Connecting Words to Numbers: An inquiry exploring effective means of adapting math word problems for English Language Learners

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Abstract

Throughout the 2010-2011 school year, I was given the opportunity to work closely with two English language learners in the subject of mathematics. I immediately noticed how well versed both students were in the area as they demonstrated a strong grasp of the foundations of mathematics. The students illustrated the ability to quickly and accurately compute and solve equations, yet exemplified feelings of distress when assigned the task of tackling lengthy word problems. I wanted to look for ways to help these English language learners live up to their full potential, and break free of any language barriers standing in their way of success. In my inquiry, I looked for effective tools and strategies to help learners excel.

Context

My third grade classroom at Easterly Parkway Elementary in the State College Area School District consists of 22 third grade students; 9 females and 13 males. A majority of students are performing at basic or proficient reading and writing levels. Two students in the classroom receive learning support for math and reading. Two students are English language learners, and two are receiving additional emotional support.

The English language learners (ELL) are from Spain and Korea, and both are new to the district this school year. The ELL from Spain plans to return to Spain after this school year, while the student from Korea plans to stay in the school district. Both ELL attend the English language classroom at different times throughout the day, where they are very engaged and outgoing with the ELL group of about 10 students.
The two language learners depend on one another in the regular classroom, with the student from Korea relying heavily on the student from Spain’s understanding of English. The student from Spain is particularly sociable and often takes risks. His comprehension has improved significantly since the beginning of the school year, and he is now reading at a proficient level. The student from Korea still struggles with speaking and reading English. He is more hesitant and reluctant to engage in speaking English.

The social dynamics of the classroom seem to generally display students getting along with each other and have established close friendships. Roughly a third of the students are leaders who can easily influence others. The students work well with clear and concise directions. Along with the talkative social environment, students need a lot of re-focusing and re-direction. Almost all of the class in its entirety is comfortable with volunteering and participating in activities and discussions.

**Context 2**

The third grade class underwent math grouping, where students were sent to a classroom, which would better meet their needs. The two ELL from my classroom were grouped with 25 other students, 2 of which were the other third grade language learners. I also entered this classroom two provide additional support to all third grade English language learners.
Wonderings and Questions

My wondering and sub questions involving adapting math word problems for language learners came from a number of factors. Firstly, being a bi-racial individual, I felt I could empathize with my learners in that I have had the opportunity to understand both the Chinese culture as well as the American culture.

Secondly, I grew disheartened by the struggles students were facing when given assessments. I had worked individually with my learners since the start of the school year, giving them extra guidance and clarification when needed. When the students took their first math assessment, they were begging for additional help and confused as to why I could not offer it. I knew students had the potential in the skills to succeed, but were only held back by their language barriers.

Lastly, I noticed ELL being alienated from their peers the first few days of school. When students were participating in community building activities, such as interviewing one another, they did not engage the English language learners. When I spoke with these students, they stated they could not communicate with the ELL, and did not feel the need to include them. This drove me to want to explain to all students they are a key piece in developing ELL understanding of English. It also encouraged me to find ways to help ELL become more included in the classroom community.
Main Wondering

In a math curriculum rich in word problems, what methods are most effective in helping English language learners understand their context rather than isolating numbers from the words?

Questions

• What ways should math word problems be altered so they are still challenging for ELL students, yet appropriate for their understanding of the English language with nothing lost in translation?

• How can the ELL classroom and the regular classroom collaborate to further students’ understanding of math word problems?

• What are the most effective ways to administer assessments to ELL learners?

• Is there a way to help ELL students learn to support one another more during math time?

• In what ways does discussion about math word problems (before and/or after solving) affect ELL learners’ understanding of the problem?

Data Collection and Analysis

Throughout my inquiry, I collected anecdotal notes and maintained a checklist to keep track of how often my ELL participated and were called on to volunteer an answer. I also used surveys, interviews, and video footage of students solving both adapted and unadapted math word problems. Reflecting on student work and taking opportunities to get to know my students’ cultural background was central to my inquiry.
Data Collection

Before

In addition to creating a timeline of my project, I collected data in the following ways (Appendix A):

Student Interviews

I first interviewed students to develop better insight into the culture surrounding the way they were accustomed to learning math. I wanted to be able to uncover connections as well as contrast their school atmosphere with ours in the United States. I asked students questions to help me understand the context of their previous classrooms, the approaches their teachers had taken in teaching math, and their experience with math word problems (Appendix B).

Surveys

Developing surveys for students regarding their attitudes towards math class was a tool I used to guide my inquiry. I could use the information the surveys provided me in designing interventions. Questions were asked about students’ experience with understanding directions, working with peers, and their feelings towards math word problems. As a result of the language barriers, surveys were given orally to students and they responded with their answers (Appendix C).
**Student Work**

Adapting word problems for students was a tool I used to assess students’ comprehension. Prior to giving students a math problem to solve, I was able to modify it in a way that I anticipated would make the problem easier to grasp. I removed words from math problems that I felt would overwhelm English language learners, as well as substituted new words for any words they may not have been familiar with (Appendix D).

**Anecdotal Notes**

Prior to and throughout my inquiry project, I maintained detailed notes about students’ involvement in math class, interactions with peers and teachers, and attitudes towards math word problems. These were factors I found most significant to concentrate on prior to introducing interventions to students. I referenced these notes to help me develop effective intervention strategies (Appendix E). I also maintained a chart in which I would record when students would volunteer to participate in math discussion.

**Math Dictionary**

Creating a math dictionary for students to sustain and reference was another strategy I used during my inquiry process. I reviewed the 3rd grade math curriculum in search of terminology students would be encountering throughout their math experiences. I added this vocabulary to students’ dictionaries, and had students illustrate the particular
word or definition. I used this as both a pre-assessment and a tool for students to continue to add to throughout the year (Appendix F).

During

Anecdotal Notes

As my inquiry project progressed, I moved in the direction of recording strategies that were effective in helping students understand word problems. I also continued to document how often students were participating in class to look for a correlation between understanding math word problems and engaging themselves in discussion. The chart I had created was a tool I used to look for patterns in student participation from the beginning of my inquiry to the end (Appendix G).

Student Work

I gave students both modified and unmodified versions of math word problems and video recorded them as they solved these problems. This intervention technique provided me with instances to look at student work before and after a problem was modified. I tried several different strategies when giving students word problems. First, I gave them an unmodified version and video recorded their reactions. I also reviewed how they attempted to solve the problem. I had students read math word problems aloud and summarize what they had read in their own words. Lastly, I read math word problems aloud to students and asked them to summarize what they had heard (Appendix D).
After

Survey

I administered the same survey to students, which they had taken prior to inquiry interventions, and added a few questions. I wanted to see if students’ attitudes had changed after intervention strategies were implemented, and if they were feeling more comfortable with the subject of mathematics. I added questions related to specific strategies I had tried to help students better comprehend math word problems, such as whether reading a math word problem aloud and summarizing it in their own words was helpful (Appendix H).

Analysis

Before

Interview Analysis

Through interviewing students, I became more aware of the learning atmosphere they had been accustomed to in their home countries. I was able to recognize the adjustments students had to make after entering the education system in United States. I learned how students had similar class sizes in their native countries, and had studied a curriculum comparable to that of our school system. A major distinction between the culture in our country versus the students’ lie in teaching methods. Both students illustrated their math classes to have little to no opportunities with working in groups or pairs. The students both reported their teachers talked and lectured throughout math class, and students would be following along and solving problems in work books. This helped
me recognize students were unfamiliar with transitioning from working in groups, to pairs, to all class instruction.

**Survey Analysis**

Analyzing students’ surveys gave me a better perception of students’ general feelings towards math class. I saw that both students thought processes regarding directions in math class were sometimes hard to understand. Students also felt peers to be unhelpful at times, which gave me reason to encourage other students to help the ELL during math time, as they are a key component in helping students learn and grow in the English language.

**During**

**Math Dictionary Analysis**

The math dictionary was a tool I gave to my students early on in the inquiry process, and encouraged them to update and reference it (Appendix F). Seldom did I see students actually using this as a reference tool, but it was an effective pre-assessment. Writing the symbols or words and having students draw the symbol showed me what things they were unfamiliar with. Words such as symmetry, equation, and table were words both students were unsure of. This helped me recognize vocabulary I needed to spend more time explaining to students. I also went back and reviewed money with students, using toy coins to help them grasp their value. Initially, I hadn’t anticipated the math dictionary being any type of assessment, but was glad to be able to use it in this way.
Anecdotal Notes Analysis

Anecdotal notes helped me analyze areas student involvement in the class as well as their attitudes towards math. I referenced my notes to see areas students were struggling with and succeeding in. I used these notes to guide me in deciding what interventions to implement. I could also use notes as a tool to illustrate which of my students needed more guidance, and whether one student could support another in a particular area. Many instances throughout my notes demonstrated the stronger English speaker assisting his peer (Appendix E).

Student Work Analysis

When giving students unmodified math word problems, they seemed more anxious, asking a number of clarifying questions. Several of these problems were left blank (Appendix D). They would state they did not understand and looked for more guidance before attempting to answer the problem. When students did solve math word problems on their own, they would use accurate numbers but perform the wrong formula (multiply instead of divide, add instead of subtract).

Having students read the math word problem aloud was helpful to assess what words they were and were not familiar with. It also allowed for other English language learners to hear their peers read these math word problems aloud while following along. Having students summarize what they had read was sometimes done successfully and other times students had no comprehension of what they had read.

Reading questions aloud to students seemed to be the most helpful, and they were often better able to comprehend and repeat back to me what I had read. Each time a math
problem was read aloud, either by myself or by my students, they then had an opportunity for to ask me to elaborate on a specific part of the problem they found confusing.

When setting the adapted version and unadapted version in front of students and asking them which was easier to solve, both students said the adapted version was easier to solve all of the 6 times. A student stated, “There are less words and it is easier for me to read it out loud and know I need to do.”

**Chart Analysis**

Analyzing the student participation chart showed students were participating at least once everyday. The results in participation between the two students were similar, which may be a result of the opportunities to participate as well as the topic of discussion. The chart did not reveal any consistent or growing results, but it at least demonstrated students were somewhat comfortable in participating during math class (Appendix G).

*After*

**Survey Analysis**

Students’ results from the first survey to the second demonstrated directions in math class were slightly less difficult to understand than they had been before. Students still found math word problems hard to solve and felt peers sometimes helpful. Additional questions (6-8, Appendix H) demonstrated both students found it very helpful when a teacher reads the word problem aloud to students. They both found reading the word problem and summarizing it in their own words to be a little helpful. One student
who is less versed in the English language found drawing pictures to help solve word
problems to be very helpful. This survey was a means to assess whether the interventions
I had been implementing were effective. It gave me insight into strategies I will continue
to use, and those that are not useful.

**Claims Supported by Evidence**

**Claim 1**: Adapting math word problems by eliminating excessive detail and unfamiliar
vocabulary allows for easier comprehension for English language learners.

I began the process of modifying word problems by keeping in mind my students
grasp on the English language. I considered what things would discourage, such as
context or words, as well as overwhelm them when solving a math word problem. I noted
when students were solving unmodified problems, they immediately were stuck on a
particular name included in the problem. Coming from different countries, students were
not familiar with the names in many of the math word problems. I did not want my
students to be immediately discouraged due to pronouncing a name in a math word
problem, so I decided to keep names consistent.

If students were working on a series of word problems, I selected a name they
were familiar with (a peer or classmate’s name) and used it in each problem (Appendix
D). Video footage demonstrated students reading these names with ease.
In another attempt to help students’ comprehension with word problems, I changed any items or activities they might be unfamiliar with and replaced them with items I knew would be more recognizable. It was also important to consider cultural differences for my students when adapting word problems. For example, my student from Spain was familiar with the term football being equivalent to soccer in our society, and was confused when reading the concept of scoring “touchdowns” rather than “points.” I eliminated unfamiliar vocabulary, such as “coupons” and replaced it with a word such as “stickers” that I knew my students would recognize.

Another instance I noted was students having difficulty on a math assessment, where students could not understand the context of the Question. For question 1, three out of four ELL asked me to clarify the term “sledding” (Appendix I). In question 13B, my learners had difficulty comprehending the meaning of the word “steeper.” This demonstrated to me the importance of adapting word problems, also on assessments.

When modifying word problems, I tried to keep each word problem to a maximum of 3 sentences. Many word problems provide excess or unnecessary information in order to make the problem more challenging for learners. I felt students who were just learning the English language would be overwhelmed by a lengthy word problem. As long as the problem had the basic facts and was presented in a straightforward way, students were more confident in solving them. I also considered how contractions were thing students were unfamiliar with in their languages, so I made sure to avoid them when modifying problems.
Lastly, the math dictionary created for students helped me in adapting word problems. I observed students as they drew symbols and studied the dictionary, and made note of vocabulary that needed more clarification. I wrote these terms down, and looked for ways I could illustrate to students what they meant. An example of a word that was unfamiliar to them was a “table.” Students recognized the term in a literal sense, but were confused as to how it related to mathematics. I was able to look through their math notebooks to find examples of a table to help their understanding.

**Claim 2:** Understanding students’ cultural background prepares educators to better meet the needs of their students.

Through researching teaching English language learners and communicating with Easterly Parkway’s English language professional, it was evident how important it is to understand students from diverse cultural backgrounds. In doing so, it helps eliminate any misunderstandings. I learned both my language learners experienced a math learning environment different than the one they were placed in at Easterly Parkway.

Through observing and teaching in the English language learner classroom one to two times a week, I had a number of instances to get to know my students. I listened to and partook in conversations they were engaged in regarding their education in their home countries. I was able to use my observations to guide the interventions I wanted to implement. I saw how the ELL teacher always had her students conversing in English. She encouraged them to always be talking, and was always asking them questions and engaging them in discussion. I made sure when working with my students during math, and providing them with word problems that I discuss the problem in depth with them.
I knew both my students were unfamiliar with working in groups or pairs as a result of the interview I had given them. They had been in classrooms where a teacher would lecture and students worked independently. With this information, I decided to pull students from the entire group of 26 math learners and work with them individually. Although I saw it as very powerful to have students working in the regular math classroom alongside their peers, I also wanted to give them individual attention and allow them to work independently in a fashion they were more familiar with.

Students seemed at ease when solving math word problems independently, and asked for extra guidance when needed. Student work comparing adapted and unmodified word problems demonstrates how students were able to solve the modified problems accurately. Unmodified problems were often left blank or answered incorrectly (Appendix D).

Claim 3: Establishing a close group of English language learners and placing them in a math environment creates a strong support group.

Beginning in March, the group of third grade language learners was all grouped in the same math classroom. This was done in an attempt to encourage students to support one another and also provide an opportunity for me to provide extra guidance. The students entered the classroom with established friendships, which they had developed through working together in the English language classroom.

The students often worked with one another on class work, and if one student had a better grasp on a concept he would help his peers. The chart I kept to monitor student
participation showed my learners volunteering to answer math related questions during discussion times (Appendix G).

Through anecdotal note taking, I recognized a trend in students providing one another with support during math class. The student from Spain with a deeper understanding of English often supports the student from Korea, who has less of a feel for the language (Appendix J). In addition, the participation chart, which was tracking 2 students, demonstrates students participating when grouped in the math class with all English learners.

**Claim 4**: Providing additional teacher support to English language learners in a math environment helps students better overcome language barriers.

To help with third grade English language learners were placed in the same math environment that had a total of 26 students, I entered the setting to provide students with extra guidance. Language learners sat closely to one another, and I placed myself near them each period so they could turn to me for clarification. Students were aware they could use me as a resource anytime they felt confused or were unable to understand something.

During this time, I was able to read questions aloud to the group of students, use math manipulatives to explain problems, and elaborate on directions that may have been difficult to comprehend. This opportunity also helped me encourage language learners’ peers to provide support. When English learners were placed in pairs or groups, I was able to encourage the native English speakers to explain directions or a particular math
problem. In an effort to help English learners in a math environment, I was also able to help students help one another.

I found this opportunity helpful in instances where students were unable to understand the context of particular math questions. Many of the students were accustomed to different units of measurement. They were also familiar with different forms of currency than we have in the United States. I was able to show students drawings or manipulatives to better illustrate these concepts, or elaborate on the concepts they were confused about (Appendix K).

**Reflection and Future Practice**

**Reflection**

The inquiry process illustrated the importance of knowing my students, engaging them in a positive environment, and offering them the support they need to succeed. Being aware of my students’ comprehension and speaking skills in English helped me meet their needs. As no two students are alike, it is important to consider where each learner stood in language development before implementing interventions. I came to an understanding of how to modify word problems because I knew my learners.

Understanding that my learners come from different backgrounds helped me realize I needed to first help them become comfortable in a new learning environment before they could begin to completely engage themselves. Students were familiar with teachers lecturing in the classroom and assigning them independent work, which was
very different than what they experienced here in the United States. I was able to explain to them that we often work in groups to support one another. Comparing notes with students about their culture versus ours was a very valuable way to help me get to know my students, as well as teach them.

Students entered a classroom community full of outgoing individuals, willing to take risks. English language learners saw their peers constantly participating and involving themselves in discussion. Students rarely held back in my third grade classroom, and I feel that my language learners benefited greatly from this closely-knit classroom community. They saw their peers full of confidence, and then adopted this confidence as well. My language learners developed a strong support group in their English Language Learner classroom. They worked with each other to explore the English language and became very close friends as well as a support group.

**Future Practice**

In my future classroom, I plan to take the opportunity to understand my students’ cultures as well as allow my students to understand one another. Often times students would shy away from the language learners, labeling them as “unable to understand.” Sharing with my students that they needed to speak to the English language learners to help them develop language skills is something I will continually remind myself to do.

Establishing a strong classroom community is imperative for many reasons, but through my inquiry I saw what a deep influence it had in helping English language learners excel. Creating an environment where language learners feel comfortable to
speak and interact is a goal of mine. I feel this will be one of the most useful ways I can help them succeed.

Looking for ways to assess my language learners, whether through conversation, discussing math concepts, or observing them interact with peers will help me recognize the steps I need to take in order to promote their growth in math. I am looking forward to establishing a classroom full of support amongst peers and educators to help my students live up to their potential.


The article discusses linking teaching math to ELL learners’ background and providing them with the appropriate tools to help them excel. It encourages the educator to look at the bigger picture and explore how the classroom atmosphere is affecting students’ learning. The author emphasizes creating an atmosphere where students are continually exposed to conversation so they may pick up on language and gradually engage themselves. We must be patient with students and know that their comprehension will develop through listening and observing classroom discussion. It will be important to encourage ELL learners’ peers to work with them and help in them learn. Sharing that ELL learners’ exposure to language as a way to help them learn it more quickly will be important to share with classmates.

This article gives insight into different cultures and the beliefs families of different cultures hold. It explores students’ diverse home lives as well as their experience at school. It is a great reminder of the characteristics, which make us unique individuals. The article reminds the reader of the different lifestyles we might come from, and how important it is to be aware of this. It emphasizes being aware of students’ background so an educator is better fit to teach them. This article will help me better understand my learners and will be a good article to revisit as a reminder of the differences I might encounter due to cultural diversity.


This chapter gives insight into how to address individual differences of learners and how to help them succeed. It encourages celebrating diversity we see in our classrooms and encourages us to make efforts to understand it. The reading reminds us that equitable teaching does not mean identical instruction, but instruction adapted to differences so all students can achieve equal outcomes. It discusses the effects of peer-assisted learning, which will be useful for the two ELL students to explore. The author includes support for word problems, which are difficult for ELL learners, as their structure in English will vary in another language, confusing to students new to the language. The chapter
provides examples of modified word problems, which will be helpful to refer to when I am adapting the students’ word problems.

- Wiest, Lynda R. *Problem-Solving Support for English Language Learners.*
  

The article proposes a word problem for ELL learners and how it can be adapted to better fit their needs. It discusses strategies to help learners explore math and ways to help them feel comfortable with it. The author gives a real life scenario of a classroom that put certain strategies into effect and the impact it had on the students. It is a reminder that although adapting and teaching math word problems may be time consuming, it allows for more meaningful math to be learned by students.


This website offers a variety of different math related problems. It includes math word problems students can answer and receive a score for. The website is engaging and filled with color and different games to play. It also keeps track of how long students take to answer questions, which can be a way to assess their understanding of math problems. This is something I can encourage students do explore at home or when they have extra free time.


This piece discusses the importance in recognizing all the factors encompassing student diversity, and how we must consider all of these factors when teaching learners. It focuses on differentiated instruction, and strategies to
assure for successful differentiating. It encourages educators to get to know their students, maintain high expectations, collaborate with others, and be flexible.

- Smith, Frank. The Just So Story-Obvious but False. Language Arts, Vol. 80 No.4, March 2003; Research Library Core, pg. 256.

  Smith encourages educators to move away from the mindset that students learn to read by being taught to sound out words, and into looking for more approaches to teach readers. It emphasizes the importance that no matter what background a language learner comes from, they can learn English just as easily as their peers. He advocates giving language learners unending opportunities to read, which will help them develop as speakers and learners.


  The authors of this book illustrate how cultural differences influence classroom community. It discusses how misunderstanding and judgment can result if we do not take the time to understand our students’ cultures and values. By understanding our students’ diversity, we can achieve a better handle on classroom management and community.


  Cummins separates academic English from conversational English in this piece. He highlights the fact that conversational English is less formal and acquired more naturally amongst language learners. Academic English involves more vocabulary, written in a formal way. Students of different
backgrounds may not be able to recognize academic vocabulary, and therefore need more clarification and guidance.

- **Immersion**, http://www.imersionfilm.com/

  This video tells a story of a language learner who was forced to take a standardized test and was not permitted to receive any extra help. He was unable to understand the language as well as the context of the problems. The video illustrated school administrators unable to provide additional help to this student, who wanted to succeed. It encouraged viewers to fight for these language learners experience similar circumstances.

**Appendix**

A. Timeline

B. Culture Interview

C. Student Survey 1

D. Student Work

E. Notes

F. Math Dictionary

G. Chart

H. Survey 2

I. Assessment

J. Notes Support

K. Coins
**Appendix A: Timeline**

<table>
<thead>
<tr>
<th>Week</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 14&lt;sup&gt;th&lt;/sup&gt;-18&lt;sup&gt;th&lt;/sup&gt;</td>
<td>• Rearrange students desk&lt;br&gt;• Observe ELL students as they work in new peer groups during math&lt;br&gt;• Encourage peers at table set to help students during math</td>
</tr>
<tr>
<td>February 21&lt;sup&gt;st&lt;/sup&gt;-25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>• Discuss ways to adapt lesson plans with ELL teacher&lt;br&gt;• Continue to explain math word problems to learners during class&lt;br&gt;• Adapt student work&lt;br&gt;• Take field notes</td>
</tr>
</tbody>
</table>
| February 28<sup>th</sup>-March 4<sup>th</sup> | Develop interview questions to ask students about math class<br>• Have survey approved by mentor<br>• Adapt lessons of student work for ELL learners<br>• Analyze student work<br>• Continue taking field notes  
*Revised Brief due* |
<p>| March 7&lt;sup&gt;th&lt;/sup&gt;-11&lt;sup&gt;th&lt;/sup&gt; | Spring Break&lt;br&gt;• Review participation notes to see student progress&lt;br&gt;• Review notes and look at the progress of both students&lt;br&gt;• Create math dictionary&lt;br&gt;• Review upcoming math assignments to adapt |
| March 14&lt;sup&gt;th&lt;/sup&gt;-18&lt;sup&gt;th&lt;/sup&gt; | • Adapt lessons for learners&lt;br&gt;• Create and maintain a chart to track student participation&lt;br&gt;• Analyze student work&lt;br&gt;• Field notes |
| March 21&lt;sup&gt;st&lt;/sup&gt;-25&lt;sup&gt;th&lt;/sup&gt;  | • Adapt lessons for learners&lt;br&gt;• Video recording&lt;br&gt;• Encourage students to update their math dictionaries&lt;br&gt;• Analyze student work |
| March 28&lt;sup&gt;th&lt;/sup&gt;-April 1&lt;sup&gt;st&lt;/sup&gt; | • Adapt lessons for learners&lt;br&gt;• Review student work&lt;br&gt;• Check in with ELL instructor&lt;br&gt;• Field notes&lt;br&gt;• Administer survey 2 |
| April 4&lt;sup&gt;th&lt;/sup&gt;-April 8&lt;sup&gt;th&lt;/sup&gt; | <em>Inquiry Draft due (4/8)</em>&lt;br&gt;• Adapt lessons for ELL learners&lt;br&gt;• Analyze student work&lt;br&gt;• Reflect on peer influence/interaction&lt;br&gt;• Field notes |
| April 11&lt;sup&gt;th&lt;/sup&gt;-15&lt;sup&gt;th&lt;/sup&gt; | • Adapt lessons for ELL learners&lt;br&gt;• Analyze student work&lt;br&gt;• Explore math websites with students |
| April 18&lt;sup&gt;th&lt;/sup&gt;-22&lt;sup&gt;nd&lt;/sup&gt; | • Interview with students to discuss math class |</p>
<table>
<thead>
<tr>
<th>Date Range</th>
<th>Activities</th>
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<tbody>
<tr>
<td>April 25th-April 29th</td>
<td>• Adapt lessons for students</td>
</tr>
<tr>
<td></td>
<td>• Analyze student work</td>
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<td></td>
<td>• Explore math websites</td>
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<tr>
<td>April 30th - May 1st</td>
<td>*Final Paper due (5/1)</td>
</tr>
<tr>
<td></td>
<td>• Adapt lessons for ELL learners</td>
</tr>
<tr>
<td></td>
<td>• Analyze data and student progress</td>
</tr>
</tbody>
</table>
Appendix B: Culture Interview

Lucas

Interview

1). What types of things did you learn about in math class at home?
   - division, multiplication, fractions, (same as U.S.):

2). How many students were usually in your class?
   ~23

3). Did you usually work in groups, partners, or by yourself?
   ^ alone, no partners, groups

4). Did your teacher talk more or less than your teacher here talks?
   ^ teacher explained math problem and then student solved in books. Teacher talked less.

5). Did you ever take tests?
   ^ same, more here
   ^ tests graded

6). Did you have word problems?
   ^ mostly math word problems, teacher reads aloud to class, then students solve independently
Ohm Yoo

1). addition, subtraction, multiplication, division, fractions

2). 20

3). alone

4). talked more \rightarrow whole class

5). many tests
   graded

6). a little (not as many as here)
Appendix C: Student Survey 1

Date: 3.2.11

Math Survey

1). Do you enjoy math class?
   All of the time  Sometimes  Not very often

2). Directions are
   Hard to understand  Sometimes hard to understand  Never hard to understand

3). Math word problems are
   Hard to understand  Sometimes hard to understand  Never hard to understand

4). My peers in math class are
   Always helpful  Sometimes helpful  Never helpful

5). What ways can my teacher help me make math class more enjoyable and understandable?
   - Read question
   - Change some questions
   - Easy math if it were in Spanish it'd be too easy

6). Math equation problems in math class are
   Hard to understand  Sometimes hard to understand  Never hard to understand
Math Survey

1) Do you enjoy math class?
   - All of the time
   - Sometimes
   - Not very often

2) Directions are
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   - Hard to understand
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   - Never hard to understand

4) My peers in math class are
   - Always helpful
   - Sometimes helpful
   - Never helpful

5) What ways can my teacher help me make math class more enjoyable and understandable?
   - Read word problems
   - Drawings

6) Math equation problems in math class are
   - Hard to understand
   - Sometimes hard to understand
   - Never hard to understand
## Appendix D: Student Work (Unmodified)

### Time Problem Solving

**Name**  

Solve each word problem. Show your work and write the answer in the space provided.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mark left his house at 8:15 A.M. He was at work for 9 hours and 45 minutes. At what time did he return?</td>
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<tr>
<td>2.</td>
<td>Meg started her workout session at 5:30 P.M. It lasted 65 minutes. What time did she finish?</td>
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<td>3.</td>
<td>Mr. Walters rode the bus to the stadium at 4:25 P.M. He returned that night at 11:35 P.M. How long was he gone?</td>
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<td>4.</td>
<td>Chandra planned a business trip every Tuesday for an entire month. There were 30 days in the month, and her first trip was on the third. How many trips did she make that month?</td>
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<td>5.</td>
<td>Reggie went to bed at 9:30 P.M. If he slept for 8 hours, when did he wake up the next morning?</td>
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<td>6.</td>
<td>Monica wants to go to the ball game and to the movies. The ball game begins at 2:15 P.M. and lasts for 3 hours. The movie is at 5:00 P.M. Will she be able to attend both events the same day?</td>
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<tr>
<td>7.</td>
<td>Sally began playing golf at 9:15 A.M. She played for 3 hours and took a break. She resumed playing at 2:00 P.M. and played until 5:00 that evening. How many hours in all did she play golf?</td>
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<tr>
<td>8.</td>
<td>Mrs. Jackson sends a postcard to her grandson every month on the 15th. If she does this for a full year, how many postcards will she receive in all?</td>
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</tbody>
</table>

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**Total Problems:** 8  **Total Correct:** 8  **Score:** 100%
Solve each word problem. Show your work and write the answer in the space provided.

1. Melanie bought 7 packages of greeting cards. Each package had 9 cards inside. How many greeting cards did she get in all?
   \[7 \times 9 = 63\]

2. Grace saw 16 cages of birds at the zoo's aviary. The sign said each cage had 12 birds. How many birds were in the aviary cages in all?

3. Matthew unpacked 43 boxes of light bulbs for the discount warehouse. Each box contained 6 bulbs. How many bulbs were there in all 43 boxes?
   \[43 \times 6 = 258\]

4. Nell sold 125 packages of cookies at the bake sale. Each package was tied with 2 ribbons. How many ribbons were used in all?

5. Mr. Harding gave out 15 coupons per hour at the appliance show. After 2 days at the show, working 14 hours total, how many coupons did he distribute?

6. Chris walked 4 miles a day for 21 days. How many miles did she walk in all?

7. Kelly practiced her flute 30 minutes a day for 15 days. After the 15 days were completed, how many minutes had she practiced?

8. LaToya played her new CD for 3 hours every day the first 5 days she had it. How many hours did she play the CD? How many minutes was this?
Mark left home at 8:15 AM. He went to work for 9 hours and 45 minutes. What time did he go home? (pg. 61, #1)

Julia started to play golf at 9:15 AM. She played for 3 hours and then took a break. She started to play again at 2 P.M. and stopped at 5 P.M. How many hours did she play all together? (pg. 61, #7)

Tom bought 7 packs of gum. Each pack had 9 pieces. How many pieces did he get all together? (pg. 34, #1)

Matt had 43 boxes of light bulbs. Each box had 6 light bulbs. How many bulbs did he have all together? (Pg. 34, #3)

Julia had $15.00. She bought a hot dog and drink for $4.20. She bought a toy for $6.25. How much did she have left over?

Matt wants to buy 2 shirts for $14.50. If he has $30.00, how much change will he get back?
Solve each word problem. Show your work and write the answer in the space provided.

<p>| | |</p>
<table>
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<tbody>
<tr>
<td>1.</td>
<td>Melanie bought 7 packages of greeting cards. Each package had 9 cards inside. How many greeting cards did she get in all?</td>
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<td>Grace saw 16 cages of birds at the zoo’s aviary. The sign said each cage had 12 birds. How many birds were in the aviary cages in all?</td>
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<td>Chris walked 4 miles a day for 21 days. How many miles did she walk in all?</td>
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<td>7.</td>
<td>Kelly practiced her flute 30 minutes a day for 15 days. After the 15 days were completed, how many minutes had she practiced?</td>
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<td>Nell sold 125 packages of cookies at the bake sale. Each package was tied with 2 ribbons. How many ribbons were used in all?</td>
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<td>LaToya played her new CD for 3 hours every day the first 5 days she had it. How many hours did she play the CD? How many minutes was this?</td>
</tr>
<tr>
<td>Problem</td>
<td>Description</td>
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<td>-------------</td>
</tr>
<tr>
<td>1.</td>
<td>Kathleen had $15.00 to spend at the fair. She bought a hot dog and soda for $4.20. Kathleen spent $6.25 on a souvenir. How much money does Kathleen have after her purchases?</td>
</tr>
<tr>
<td>2.</td>
<td>Glen went to the store to buy items for his birthday party. He spent $14.23 on balloons and $28.32 for food. How much did Glen spend in all?</td>
</tr>
<tr>
<td>3.</td>
<td>Last year, Jimmy earned $413.29 by selling his prize-winning carrot cake at the Georgia State Fair. This year, he earned $592.56. How much more did Jimmy earn this year?</td>
</tr>
<tr>
<td>4.</td>
<td>John spent $4.75 on food at the baseball game. He spent $13.27 on a souvenir hat. How much more did he spend on the food than on the hat?</td>
</tr>
<tr>
<td>5.</td>
<td>Lisa earned $31.38 each week for delivering newspapers. She delivered newspapers for 2 weeks. How much money did Lisa earn after 2 weeks?</td>
</tr>
<tr>
<td>6.</td>
<td>Brittanì wants to buy 2 shirts that are on sale. Each shirt is on sale for $14.50 including tax. If Brittanì has $30.00, how much change will she get after purchasing 2 shirts?</td>
</tr>
</tbody>
</table>
Solve each word problem. Show your work and write the answer in the space provided.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
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</tbody>
</table>
| \[
\begin{array}{c}
8:15 \\
+9:45 \\
\hline
6:00
\end{array}
\] |   |

| **2.** Meg started her workout session at 5:30 P.M. It lasted 65 minutes. What time did she finish? | **6.** Monica wants to go to the ball game and to the movies. The ball game begins at 2:15 P.M. and lasts for 3 hours. The movie is at 5:00 P.M. Will she be able to attend both events the same day? |
|   |   |
| **3.** Mr. Walters rode the bus to the stadium at 4:25 P.M. He returned that night at 11:35 P.M. How long was he gone? | **7.** Sally began playing golf at 9:15 A.M. She played for 3 hours and took a break. She resumed playing at 2:00 P.M. and played until 5:00 that evening. How many hours in all did she play golf? |
|   |   |
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<table>
<thead>
<tr>
<th>Total Problems:</th>
<th>Total Correct:</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8</td>
<td>61</td>
</tr>
</tbody>
</table>
Adapted Student 2

1) Mark left home at 8:15 AM. He went to work for 9 hours and 45 minutes. What time did he go home? (pg. 61, #1)

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Appendix E: Notes

9/27
W/W
- sat next to own you
- listened to read aloud & looked at pictures intently
- sat in front row
- 2 books (just read read) & stayed focus
  → ESL student next to him did not, played
- look w/ his watch instead
- without pictures → still focused

Math
- given back test and went over them
  → discussed w/ ESL student

9/28
W/W stories
about seasons, family → used illustrations
Math: data
uncovered after organizing data
into groups

10/4
Lucas shared at morning meeting
I am going to Washington Sat. → white house museum
(See pg. 112)
difficulty w/ past tense

10/5
shared pictures from his camera from D.C.
"butterfly" "flower" → used English words
10/18
Volunteered multiples of 10 for case study
*Outgoing influences onn Yoo
10/19, onn Yoo made shape prediction during calendar math
- Draws Star Wars colors for other students. Boys all encourage Lucas for being a great drawer.
- Draws, doodles on papers during math
  10/20, onn Yoo volunteers date
- Lucas & onn Yoo present solar system
  → Lucas forgets names, goes behind paper & pushes onn Yoo out

10/22 Lucas offers date during morning meeting after onn Yoo does
- Take out math binder - realize it is wrong binder after observing others
- Take out writing
- Offered to get more paper → 'no no me'
- Loves to draw → Draws during WW
- Still writing in English
- Other students mad all ELL students are drawing

11/1
Goal Setting
  1). Academic: Speak more English during conversation
  2). Work habits: Focus on WW and math rather than drawing
Off task
WW - draws math word problems.
   → dictionary,

* Good influence on Ann Yoo
* Talk to ELL teacher
* WW - write stories more in English
* A lot of acceptance comes from drawing
  → How could he share more about his culture w/ the class
* WW - write about Spain in English to share w/ the class?

*Lunch Bunch

Creating a dictionary for Lucas

11/9
WW - Lucas interested rather read his story in English to him than Spanish

Parent conference
- Father speaks moderate English
- Mother back to Spain this month, father worried

42 WPM Aimsweb
- vocabulary in context
- Read books
- science lessons
- math ELL vocabulary in & investigations
- write in English
- writing journal
- core 3rd grade words for Lucas & Enny
* choices in discussion
- ESL Science lesson
- Science inquiry in shadows

11:30
Math: Lucas read & sent math problem perfectly to me aloud! Read at a good pace
- understanding? need to clarify words, such as "bottle caps"
- not drawing during math, neither is Ann You
- read math word problem & explained it
to Lucas; corrected my error when I read "Mrs." as "Ms."
Thanksgiving - uncle & cousin visited 
and ate turkey 
Cousins live in U.S., ages 15 & 30 

Math word problems, division 
used glue sticks to represent stacks of 10 
used "stickers" each time - something both ESL 
students understood/recognized 

Recognized pattern of multiplying a 2-digit number by 10, adding a zero to that number 
53 x 10 = 530 

Explain this well in English
Inquiry notes

2/8
Lucas volunteers answer for answering how to determine square units in an 8 x 10 rectangle “Count 8, then 10, then 8 x 10 and get 80”
Listened to the discussion to figure out what square units were and then volunteered his answer
Drawing less during class

2/9
Page 18, unit 4 “Why does it take 20 teromino shapes to cover the 8 x 10 grid?” encouraged to talk to a partner. L starts explaining to O right away
L explains to O how he gets this. I encouraged him to point to the grid and show him, so he explained to him pointing at the grid showing him how 4 pieces of a teromino cover 4 blocks of the grid.
Not drawing (L)
O draws

2/10
L volunteers answer at 10 10 for the area of an object on pg. 25
L raises his hand at 1013 to answer another question about area
O draws at first then is directed to page 25
1043, O volunteered answer for area of a problem 2 pg 29, finding the area of a square under a rug. Showed how he multiplied length x width (5 x 5) and said he got 25. “25 what?” “Square units”

2/14/
L offers to answer to where is the force during science discussion. Asked which direction and points with his thumb in the right direction

2/15
Levers lesson 2, L volunteers to do demonstration with the board when needing a volunteer
L and O work in a group with another strong science thinker

*Seats change, l and o no longer sit next to one another

2/16 “How do you know this is a rectangle?”

O volunteers (sitting next to the L on the rug) shares it has 4 sides. Asked what else, and looks at L to help him with his response

2/17

L volunteers his answer for a rectangle with an area of 10 during warm up of math

L volunteers to point out the obtuse angles

O volunteers to draw an obtuse angle on the board (5-7min after L)

2-18

-Hw: did with Ohn Yoo. Drew pictures for fractions

Volunteers an answer of a fraction

2/28 (new class)

Ohn Yoo volunteers numerator and denominator definition after I share the definition with him

Word problems with fractions using drawings

Encourage him to use drawings

Created survey

-broken into partners- all ELL with a native English speaker. Syndey asked, “Will he understand me if he doesn’t speak English?” encouraged her O needs to hear her speak to learn the language- she is helping him by talking with him

-Explain word problems to me before explaining to them

-Garage band play back video recording

3/3

-L Continues hand rasied for HW answers

-O continuous half way through homework

3/23
Had students fill in their math dictionaries – I wrote the words, and students filled them in

Trouble with “table, symmetry,

3/24

- Page 1, unit 6: Graphing Temperature
- Lucas volunteers each time to answer questions
- Ohn Yoo volunteers each time to read temperature
Teaching Inquiry
pg. 47, 48, 49

Case Study
- Quiet, speaks little English
- Animated/ facial expressions
- Played w/ brother at recess
- Brought grasshopper to me at recess, excited
told me how to say the name in Spanish

Math
- Uses UNifix cubes, 100's chart
- Knows numbers in English
- Likes to write messages on white board
  (thinks it's funny)
- Told me in Spanish, in second grade, ÷ in third
- Math game w/ on X Y = very talkative,
  cheated & laughed

* Math assessment was confused why I couldn't
  help

- Likes to draw, ride bikes, cook
- "Easier to understand English than speak it"
- Father professor for PSU
- Mother doesn't speak English
- Looks for me w/ explaining math

- Make cookies, pen pal
- Write in English

9/30
understood math data assignment
where students like to read & organize data
Math Dictionary
'Add' or 'Plus' +

'Difference' –

'Equation'  
$\frac{20}{2} = 10$

'symmetry'

'Least'  

'Greatest'  

'Most'
Greater than 203
Less than 203
Equals =

Fraction \[ \frac{4}{6} \]
Graph
Table

'Most' 'Minus' Multiply
quarter = 25¢
1 Penny = 1¢
1 Nickle = 5¢
1 Dime = 10¢

1 minute = 60 seconds
1 Hour = 60 minutes
Half hour = 30 minutes
Quarter of an hour =

Divide Times
## Appendix G: Chart

### Participation Chart

<table>
<thead>
<tr>
<th>Date</th>
<th>Lucas</th>
<th>Called on</th>
<th>Ohm Yoo</th>
<th>Called on</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/24</td>
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</table>

### Appendix H: Survey 2
Math Survey

1. Do you enjoy math class?
   All of the time  Sometimes  Not very often

2. Directions are
   Hard to understand  Sometimes hard to understand  Never hard to understand

3. Math word problems are
   Hard to understand  Sometimes hard to understand  Never hard to understand

4. My peers in math class are
   Always helpful  Sometimes helpful  Never helpful

5. Math equation problems in math class are
   Hard to understand  Sometimes hard to understand  Never hard to understand

6. Drawing pictures to solve math word problems helps
   A lot  A little  Not at all

7. Reading the problem out loud helps
   A lot  A little  Not at all

8. Reading the math word problems and then explaining it in my own words helps
   A lot  A little  Not at all
Lucas

Date: 4/1

Math Survey

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Appendix I: Assessment

Name ____________________________ Date ____________________________

School ____________________________

Unit 6 Assessment: Stories, Tables, and Graphs

Part I Multiple Choice: Fill in the letter of the correct response. You may use the space provided to show work if needed.

1. What is the best outdoor activity to do given the temperature on the thermometer?
   - (A) sledding
   - (B) swimming
   - (C) skiing
   - (D) ice skating

2. Which graph of Fahrenheit temperatures below matches the following story?
   It was very cold at the beginning of the week. It kept getting warmer and warmer until Friday, when it got cold again.
   - (A) [Graph A]
   - (B) [Graph B]
   - (C) [Graph C]
   - (D) [Graph D]
12. I am playing **Guess My Rule** and my rule is "Factors of 30". Write 2 numbers that **will fit my rule inside** the circle below. Write 2 numbers that **will not fit my rule outside** of the circle below.

![Circle](image)

---

**Part III: Open Response**

Show all your work (drawings, tables, and/or computations) in the space provided. If you do work in your head, explain your thinking in writing. Write your final answer or answers in the box, including a label if appropriate.

---

**Problem 13A:** Complete the following table for these two children from Rhomaar using the following situations:

<table>
<thead>
<tr>
<th>Day</th>
<th>Trevor</th>
<th>Harley</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
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<td>8</td>
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</tr>
</tbody>
</table>

Trevor starts with 5 marbles and adds 2 each day.

Harley starts with 3 marbles and adds 4 each day.

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13B. Imagine what a graph of both children’s data would look like. Whose line would be steeper? Write his or her name in the box. Explain your reason below.

![Graph](image)
Appendix J: Notes

3/2
-Lucas explains to Ohn Yoo how to graph a temperature chart, explains the x and y axis

3/16
-Lucas finishes his problem first and then looks at Ohn Yoo and explains to him what he did wrong

3/21
-Ohn Yoo seems unclear about directions given by Mr. H and raises his hand. Lucas asks him what is wrong and then explains to him directions.

Appendix K: Coins as manipulatives