qualitative data for trustworthiness (Erlandson et al., 1993). The analysis summaries for both the color-coded emergent category designation using Microsoft Word and the MAXQDA Summaries Confirmation sets were compared for verification and trustworthiness of findings. This data analysis allowed the study to delve into this phenomenon of children teaching children to determine acceptability and adoptability for possible inclusion in the school system.

Results and Discussion

In studying the qualitative data from the math tutoring research study, the testing of the tutees from the Fall to the Winter Benchmark seemed to suggest improved math skill beyond the expected growth. All thirteen kindergarten and first grade students in the study completed the pre-test Fall Individual Benchmark before the intervention began and then completed the post-test Winter Individual Benchmark from Pearson's *Aimsweb Plus* (Pearson, 2017) after the ten weeks of tutoring. The average composite math percentile for the tutees on the Fall Benchmark was 40.46%, and the average composite math percentile for the tutees on the Winter Benchmark was 44.85% showing a higher than expected growth.

Table 3. Pre-test to post-test data comparison for tutees

			Fall Composite		Winter Composite		
Student	Grade	Gender	Score	%	Score	%	Factors
1	K	M	40	66%	57	88%	
2	K	F	36	54%	45	54%	
3	K	F	43	75%	45	54%	Retained
4	K	F	19	9%	32	18%	
5	K	F	40	66%	56	85%	Teacher Suggested
6	1	M	27	13%	44	17%	SPED/Speech Impairment
7	1	F	15	1%	24	1%	SPED/Intellectual Disability
8	1	F	57	70%	61	54%	
9	1	F	33	20%	46	20%	Teacher Suggested/RTI
10	1	M	53	62%	67	70%	
11	1	M	16	2%	28	2%	RTI
12	1	F	51	57%	77	88%	
13	1	F	40	31%	52	32%	
			36.15	40.46%	44.77	44.85%	

Note: SPED: Special Education Identifie, RTI: Response to Intervention Program

The eight middle school tutors completed the *Aimsweb Plus* (Pearson, 2017) Fall Individual Benchmark math assessment before they started tutoring the kindergarten and first grade students and then completed the Winter Individual Benchmark after they completed the tutoring experience. Three of the eight middle school students scored a lower score on the Winter Benchmark assessment than they scored on the Fall Benchmark assessment. This result was not expected. These students had originally scored between 70% to 88% which may have been an elevated score or their homeschool curriculum may not have been aligned with the expected curriculum-based objectives for the Winter Benchmark. The three lowest scoring students on the Fall Benchmark seemed to make significant improvements on the Winter Benchmark's percentile ranking. The average composite math percentile for the tutors on the Fall Benchmark was 54.00%, and the average composite math percentile for the tutors on the Winter Benchmark was 48.75% showing a lower than expected growth. As the study was an instrumental group case study, there may be too few students to draw generalizations from the results.

Table 4. Pre-test to post-test data comparison for tutors

			Fall Composite		Winter Composite	
Student	Grade	Gender	Score	%	Score	%
1	6	F	181	6%	197	18%
2	6	F	195	19%	208	32%
3	6	F	240	79%	234	62%
4	6	M	251	88%	239	67%
5	6	M	261	92%	277	90%
6	7	F	218	50%	221	55%
7	8	F	208	28%	223	44%
8	8	F	237	70%	208	22%
			223.88	54.00%	225.88	48.75%

This study utilized the data from the students' math teacher interviews to determine the effects of the math tutoring on the students' math skills and attitudes.

1) Have you seen any documented math gains for this student and what type of documentation shows that (overall grades, homework grades, test grades, test scores, etc.)?

Eleven of the thirteen tutees' teachers said they had found documented math gains for their students and the other two teachers qualified their responses. Of the two teachers who qualified their answers, one teacher stated that the student was not struggling on math assessments, but now demonstrated confidence, better work ethic, and leadership. The other teacher noted that her student was "making some progress," but still needed additional help.

Five of the tutees' teachers listed the measurement device which confirmed their academic gains. Three of these teachers noted the district-wide math screener showed significant gains between the first and second assessments. One teacher explained that her kindergarten student improved in the district wide math screener "from 24% to 53%." A first-grade teacher wrote that when taking the district screeners during the year, her student "improved dramatically the second time we took it." Another teacher mentioned that her first-grade student showed above grade level math work by her grades and district screeners. A special education teacher described her first-grade student's documented math gains through her Individualized Educational Plan (IEP) progress reports where she has "shown growth in her Math IEP's."

Most of the teachers of the tutors did not believe their students improved specifically in math skills from the tutoring experience. This finding is consistent with the curriculum-based testing of the tutors where, on average, the tutors made slightly less than the expected math gains.

2) What types of math gains have you seen? (number identification, basic addition facts, basic subtraction facts, number sense, problem solving, etc.)

Each of the thirteen teachers of the tutees described the types of math skills they observed student improvement during the tutoring period. Eleven of the teachers noted that their students improved in number identification and number sense. Eight teachers mentioned that their students improved in math facts, especially addition. One special education teacher explained that her first-grade student could now "count 20 items 1:1 correspondence with great confidence" and recognized almost all those numbers, which she had been unable to do in the Fall. A kindergarten teacher responded that her student could now "count backwards from 20, write #16-20 correctly & build sets to 20. She recognizes #21-39 & counts by 5's & 10's to 100. These are all skills that she did not have before" the tutoring intervention. A first-grade teacher remarked that her student has "gained tremendously in her number sense, addition, subtraction, and strategies she is able to apply to solve a problem in various and numerous ways…She has demonstrated knowledge of higher-level math skills such as regrouping and multiplying." The math curriculum approach used in the tutoring covered problem-solving strategies and allowed many students to reach the multiplication levels. Figure 1 notes the areas of math improvement reported by the teachers of the tutees.

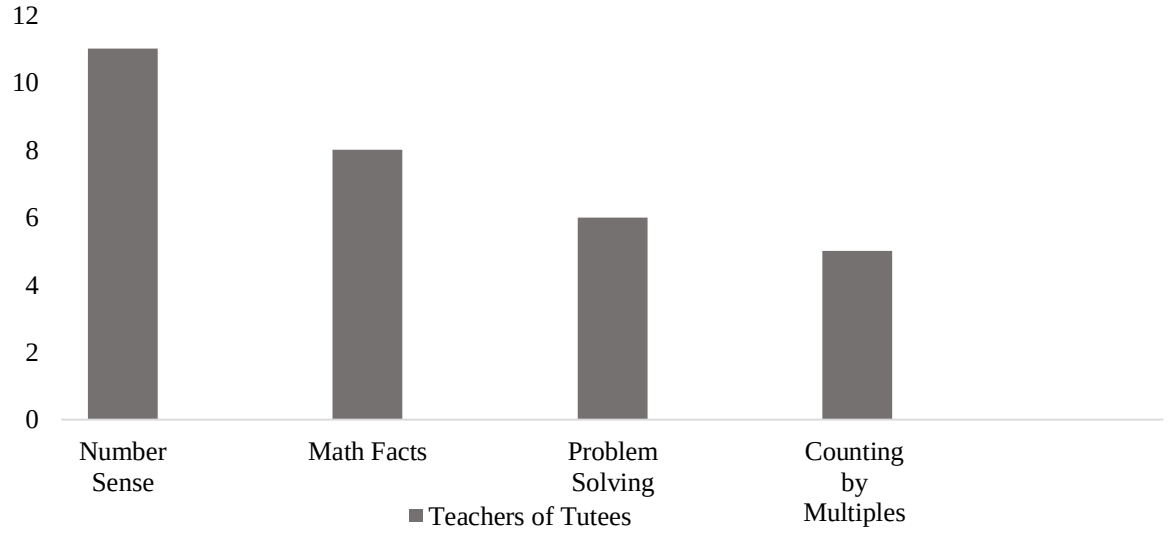

Figure 1: Skill ımprovement noted by teachers of the tutees

3) Does the student exhibit more positive attitudes in attempting math work? How have you seen this?

The teachers of both tutees and tutors were asked whether or not their student demonstrated a more positive attitude in attempting math work. Seven of the primary age tutees' teachers noted an improved positive attitude towards math work whereas four of the teachers said their students have always had a positive attitude towards math work, and only two teachers noted their students still struggle with their attitude towards math work. The middle school tutors' teachers believed that five of their students demonstrated a more positive attitude towards math work and only two teachers noted that there was no difference.

The socio-emotional impact of the tutoring demonstrated a significant finding especially for the young tutees. A kindergarten teacher observed that her student was "more likely to participate in whole group math discussions than previously". A first-grade teacher of Tutee 6 who was diagnosed with a speech impairment disability expressed that her student "has shown some leadership in group discussions during math workshop. He often volunteers to show the class how to work out a problem, or voices opinions that are often correct during group discussion." A self-contained special education teacher agreed that Tutee 7 who was diagnosed with an intellectual disability has "much more confidence in her math ability and it shows with a positive attitude and not being quite as defiant when asked to do her work." Another first-grade teacher remarked that her student "is so excited to be learning all the new math skills she has been introduced to. She loves to practice and share the skills in class." Improved confidence and a more positive attitude are important results for an instructional intervention to help low math achieving students.

4) Would you recommend the cross-age math tutoring program for other students? Why?

Teachers of both tutees and tutors were asked if they would recommend cross-age math tutoring for other students. Eight of the thirteen primary age tutees' teachers said they would recommend cross-age tutoring while three teachers hesitated to recommend an intervention they did not fully understand, or they felt their student still struggled in math. One of the teachers of a tutee who was not sure she would recommend cross-age tutoring said that she did not know much about the intervention, but "any program geared towards helping students close gaps in their learning is beneficial."

The math curriculum approach allowed the tutors to teach math skills at the speed of the tutees, but the tutors were encouraged to push the younger students to keep them moving on to the next level. The special education teacher of Tutee 7 said that she would recommend cross-age tutoring as she stated, "I absolutely think cross-age math tutoring is a great program – it's great for confidence building and building relationships along with learning skills. Sometimes kids learn better from other kids!" Another teacher of a tutee said that she would recommend the approach because her "student has shown significant gains in math and confidence from the program." A first-grade general education teacher of Tutee 6 who has a disability remarked that she has "seen a lot of growth in (his) mathematical confidence and the agility of his mind to handle multi-step problems. I think the program has helped him reach new levels of confidence and ability by solidifying budding math skills." The tutoring activities were not intended to replace school instruction for math as expressed by a first-grade teacher who would recommend the intervention because she "saw progress in (her student). With help at school and help in your program, she was able to be more successful." Describing the goal of cross-age tutoring, one kindergarten teacher commented that she would recommend the model because "not all students come to us at the same levels, and although we differentiate the best we can, there is often not enough time to spread around our large class sizes in order to meet their needs." Helping differentiate math instruction to struggling primary-age students through the middle school-age mentors allowed the tutoring intervention to improve some students' math skills and attitudes.

Surprisingly, all seven teachers of the tutors said they would recommend cross-age tutoring to other students, most often citing that it was a positive or enjoyable experience for their student. Four teachers of the tutors recommended the experience because it was positive or enjoyable for their students. As one teacher of a middle school tutor stated that the student "thoroughly enjoyed this opportunity and it gave her a positive outlook on helping others." Two teachers of tutors noted that they would recommend participation because their students improved in confidence, as one teacher explained, "it builds their confidence. Once you teach something, you learn it." Another teacher noted, "He has taken a very positive leadership role in helping younger students. He has strengthened his leadership skills and is able to step out of his comfort zone to help others."

Some of the teachers of the tutors recommended the experience for other reasons. One teacher said that she would recommend cross-age tutoring for any student who "may become a professional teacher. I do believe one learns best when one teaches and that kids enjoy the fulfillment that comes from helping other children." Another teacher noted that the student is "normally quiet, gets animated and loves talking about her tutoring experience, being careful not to reveal any confidential information."

Discussion

Two key findings emerged from the data analyzed. First, the study determined that the cross-age math tutoring resulted in improved mathematical skills. Second, the study suggested that there was improved attitude towards math for the low math achieving kindergarten and first grade students. Research has found that early math skills

for young students continue to have long-lasting effects for their future with early math skills predicting later ones (Sonnenschein, et al., 2012). This study highlights the potential positive impact of training middle school students as tutors to provide intensive instruction for low math achieving kindergarten and first grade students. Research indicates utilizing cross-age math tutoring and research-based instruction improves the chance of success for the low math achieving students including students with disabilities (Garderen, Scheuermann, Poch, & Murray, 2018).

Cross-Age Tutoring Improves Mathematical Skills of Tutees

As noted from previous studies (Vaughn et al., 2012; Knight & Sartini, 2015), the use of tutoring as an instructional intervention practice improves the academic skill level for students. The testing data from the Individual Benchmark assessments from Pearson's *Aimsweb Plus* program (Pearson, 2017) and the qualitative data gathered from the teachers supported the conclusion of improved mathematical skills for most tutees. Most teachers noted the areas of number sense, math facts, problem-solving skills, and/or counting by multiples showed improvement in most of the tutees. The teachers' confirmation of the testing data reinforced the result that the tutoring intervention improved the tutees' math skills. These findings are corroborated by studies on tutoring programs showing favorable results for the cross-age tutoring format (Shenderovich et al., 2016; Robinson et al., 2005).

Schools which incorporate cross-age math tutoring interventions once or twice a week for low achieving math students to improve the kindergarten and first grade students' math academic skills have a solid research base for improving their academic skills (Robinson et al., 2005). The kindergarten and first grade students who showed an improvement in math skills were tutored for less than ten hours of intervention instruction (50 minutes a week for 10 weeks) which could be replicated in the school setting.

Teachers Reported the Students Demonstrated Improved Math Confidence

Interviews conducted with the teachers of the tutees revealed the teachers thought the students demonstrated an improved sense of confidence in their math abilities. Four of these seven teachers specifically mentioned that their students shared more in class math discussions or helped others with math. Re, Pedron, Tressoldi, and Lucangeli (2014) found that students' attitudes regarding math corresponded to their math achievement. Improved self-confidence has shown positive correlation to increased math achievement. By providing extra academic assistance and mentoring for students who may struggle with social difficulties associated with math disability, schools may improve these students' confidence towards math and the classroom (Willcut et al., 2013).

Most of the middle school tutors' teachers noted that their students demonstrated a more positive attitude towards math work. The qualitative data provided by the teachers of the tutors suggested an improved attitude towards math work as described by five of the seven tutors' teachers describing that they have seen stronger leadership skills by the students working with younger children or that these students seem to be more willing to help other children. From the research, Paterson and Elliot (2006) found cross-age tutoring developed pedagogical skills, an improvement in attitude toward school, increased self-esteem and motivation to learn in the tutors. Robinson, Schofield, and Steers-Wentzell (2012) found that tutoring studies revealed an increase in the self-concept scores for tutors and that the students rated themselves as having greater social skills after tutoring other students. These research studies support the finding that the cross-age tutoring intervention may increase the confidence and leadership skills of the tutors. Middle schools could develop structured cross-age math tutoring interventions to foster confidence and leadership skills for their students.

Limitations

This instrumental group case study of only thirteen kindergarten and first grade students tutored by eight middle school tutors was limited due to its number of students involved in the tutoring intervention. A greater number of students would allow for more generalizable findings. This study only investigated a limited number of variables related to cross-age tutoring and the teachers' perspectives. The qualitative data were largely based on the teachers' answers to four interview questions. The math teachers' perspectives from large school districts to homeschool situations could be very different and could have affected their responses.

Although learning to tutor others is a valuable experience, middle school tutors in this study were not allowed to tutor more than two hours a week. There must be concern for their time commitment for such an experience. Also, these tutors may have been more conscientious than a random group of middle school students as the tutors were volunteer homeschooled students.

Future Studies

Incorporating cross-age tutoring in the school day with more students in future studies may add further understanding to the role of children teaching children. Studying middle school students tutoring with a less structured curriculum may or may not yield different results. A different curriculum not incorporating the embedded memory activities may or may not yield different findings to identify if those activities made a difference to math skill acquisition. Choosing a different curriculum using a different way to introduce the material may find if these research-based recommendations of visual supports and direct, systematic instruction really made a difference. Finally, choosing a different group of tutors whether the age is high school students or older elementary students may explore the role of the tutor as an instructional change agent.

Studying an intervention which spans most of the school year, such as 20 to 25 weeks, may create a greater impact or develop more substantial interpersonal relationships between the tutors and tutees. The most requested change by the parents of the tutees was to create a tutoring intervention for the older elementary students who were struggling with math. Creating a math intervention especially designed for older elementary math students and implemented by middle school tutors may be an important future study.

Conclusion

Cross-age middle school math tutors remediating low math achieving kindergarten and first grade students produced some positive findings. Corroborated by research, cross-age tutoring improved the math skills of the tutees. In addition to improved academic skills, the tutoring activities appeared to improve the math confidence of the students being tutored. For the tutors, it was also a positive experience as they seemed to develop more confidence and leadership skills. Further study should be considered concerning the curriculum approach for the tutoring and the age of the tutors. Yet, from this study, cross-age math tutoring using middle school tutors allows a potentially useful instructional approach to improve academic achievement and positive attitudes towards math for a greater number of kindergarten and first grade students.

Recommendations

Cross-age tutoring provides a positive remediation for younger low achieving math students for increased skill development and attitude towards math. Creating opportunities to train older students to work with younger students may enhance remediation interventions for lower performing students. Older students are a natural resource available at most school campuses. Excellent training and limited time requirements are important for positive results for the older tutors. Using research proven explicit instruction, visual representations with systematic instruction, math fact review, and immediate feedback for remedying errors enhances a non-curricular remediation program. Allowing tutors to work one-on-one or with two students provides the tutoring format which seems to yield the highest results. Providing early intervention may help reduce the need for later remediation for many students.

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