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English Language Learners in the Mathematics Classroom

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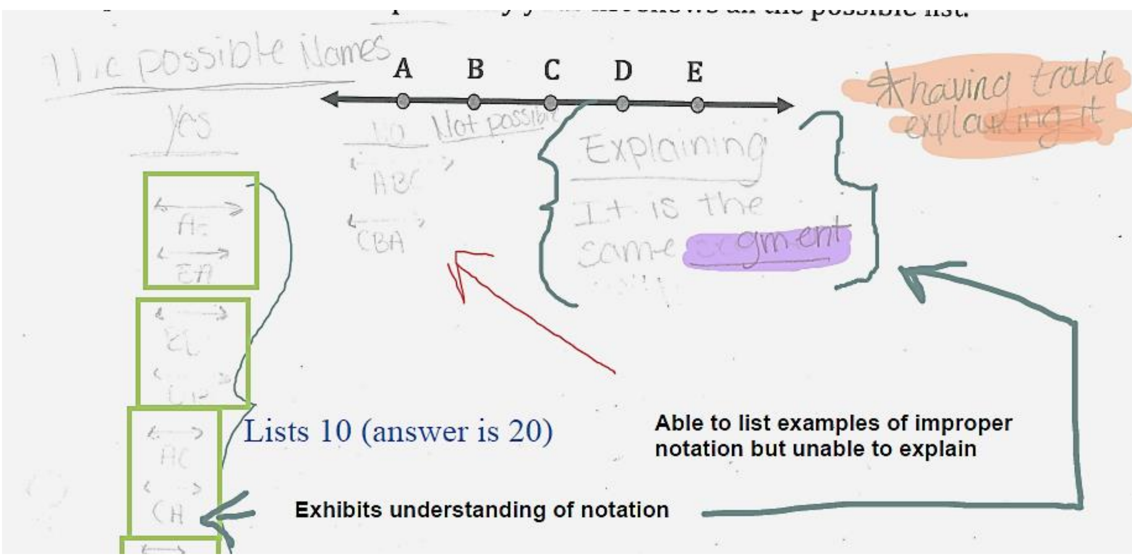
From a young age, students around the United States are required to begin their mathematics studies. Starting at simple addition and progressing into memorizing times tables and finding angle measurements, students are assured the entire time that mathematics is the universal language. However, what is lost in this statement is the difference in experiences of each of these students and how that affects their experience with mathematics. For English Language Learners, this statement is certainly not the case. Oftentimes there is a major disconnect between mathematical skills and the language that is required to express those skills. In my Honors project, I investigated the experiences of different ELL students in hopes of creating tools or techniques to help build a bridge between math skill and language. Over the course of the year, I have discovered that ensuring success for ELLs in the math classroom is much more than a mnemonic device or vocabulary trick; it is a mesh of classroom environment, appropriate instruction and pedagogy, and a chance for students to interact with their peers.

Over the course of the past year, I have worked in two different classrooms. One was an eighth grade math class at Park View Middle School in Cranston, RI and the other was a high school "quantitative reasoning" class at the Met School in Providence, RI. Both classes have a high level of diversity and a number of ELLs. Most of these ELLs are individuals who were born and raised in the United States, but whose parents came from another country and spoke a different language at home. Thus, these students were still fluent in English, but their exposure to another language that was primarily spoken at home became apparent in their math process and reasoning. I spent the first semester observing the two classes, working with the students one on one, and analyzing student work. The second semester during my student teaching, I was able to implement various types of instruction and practice appropriate pedagogy that would help these ELLs succeed.

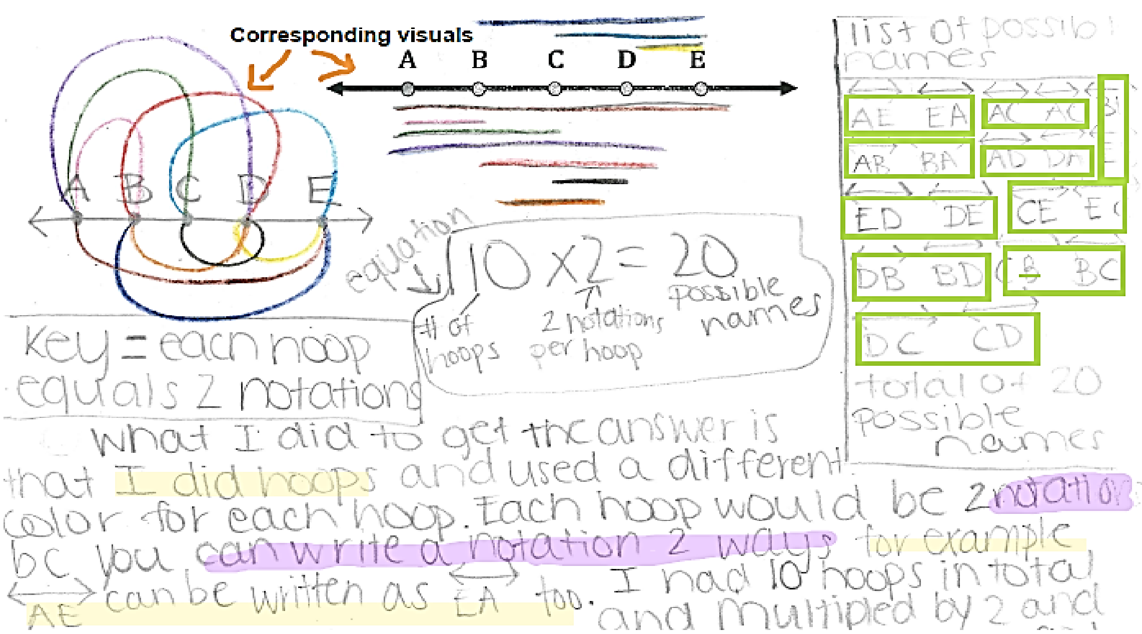
My first semester of this project was more of a research period and proved to be very important to my success in this study. I spent approximately 60 hours combined in the two classes I worked with, becoming acquainted with the students and getting adjusted to the classroom environment. I started off not exactly sure what shape this tool or technique would take, and so I spent a lot of time reading various texts about different types of instruction that ELLs benefit from, including the SIOP model and work by Robert Moses. In addition, I took some samples of student work and annotated them, noting any trends or unique approaches to solving problems and tasks.

The analysis of student work proved to be the most important in creating a device to help my ELL students. In a task called “Naming Mayhem”, students were required to list as many possible line segments as they could from one line with five additional points located on it. The nature of the task was largely open inquiry with one set of instructions, allowing students to approach the task as they find most useful. The work of two students stood out to me the most as seen below:

Student A:



Student B:



Student A demonstrates that they understand the nature of the task, but becomes frustrated in the fact that they are unable to express their understanding and explain. Student B also demonstrates their understanding of the task, but finds alternate, non-mathematical ways to explain their work, i.e. “I did hoops”. I found these two cases to be frequent among ELL students: generally, they either became frustrated with the language aspect and unable to express their understanding or they found alternate ways to describe their process using terms that are not necessarily the most mathematical.

Through this work, I decided to create a scaffold that would help students like student A create some sort of explanation of their process. I based the scaffold on the Reasoning and Proof category on the Standards-Based Math Rubric by Exemplars, with the goal being to have students score in the practitioner or expert level. A copy of the rubric is seen below:

Standards-Based Math Rubric (cont.)

	Problem Solving	Reasoning and Proof	Communication	Connections	Representation
Practitioner	A correct strategy is chosen based on the mathematical situation in the task. Planning or monitoring of strategy is evident. Evidence of solidifying prior knowledge and applying it to the problem-solving situation is present. *Note: The Practitioner must achieve a correct answer.*	Arguments are constructed with adequate mathematical basis. A systematic approach and/or justification of correct reasoning is present.	A sense of audience or purpose is communicated. Communication of an approach is evident through a methodical, organized, coherent, sequenced and labeled response. Formal math language is used to share and clarify ideas. At least two formal math terms or symbolic notations are evident, in any combination.	A mathematical connection is made. Proper contexts are identified that link both the mathematics and the situation in the task. Some examples may include one or more of the following: • clarification of the mathematical or situational context of the task • exploration of mathematical phenomenon in the context of the broader topic in which the task is situated • noting patterns, structures and regularities	An appropriate and accurate mathematical representation(s) is constructed and refined to solve problems or portray solutions.
Expert	An efficient strategy is chosen and progress towards a solution is evaluated. Adjustments in strategy, if necessary, are made along the way, and/or alternative strategies are considered. Evidence of analyzing the situation in mathematical terms and extending prior knowledge is present.	Deductive arguments are used to justify decisions and may result in formal proofs. Evidence is used to justify and support decisions made and conclusions reached.	A sense of audience and purpose is communicated. Communication at the Practitioner level is achieved, and communication of argument is supported by mathematical properties. Formal math language and symbolic notation is used to consolidate math thinking and to communicate ideas. At least one of the math terms or symbolic notations is beyond grade level.	Mathematical connections are used to extend the solution to other mathematics or to a deeper understanding of the mathematics in the task. Some examples may include one or more of the following: • testing and accepting or rejecting of a hypothesis or conjecture • explanation of phenomenon • generalizing and extending the solution to other cases	An appropriate mathematical representation(s) is constructed to analyze relationships, extend thinking and clarify or interpret phenomenon.

"Standards-Based Evaluation." *Standards-Based & Responsive Evaluation* (n.d.): 54-85. Exemplars. Web. 17 Apr. 2017.

After analysis of the rubric, I created the following scaffold that can be used to design tasks and assessments to guide ELLs in their understanding:

I. Concretely act out the situation.

Present the mathematical scenario in terms of a real world situation that students will be familiar with.

II. Represent the situation in a diagram or a model .

Have students provide a visualization or model of the situation. After creating this model, have students to think about what the question is asking and what is important.

III. Abstract math from the model.

Have students analyze what information they have and what information they need. Students should put their model into a math model (an equation, chart, graph, number line, etc.)

IV. Mathematize.

Solve the task at hand. This is usually where students try to jump right to in a non-guided inquiry based method.

V. Verbalize

It is often a good idea to have students write out their process to practice language.

This scaffold was one of the many things I implemented once I began putting my research into action during the spring semester. In this time period, I began my student teaching in the same two classrooms that I had begun my research in. My first six weeks were spent in Cranston at Park View Middle, and the following seven were spent working with ninth and tenth graders at the Met School. During my student teaching, I implemented different types of instruction and activities to help guide my ELL students. In addition, I made it my goal to create a classroom environment that allowed all students to meet their full potential.

Amid my stay at the Met, I also collected some data on the interactions I had with students and the work that they completed on an open inquiry assignment. I created a checklist to tally the number of times that students portrayed a behavior that I had noticed among the ELLs in the class, including “Uses models/manipulatives to guide thinking”, etc. The most remarkable thing that I noticed was that on average in one on one interactions, students were unable to produce a correct math term 45.1% of the time. However, 100% of these interactions were followed with an alternate description using non-mathematical terms. For example, I often found students saying that they “did this and that” while pointing to various parts of their work and incorporating improper math terms, like “timesing” instead of multiplying. This showed to me that these students were able to understand the process, but had a hard time explaining what that process was.

One way to combat this behavior and promote mathematical conversation and language is group work. The first thing I did during my stay at Park View was stress an importance on peer collaboration by moving the students into groups. My goal was to get students to learn from each other and practice mathematical language with other students of varying mathematical skills and learning abilities. I gave explicit directions and descriptions of what group collaboration looked like, and enforced these throughout the weeks that I was teaching. The resulting work from this arrangement was better than I could have ever expected. I was beyond impressed by the mathematical conversations that took place, and ELL students were exposed to math language and able to practice their own language in the group setting from their peers.

In addition, I put my scaffold into action by creating an assignment with questions following the device I had created. The assignment was called “Hit the Deck” and involved a variety of math skills, including square roots, perimeter, and area. The question itself was open ended, but I presented it in a way that broke the situation in the five steps of the scaffold in order to help my ELL students make sense of the problem at hand. After completing the assignment, students indicated that the scaffold helped them to better understand what the question was asking and thus they were able to answer it in more detail.

Through the entire spring semester, I found a couple of things to be surprisingly important to this research. The first was that oftentimes I found that it was not just the ELLs in my class that struggled to connect their mathematical knowledge and language, but many of the students in the class regardless of language fluency. To me, this indicates how mathematics education has transitioned from being taught in a pure form to being taught as a set of shortcuts before pure mathematics has been understood. Students are often taught tips and tricks like “FOIL” and “PEMDAS” that take away from the art of math and focus solely on finding the right answer. This method of teaching is especially detrimental to ELL students, who experience an even greater barrier as it is.

Additionally, I found the most important and surprising aspect of my research to be the impact of teacher presence and classroom environment on the success of ELL students. It turned out to be very beneficial that I was able to become accustomed to the school settings in the fall semester, as this allowed me to jump right back in in January with an established level of comfortability with the students. More importantly, they were comfortable with me. I was able to have relationships with them, and also insert my personality into each lesson, making the mathematics less dry and formal and instead more fun and personal. Students indicated that they appreciated my enthusiasm and positive attitude in a daily feedback form given to them. One student commented, “I like the way you joke around and don’t get aggravated with us (even though we’re a lot)”. To me, this indicated a comfort level with me, the classroom, and thus a willingness to take risks and make mistakes. This, of course, is the best way that students learn. I found that students who were quieter and less comfortable in class were the ones who struggled with this barrier the most because they were afraid to ask questions and make mistakes.

Ultimately, what I have learned from this study is that there really is not just one technique or device that will help an ELL student reach success. It is a combination of proper instruction and pedagogy, interactions with peers, and teacher presence and classroom environment. These elements will not work to their full potential unless they are used in conjunction; a scaffold will not help clarify a problem if a teacher does not create an environment where a student feels that they can make mistakes. Students cannot learn from each other if a teacher does not make expectations for group work clear. Moving forward, I will be working in a high-need area with a lot of diversity, which will allow me to continue to test these factors out and search for other ways to help English Language Learners bridge their knowledge of their existing mathematical skills and the English language that comes along with it.