More than numbers:

Teaching ELLs Mathematical Language in Primary Grades

Michelle Sistla
Jay Feng

Chinese American Educational Research & Development Association Annual Conference
Philadelphia, PA
April 2-3, 2014

Abstract: Teaching English Language Learners (ELL) academics while they are acquiring English language skills is a challenge for teachers. This action research examines the use of Response To Intervention (RTI) in teaching ELLs mathematical language and its effect on students' math achievement. It shows that when mathematical language is explicitly taught, ELLs improve mathematical understanding significantly.

Introduction

English language learners (ELLs) represent the fastest growing segment of the public school population (National Clearinghouse for English Language Acquisition, 2007). Yet, with this growth our analysis of the academic performance of ELLs on the 2005 National Assessment of Educational Progress indicates that only 29% of ELLs in eighth grade scored at or above the basic level in reading as compared to the 73%of non-ELLs (National Education Association, 2008). The question is, how to ensure that ELL students have equal access to a quality education when they have to juggle the cognitive demands of content-area curriculum, but also simultaneously acquire literacy skills, academic vocabulary, and English language structures? "Mathematics is one of the critical areas in which ELLs have language-associated learning difficulties." (Lee and Jung, 2004, p. 270) A critical problem affecting teaching ELLs mathematics is the misconception that mathematics is based on language of numbers and symbols. (Janzen, 2008, p.1015) Studies have shown that there is a strong correlation between children's English proficiency and mathematics performance. There was an 18 point difference between the beginning English speaker scores from the advanced English speaking scores, for a group of Fourth graders. (Abella, Urrutia, & Shneydernam, 2005. P. 133) The Fifth grade scores from (Young, 2010. P.97) studies show similar results, Non-ELL students' score is 35, where the ELL students' score is 29.

There are many methods that have been researched to try and close the language gap. Some schools are offering bilingual enrichment programs by enhancing opportunities to both language-majority and language-minority students. Many studies like "Proposition 227" (Paredes, 2000, p. 179) and "Dallas' Dual Language" (Pascopella, 2011, p. 29) have shown positive effects of dual-language programs on students' success on English language standardized tests marking great success. "For students who had Spanish as the native language, the percentage of those who performed in the Fluent Spanish Speaker category on the LAS-O increased from 61% to 91% during the 2004 – 2007 period." (Shneyderman and Abella, 2009, p. 253) The issue for this method of learning is finding teachers that are bi-lingual and re-shaping content to fit individual needs of each student. Others have used cultural stories to bridge the gap, but this involves a lot of research and time, as in the study of Lisen and Yiqing's first start in public schools by Yanhui Pang. (Pang, 2010, p. 69-75)

Teachers have also relied on computer generated programs. Educators believe that the advanced features of computers will mediate difficulties that ELL students may experience. Computers provide vocabulary and comprehension support for ELL students, who have difficulty with understanding instructions of a teacher. Some research indicated that computer based reading programs benefited not only ELL students but also adult immigrant learners.

(Kim and Chang, 2010, p. 289) With the improvement in reading fluency and comprehension it also helps with the understanding of math word problems. The downfall to using computer programs is that these programs can be very expensive. Many schools have endured budget cuts and purchasing any extra programs would be excessive.

Response To Intervention (RTI) is another popular method for helping ELL students. RTI is a multi-tiered intervention model that involves all students and teachers rather than only students who are at the risk of a disability. This model is designed to reduce the disproportionate representation of culturally and linguistically diverse students in special education. For example, ELLs who are struggling in reading would be provided extra assistance and support instead of being pushed into a Special Education services. The ongoing progress monitoring would demonstrate the efficiency of the interventions. I know from personal experience with my ELL students, the RTI process does work, but you need knowledgeable staff and a multitude of resources to pull from. The program is only as good as what you put into it. The concern is that teachers still need training and the reduced number of students that are referred.

This study is designed to explore how to manipulate mathematical language into a visual representation for ELL students. Language proficiency is one of the most noticed differences when testing students, especially on Standardized Tests. Research has shown that with multiple methods of learning, ELL students can be successful on Standardized tests. (Martiniello, 2008, p. 333) If words can be changed to a visual reference, the 'language' factor is changed into a simple 'plus' or 'minus' sign, which asks the question, can mathematical language be taught and comprehended for standardized tests? The purpose of this study is to determine whether an innovative strategy, using visual representation in teaching ELL mathematical language, will have positive effect on ELL students' math achievement.

There are three tiers or levels of words that ELL students learn. Tier 1 words are those that can be easily translated into the child's language like 'butterfly'. One can say the word and point to a picture of a butterfly and the child now has associated the English word with their own vocabulary. These words typically have one meaning. Tier 2 words are those that are more abstract and important to the storyline. These words involve pre-teaching. Take a work like 'bat'. A 'bat' can be the nocturnal animal or it can be the object used to hit a baseball or it can be used as a verb to hit at. There are over 15 definitions used with this one word. "To make mathematics learning meaningful, it is recommended that teachers connect mathematics concepts with children's own experiences and cultures." (Lee, Lee, and Amaro-Jimenez, 2011, p. 254). Tier 3 words are low frequency words and are isolated to content areas, like photosynthesis.

Review of Literature

Literacy is one of the critical elements that experts have all agreed is the most important to teach ELL students. It is also one of the hardest. Although math may seem to be number sense, there is the underlying element of mathematical literacy. Baumann and Grames (2010) tried to define academic literacy. "We had expected to find a consistent definition-something like "the words students encounter when they read informational texts"-but we soon realized that our sense was not shared by vocabulary scholars and adolescent literacy educators. Thus,

the seemingly simple task became complex." (Baumann and Grames, 2010, p.4) There are a plethora of terms and meanings that are used in academics. "After examining their meanings, we realized that some terms had several definitions and that different terms were sometimes used to mean the same thing." (Baumann and Games, 2010, p. 4) This is where the confusion of language plays havoc on ELL students. Each content group has domain specific words that are used to help define or explain a question. In Math, there are many words used for the same operation, for example, 'add them up', 'the sum', 'the total', 'in all', and 'altogether' are phrases use to mean to use the addition operation, but these are not terms used in everyday language. Many are isolated to math and they are considered Tier 3 words. They are low frequency and content specific. "The cognitive dimension involves the ways students know, think, and apply. The educator's challenge is to facilitate a student's construction of the targeted knowledge and guide his or her development of the related skills." (Perez and Holmes, 2010, p. 34) Janzen supports this in her research, "Ron observes that the language of math and the language of everyday life can overlap, but that math language is used to express concepts that are not necessary or important in everyday usage. Additionally, mathematics may require specialized meanings for words. She points out that one of the challenges of ELLs in learning mathematical language is that I can only be acquired in school and not through conversational interaction." (Janzen, 2008, p.1027) Mathematical language includes words like sets, tables, and combines to give examples.

The need for ELL students to have an understanding of mathematical language is because of the NCLB act. "To ensure that ELLs are included in all of NCLB's assessment requirements, the law mandates a 95% participation rate and calls for all students in the U.S. schools to achieve a level of 'proficient' on state tests by the year 2014" (Menken, 2009, p. 112) This has changed the methods of teaching ELLs. "The reduction of bilingual education programs in U.S. schools since the passage of NCLB provides compelling evidence of the link between testing and language policy."

The data from New York City in Menken (2008a, 2008b) support this point, which is noteworthy given that the state of New York has historically been supportive of bilingual education. In 2002, 40% of ELLs were enrolled in a bi-lingual program and 53% were enrolled in an ESL program. With the passing of the NCLB in 2007, the same school systems saw a decline in the bilingual program, 25% and an increase in their ELL program, 69%, because the bill does not promote bi-lingual services. As a result of the decrease in the bi-lingual programs, test scores have declined as well. (Menken, 2009, p.113)

There are many methods and ideas that experts have practiced to teach ELL students. Some schools instituted literacy specialists for math classes. There are literacy specialists that have been implemented to maintain three main focus points in lessons with ELL students, they are stated as, 1. Teach students to recognize the types of vocabulary used in math questions and reinforce math vocabulary; 2. Provide students with strategies for reading the questions and identifying what they need to do; 3. Give students practice "explain their thinking or showing their work." (DeGisi and Fleming , 2005, p.48) These are steps that all teachers should practice with rigor. Many of the teachers used in this method are specialized in the content or have worked with ELL or Special Education students. Dual teachers are always helpful in a

classroom, and have them highly trained in standards based learning. This model involves many hours of training and collaboration with teachers.

All these involve understanding the vocabulary built around a math question. This is not a model for most schools because of the drastic budget cuts. Martiniello analyzed the KGMA (Kansas General Math Assessments) and the MCAS (Massachusetts Comprehensive Assessment System) for items that showed low DIF (Differential Item Functioning) for discrepancies with everyday language and mathematical terms. In her findings she stated, "This item is characterized by the use of long noun phrases. The subject of the second sentence is a noun phrase that includes a chain of two prepositional phrases." (Martinello, 2008, p. 343) Much of the language used in state tests have multiple steps, long sentences, and specialized words for the mathematics content.

Some research pointed out that children needed to show mathematical readiness to have success. "Regarding racial/ethnic differences in mathematics achievements, this study's results confirm some previous studies' findings showing that white children earn higher scores on mathematics readiness than other racial/ethnic groups of children." (Lee, Autry, Fox and Williams, 2008, p. 317) This was conducted with Kindergarten and first grade students, many of the white population attended a pre-k group prior to formal schooling. This also brings up the home factor and how much practice is needed to master these words.

Much of the research found that a bi-lingual program had the most success. "In language proficiency that year, at least 30% of ELLs rose two proficiency levels." (Pascopella, 2011, p.42) The primary job of teachers of ELLs is to help children bridge their conversational everyday language into mathematics language for the understanding of mathematics symbolic language. In a dual-language program, students usually include a mixture of some native English speakers and speakers of another language studying together. In this mixed classroom, students acquiring English have the daily practice of speaking English with peers. When many of the ELL students go home, they do not practice their English skills because it is not the primary language of the home. I have found this to be true with my ELL families. ELL parents also do not feel comfortable or confident that they can help their children with English. When reading homework goes home, I often have to review with my ELL students, their homework so they can complete the work at home. A duel language program is limited to areas that have a high population of teachers that have dual language certification, it is a very limited resource. RTI (Response to Intervention) is also used to help bridge the gap between the language barriers. This is one of the more favored methods because it can be implemented with little budget constraints and can meet the many needs of each individual school. ELLs represent more than 400 different language groups, just in the United States. The RTI model can serve on many levels and with many languages because it only uses the English language to implement any strategy.

All these are great strategies, but they are limited to the resources around each area, budgets of school districts, and knowledge of student's needs in a regular education class. My research method involves little money, use of RTI strategies, and works on proficiency of the English language. I feel that being able to support the learning of the ELL population needs to be done on a visual and oral level. The ELL students are usually coming to us from very little resources and a language based model will not meet their needs, initially. My study takes the

language part of math and connects it with a visual symbol. All students understand the simple addition and subtraction symbols; they are a universal sign in mathematics. When you can take a phrase or word and link it with the symbols, then language is no longer a barrier.

Research Methodology

Overview of Project

The purpose of this study is to determine whether an innovative strategy, using visual representation in teaching ELL mathematical language, will have positive effect on ELL students' math achievement.

This project blends the written, oral, and visual methods that I read about, to tie the mathematics language to a visual representation. Each test was given without being read aloud or prompts given. This was done to model the testing practices of the upper grades, 3rd through 5th grade testing practices. Each time my students encountered a word or phrase they were having difficulties, we would write the phrase on a sentence strip and place it on our "plus sign" or "minus sign" that was on our math wall. The following time we encountered the same word or phrase they would look at the wall and found the correct operation they needed to compute the correct answer. We did also talk about the names that were used in the test questions, many of them were not common names, like Duncan or Tamia. We concluded that they should not pay close attention to the names and just read them as their first letter, "D" or "T".

I have selected my second grade ELL students in my general education classroom. They were chosen because their families chose to participate in the ESOL program at our school. There were some families that declined this service, but still participated in my study. The test questions were pulled from past Second Grade CRCT tests. I selected the test items that were most missed. I made a pre-test and 8 follow up tests, as well as, a post-test to evaluate the results. I administered a pre-test to see what type and level of mathematical language that my students needed help with. Each week I administered a follow up test. I would take my ELL students and review their tests we would have a small group discussion about their answers. I asked specific questions:

1. Why did you choose the answer you did?
2. What words did you focus on?
3. Which clue words did you use?
4. Did you look at the words or numbers first?
5. Did you use the charts or pictures to help you understand the question?

Research Question:

Does the instructional strategy, using visual representation in teaching ELL mathematical language, have positive effect on 2nd grade ELL students' math achievement?

The independent variable is the instructional strategy, using visual representation in teaching ELL mathematical language, and the dependent variable is ELL students' math

achievement as measured by progress in the Post-Test where questions were pulled from past CRCT Second grade Mathematics tests.

Hypotheses

In this study, I am linking a visual aid with words and phrases used in standardized tests. This will improve math test scores, along with reducing the stress of mathematical linguistics. Using this method will also bring mathematical language to a simpler understanding with my second grade ELL students. The hypothesis is the instructional strategy, using visual representation in teaching ELL mathematical language, will have positive effect on 2nd grade ELL students' math achievement as measured by CRCT.

Description of the Participants

As an action research project, this study uses the intact 2nd grade ELL class where the researcher is also the teacher. The students in the class are of average age for a second grade, 7 years to 8 years. I do have one student who is repeating second grade, he is also 8 years old. I have added the demographic chart for my participants, please see Appendix 4 . Out of my 10 students, 4 were born outside of the United States. Two students speak English at home; the others speak another language at home. Two speak Spanish, three speak a dialect of Hindi, one speaks Korean, one speaks Chinese, and one speaks Taiwanese as their home language.

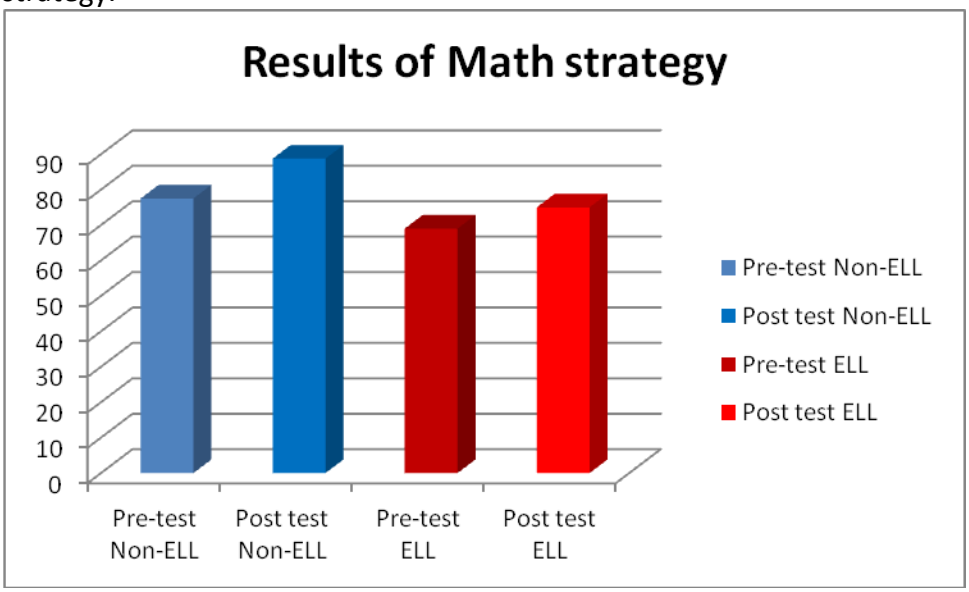
I have 26 students enrolled in my class, 10 have qualified for ESL instruction from a specialized teacher. Only 6 of the 10 students are enrolled in the ESL class. I have one girl who participates in the ESL class and 5 are boys. My class has 11 girls and 15 boys. We are not a Title-one school, so we do not receive extra state funding for specialized programs. Our school's demographics have changed drastically over the past 5 years. We have moved from 14% non-white to 37% non-white. The majority of our non-white population is Asian, specifically Asian-Indian students. This growth has been a huge change to our school's dynamics and culture.

Data Collection and Results

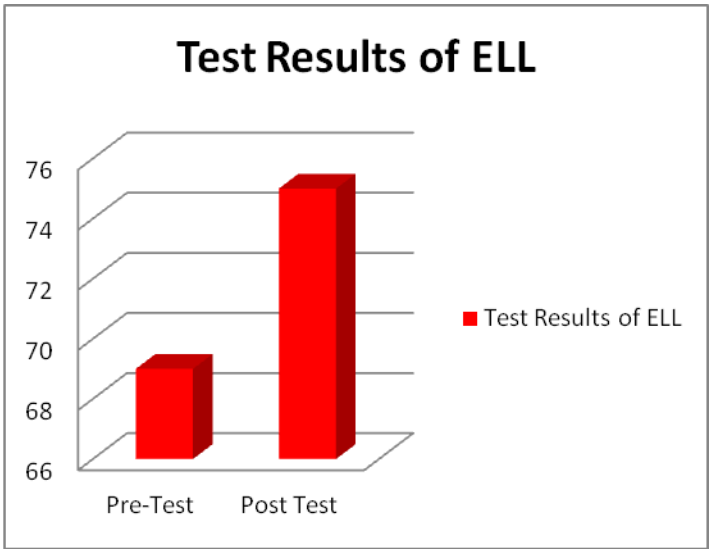
I will be using the teacher-made tests from past CRCT second grade tests. Each test was designed with 3 or more data analysis questions, 3 or more inference questions, and 3 or more problem solving questions. The 10 tests have 10 questions each, with a multiple choice answer. Answers for each test will be itemized as to whether they are correct or incorrect. A pretest will be given at the beginning of the study to generate a base score for the testing sample. Each subsequent test will be given every 5 to 8 days. A total of 8 tests will be given over the 10 week study. During this time a small group discussion will be conducted to help bring understanding to how to read the test. Small group discussions about the choice of the answers, correct and incorrect, will also be discussed. The discussion will lead to why the child chose the answer and continue with the discussion of mathematical language. We will focus on the mathematical word or phrases that led to the answer and then write the word or phrase onto a piece of paper to be placed on the appropriate symbol.

Data Analysis and Results

The results of my research support my hypothesis that the instructional strategy of using visual representation to teach ELL mathematical language does have a positive effect on 2nd grade ELL students' math achievement as measured by CRCT. As you can see in the charts below, the scores of both groups ELL and non-ELL gained as a result of the instructional strategy.



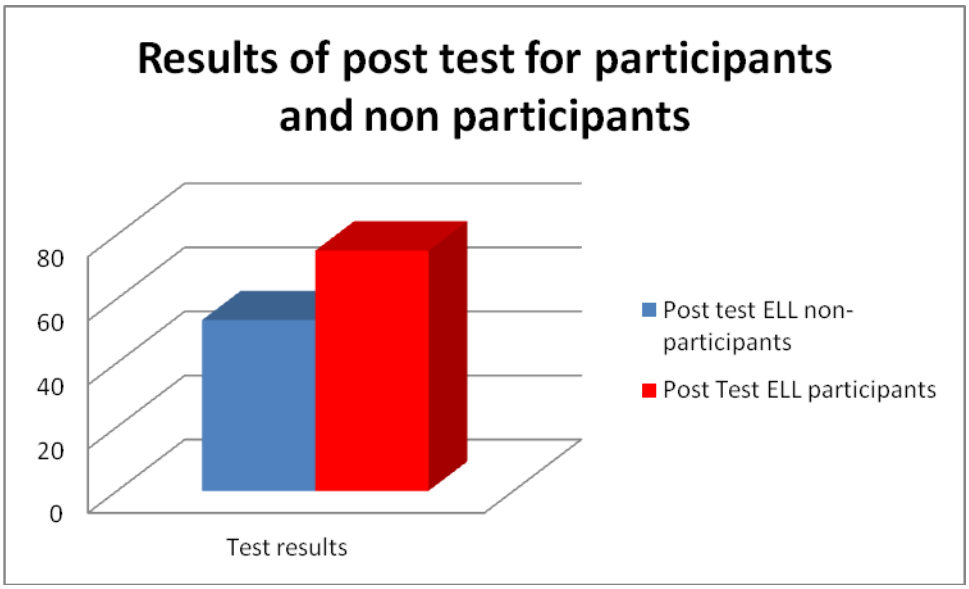
The pre-test scores of my ELL group rose 6 points in the 10 weeks of this study. What showed significance was that the ELL group closed the gap between their non-ELL participants, in there Standard Deviation. The ELL had a SD score of 14.3 where the non-ELL group had a SD score of 15. The pre-test SD score for the ELL started at 24.7. This shows that a visual type of learning is effective with the ELL population. This data also supports the research done my Martinello and Baumann and Grames. They too felt that language was the barrier for the ELL population. The ELL population can test well if the mathematical language is simplified to a visual chart.



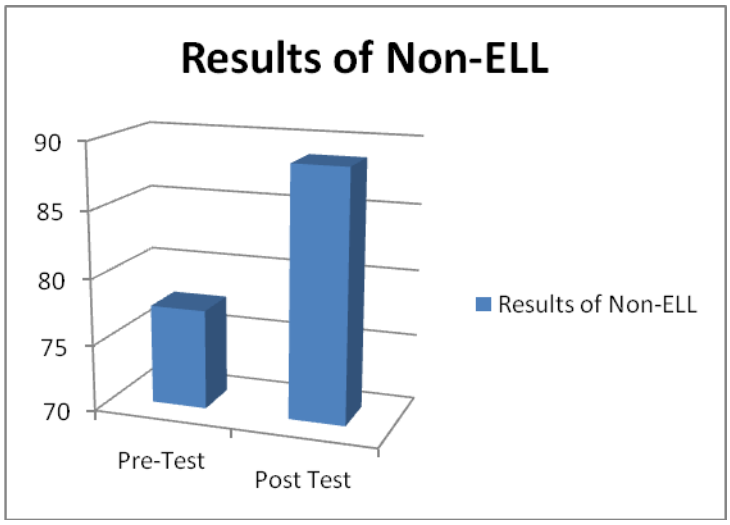
These scores show a drastic increase in items correct. The same types of questions were pulled from past CRCT tests.
I also used our small group time to question why some questions were harder than others. Many times it was the fact that there were multiple steps involved in the problems.

Discussion

This data supports the research done my Martinello and Baumann and Grames. They too felt that language was the barrier for the ELL population. I also tested three ELL students that enrolled later in the year and were not placed into my classroom because my class size was full. Their results show that without a visual reference to the mathematical language their results were similar to the results of ELL students not attending an ELL program.



The visual strategy was effective for both groups, ELL and non-ELL students. My non-ELL students made higher gains than my ELL students. This shows that the non-ELL group understood the concepts more clearly than my ELL groups and retained the information longer.



I found it interesting that during the pre-test many of my students, ELL and non-ELL, came to me asking about certain phrases and what operations they should use. During the post-test I only had two students come and ask from my class. The non-participants questioned me for most of the test.

Throughout the research I would conduct my small group questioning with my ELL students only. This was so they would have the confidence to answer when we had our whole group discussion about mathematical questions. When we discussed as a whole group about the math questions and which ones were harder to understand the ELL group participated equally with the non-ELL. This shows that my ELL students did gain the confidence to ask and answer many of their classmates questions.

This research will continue because it was effective and can only continue to improve test scores. Some researchers may say that I am teaching to the test, but the test is only a resource. The focus of this study was the language used in tests. The mathematical language is not used in everyday language, so there is no common ground for use. Making the phrases that are only seen on a test into a visual representation helps take away the confusion of how to find the answer.

Limitations of the Study:

The possible limitations of this study are the small number of students that I am pulling from and the researcher bias. I have a small number of ELL students to pull from because I am only documenting on my class with a few from other teacher's classes. As I am the researcher, I am also the student's teacher, so I have more personal knowledge of my students rather than just a researcher. I know their family dynamics and many of their personal interests, so I can pull their life experiences into our discussions. The students are with me for the year and will also mature, which also helps with academic knowledge.

References:

Baumann, J., & Graves, M. (2010). What is academic vocabulary? *Journal of Adolescent & Adult Literacy, 54*(1), 4-12. Retrieved from http://search.proquest.com/docview/750429274?accountid=12382

Bay-Williams, J., Scott, M., & Hancock, M. (2007). Case of the mathematics team: Implementing a team model for simultaneous renewal. *The Journal of Educational Research, 100*(4), 243-253,264. Retrieved from http://search.proquest.com/docview/204196803?accountid=12382

Bonham, B., & Boylan, H. (2011). Developmental mathematics: Challenges, promising practices, and recent initiatives. *Journal of Developmental Education, 34*(3), 2-4,6,8-10. Retrieved from http://search.proquest.com/docview/901456776?accountid=12382

DiGisi, L., & Fleming, D. (2005). Literacy specialists in math class! closing the achievement gap on state math assessments. *Voices from the Middle, 13*(1), 48-52. Retrieved from http://search.proquest.com/docview/213930667?accountid=12382

"Fred" Ramirez, A. (2011). INTRODUCTION: Linguistic & cultural diversity. *Multicultural Education, 18*(2), 2-3. Retrieved from http://search.proquest.com/docview/898419743?accountid=12382

Janzen, J. (2008). Teaching English language learners in the content areas. *Review of Educational Research, 78*(4), 1010-1038, doi:10.3102/0034654308325580

Jitendra, A., Sczesniak, E., Griffin, C., & Deatline-Buchman, A. (2007). Mathematical word problem solving in third-grade classrooms. *The Journal of Educational Research, 100*(5), 283-285,386,287,290-297,300-302,328. Retrieved from http://search.proquest.com/docview/204196660?accountid=12382

Kim, S., & Chang, M. (2010). Computer Games for the Math Achievement of Diverse Students. *Educational Technology &Society*, *13* (3), 224–232.

Kim, S. & Chang, M. (2010) Does Computer Use Promote the Mathematical Proficiency of ELL students? *J. Educational Computing Research*, 42 (3), 285-305.

Lee, J., Autry, M., Fox, J., & Williams, C. (2008). Investigating children's mathematics readiness. *Journal of Research in Childhood Education, 22*(3), 316-328. Retrieved from http://search.proquest.com/docview/203892265?accountid=12382

Lee, H., & Jung, W.S. (2004). Limited-English -_proficient (LEP) students and mathematical understanding. *Mathematics Teaching in the Middle School, 9*(5), 269-272.

Lee, J., Lee, Y., & Amaro-Jiménez, C. (2011). Teaching English language learners (ELLs) mathematics in early childhood. *Childhood Education, 87*(4), 253-260. Retrieved from http://search.proquest.com/docview/866565276?accountid=12382

María, G. L., & Tashakkori, A. (2004). Effects of a two-way bilingual program on the literacy development of students in kindergarten and first grade. *Bilingual Research Journal, 28*(1), 19-34. Retrieved from http://search.proquest.com/docview/222008809?accountid=12382

Martiniello, M. (2008). Language and the performance of english-language learners in math word problems. *Harvard Educational Review, 78*(2), 333-368,429. Retrieved from http://search.proquest.com/docview/212283604?accountid=12382

Menken, K. (2009). No child left behind and its effects on language policy. *Annual Review of Applied Linguistics, 29*(02671905), 103-117. doi:10.1017/S0267190509090096

Pang, Y. (2010). Working effectively with ELLs: What public school teachers should know. *New England Reading Association Journal, 45*(2), 69-75,103. Retrieved from http://search.proquest.com/docview/206031055?accountid=12382

Paredes, S. (2000). How proposition 227 influences the language dynamics of a first- and second-grade mathematics lesson. *Bilingual Research Journal, 24*(1), 179-198. Retrieved from http://search.proquest.com/docview/222043518?accountid=12382

Pascopella, Angela. (2011). Successful Strategies for English Language Learners: Districts Employ a

variety of programs to address surging ELL enrollment-and dropout rate. Retrieved from http://www.DistrictAdministration.com.

Perez, D., & Holmes, M. (2010). Ensuring academic literacy for ell students. *American Secondary Education, 38*(2), 32-43. Retrieved from http://search.proquest.com/docview/276321096?accountid=12382

Shneyderman, A., & Abella, R. (2009). The effects of the extended foreign language programs on spanish-language proficiency and academic achievement in English. *Bilingual Research Journal, 32*(3), 241-259. Retrieved from http://search.proquest.com/docview/222029349?accountid=12382

Willig, C., Bresser, R., Melanese, K., Sphar, C. & Felux, C. 10 WAYS TO HELP ELLS SUCCEED IN MATH. *Instructor*, 15320200, Mar/Apr2010, Vol. 119, Issue 5

Wynne, C. (2008). Culturally specific pedagogy in the mathematics classroom: Strategies for teachers of diverse students. *Harvard Educational Review, 78*(3), 563-564. Retrieved from http://search.proquest.com/docview/212292953?accountid=12382

Xu, Y., & Drame, E. (2008). Culturally appropriate context: Unlocking the potential of response to intervention for English language learners. *Early Childhood Education Journal, 35*(4), 305-311. doi:10.1007/s10643-007-0213-4

http://margaretmwilliams.suite101.com/strategies-to-support-esl-students-in-math-a116386
http://margaretmwilliams.suite101.com/anchor-charts-help-scaffold-esl-math-learning-a126537
http://www.districtadministration.com/article/successful-strategies-english-language-learners
http://www.districtadministration.com/article/english-language-learner-charter-schools