INTEGRATING MATH AND LANGUAGE ARTS IN THE CLASSROOM: A STUDY ON THE EFFECTIVENESS OF MATH JOURNALS ON LANGUAGE SKILLS NEEDED TO SOLVE WORD PROBLEMS FOR THIRD GRADERS LEARNING ENGLISH AS A SECOND LANGUAGE

A Thesis by

Tamber Hepner

Bachelor of Arts, California State University Long Beach, 2007

Submitted to the Department of Curriculum and Instruction
and the faculty of the Graduate School of
Wichita State University
in partial fulfillment of
the requirements for the degree of
Master of Arts in Teaching

July 2012

INTEGRATING MATH AND LANGUAGE ARTS IN THE CLASSROOM: A STUDY ON THE EFFECTIVENESS OF MATH JOURNALS ON LANGUAGE ACQUISITION SKILLS FOR THIRD GRADERS LEARNING ENGLISH AS A SECOND LANGUAGE

The following faculty members have examined the final copy of this thesis for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Master of Arts in Teaching.

_____
Kimberly McDowell, Committee Chair

_____
Jeri A. Carroll, Committee Member

_____
Catherine Bohn-Gettler, Committee Member

ABSTRACT

The contemporary American elementary classroom is comprised of a more diverse student population than has ever been seen before. The strong emphasis of mastery in language arts and mathematics at the elementary level as outlined by the no Child Left Behind Act, causes enough stress for students whose primary language is English (native English speakers), let alone those English language learners (ELL) who require extra instruction to "catch up" to their native speaking counterparts. For teachers, the task of getting their students to reach their expected potential is getting more difficult as blocks of instruction decrease, class sizes increase, and the demands of performance based education prevail.

This study intended to look at the use of the language arts practice of journaling for math instruction and its effect on academic performance in both language arts and math. Solving math word problems and writing skills were specifically assessed. A five-week intervention of math journaling was implemented in a third grade classroom. Twenty two students were divided into a control and an experimental group based on academic achievement and language status (English language learner (ELL) or native English speaker) per student records. The experimental group was given math journaling time three to four times a week for five weeks for 20 minutes to write about a prompted math concept with the researcher while the control group practiced and reviewed already taught concepts with the classroom teacher. Results showed there was a statistically significant difference in academic performance between groups in both word problem solving and writing skills with the experimental group using mathematics writing journals scoring higher in both.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

With larger class sizes, smaller blocks of learning time, and the ever-looming presence of the No Child Left Behind Act of 2001 (NCLB), today's teachers are faced with the growing conundrum of how to teach required curriculum while dealing with a more widely diverse classroom population. No one school district or state has a cure-all solution for this challenge, and it appears that effective interventions are as widely diverse as the student population itself.

Schools across the nation are seeing more diversity in culture, language, and ability (Winter, 1999). Being that NCLB stipulates that all children in the public school systems, regardless of disability or English language learning (ELL) proficiency levels, be held accountable to the standards set by each state, the achievement of a certain level of mastery for all students has now become a forefront issue (de Cohen & Clewell, 2007; Gruenberg & Miller, 2011).

Specifically speaking about ELL students, the use of language-based math instruction can sometimes be a detriment, although necessary to prepare for assessment. In other words, students who may not yet fully understand English are still required to be tested in the language they are being taught, which is often English (de Cohen & Clewell, 2007). As pointed out in one study, "[s]tudents are now required to demonstrate their ability to communicate their mathematical thinking on high stakes testing" (Kostos & Shin, 2010, p. 234). Suggestions such as using manipulatives, graphic organizers, or even physical movement help the child communicate attained math knowledge, but these suggestions do lack in instruction on how to execute successful language strategies needed for assessments (Lee, Silverman, & Montoya, 2002).

Instruction in schools that serve a high ELL population has changed since the introduction of NCLB to assist in promoting the language skills of ELL students. Also noted, a "great deal of variation" is used to assess in districts with high ELL populations for "NCLB testing requirements in both subject areas and ELP (English Language Proficiency)" (de Cohen & Clewell, 2007, p. 6). More accommodations and exemptions are used for high ELL population. This begs the question whether they are really learning what they are assessing. Some districts with high ELL populations used tests "inappropriately to measure both subject area and [English language proficiency] skills" (p. 6). The focus has become less on the student and what he or she has learned, and more on whether the district will be able to pass to proficiency.

With a intense need to expose ELL students to as much language as possible, many studies have focused their attention on the integration of language arts in areas never thought of as language based subjects, such as math and science. Since many schools with high ELL populations utilize ESL strategies such as immersion, ESL classrooms, and bilingual education, language arts has naturally been integrated into many different areas of education. Research shows, however, that the integration of writing into different subject areas has positive effects in many different respects (Brandenburg, 2002; Carter, 2009; Kostos & Shin, 2010; Wallace, Pearman, Hail, & Hurst, 2007). These strategies are not only useful for ELLs, but also for students with special needs and young learners as well. Teachers benefit from the use of writing integration as it provides a new style of insight into how a student learns and synthesizes information (Powell, 1997). Since high stakes testing has a focus of language and word problems, writing strategies in the classroom ideally help the administrators and districts to further educate children on how to dissect and interpret information they may later see on a test.

Journals specifically create a dialogue between teacher and student that may not otherwise occur (Kostos & Shin, 2010). Even if some teachers don't first see the importance of this kind of writing strategy, if exercised, they soon realize the many benefits writing can have on instruction (Quinn & Wilson, 1997).

This study examines the possible benefits of using journal writing in mathematics lessons to increase mathematics and language competency. Students classified as ELL were the main focus, but because there is research that suggests this kind of integrative intervention is beneficial to all students, this study also took into consideration the effect academic achievement math journaling had on native English speaking students as well as students with special needs.

CHAPTER II

LITERATURE REVIEW

Inclusion of students who do not speak English as their primary language has increasingly become more prevalent in the American educational system. The terms used to classify and categorize services, strategies, and even the children themselves are plentiful and, at times, become confused. For this paper, three terms will be used to classify student subgroups: English language learners (ELLs), English as a second language (ESL), and native English speakers. ELLs refer to the children who do not speak English as their primary language, while ESL refers to the services and interventions these students are offered in the educational system (Bassof, n. d.). As comparisons rise between ELL and non-ELL students in this study, the term native English speaker will also be used. This term refers to those students who do speak English as their primary language, much like the term non-ELL.

Integrated Writing Exercises

Integrated writing exercises are not new. Several studies have targeted various kinds of writing strategies to demonstrate effectiveness of integrating writing and language navigation skills in order to improve math, science, and reading achievement. These studies include math journal exploration for high school students in ESL classrooms (Powell, 1997) and other interventions to teach advanced math skills with great success (Brandenburg, 2002; Bowe, 2009), while success in implementing math thinking into writing exercises has been chronicled by professionals in elementary education (Carter, 2009; Kostos & Shin, 2010). The use of such strategies as graphic organizers, lists, and reviews of materials can be highly useful to increase students' reading comprehension (Wallace et. al., 2007).

Writing and Math Integration

Research has found that integrating writing in other subjects not only demonstrates a student's ability to improve language acquisition skills, but students benefit from a teacher who can track and help improve certain language and critical thinking challenges that individual students may exhibit through their writing entries, and vice versa (Armon & Morris, 2008; Honnert & Bozan, 2005). Providing proper training for teachers in pedagogical knowledge of mathematics in the primary grades will help those teachers understand how a child constructs the concept of a number, as opposed to giving the children concepts they are not prepared for (Bailey, 2010) like calendar concepts (Biddle, 2007). In understanding the concept of number through the eyes of the child, a teacher can better understand what next steps to take in instruction. Taking this into consideration, along with the idea that math journaling helps the communication between student and teacher, a journal may help solve the communication barrier as well as help alleviate any fears the teacher may have about not being effective. Writing strategies and integrated mathematical concepts are not only beneficial for students, as many teachers struggle with math and teaching mathematics concepts as well. There is a sentiment of math phobia in this country, which often makes teaching mathematics a daunting task, even for special education teachers (Humphrey & Hourcade, 2010).

Neurological Basis for Integration

Using writing integration in math classes may have a special correlation in regards to where language and math thought originates in the brain as well. Researchers at MIT conducted a brain imaging study to find out what parts of the brain are elicited during mathematical thinking. Exact and estimated arithmetic calculations were given to Russian students to solve. What the researchers found is these two kinds of arithmetic calculations are solved using very

different parts of the brain. Exact arithmetic calculations are solved using the same areas of the brain that are elicited during the use and exercise of language. It was also shown that, regardless of whether the language was primary or secondary for the students, computation and solving of the exact calculations happened faster if the lessons were taught in the same language the calculations were given (Dehaene, Spelke, Pinel, Stanescu, & Tsivkin, 1999). Knowing that exact arithmetic calculation is solved in the same area of the brain as language is processed, it is possible that the link between journaling and math comprehension may even be stronger than a link for writing integration in other subject areas, specifically in learning exact math.

The neurological connection between math and language arts is impressive information to have uncovered, but students who are still not adept in the instructional language don't benefit from the instruction if they are unable to understand the language. Barbu and Beal (2010) explored the instructional implications of the Cognitive Load Theory (CLT) as cited in John Sweller (1994) and other scientists and scholars who have attempted to classify and understand cognitive mapping of the brain. After conducting a series of tests, they concluded that the difficulty of the material for ELLs was not necessarily in the computational difficulty, but in the wording of the questions (Barbu & Beal, 2010).

Theoretical Underpinnings

Understanding where a child is in development at a given time can benefit the knowledge of how cognitive load and neurological make up will affect a child's ability to learn. Theorists have long connected the idea of working memory with the theories of Piaget and his developmental stages (Biemiller, 1981). The Cognitive Load Theory centers itself on the idea of working memory and how it affects retention and understanding of materials (Paas, Renkle, & Sweller, 2004). Therefore, knowing that a child is in a particular developmental stage will also

assist in knowing the level of working memory; ability to retain information is established. Sweller (1994) also noted that it is not necessarily the amount of information that is given, but the kind of information. If the information presented does not fit into the schemas and ideas that are already forming in the mind, it becomes extraneous and burdensome – widening the overload a learner will experience. By building schemas within the learner, utilizing practice, "schemas can become automated, thereby allowing learners to further bypass working memory capacity limitations" (Paas, Renkl, & Sweller, 2004, p. 2).

Altogether, these facts are crucial to understanding why and how the integration of writing in instruction, specifically in math instruction, can improve a student's experience and knowledge of math skills. Much is the same for illustrating how a teacher can benefit from using writing, especially journal writing, in math lessons. Coupled with the information on ESL instruction in the United States, the push for aligned curriculum, and the constant struggle to cut budgets and programs that fund education, integration of subjects across fields will extend learning time and allow more opportunities to relate content to everyday life, a technique known to have positive and lasting results.

Math Journaling

Writing strategies specifically in math have been surveyed through the eyes of teachers for effectiveness. There was, however, a direct correlation between the amount of time spent using journaling as an instructional tool and the teachers' opinion about journaling. In other words, teachers who had rarely or never used journaling as a writing strategy were the ones who considered it to be ineffective or too time-consuming (Quinn & Wilson, 1997). Many times, when introduced to a new curriculum or reform, teachers will hold personal ideas, or efficacy beliefs, that can hinder the instruction of the new material. These beliefs also hinder the idea that

new ideas could influence their students and improve their learning (Charalambos & Phillipou, 2010). This view is shared uniformly by teachers when introduced to integrating language arts or other reforms into curricula, but tends to soften and even completely reverse after the implementation of this type of instruction (Armon & Morris, 2008; Charalambos & Phillipou, 2010; Kostos & Shin, 2010; Quinn & Wilson, 1997).

Though thought of as a useful tool, teachers often did not use writing with their ELLs due both lack of time to properly instruct the children on these practices and the children's own lack of skill in the language. As one teacher stated, "The task of writing itself is very difficult for [ELL] kids. Verbal communication is easier for the student" (Quinn & Wilson, 1997, p. 18). While there is debate on whether writing and instruction in a second language is as useful as verbal interaction and other non-verbal math strategies such as drawing pictures, using manipulatives, or creating graphics, it is journaling that can help provide correct English usage through responses from teachers and allow students to work out their issues through pictures, descriptions, and the ordering of their own thoughts without added structures (Lee, Silverman, & Montoya, 2002). Guided practices such as creating paragraphs from a vocabulary framing worksheet have also helped in the language acquisition skills of ELLs, thus strengthening the idea that integrating writing in with other subjects can benefit the student in multiple areas (Honnert & Bozan, 2005).

Math journaling has also been shown as an alternative source for communication and navigating academic concepts not just for ELLs, but also children who fall under the classifications of special education and low-achieving students. Often times, low-achieving students do not participate in class discussion, so keeping a journal helps those students open and maintain a communication dialogue with teachers that may not have existed otherwise (Baxter,

Woodward, & Olson, 2005). This, in turn, helps the teacher as well. Being more connected with an individual student's work can help them understand where they are lacking in understanding (Armon & Morris, 2008). Teachers get an insight to a student's understanding that they could not achieve with just an answer and work shown on a page (Powell, 1997). As for the student's ability to learn and reflect, reviewing one's own writing and explaining how the answer was achieved creates "an active, not passive, learner" (Powell, 1997, p. 23).

The one area that has little research is the instruction in this manner for elementary school-aged children. One study did show the effect of math journaling on second grade students to be extremely effective and useful for the teacher (Kostos & Shin, 2010). This study, however, did not explore the use of math journals for ELLs, nor did it track any effect on language skills for the students involved. The questions that are explored in this research intend to not only track the effect math journals have on math proficiency, but to assess any effect that math journals may have on ELL students' ability to demonstrate language proficiency and language acquisition skills in writing. The specific research questions addressed are (1) How does math journaling affect the mathematical problem solving skills of students who are also English language learners? (2) What kind of effect does math journaling have on the language acquisition and writing skills of students who are also English language learners? (3) Is there a difference in effect between ELLs and those who are classified as native English language learners?

CHAPTER III

METHODOLOGY

Participants

Participants were students attending third grade at one grade school in a large midwestern city, all in a self-contained classroom. A total of 22 students between the ages of 8 and 10 years old participated, consisting of 14 boys and 8 girls. Thirteen students were classified ELLs, twelve native Spanish speakers and one native Vietnamese speaker. Five students in the classroom were classified as needing special education services. The average of student achievement for the class as a whole is below grade level as determined by AIMSweb assessment scores, a progress-tracking system used in the school district to assess student skill levels and achievement three times a year. Data from the, January scores were used. According to the AIMSweb assessments, six students scored above academic proficiency for the third grade level.

This study used a quasi-experimental design in that the participants were not selected randomly. Using matched stratified random assignment based on academic skill level and language status (ELL vs. native English speaker), students were paired and grouped with similar students. AIMSweb scores as well as input on performance from the classroom teacher were used to determine proper classifications and grouping. The classification of special needs for this particular group was not a determining factor for matched stratification, as each child had a different diagnosis. These diagnoses do not uniformly denote academic achievement. For instance, one child is emotionally disturbed but performs at proficient levels on AIMSweb, while another child has a reading disability but scores highly proficient in math concepts. Then, participants were drawn randomly for either the experimental or control group. The students

were evenly represented in both groups. Students with special needs ended up evenly assigned at random between groups. Table 1 illustrates the characteristics of each student in both groups. It shows a similar pairing of students categorized below, average, or above academic level for third grade.

TABLE 1

STUDENT INFORMATION BY STUDY GROUP

Student	Group	ELL	Academic Level as Reported by AIMSweb	Sex	Special Needs
1	Experimental	Yes	Average	F	No
2	Experimental	No	Below	M	Yes
3	Experimental	No	Above	M	No
4	Experimental	Yes	Average	F	No
5	Experimental	Yes	Average	M	No
6	Experimental	Yes	Above	M	No
7	Experimental	Yes	Above	F	No
8	Experimental	Yes	Below	M	Yes
9	Experimental	No	Below	M	No
10	Experimental	Yes	Below	F	No
11	Experimental	Yes	Average	M	No
12	Control	Yes	Above	F	No
13	Control	Yes	Average	M	No
14	Control	Yes	Above	F	No
15	Control	No	Below	M	Yes
16	Control	No	Average	M	Yes
17	Control	Yes	Average	F	No
18	Control	No	Above	M	Yes
19	Control	Yes	Below	M	No
20	Control	Yes	Average	F	No
21	Control	Yes	Below	M	No
22	Control	No	Average	M	No

Materials

This section has been divided into two parts: assessment materials and intervention materials.

Assessment

An original math pretest and posttest was generated for the assessment. These tests were identical. The test consisted of ten word problems that covered operations the children had already learned in the classroom, from simple addition and subtraction to multiple-step division and multiplication questions. The questions were worded with grade-level academic language.

The writing prompt consisted of one question that the participants were asked to use in order to author a narrative piece. The same prompt was used for both the pretest and posttest: "You are walking out of your house one day on the way to school. Suddenly, you trip over something. It is a magic lamp. Not only is it a magic lamp, but it is sitting on a magic carpet!" Once introduced to the prompt, the teacher and students read the prompt together, and an understanding of what both a magic lamp and a magic carpet could do was established. Instructions were given to continue the story from that point. Students were unassisted during the writing and encouraged to use descriptive speech, original words, and to be mindful of conventions such as proper use of punctuation, spelling, and capitalization. Scoring of this prompt was based on the six trait writing rubric (see Appendix A).

Intervention

Regular wide-ruled notebooks were given to the children of the experimental group. These math journals were the actual record of the intervention, and were not used for any specific results or assessment outside of instructional decision making during the journaling process. Exposure to journaling due to attendance was also noted for each student in the experimental group. During journaling time, the control group continued working on regular math lessons, but only reviewed concepts. Explicit instructions were given to the teacher in

charge of the control group to only review and refrain from teaching any new concepts so as not to leave the experimental group out of any pertinent math information.

The entire class, both control and experimental groups, was involved in three lessons on solving word problems. The first lesson helped the students generate a graphic organizer that categorized certain words within the questions of word problems to give "clues" on what operation was needed to solve for the answer. For instance, if one sees the words "left over" in the question of a word problem, usually that is a clue to subtract (see Appendix B). The second and third lessons involved learning solution strategies to word problems such as how to pick out important information from a question, draw pictures, and prove answers. These whole class lessons were taught as a way to control for some of the information that was provided for students during math journaling that did not directly pertain to the journals, as the study is to determine the effects of journaling and not of learning problem solving strategies.

Procedures

As in the materials section, this portion has been divided into assessment and intervention. The entire study lasted six weeks, including the pretest, intervention, and posttest.

Assessment

Mathematical skills pertaining directly to language acquisition are the focus of this study, and thus pretesting and posttesting for these skill sets through solving word problems was used to determine the effect the math journaling intervention could have on the experimental group. For math skills, AIMSWeb scores from January 2012 were used to determine the skill levels and pairings of students to ensure an even representation in both groups. Specific math skill content included multiplication of double-digit numbers by a single-digit number, counting money,

solving addition and subtraction word problems, and simple fraction addition and subtraction problems. The posttests were administered after the five-week intervention of journaling, and measured the same math and language skills used in the pretest, assessing for improvement in the same areas.

To attempt to control for and measure a level of language proficiency outside of the math problems on the pre and post assessments, a written assessment narrative question was created and used for both pre and post testing. Students were assessed based on a four-point writing rubric using six traits of writing adopted by the Fairfield-Suisun school district in Fairfield, California (see Appendix A). This rubric was chosen based on criteria it assessed that matched the traits and criteria sought to be assessed for this study: Adequate content, voice of the writing, conventions, central ideas and themes, sentence fluency, and word choice. A narrative piece was chosen as the assessment to fully encompass all of these areas in one assessment.

Intervention

A math journal was introduced to the study group to be used three times a week after a math lesson was completed. These lessons came from the curriculum already outlined by the state curriculum standards. A written prompt was given based on further exploring previously mastered skills. The experimental group of students was asked to write a journal entry answering the questions (see Appendix C). Questions each day were evaluated for difficulty, and instructional decisions were made based on the answers received and perceived level of difficulty observed through student actions during journal time (i.e. talkativeness, number of questions asked, perceived struggle, etc.). These daily observations of student behavior during the intervention were noted for instructional decision-making purposes only and used solely to

guide the direction of the math journal prompts (see Appendix C). During the intervention, students also received feedback for the answers given two to three times in a week from the teacher through a review of the journals. This feedback consisted mainly of positive comments on provided answers and writing, and also asked questions or prompted for further exploration if a particular step or concept had been misinterpreted or skipped by the student. This feedback was presented individually to either each student or to the group based on how many students had similar or identical concept issues. The feedback was delivered both as notes within the journals themselves and points of clarification prior to beginning another prompt the next day.

In this particular classroom, journaling had not been used in any content area. Therefore, since this study sought to examine the effect of math journaling specifically, all students were exposed to English journal writing four days of the week for fifteen to twenty minutes every morning two months prior to beginning the intervention. The exposure included expository, narrative, and some persuasive writing. This journal time was separate and conducted at a different time than the math journaling. The entire class was involved with the English journal writing. Immediate feedback was given for these entries, individually by student through notes written as comments in their English journals. Entry prompts were often based upon topics of interest for the children ("Tell me about your favorite game.") as well as those pertaining to what was happening in the classroom or in their lives ("What do you think work ethic means?" or "Tell me about where you were and what you were doing during the big tornadoes last Saturday.").

CHAPTER IV

RESULTS

Math Assessment

Pretest and posttest scores between groups were assessed to determine any difference in performance for both experimental and control groups based on descriptive statistics. It should be noted that the experimental group on average did score roughly 2 points higher on the pretest, creating a small equivalence discrepancy. Per the information on Table 2, the experimental group had a mean score of 15.3636 on the pretest with a SD = 5.73189. The control group had a mean of 13.2 with a SD = 6/74619 (see Table 3). However, the general statistical information sought marks the improvement within groups and between groups, and the discrepancy is slight.

At the time of the posttest assessments, there were 11 in the experimental group and 10 in the control group. One student in the control group was absent the day of posttest assessments. At posttest, the experimental group raised their mean score to 17.8182 with SD = 7.65269 (see Table 2). The control group received a lower mean score at posttest: 12.2 with SD = 7.17712 (see Table 3). This information includes the scores of outliers and this possibly reflects the change in standard deviation for both groups.

TABLE 2

DESCRIPTIVE STATISTICS – EXPERIMENTAL GROUP
PRETESTS/POSTTESTS: MATHEMATICS

	N	Minimum	Maximum	Mean	St. Dev
Pre	11	4.00	26.00	15.3636	5.73189
Post	11	6.00	29.00	17.8182	7.65269
Valid N	11				

TABLE 3

DESCRIPTIVE STATISTICS – CONTROL GROUP
PRETEST/POSTTESTS: MATHEMATICS

	N	Minimum	Maximum	Mean	St. Dev
Pre	10	5.00	22.00	13.2000	6.74619
Post	10	4.00	23.00	12.2000	7.17712
Valid N	10				

These scores within groups were then compared between groups. The mean gain for students in the experimental group was 2.46 (SD=1.92). The mean gain for students in the control group was -1 (SD=.43). A Mann-Whitney U test, a non-parametric equivalent t test commonly used for smaller sample sizes, was used to determine statistical significance. Using all data collected (11 students in the experimental group and 10 in the control group), results were not statistically significant $t = .062$, $p < .005$.

In using all the data available, significance was lost. However, upon further investigation of the data, it was decided that outliers with a difference of nine points or more would be eliminated from the final data. One participant from each group met the outlier criterion and their respective scores were taken out of the final statistical analysis. Therefore, nine students in the experimental group and 10 in the control group were analyzed for significance after outliers were eliminated. A Mann-Whitney U test was run for results again. With outliers extracted, the results were found to be statistically significant $t = .033$, $p < .05$.

Writing Assessment

In the final analysis of writing assessments, nine students were used in the experimental group, while eight were used in the control group. This was due to absences on the days the tests were administered. The mean gain for the students in the experimental group was 3.25

(SD=1.67). The average gain for those in the control group was -0.33 (SD=1.66). To determine if group differences emerged in pre-post writing, the Wilcoxon t test was calculated. This is the nonparametric equivalent to a traditional t test and used typically with small sample sizes that violate assumptions of normality. Results were statistically significant $t(7) = 4.10$, $p<.001$ with the children in the experimental group outperforming those in the control group at post-test. By a large margin in comparison to the control group, the students in the experimental group provided longer narratives with more content, more indications of voice, a wider variety of word choice, and more successfully executed conventions such as correct use of quotations and punctuation. Though these improvements from pretest to posttest were not uniform in the experimental group, they were more prevalent than in the control group. The control group itself did not uniformly exhibit a worse performance in posttest than in pretest, but tended to remain at the same level of writing skill and content.

ELL versus Non-ELL Students

The comparison of ELL versus non-ELL students needed to answer hypothesis question three (Is there a difference in effect between ELLs and those who are classified as native English language learners?) required another set of grouping and statistics within the experimental and control groups.

TABLE 4

ELL AND NON-ELL EXPERIMENTAL DESCRIPTIVE STATISTICS
PRETEST/POSTTEST: WRITING

	ELL Experimental			Non-ELL Experimental		
	Mean	St Dev.	Gain	Mean	St. Dev.	Gain
Pretest	17.38	4.69	-	10	5.29	-
Posttest	19.63	6.63	2.26	13	9.54	3.0

TABLE 5

ELL AND NON-ELL CONTROL DESCRIPTIVE STATISTICS
PRETEST/POSTTEST: WRITING

	ELL Control			Non-ELL Control		
	Mean	St Dev.	Gain	Mean	St. Dev.	Gain
Pretest	13.86	7.20	-	11.67	6.66	-
Posttest	14.14	8.9	.28	11	8.19	-1.53

Between ELL and non-ELL students, statistical significance was not found. The gains and scores were not different enough between the two language statuses to produce a significant difference.

CHAPTER V

DISCUSSION

Implications and Future Research

This study sought to determine the effect on academic achievement in math and language arts based on a math journal intervention for ELL students. Results indicated that there was a possible positive effect on academic achievement in both areas. This supports former research in similar areas of curriculum integration (Armon & Morris, 2008; Kostos & Shin, 2010; Carter, 2009)), and indicates that math journals can improve not only performance in solving math word problems, but also in developing language arts skills in writing.

The improvement in writing skills is a positive indication that correlates to the gap in math instruction ELL students face noted in the introduction of this paper. While using non-verbal forms of communication (pictures, gestures, manipulatives) has been found to be an effective method for ELL children to relay the amount of math knowledge they have acquired (Lee, Silverman, & Montoya, 2002), using such methods assists neither the student in creating critical and applicable language skills to solve math word problems, nor the teacher in creating instruction that furthers these skills (Armon & Morris, 2008; Honnert & Bozan, 2005). By introducing an intervention that exercises both math and language arts skills, students were able to improve in both areas simultaneously. Speaking in terms of experimental versus control groups in this research, students in the control group carried on with regular math activities which did not incorporate language arts (using pictures and manipulatives for example example). They did not have the opportunity to exercise critical and creative thinking skills in language arts while engaging in math lessons, and therefore, it was less likely that they would improve in

language arts skills any more than or the same as their experimental group counterparts. No other differences between groups were present; all children received the same instruction in both math and language arts outside of math journaling time. The results showed that the control group did not, in fact, raise their scores in the posttest. This could be an indication that the extra practice the experimental group received during math journaling supported their academic growth in both math and language arts.

The results of the math assessments also indicated that the math journaling improved word problem scores. Because no other instruction occurred outside of the time when the experimental group engaged in journaling and the control group engaged in other familiar and review math activities, it is likely that the intervention helped boost scores on the posttest assessment. Students gained more points in the ability to show work, draw pictures, and actually write out the logic of the word problems in addition to higher scores in computation and correct answers. One student in the experimental group even added a complete sentence to each answer, explaining it in succinct language. To be clear, this was not necessarily given a point toward his score, but was an indication that the connection between math and language had been strengthened in his work. However, this particular student did receive a seven-point gain in his score on the posttest.

Originally, in entering into this research, there was a blind assumption on the part of the researcher that the change and improvement would be most seen in the math posttest assessment, but such was not the case. It was not until the results returned from the writing samples that this assumption uncovered itself. Improvement in solving math word problems was expected as shown in other research (Kostos & Shin, 2010). The greater significance and improvement in the writing samples came as a surprise. Considering the research on cognitive load theory (CLT),

there is a possible explanation for the rise in writing scores for the experimental group. First, CLT explains that applicable working memory is based on schema and developmental understanding (Paas, Renkle, & Sweller, 2004; Sweller, 1994). The amount of information is not nearly as important as the kind of information given. If the information doesn't fit into a particular schema, a student has already developed, then it is extraneous and possibly detrimental (Sweller, 1994). Likewise, if a schema is created, then the information in that schema can become nearly automatic and adapted by the student (Paas, Renkle, & Sweller, 2004).

The students in the experimental group had a difficult time at the beginning of the intervention correlating language arts with math. Many commented that they did not understand the task of writing about math (see Appendix C). With the argument of CLT in mind, another way to describe this is to say they had not been able to assimilate to the information that math and language arts could correlate. Since this was a short study, much of the focus went to the children developing this concept of "schema" that math could be explained through language and writing. Though they did improve on math scores, most of the improvement came from showing work and drawing pictures. Not all of the higher scores were achieved through computational math concept improvement.

Had this experiment continued for a longer period of time, once the schema of math and language arts working together was successfully in place, more emphasis could have been put on the computational math concepts and number sense. Having said this, however, it is also the argument for why the language arts skills posttest achieved higher significance. A possible explanation of this is that the students translated the work done to create a combined math and language arts schema and allowed the focus on writing to spill over into the schema they had

already formed about writing skills. The results indicate that the extra practice helped strengthened their already budding writing skills.

A similar reasoning can be offered about the control group's lower mean in the math posttests. For the pretest, the students were not taught any problem solving strategies and were left to the schema they had worked with during the school year. During the study, the entire class participated in three short lessons about solving math problems. Though meant to be a way to level the information given to both groups about word problem strategies, these lessons may have backfired in giving the control group tools to solve word problems. Without the practice and ability to assimilate to these new concepts and information, the control group may have suffered the three lessons as extraneous information not yet adapted or assimilated for proper use. This could have created a detriment to their ability to solve the word problems on the posttest assessment by confusing the schemas they already had in place for solving word problems. When the experimental group received further practice and application of these problem solving strategies, they were more able to use them successfully for the math assessment, hence gaining more points for showing work and drawing pictures. According to these two arguments, this study could support Cognitive Load Theory in further research.

We have seen that between groups, there was statistical significance that indicated math journaling improved both math and language arts scores. The original statistical information was run based on group alone, and with no groupings based on language status. Thus, this could imply that math journals improve scores for ELL students and the first two hypothesis questions are supported. The third question, however, is whether there is a difference in scores between ELL and non-ELL students. The results show that there is no difference. To be fair, the proficiency levels of math and language skills as deemed by the January AIMSweb student

scores are similar between ELL and native English speakers in most cases, with some ELL students scoring higher in proficiency than some classified as native English speakers. Therefore, this creates a limitation to fully conclude that the research supports this particular hypothesis question. The argument could be made, however, that at this grade level, all students are learning language arts and math skills and are therefore all still in the process of learning the English language.

Teacher/Student Communication

Honnert and Bozan (2005) discussed in their research the positive affect a teacher's ability to track critical thinking skills has on the academic achievement of a student. During the intervention, students were given individual and group feedback for the answers they had for each daily prompt. The feedback given provided a dialogue for the student and teacher. When feedback was not given, the students were aware and even commented that there was no feedback. If they did not understand the feedback, they asked more questions before the next prompt was started and the critiques or praise were discussed. This was especially useful for the two students with special needs, as they were able to work on their understanding of a concept with more clarity and ask questions where they may not have asked before. The same is true for the students who fell under academic proficiency levels. Also, the teacher was able to pinpoint where the students lacked understanding and review concepts for better understanding. Through this dialogue, concepts were more easily understood by the students, and it became easier to make instructional decisions as progress of not only computation but critical and creative thinking skills could be assessed.

The intervention was not only a time for students to learn, but provided instructional critique moments as well. By opening up the dialogue, there was a sense of stress that was

alleviated that teachers can hold about teaching math and math concepts, both as a phobia and as a question of whether the information is being received properly (Armon & Morris, 2008; Powell, 1997; Humphrey & Hourcade, 2010). The feedback that was given was not only to the students; the journal entries themselves provided instructional feedback. As the students engaged in the writing prompts, it became clear the level of understanding that was comfortable for them. For instance, the first writing prompt was about fractions, a math concept to which they had just been introduced. Instructional decisions were made based on the feedback from the students entries, and a decision was made to focus the math portions of the prompts on the more familiar concepts of addition and subtraction. Once the math concept was changed, the comfort level to the material appeared to change as well and students seemed more confident in learning how to explain the familiar concepts through writing.

As for the argument that writing as an integrated math instruction is too time-consuming or difficult for students, as reported by some teachers in the research (Quinn & Wilson, 2007), the actual time taken to read entries and write down feedback for 11 math journals two to three times a week was roughly 30 minutes per session. At certain times, these 30 minutes were even used to provide feedback for two or three short entries or to provide further feedback on a previous entry. Keeping this in mind, it would then take roughly one hour twice a week to provide adequate feedback on similar journal entries for an entire class. Granted, the schedule of the average teacher isn't commonly known to be very loose, but considering the possible implications of this study and its supporting research, the benefits appear as though they could outweigh the drawbacks. Likewise, if the sentiment is held that ELL children find writing exercises such as this too difficult, this study is a positive beginning to further research that supports the idea that any exposure to exercising language and writing skills is beneficial to ELL

– and native English speaking - students whether in a purely language arts lesson or integrated into another curricular area.

Implications for Students with Special Needs

The research based on the effect of journaling for students with special needs served as a supporting argument for math journaling (and journaling in general) as an effective tool in an integrated and diverse classroom. This includes a classroom with special needs students. Because there was no hypothesis question specifically addressing whether this intervention could be effective in improving the academic skills of students with special needs, no statistical data was collected to support or refute the research in this area. However, based on an overview of raw scores collected, there was not an improvement in the scores for the five children who were categorized as special needs. If anything, these students as a whole – in both groups – did worse on the posttests. This does not reflect findings in other research that journaling raises academic skill in special needs students (Honnert & Bozan, 2005). Nothing can yet be concluded from this information, and further study with a larger sample size would most likely better support the research found in the literature.

Limitations and Future Research

It should be noted that this study serves as a pilot for further action research and other research opportunities on the subject. The small sample size and short duration of the study caused some limitation in the effect the intervention may have had on mastering math concepts and number sense as well as its usefulness for students with special needs or those who require more time to master skills. This study was also conducted in one classroom of 22 students whose language proficiency skills were similar across ELL and native English speaking students. Future

research could include samples that represent ELL students with lower English proficiency levels.

Overall, achieving statistical significance in this short study with a small sample can also be seen as a fair indication that replications or studies which build on the information collected here could also render positive gains and supportive research. The controls set in place were all to ensure the intervention of math journaling specifically created the results, even down to the exposure to English journals for all students and the use of math interventions such as graphic organizers and manipulatives used in whole group math lessons. The results in this small study mixed with the results and reporting of other similar studies are positive indications that, with longer duration and larger sample sizes, similar results can be achieved for all students.

REFERENCES

REFERENCES

Armon, J. & Morris, L (2008). Integrated assessments for ELL: Students – and teachers – benefit from incorporating writing and drawing in science. *Methods and Strategies*, April/May, 49-53.

Bailey, L. (2010). The impact of sustained, standards-based professional learning on second and third grade teachers' contact and pedagogical knowledge in integrated mathematics. *Early Childhood Education*, *38*, 123-132.

Barbu, O. C., & Beal, C. R. (2010). Effects of linguistic complexity and math difficulty on word problem solving by English learners. *International Journal of Education*, *2*(2), 1-19. Retrieved from http://search.proquest.com/docview/846781822?accountid=15042 [cited November 2011]

Bassof, T.O. (n. d.) So what's the difference between ESL and ELL? Retrieved from http://teachersnetwork.org/NTOL/howto/eslclass/eslell.htm [cited July 2012]

Baxter, J. A., Woodward, J., & Olson, D. (2005). Writing in mathematics: An alternative form of communication for academically low-achieving students. *Learning Disabilities Research and Practice, 20*(2), 119-135. doi.org/10.1111/j.1540-5826.2005.00127.x [cited Novermber 2011]

Biemiller, A. (1981). A neo-Piagetian approach to development during the formal operational period. Retrieved from http://search.proquest.com/docview/63641910?accountid=15042 [cited February 2012]

Brandenburg, Sr. M. L. (2002). Advanced math? Write!, *Educational Leadership, 60*(3), 67-68.

Bowe, G. (2009). Knowing and teaching elementary language arts: A math lesson for English teachers. *Western Journal of Black Studies*, *33*(4), 259-272.

Carter, S. (2009). Connecting mathematics and writing workshop: It's kinda like ice skating. *Reading Teacher*, *62*(7), 606-610.

Charalambous, C. Y., & Philippou, G. N. (2010). Teachers concerns and efficacy beliefs about implementing a mathematics curriculum reform: Integrating two lines of inquiry. *Educational Studies in Mathematics*, *75*(1), 1-21.

de Cohen, C. C., & Clewell, B. C. (2007). Putting English language learners on the educational map: The No Child Left Behind Act implemented. Education in focus: *Urban institute policy brief.* Washington, DC: Urban Institute.

Dehaene, S., Spelke, E., Pinel, P., Stanescu, R., &Tsivkin, S. (1999). Sources of mathematical thinking: Behavioral and brain-imaging evidence. *Science, 284*(5416), 970-974.

Gruenberg, A. M., & Miller, R. M. (2011) *A practical guide to early childhood inclusion: Effective reflection.* Boston: Pearson.

Honnert, A. M., & Bozan, S. E. (2005). Summary frames: Language acquisition for special education and English language learner students. *Science Activities: Classroom Projects and Curriculum Ideas*, *42*(2), 19-19.

Humphrey, M., & Hourcade, J. J. (2010). Special educators and mathematics phobia: An initial qualitative investigation. *Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83*(1), 26-30.

Kostos, K. & Shin, E. (2010) Using math journals to enhance second graders' communication of mathematical thinking. *Early Childhood Education Journal*, *38,* 223-231.

Lee, F., Silverman, F., & Montoya, P. (2002) Assessing mathematics of young ESL students. *Principal*, *81*(3), 29-31.

Paas, F., Renkl, A., & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science, 32*(1-2), 1-8. doi:10.1023/B:TRUC.0000021806.17516.d0 [cited February 2012]

Powell, A. (1997) Capturing, examining and responding to mathematical thinking through writing. *The Clearing House*, *71*, 21-25.

Quinn, R. & Wilson, M. (1997) Writing in the mathematics classroom: Teacher beliefs and practices. *The Clearing House*, *71*, 14-20.

Sweller, J. (1994) Cognitive load theory, learning difficulties and instructional design. *Learning and Instruction 4*, 293-312.

Wallace, R., Pearman, C., Hail, C., & Hurst, B. (2007) Writing for comprehension. *Reading Horizons*, *48*(1), 41-56

Winter, S. M. (1999). The early childhood inclusion model: A program for all children. *Childhood Education International*. Retrieved from http://search.proquest.com/docview/62381956?accountid=1 [cited November 2011]

APPENDICES

APPENDIX A

SIX-TRAIT WRITING RUBRIC

Grade 3 – Personal and Fictional Narrative Rubric

Six Traits	4	3	2	1
IDEAS/CONTENT	• Has a very clear, focused central idea • Idea/plot is developed with well chosen details and memorable insights	• Has a focused central idea • Idea/plot is developed with appropriate details and memorable insights	• Has an unclear or unfocused central idea • Idea/plot is poorly developed with few or inappropriate details	• Has an unclear or unfocused central idea that address little of the topic • Lacks details
ORGANIZATION	• Organization has a logical sequence of events or time order • Engages the reader creatively, relates significant events and moves to a good conclusion	• Organization has a logical sequence of events or time order • Engages the reader, relates events and moves to a conclusion	• Organization provides a minimally developed sequence of events or time order • Has a weak beginning, relates minimal events and attempts a conclusion	• Organization is disjointed and difficult to follow • Lacks a beginning and/or conclusion, and significant events
VOICE	• Voice is appropriate for audience and purpose • Writing is expressive, engaging, or sincere	• Voice is appropriate for audience and purpose	• Voice is limited and weak with little awareness of the audience	• Voice is not evident; personal involvement or awareness of audience is limited
SENTENCE FLUENCY	• Sentences flow • Sentence length, structure, and complexity is varied	• Sentences flow • Sentence structures are varied	• Sentences are fragmented, run-on, and/or confusing • Sentence structures are limited in variety	• Sentences are incomplete and/or unclear
WORD CHOICE	• Uses vivid descriptive language and concrete sensory details that enables the reader to visualize the events or experiences	• Uses concrete sensory details that helps the reader visualize the events or experiences	• Uses limited, repetitive words, that do not give a visual picture	• Dull, repetitive words • Word choice may confuse the reader
CONVENTIONS	• Grammar, punctuation, capitalization, spelling and paragraphing are effective and make the writing easy to read	• Grammar, punctuation, capitalization, spelling and paragraphing are generally correct • Existing errors do not make writing hard to understand	• Grammar, punctuation, capitalization, spelling and paragraphing have problems that slow or confuse the reader	• Grammar, punctuation, capitalization and spelling contain frequent significant errors that cause major confusion

3=proficient 2 and below=non-proficient, still developing revised 7/12/2004

APPENDIX B

SIMPLE QUESTION WORD GRAPHIC ORGANIZER

Addition	Subtraction
Multiplication	Division

APPENDIX C

TABLE OF JOURNAL PROMPTS AND INSTRUCTIONAL DECISION-MAKING INPUT

PROMPT #	JOURNAL	ASSISTED INSTRUCTION?	NOTES FOR INSTRUCTIONAL DECISION-MAKING
1	½=2/4=4/8 How can I prove this equation is true	Individually	This was a hard start for the kids. May need to bring it down to an easier level as they are just learning fractions
2	How many different ways can you write the fraction ½? Include pictures, words, and other fractions	No	Somewhat easier for the students, though they did have some questions.
3	Write down all the steps to solve this problem: 41-27=	Yes. Talked through the steps and how to write them down	The children were engaged and enjoyed answering correctly what step they felt came next. Was able to help them transfer words to writing.
4	Write down all the steps to solve this problem: 61-38=	No. Prompted to look at the previous day's entry	A little touch and go. Lots of talking which notes a bit of frustration and confusion
5	Write down all the steps to solve this problem: 517-125=	No.	The three digit subtraction tripped some of them up, but once explained, most were able to complete the steps
6	Write down all the steps to solve this problem: 1293-567=	No.	After encountering the three-digit subtraction yesterday, kids took right to this.
7	A problem was given already solved. Simple subtraction. Students had to determine what mistake was made in the answer	Yes.	Really had to guide the children through looking for the problem in the solution and why the solution was wrong.
8	A problem was given already solved. Simple subtraction. Students had to determine what mistake was made in the answer	No.	This was pretty tough for the kids, despite having an example of it the day before. Most children, with individual assistance, were able to find the mistake.
9	A chart to buy candy was provided with different prices for different combinations of candy. Students were asked to	Yes.	Walking through this was actually quite fun. Giving the kids a real life experience allowed them to find the task fun. The trick on this one was to get them to use what they talked

PROMPT #	JOURNAL	ASSISTED INSTRUCTION?	NOTES FOR INSTRUCTIONAL DECISION-MAKING
	figure out what they could buy with $15 or less. Prices were $5, $2, $3, and $10		about with the teacher and transcribe it to their journals.
10	A chart to buy buttons was provided with different prices for different combinations of buttons. Students were asked to find as many combinations that totaling $25 or less. The prices were $3, $5, $7, $12, and $15	No.	Because this was on their own, it took a bit to get them to understand we were not discussing it. The kids talked amongst themselves for a bit, but once reminded not to, they got to work. Kids raised their hands when they found new combinations, proud of their answers. Reminders to write them down were plenty.
11	A chart to buy buttons was provided with different prices for different combinations of buttons. Students were asked to find as many combinations that totaled **exactly** $25 as they could. The prices were $3, $5, $7, $12, and $15	No.	Given the extra task of making exactly $25 dollars of combinations furthered the excitement of figuring out new combinations.
12	A chart to buy buttons was provided with different prices for different combinations of buttons. Students were asked to find as many combinations that totaled **exactly** $15 as they could. The prices were $3, $5, $7, $12, and $15	No.	Same idea, different total.
13	What are some good ways to help solve word problems? What are some things you can do?	No.	After the lessons with the whole class, children were asked to reflect.
14	Go back through your entries. What have you learned? What were some concepts in math we looked at? What did you like, what did you not like?	No.	A simple reflection on the whole intervention for the students.

APPENDIX D

MATH ASSESSMENT QUESTIONS

(Test has been condensed for space. Students were given ample space in between questions to provide answers.)

1. Tim had 20 fireballs. If he gave half to Amy and then half of what he had left to Lisa, how many fireballs would Tim have?

2. I have $10. I want to buy the following toys:
    Ball - $2
    Whistle – $3.86
    Yo-yo – $3.92
How much more money would I need if I wanted to buy 2 yo-yo's instead of one?

3. I have to give each of my friends 3 pencils in class. I have 7 friends. How many pencils do I need in all?

4. Kelly has $20. She bought a box of candy for $4.99 and a stuffed animal for $12.87. How much money will she have left over?

5. I have 15 minutes to get to school. If I spent 1/3 of that time stopped talking to a friend, how much time would be left for me to get to school?

6. Ryan grabbed 20 jelly beans out of a jar at his friend Jose's house. Jose then grabbed 17. Later, Jose's sister Jen took 42 jelly beans. How many jelly beans were taken from the jar?

7. Maria has three dogs named Sparky, Sniffles, and Snoopy. None of the dogs like each other and need to be walked separately. If all three dogs need to be walked five times each week, how many walks does Maria have to take?

8. Oh no! I had three stacks of blocks of 10 blocks. My friend came over and knocked 2 blocks off of the first stack, 15 off the next, and 3 off of the last stack!

a. How many blocks were stacked at the beginning?

b. How many blocks were left standing after my friend knocked them over?

9. A lion's tail is 40 inches long. A monkey's tail is ½ the length of a lion's tail, but a sloth's tail is half the length of a monkey's tail. How many inches long is the sloth's tail?

10. Answer each part of the question.
a. What is the product of 8 and 2?
b. What is the sum of 2 and 8?
c. What is the difference between 8 and 2?
d. How many times does 2 go into 8?