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Building Student Confidence and Performance Through Emphasis on Academic Language

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The purpose of this action research study was to observe the effects of vocabulary learning tools and reflective journaling on student confidence. Participants were from three classes of 15-20 students who attend math class for 45-90 minutes each weekday in a suburban high school setting. They were assigned Frayer Model vocabulary learning tables, as well as three journal prompts a week regarding either mathematics content or personal thoughts on classroom activities. These were completed across two units in the course. Several classroom benefits were observed over the course of the study, including but not limited to higher student confidence and increased participation in mathematical discourse.

Introduction

A critical factor in any lesson is engagement, opportunities for students to interact with and make sense of content for themselves. Merely listening to a teacher while passively participating in class is not nearly as effective for students as persevering through new problems, working with manipulatives, or communicating ideas to their peers. Students who are actively engaged are more able to draw conclusions and make connections with content, and they also tend to find the learning process more rewarding in this respect. However, there is a key component to student engagement that can complicate even the most interesting lesson plan. Student confidence, which is typically based on perceived ability to work with given content, is crucial to engagement and participation. Highly confident students who have a strong understanding of the academic language being used in class are more likely to share their thoughts and ideas, while students who lack confidence and struggle with academic language tend to feel overwhelmed and fall behind during lessons. In order to keep everyone focused and engaged, teachers need strategies that can improve students' vocabulary-acquisition and boost their general academic confidence.

This study was conducted in an effort to gather data on a few of those strategies. The first step was the introduction of Frayer Models as an assignment, in order to place a higher emphasis on student retention of academic language. A Frayer Model is a tool for sharpening student vocabulary, which requires students to define, describe, and exemplify mathematical concepts and terms. To reinforce this tool, students were also assigned journals with prompts to respond to each week. This provided them with opportunities to reflect on their learning as well as give qualitative feedback on different lessons and learning tools. While the study was limited to three classes in a suburban town, with students that may not reflect a large population of all students across the nation or the world, the results still lead to relevant conclusions about vocabulary emphasis and journaling in the classroom. As hypothesized, these tools did appear to build student confidence in mathematics, in addition to providing several other previously unconsidered benefits in teaching and planning.

Literature Review

The purpose of my research was to see the effect of placing a higher emphasis on academic language in the mathematics classroom. Specifically, I wanted to see if it increases discourse during lessons. When students participate in academic discourse, they are actively practicing and manipulating mathematical ideas while relaying their thoughts to the teacher and their peers. This skill is invaluable in any classroom, but it is often overlooked in mathematics. Practicing discourse allows students to attain precision and confidence with vocabulary, syntax, symbols, and semantics (Kersaint, 2015). These four areas of language and discussion are a vital part of true mathematical understanding and contribute heavily to student conversation, but there are obstacles tied to each.

Vocabulary can be complicated for several reasons. There are words in mathematics that have a different meaning in conversational language, or even within different topics of math itself. There are also terms specific to mathematics, like “apothem” and “circumference”, which are somewhat complex and seem less accessible to students initially. According to Eric Jensen in his book, *Engaging students with poverty in mind: Practical strategies for raising achievement*, “When students don’t understand many of the words used in class or in their reading materials, they may tune out or believe that school is not for them. Often, they won’t participate because they don’t want to risk looking stupid, especially in front of their peers” (Jensen, 2013, pgs. 11-12). Prioritizing student mastery of vocabulary can help to avoid this type of scenario. Similarly, symbols in math often lead to student confusion because there are many equivalent ways to translate symbolic expressions to verbal phrases. If students only understand one way to describe a symbolic expression, they can easily miss the meaning of a mathematical prompt or fall behind during a demonstration.

As students practice finding multiple ways to translate symbols to words, they tend to struggle with syntax, the underlying rules of properly and effectively structuring their sentences. The translation back and forth of symbols to words requires a full understanding of syntax, a skill which is only gained through the practices of written and oral communication. Additionally, this communication provides an opportunity to sharpen students' use of semantics. Semantics deal with the true meaning of language, allowing students to accurately interpret situations and instructions for mathematical tasks. The more students practice discourse, they more they will sharpen their individual semantics, making the related content more accessible in the future. Without these four basic skills, it becomes incredibly difficult to effectively apply and think about mathematical ideas. Increasing discourse in the classroom will help to improve students' understanding on all of these fronts (Kersaint, 2015).

Beyond those four linguistic constructs, there are plenty of more general benefits to increased student discourse. Discourse allows students to practice listening to and responding to arguments and ideas, which is a key part of the learning process. In order to respond, students must build their own intelligent arguments, which is another great way to help practice and solidify content. Specifically, this relates to the Common Core State Standards' third Standard for Mathematical Practice, "Construct viable arguments and critique the reasoning of others" (corestandards.org, 2019). Outside of direct student benefits, classroom discourse grants teachers additional insight in to student understanding. Discourse doesn't just build student skills; it allows educators to assess student progress at different points in a lesson or unit, giving feedback on the effectiveness of recent instruction (Todd, 2018). In short, it is clear to see that discourse is invaluable to student success and teachers' understanding of student progress. The real problem is finding ways to increase discourse in the classroom.

As much as we want our students to talk to us and to one another, there are several reasons why this is often difficult. A main focus of this study was improving students' confidence, which is one of the largest factors in their willingness to talk and participate in class. Based on a study he performed with two other education researchers for the National Institute of Education in Singapore, Dr. Lazar Stankov noted, "…we know that confidence is a much better predictor of students' achievements than any other non-cognitive measure… In fact, it acts in a way that it overcomes everything else; so confidence is very important" (http://singteach.nie.edu.sg, 2011). Confidence in itself has multiple components; leading factors are self-efficacy and self-concept, as well as anxiety. Self-efficacy refers to a student's belief that they can effect a certain change or accomplish a task, while self-concept pertains to a student's perception of personal skill in a particular subject or topic (http://singteach.nie.edu.sg, 2011). These two combine to build a student's confidence in the mathematics classroom, while other factors like anxiety can bring confidence down.

Many students feel apprehensive about mathematics because of poor experiences in the past or current sensations of being overwhelmed by the material. As noted by Taylor and Brickhill in the Australian Senior Mathematics Journal, each student carries their own history with mathematics coursework in to the new schoolyear. "Students typically arrive with diverse knowledge and experiences… often present with high levels of anxiety, negative views, (and) low self-efficacy…" (Taylor & Brickhill, 2018). While many students come in to math class with a diminished outlook, others can still feel anxious in class without any prior negative experiences due to the very nature of mathematical learning. "In a mathematical context, it is to be expected that individuals will at times struggle to apply their mathematical knowledge and skills when solving problems in unfamiliar settings, particularly when writing about the mathematics itself… Such struggle may contribute towards 'math anxiety'" (Taylor & Brickhill, 2018). When students are uncertain of how to proceed, or they're unsure how to communicate what they're thinking in words, they often lose confidence and feel less comfortable about their performance. Students who aren't acclimated to productive struggle in the classroom can feel anxious when working through activities that don't initially make sense. The best way to combat the issue of anxiety is to support productive struggle and focus on building self-concept and self-efficacy.

Self-efficacy is central to the theories of Alfred Bandura, who proposed that students' beliefs about their abilities are leading factors in their academic performance. In a review of self-efficacy for STEM students, Morán-Soto and Benson write, "Bandura's theory hypothesizes that self-efficacy beliefs that slightly exceed one's current skill level could encourage people to try challenging activities that may promote better skill development" (Morán-Soto & Benson, 2018). If increased self-efficacy makes students more perseverant, then it can also be expected to increase the effectiveness of complicated tasks on their learning. Creating a classroom environment that puts a positive emphasis on productive struggle can encourage students to push themselves further academically. With the right mindset, students can even learn to push past failure. “Despite the negative behaviors and attitudes related to…(having) a gap between high mathematics self-efficacy and lower mathematics competence, these students are very likely to keep trying to complete the mathematics courses… because of their high levels of mathematics self-efficacy” (Morán-Soto & Benson, 2018). When a student has high self-efficacy and is willing to persevere through a difficult task, they are ultimately more likely to succeed.

These factors of self-concept, self-efficacy and anxiety have a strong influence on motivation in the classroom. As Jensen writes, “… when students have positive attitudes about their own learning capacity, and when teachers focus on growth and change rather than on having students reach arbitrary milestones… student engagement increases” (Jensen, 2013, pg 13). It follows that when teachers make general progress a higher priority than final mastery, students are more receptive to content and more willing to participate. Building efficacy and motivation isn’t limited to reflection on final performance; these are also constructed during the attainment of basic skills and vocabulary. Usher and Pajares state that, “Self-efficacy beliefs are most likely to change during skill development, when individuals are faced with novel tasks. Although failure may occur periodically, when students notice a gradual improvement in skills over time, they typically experience a boost in their self-efficacy” (Usher & Pajares, 2008). While a high final grade in a math class is likely to make a student feel more confident, there is an ongoing need for reassurance each day throughout the course. Focusing on the smaller details and skills that go in to student performance and comprehension can lead to higher engagement all school year, perhaps more impactfully than strong performance on a final test.

A leading component in this ongoing confidence is mastery of academic language. When students are more confident in their ability to understand and use academic vocabulary, they are more likely to engage in classroom activities and follow along during lessons. There are many practices through which educators can increase student focus on academic language, with each of them involving some sort of writing, speaking, drawing, and/or reflecting about content. In a study conducted on the "Think-Talk-Write" model, in which "(1) Students learn the material (thinking), (2) Students discuss the results of learning material (talk), (3) Students write the ideas obtained from talk phase (write)" (Supandi, et al., 2018), it was noted that use of this model led to higher classroom confidence and higher content achievement. Specifically, it was noted that "during the learning process with the think-talk-write strategy, many students were enthusiastic about learning mathematics, and actively presented questions and competitively addressed the problems and answers. Moreover, the students were eager to improve their mathematical representation abilities" (Supandi, et al., 2018). Giving students more opportunities to speak about and write down their thoughts provides greater practice with vocabulary and formalizing their ideas. Additionally, the writing portion is an act of reflection on the lesson, which is beneficial to students as they can summarize and draw conclusions from their recent mathematical activities.

A more direct means of reflection is journaling. Journaling in a mathematics classroom can come in many forms, but it typically centers around having students write their personal thoughts and reactions to the day's events after a lesson. A report by Heather Knox for the journal *Gifted Child Today* emphasized that "…journaling in math class can increase students' content learning while developing deeper cognition and problem-solving skills. It provides students with opportunities to see the processes of math rather than just the results. Studies show that teaching reflection and self-reflecting activities such as journal writing positively influence a student's academic performance" (Knox, 2017). When prompted to write about the strategies they used in class or the connections they can see to other content, students' journaled responses allow them to practice the use of academic vocabulary and truly reflect on their mathematical learning. Additionally, journals can be used to ask students for feedback on other classroom tools and initiatives. Student input is crucial as teachers try to implement new learning strategies and compare their effects.

Another classroom tool that can enhance vocabulary acquisition is a Frayer Model. These simple tables of information can be used by students to define, break down, provide examples of, and record non-examples of new and old academic language. This research study implemented Frayer Models with students in order to see if they would respond well and increase confidence with vocabulary. Though not the specific focus of the study, it was also hypothesized that it may strengthen their use of syntax, semantics, and symbols. Eventually, improvements in all of these areas would then lead to an increase in classroom participation and discourse. Overarching all of this was student journaling, which not only allowed students to write about the math content they were learning and reflect on their understanding, but it provided opportunities for me to see how they felt about each new initiative that was implemented in the classroom. Journaling doesn't just improve student practice, it provides teachers with qualitative feedback about different activities in the classroom.

Overall, the goal of this project was to address the issue of student engagement by focusing on academic language and student reflection. Through the use of vocabulary-focused learning tools like Frayer models, I hoped to see students become more comfortable with academic language. This would then result in higher self-efficacy and motivation in the classroom, leading to increased participation and, ultimately, improved learning. Journaling was implemented in order to give students more time to formulate and write their thoughts using academic vocabulary, while also providing me with qualitative feedback on any new strategies introduced during the study. In the end, these teaching tools combined to provide plenty of information regarding the relationship between academic language and classroom engagement.

Methodology

Participants

The participants were three classes of Geometry students in grades 9-11. This was exactly 55 students total. There were students on various IEP and 504 plans with objectives related to reading comprehension and speaking, and even a few students with anxiety-related accommodations. Not every student's first language was English, and some students primarily spoke Spanish at home. The school itself was in a suburb, but many of the students were from rural areas nearby. Classes met according to a regular weekly schedule of three 50-minute periods (Monday, Tuesday, Friday) and one 90-minute "block" period (Wednesday or Thursday).

Procedure

The only materials needed for reflections and the Frayer Models were printed papers for each student to fill out. Often with reflections, the prompt was actually displayed in a slideshow or document on the projector, and students responded either electronically or on a spare piece of paper they turned in.

At the beginning of the process, it was explained to the students that these journals would be opportunities to reflect on their experiences in math class, and that there would be three mandatory prompts for them to respond to each week. In these journals, they were asked to write summaries of their understanding of content, as well as how they personally felt about the material and what they thought about activities done in class each week. It was made clear to the students that these journals would only be read by the mentor teacher and researcher, and anyone else who read their reflections/Frayer Models would not be able to see who wrote them. The idea was that students could provide feedback on their learning experiences while also personally reflecting on their understanding and trying to draw extra connections between old and new content.

At the beginning of each unit, Frayer Models with only the vocabulary words in the center were given to each student. It was explained that in each table, there was a specific given vocabulary term to consider. I filled out one example Frayer Model for the students to see and understand. The Definition box was for writing an explanation of the given word, and the Characteristics box was for providing various attributes of the term. Another two boxes were provided for students to fill with Examples and Non-examples, in this case specific examples and non-examples. The process for filling out the entire table for a given vocabulary word was explained the first day they were introduced.

Throughout two units, students were given two or three reflection prompts a week during class, with 5-10 minutes to write (depending on the prompt). These prompts ranged from detailed content-related questions to simple requests for personal opinions on the activity for the day or the use of the vocabulary tables. Whenever a new vocabulary term was introduced, students were asked to fill out a table for it before the end of the unit. In the week leading up to unit quizzes, students were reminded that a vocabulary table would be due for the given list of words by the day of the quiz. The Frayer Models were specifically mentioned in journal prompts in order to obtain student feedback, so that qualitative data could be gathered about the learning tool as well.

Timeline

This took place over two back to back units, across four weeks. I read journals each day that they were filled out, recording particularly interesting reflections for the purpose of the research and also using student feedback to improve the implementation of various learning tools and activities. At the end of the second unit, the students were asked to reflect on Frayer Models and their self-confidence in math as a whole, then I took all reflections and completed Frayer Models from the room for further analysis. The vocabulary tables were collected on the last day of each unit before final assessment.

Analysis

The main source of information in this study was student journaling. Brief consideration was given to depth of responses in the Frayer Models compared to students' assessment performance, but conclusions about vocabulary tables were derived mostly from students' journal responses and completion of the tables themselves. Overall, the data included students' perception of their own abilities in the classroom throughout the entire process, demonstrations of their ability to think about and reason with new vocabulary, and personal descriptions of how they felt about the use of the vocabulary tables. The goal was to draw a general conclusion as to whether the use of each tool had a positive or negative impact on student learning.

With 55 students and nine journal prompts, I received more data than I initially knew what to do with. The topics of discussion were special triangles and triangle congruence theorems, so there was plenty of vocabulary to discuss in Frayer Models as well. The first journal I gave students included several questions to gauge their general thoughts on academic language, and I repeated this journal in the last week to see if their responses shifted at all. The final journal I collected was also several questions, this time about Frayer Models specifically. The other six journals collected in between were a mixture of concept-focused questions, vocabulary-focused questions, and general check-in questions. I will break each of them down individually in the Findings section, and I have spelled out the nine journal prompts in Appendices B-D.

Journal implementation mainly worked as the final component of a class period, where students reflected on what they had learned in class that day or told me what they still had questions about. I made sure to remind them each time that what they wrote was not for a grade, but should be taken seriously because it was an opportunity for them to give feedback on what they were learning and what they would be doing next. Students seemed accepting of this and it lowered the pressure to "write the right response" instead of whatever was on their mind. While the first journal and final two were more general and had several questions, the other six were mostly focused on one particular concept or set of concepts for students to write about. These often acted as a way for students to reflect on the day's lesson and form additional connections between content and vocabulary. In doing so, they also gave me an opportunity to see where students were at, which was an additional benefit of the journals. I could use their responses to gauge general understanding of the lesson and student preparedness for the next day. This was especially true for the check-in journals, where students specifically wrote down questions they had or ideas they felt they didn't fully understand. With 55 students and nine journals, this ended up being a considerable amount of data, but it was still manageable and very informative.

Findings

For the first journal, students were asked to rate their confidence from 1-5 when using academic language in math class, then to explain that rating. I have compiled a chart for this, but given that I have also made a chart for the same question asked at the end of the study, I will display both charts next to each other when discussing Journal Eight for the sake of easy comparison. Students were then asked two more questions regarding how well they keep up with others when they use academic language during discourse, as well as what they think it means to be "good at mathematics" (and if they would describe themselves in that way). This helped me to get an idea of how the students perceived themselves as mathematicians and users of mathematical vocabulary, with many giving me an explanation of their rationale and/or criteria for these feelings. Comments showed a wide range of confidence and optimism, though these two were not necessarily correlated. While there were many ideas of what it means to be good at mathematics, there were only a few different types of response to the second prompt about listening to others who use academic language. Additionally, most students seemed to feel a confidence level of about 3 out of 5 (the average overall was 3.19, with each class averaging between 3.05 and 3.35). I think the specific comments in some of these responses, though, are even more interesting than the general trends. I've listed several here, along with how they affected my planning and behavior afterward:

"… to be able to solve a problem quickly without help. Yes I would be good at math."

Here we seem to have a performance-centered approach to the idea, with the notion that requiring assistance makes you 'bad' at math. Reading a comment like this made me begin to consider how I responded to questions more. I wanted to make it clear moving forward that asking for help is a sign of a strong learner who is taking charge of their learning and using their resources. I may not have been so conscious of this misconception if it hadn't been for responses like this one.

"To remember how to do math and to do such [sic] *in a short amount of time."*

Another performance-focused approach, this time tied even more clearly to the misconception about “being fast”. After reading this, I began to emphasize the importance of taking their time when students worked, and when students claimed to finish quickly, I made sure not to commend their speed but instead other aspects of their work like neatness or clever thinking/problem solving.

“I would say that if you can do the problems on your own, your [sic] *good at mathematics.”*

This one is interesting, because it may be the same mindset as the first response mentioned, or it may simply be saying that once you reach the point of independence on a topic, you must fully understand it. In hindsight, I wish I had followed up with this student to gain some clarity on their phrasing.

“I would define being ‘good’ at math as it being something that comes naturally. You understand it right away and you don’t feel at all challenged by it.”

One of the most common misconceptions that I feel my students carry, though this student was one of select few who stated it so clearly. Reading this response prompted me moving forward to positively recognize perseverance and productive struggle in the classroom in order to fight this misconception.

“Someone who is good at math is someone who understands all the patterns in math and works hard. Most people who enjoy math are normally good at it because they care more.”

This seems to follow a similar mindset, but this student also recognized the value of hard work. Getting the students to care is of course a goal of mine in this study, and this student’s statement validates that motivation of mine as even they can recognize the impact that caring about the class has on performance.

“To be ‘good’ at math is to be really smart know the answer to every math questions and get every test right. I am not ‘good’ at math at all I am very poor.”

This response is incredibly performance-centered, with an emphasis on perfect test scores and the idea of being “smart” (which is such a difficult word to pin down). Not surprisingly, this student also had one of the lowest confidence levels across all three classes. Responses like this really pushed me to try to emphasize the fact that no student is naturally mathematically 'superior' to the others, and to make it clear to each student that I believed in their ability to succeed. Any time I heard a student describe a person as 'smart' in the following weeks, I challenged them to explain what it meant. We would break it down until we came to the conclusion that they really meant the person worked hard academically, and I made sure to commend student efforts and questions instead of performance. Now, here are some examples of the more positive responses I received:

"I think to be good at math is to not just solve questions, but to be able to explain why and how you got your answer. By that definition, for the most part, I'm good at math."

"I think it means that a person is trying their best, and keeps trying until they get it right."

"I don't think there is a 'good' or 'bad' at math type of thing. I think all there is, is to understand and pay attention and to try your hardest. Its [sic] *about participation and understanding it."*

This was nice to see, and definitely encouraging for me as I tried to figure out where my students were in terms of confidence and mindset. However, if I expected to understand the more negative responses, I needed to examine the other two questions of Journal 1. When asked if academic language comes naturally to them, one student responded,

"No, because I never used them and now we have to. I always have to think about the words to use.

This is another case where I would follow up with the student if I repeated this study. Still, it appears that this student feels in some capacity that they are being forced to do something. Whether they feel that Geometry requires more vocabulary than previous years of math, or if they simply mean that math vocab are words they never used before the topic is introduced, this student seems to think of the words less as tools and more as burdens. Another student responded that they tend to feel lost, but then they explained their feelings a bit more:

"I feel lost. I think this happens because if I don't know what a lot of the vocab is then it would make it harder for me to understand."

And thus we get to the root of the problem… even some of the students recognize the cause of their disconnect from the subject. If they don't understand the words being used, it's harder for them to understand the content. This quote (and others like it) simply validates the motivation for my research, and sets the scene for the rest of the journals and Frayer Models. From here, my goal was simply to use those tools to get the students thinking about the content and vocabulary more comprehensively and reflectively, forming connections to that academic language so that they would gain confidence in their abilities and be more successful in mathematics. I'll break these down in the order in which they were given to the students.

The second journal was a check-in, administered during their Block Day. Our school runs on a block schedule every Wednesday and Thursday, so we have each class for 90 minutes on one of those days each week. Block Day is typically used for what we call Math Workshop, when students simply work on their assignments and can ask questions on anything they need assistance with. On this particular Block Day they had a standard-length lesson at the beginning of the block, followed by Math Workshop for the remainder of the time. With a few minutes to go, students were given a prompt asking them what questions they still had about the day's lesson or anything learned on Monday and Tuesday. If they had no questions, they were to mention something they felt they understood well and explain why they felt that way. This journal helped to determine what should be the focus of review before the coming quiz, and I was actually able to fit these small review bits in various ways before then thanks to the simplicity of the journal. There were other benefits as well, which I will discuss. Here are some snippets of responses:

"I need to practice 4.2, specifically #7-12."

This student has identified something they need to work on not just for my sake, but for their own. In doing so, they have not only let me know what a possible trouble area is for them and their peers, but they have consciously labeled something for their self that will require additional preparatory effort. This will help them get ready for the coming quiz and any other content we learn that builds off of the ideas associated with 4.2. So in addition to helping me identify topics for review, this journal also helped keep students aware of and accountable for their own learning.

"How can we tell if a triangle is scalene? I'd like to go over our vocab more."

"I'm confused about the congruence statements."

"I need help with the thing where there is a [sic] *angle outside the triangle."*

Responses like these gave me specific topics to look at in the coming days to prepare students and fill in content gaps. I implemented each of these ideas in to their opening activities (bellringers) in the next few days so that students could work on them at the beginning of class and we could go over them before learning new content. This allowed me to clear up misconceptions before learning material that built off of the concepts the students had been struggling with. Interestingly, it also led to increased motivation during bellwork. All I had to say was, "Several of you asked for more work with this concept before the quiz, so I set this up for you all to practice," and many students took the bellwork more seriously than before. As I had hoped, the journal really acted as a method of communication between the students and me, and my reaction acted as another form of communication in part of the larger conversation that is their learning progression. Students seemed to appreciate having a part in this conversation, and I know it helped make planning easier for me. Not only did I implement bellwork strategically to facilitate this needed review, but I also kept student comments in mind when planning instruction and anticipating misconceptions for related ideas in the coming days. Check-in journals like this are certainly valuable in more ways than one.

"I understand identifying congruent corresponding parts. All you have to do is look at the order of the points."

Responses like this one, which mainly let me know the students who wrote them were feeling pretty confident about the week's content, also gave me a window in to their specific understanding or <u>why</u> they felt a concept was so straightforward. This actually helped me in several cases later on when addressing misconceptions because I had suggestions from confident students about what phrasing or explanations worked well for them. This of course didn't mean I started explaining things only the one way, but it aided me in seeing what methods seemed more accessible to students for the most part.

The third journal was sort of a test in the fact that I made the prompt a bit lengthy. Students had just learned about ASA and AAS congruence, so I asked them at the end of class to explain why they only needed to prove one pair of corresponding sides congruent if there were already two angle pairs identified as congruent. There are many accurate ways to answer this question, but I was curious about how the students would respond to the somewhat hyperverbal phrasing. As I expected, the students audibly complained about it and were resistant, despite the fact that there were only two new vocabulary terms in it: corresponding and congruent. Many students left responses that didn't answer the question, and a few even wrote "I don't understand what this is asking." However, I did receive several accurate responses referencing ASA and AAS. Some students drew pictures to elaborate, and others wrote brief responses like, "Because of AAS/ASA." While I couldn't conclude from this journal that students across the board had a strong understanding of ASA and AAS, this journal helped me to structure future prompts more effectively. In other words, even when a journal didn't help me gauge student knowledge, it still helped me to better understand how to relate to them and nonetheless it informed my instruction.

Journals Four and Five operated similarly, though they were phrased much more succinctly and students seemed to respond more confidently. The former asked students to do a sort of "brain dump" about isosceles and scalene triangles at the end of a lesson where we had explored properties of the two special triangles. The latter asked students to explain <u>why</u> the polygon interior angle sum formula is

$S = (n-2)180$, and was given at the beginning of class the day after the related lesson. For both, students used a mixture of charts, pictures/diagrams, and known theorems to address the prompts, and even when students were inaccurate in writing about the angle sum, they were still able to display some knowledge. The most common recurring theme in these responses was students' tendency to explain vocabulary terms they knew (especially with the labeled components of an isosceles triangle), so these journals acted as good practice for their academic language skills.

I was able to parse through the responses to see what common misconceptions were occurring, and just like with Journal Two I planned to address them accordingly in future lessons. By the time I got through looking over responses to Journal Five, I felt that it was very easy to look through journals briefly and pull useful data about my students' content knowledge that accurately informed my instruction. I really began to feel like students and I were communicating more effectively through this setup. I could see what they were understanding and what they weren't; meanwhile, they gained an opportunity to reflect on their own learning and see for themselves what they should be working on to prepare for each lesson and/or quiz. This was valuable for both parties involved.

Journal Six was part of a larger set of questions administered by my cooperating mentor teacher (CMT) to get students' reflections on her Math Workshop that she had implemented this school year. My question was another simple check-in like Journal Two; I asked them at the end of class on a Tuesday what they would like to discuss or practice more during Block Day Workshop that week. Responses were generally fairly brief; here are a few examples:

"I need to practice constructions and 6.1."

"Need help with the (n-2)180 and stuff like that."

"Finding the measure of interior angles."

"I'm just confused on ASA, SAS, etc…"

And then there was a good number of responses like this:

"I would say proofs are what I struggle with."

"Help with proofs."

"PROOFS"

"Definitely proofs with triangles."

Once again, I was able to get a good picture of what review materials students would most benefit from me supplying (emphasis on the proofs, apparently), and students were able to identify for themselves what they should be working on to prepare for the quiz that Friday. I had begun making a review activity for the students prior to administering that journal, but that night my CMT sent me several proofs and we added them to the review so that students could practice that skill they clearly felt unconfident in. It only took me about five minutes to read through all 55 students' responses, and I felt like I had a very clear understanding of their concerns (and confidences) from that brief review of their reflections.

The students seemed appreciative that there were proofs in the review activity the next two days, and many of them did challenge themselves to practice what they were struggling on after my CMT and I encouraged them to do so. It seems that when you cite students' words from their reflections (without calling names of course), it makes the class more willing to accept that they should be practicing something. I think hearing that their peers share the same struggle helps them to feel more comfortable asking for help on something, and if it's their own words they're hearing, it probably makes them less likely to blow off the review activity when they know it was created based on their personal request. Again, students really seem to respond better when they know they have a voice in their learning process.

The seventh journal was actually administered on computers. We had just wrapped up a lesson on rotations in a coordinate grid using an activity from Desmos, and there was a blank slide at the end for students to write what they had learned. I projected a question of my own on the board for them to answer, and the students responded in that Desmos box. The prompt asked them to compare a 180 degree rotation about the origin to a reflection over both axes. While I wanted them to reflect on the rules and notation they had learned in the last two lessons, I was also using this journal to prime them for the next day's lesson on compositions of transformations. As I had hoped, many students saw the connection between the two types of transformation and seemed very comfortable with the idea of using two transformations to represent an action that can be done by one on its own.

I received responses like, *"They're the same, rotating just cuts out the middleman"* and *"Rotating it 180 degrees makes both x and y values their opposites and reflecting it twice also makes both the values their opposite"*. Some students used coordinate notation to represent their ideas, and others were very wordy. What mattered was that they were reflecting on the two lessons, making connections, and seeing that there is more than one way to represent the same information with transformations. Reviewing all of these responses took me less than five minutes, and despite the fact that some students simply said, "They're the same", it seemed apparent to me that the journal was effective in wrapping up the lesson, giving me feedback on its effectiveness, and prepping students for the next day's content.

The eighth journal was the same set of questions as the first journal and was given the final week I was in the classroom that semester. Responses for some students were nearly identical, even in phrasing, but others were very different from their initial prompt. This was both positive and negative across the board. The most common response was something along the lines of, "Being good at math means you understand what is going on in class and/or on tests." There was more of a consensus on this type of response than in the first journal, but here are some examples of different answers I received:

"It's not being good or bad, it's understanding how and why in math. Because if you don't understand your [sic] *not bad but you just don't know what to do."*

What's interesting is that this student's initial journal had been more performance-based, stating that they felt "being good at math" meant to recall step-by-step processes clearly. It seems that something has changed in this student's mindset in the last month for them to now say that there's not really a "good" or "bad" in mathematics.

"I think it means…to be able to understand how you got your answer and understand the steps you go to get your answer."

This student had originally responded in the first journal that they thought independence and speed were critical, so this is also an interesting shift in perspective.

"Good meaning [sic] *you're trying and paying attention or you just understand what to do and I'm not very 'good' at geometry I am a lot better at algebra."*

There's a lot to unpack here. Interestingly, this student's initial response was much more positive (they were the one who said they didn't think there is a 'good' or 'bad' in math; it's just about trying your hardest). They seem to have focused more on finding a definition for 'good' this time, and they even said that they are not very good at geometry despite making their criteria "trying and paying attention". Perhaps they described their own level of ability based solely on the "you just understand" portion of their description. One last thing to note about this response is the suggestion that they are "a lot better at algebra." Many of the students who said they were "not good" or were "bad" specified that they were "better at" or "pretty good at" algebra. There seems to be a strong distinction between the two classes for most students; it might be worth administering a journal in the future that asks students what they think specifically makes algebra different from geometry, and why they feel they are 'better' in algebra.

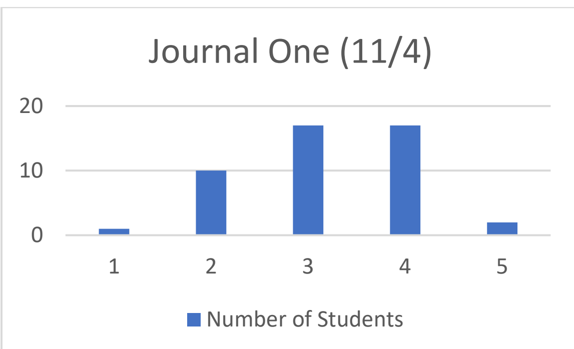
"To be good at math is to understand it right away or with little difficulty. Being able to recall equations off hand."

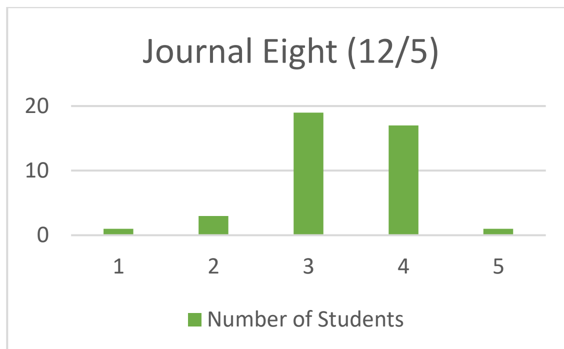
This is almost word-for-word what the student said in their initial response, so as I said, some students didn't seem to alter their opinions/mindsets in the one-month timespan of the study. It would be interesting, however, to see how their responses might differ after several months.

"I feel like to be good at math is practice and patience [sic], *and I would consider myself to be average at math."*

I would need to check in with this student to be certain about this, but it seems that they feel <u>anyone</u> can be 'good' at math if they practice enough and are patient. This is something I tried to instill in the students' minds over the month-long timespan, so it was reassuring to see someone saying it more or less in their response. However, as I said, I would need to verify this interpretation with the student to be sure.

As mentioned previously, I've charted the students' confidence ratings for the first journal and the eighth journal for comparison's sake. The data spreads pretty much in a bell curve as expected, with a little more lean to the higher values toward the end of the study.





I should note that each individual class had a similar spread for their confidence ratings, though seventh period was noticeably more right-skewed for both responses than periods four and five. The overall average rating in the first journal was a 3.19, and in the eighth journal it was a 3.34. A similar pair of averages exists for each individual class period; they all started at just over 3 and then moved closer to 3.5 in December. This increase in scores seems to be very minimal and could be a result of many factors, so it's hard to say that the journals and Frayer Models significantly increased students' confidence and motivation. As the quantitative data isn't particularly enlightening, I would defer more to the students' written responses to get a sense of how they were feeling and what worked best during the study.

Now, here are a couple notable responses in the eighth journal to the first question, about confidence with academic language:

"2 because it's hard for me to understand math words because I don't even know what they mean in Spanish."

This student speaks English as a second language, and their reflection really gets to the point of how complicated vocabulary can get when you don't have a reference point in the language you prefer. Moving forward, I may want to try to find the Spanish equivalents of many of the math terms we use in class so that I can provide them on this student's personal set of guided notes. I should note that without this journal, that idea may not have crossed my mind, so the open communication that these journals have been creating continues to be invaluable.

"Typically around a 4. Most of them do come naturally because I use their properties to remember them by."

This response leads in to my next journal and topic of discussion, Frayer Models. The student seems to benefit from using properties of vocabulary terms to remember what they mean; this is a critical part of filling out a Frayer Model. I should note that their responses were also very positive for this next journal.

The last journal was a set of four questions about the use of Frayer Models in the students' last unit on Congruence Transformations. It asked if students felt Frayer Models were helpful, if students felt confident about this unit's vocabulary, if they would have like to use Frayer Models in a previous unit, and what they thought about using Frayer Models in other classes or in comparison to other vocabulary learning tools. The majority of responses were positive, but again, I'll provide some specific examples to give a clearer sense of what the students were thinking:

"I think they help but I didn't really use them for this unit because I thought this unit was easy but I really like them [sic]*."*

"I felt pretty good about it (the academic language of the unit). *However, I found myself going back to my notes rather than the models for help."*

"I would rather use flashcards/LINCs tables. Writing down the nonexamples didn't help me… I would say (I was) *kinda confident* (using vocabulary throughout this unit) *since some of these words are self-explanatory. Like rotation."*

From these three responses, it sounds like some of the students struggled to determine how useful Frayer Models were simply because the vocabulary of this unit was more straightforward than most. I would agree, and my CMT even said in a post-interview, "I would say they had some familiarity, they've at least heard of some of those terms before, so maybe they didn't feel as much need to fill out the vocab sheets (Frayer Models) as before... If we'd done a unit with some more vocabulary they weren't already familiar with, maybe they would have been more receptive to Frayer Models and focusing on the vocabulary." Beyond these types of responses, most students gave a definitive evaluation of Frayer Models, either positive or negative. Here were some of their explanations:

"It helped to fill out an example and a non-example b/c I knew what not to do… I understand the vocab more with the non-examples b/c I know if I did something wrong when doing any problems… I think they were more helpful than LINC's or flashcards."

"With those (previous) *units I think a Frayer Model would actually be incredibly helpful."*

"…it's easier to understand (the vocabulary when using Frayer Models) *because of the examples and non… they were easier to understand and take notes on."*

"They were better then [sic] *LINCs tables but not as effective as flash cards."*

"The Frayer Models were hard to fill out sometimes which made studying difficult… I prefer the LINCs tables because they are easier to fill out and they made studying easier."

"No, just real problems (would help me learn). *LINCs tables and Frayer Models are just extra… Just extra work."*

"I prefer Frayer Models better then [sic] *LINCs tables and flashcards, I would 100% use again! … I think this would of* [sic] *helped if I did have a Frayer Model* (for previous units) *because it showed me a non example of what not to do and a correct example so if I was ever stuck I could look back."*

"I like Frayer Models way better and I would use them in other classes."

"I think the Frayer Models helped me feel more confident about the vocab this unit."

Clearly, there was a wide array of reactions to the Frayer Models, though the majority were in favor of using them again or even in another course. One of the main things to take away from these responses is that some students really appreciated the Example and Non-Example portions, while others thought they were tiresome, confusing, or useless. It also seemed that some students would have simply benefitted from more guidance on using Frayer Models; I would definitely need to check in with students occasionally and explain a couple more examples if I were to reinstitute Frayer Models. My CMT stated during the post-interview, "I think maybe with a little more guidance... I feel like there's potential there for the Frayer Models, I think they just need maybe more class time to work on them or something, guidance to build the skill more… they need more practice… I'd be curious if we did another cycle what they'd do." Overall, this journal seemed to show that some students preferred Frayer Models and some did not, based on reasons related to each individual's personal learning needs and preferences. This is not shocking; the main thing to do now is to try to use this data to drive decisions regarding vocabulary tools in the future.

One last piece of data to look at was the students' performance on both the Frayer Models and their quizzes. I'll simply describe the trends I noticed: Students who filled out Frayer Models all the way and in high detail generally got higher quiz scores and claimed to be more confident on their journal responses. Those who left sections blank or very minimally filled out each box of their Frayer Models tended to score lower, even if their confidence rating was high. The question of all this, however, is a bit of a chicken-and-egg scenario. Are the quiz scores a result of performance on the Frayer Models, or are the Frayer Model performances more a reflection of quiz scores? Do students who work hard score well because of their work on Frayer Models, or simply because they are hard workers and more motivated to achieve higher in this class? It sounded like many of the students believed the Frayer Model genuinely helped them to study and prepare, but others stated that they felt they would have been successful without the Frayer Models. A little reflection on my end will help to sort through all of this and tie it together.

Discussion

The purpose of this study was to see if Frayer Models and reflective journaling could have an impact on student confidence, which based on previously conducted studies, would therefore affect academic performance as well. Over the span of five weeks and two units in my geometry classes (55 students across three classes) it became clear that there is no one specific way that every student responds to these devices. That does not mean, however, that there are no general conclusions to draw, and that there weren't other effects to discuss. In regard to the primary question of the study, it seems fair to conclude that student confidence did increase, though this begs the question of how much and why. The most easily measurable factor in the study was the average self-confidence rating for using mathematics vocabulary. As stated in the data section, there was a slight increase in this value. This is true for each class period, so it is fair to say that student confidence ratings, on average, increased over the course of the study. However, I cannot say for certain that this was caused specifically by the Frayer Models and journal responses; it is possible for this increase to be a result of many other factors.

It should be noted that the second unit in this study, the Congruence Transformations unit (in which the Frayer Models were used) featured material that is typically more familiar to students than in other units. As my CMT put it, "I would say that (the fact that the transformations unit is 'easier' than most) is probably true. I would say they had some familiarity, they've at least <u>heard of</u> some of those terms before… [I]n one sense we definitely require a more rigorous understanding of those terms (than previous years working with transformations)… but I think that's probably true." If this is truly the case, then any student who felt more confident after this study may simply be reacting to the "simpler" content of the second unit and the fact that the vocabulary was more familiar to them from the start. It is also possible that other aspects of the classroom affected their confidence, such as Math Workshop, one-on-one conferring with myself and my CMT, or even new seat placement a couple weeks before the study began. While it is fair to derive from the study that student confidence increased at least somewhat on the whole, it is hard to pinpoint the cause without analyzing the journal responses for that more qualitative data. Breaking these down also leads in to the other benefits of this process.

Across the nine journals, I found that students across the board took the prompts seriously and provided their honest thoughts. Many of them made statements at the end of the study about their mathematical abilities that were more positive than what they started the study with, and there were a fair amount who said the Frayer Models specifically boosted their confidence in the Transformations unit. There were also a few students who spoke more negatively about their abilities at the end of the study, and several more who disliked Frayer Models or said they were "more difficult" or "confusing" when compared to previously used vocabulary learning tools. What this says to me is that there probably isn't one particular tool that is going to work best for all students when learning their mathematics vocabulary, though that conclusion could also just be derived from pre-existing research and the basic understanding that everyone learns differently. More importantly, it draws my attention to the fact that students are able to identify what works well for them and what doesn't. Following this conclusion, I would like to continue implementing learning tools like Frayer Models in my classroom, but with more choices available to my students. I have proposed to my CMT that in the future we try providing a vocabulary diagram to students with four blank boxes each, where students choose if they treat the diagram like a Frayer Model or a LINCs table. Her response was, "we could do that, and they could choose which way to do it." The critical idea here is that we recognize the value of student voice in the learning process.

As I looked through and reacted to the journals, the thing that became most apparent to me was how students responded when we cited their responses in class later. If we told the class that an activity we were assigning them came from their request for more practice of a concept, many students suddenly took the activity more seriously and seemed to care more. It seems that <u>when students know that their thoughts are part of the process, they tend to become more invested in their learning</u>. I would call this the greatest benefit of the processes used in this study, but certainly not the only one. Using journals and Frayer Models also helped students to become more aware of their own learning processes. Through this self-awareness, they could take charge of their studying and review more effectively to prepare for the next lesson, the next unit, or the next assessment. Additionally, it helped me as the teacher to become more aware of student knowledge and confidence during the unit, as opposed to only at the end. These journal responses acted as great formative assessment tools, and I frequently tweaked succeeding lessons to accommodate the needs I observed from journal responses. Overall, I believe that if I continued this study indefinitely, I would find countless benefits based on increased student-teacher communication and student self-awareness of content. However, the vital conclusion to draw from all of this is that it is simply important to ask our students for feedback.

While I can’t promise the same exact results would occur in any school, I feel confident in saying that implementing reflective journaling similar to what I used in this study will have some positive benefits in any mathematics (or actually any content-area) classroom. My sample population is limited to 55 students from one high school in Northwest Ohio, with each student taking the same Geometry course under the same teachers, but the conclusions drawn here seem transferrable to any other subject. I also know that these students had previously been journaling a bit already before my study, and they had been using a similar vocabulary tool (LINCs tables) as well. This makes me wonder if the increase in student confidence would have been more drastic in a classroom that hadn’t previously experienced reflective journaling or vocabulary learning tools. When asked about this, my CMT agreed that her previous use of similar tools may have minimized the change in confidence that occurred over the course of the study, as students may have already gained confidence from her tools and journals before. While every student will react differently, I would still recommend using journaling and some type of vocabulary learning tool in the classroom to create an ongoing classroom conversation about the learning process and to boost student confidence. The more tools you introduce students to and the more choice you give them in their learning, the more I feel they will benefit from the process.

If I were to do this again and continue my research, I would probably stick to three journals a week. This seems very manageable, with typically one being a check-in journal, one being a content journal, and one being a more general reflection on recent lessons and activities. I would also make sure students fully understood how to use several learning tools like Frayer Models, LINCs tables, and flash cards, before giving them the option to use whichever they needed to learn the academic language of the unit. There would be a requirement to complete something for each term in a given list (or a select number of terms in a given list), but the tool used to break down those terms would be up to each student. I would be sure to have students occasionally reflect on their vocabulary learning tools, but I would also have them reflect on journaling itself this time. It seems likely that I could improve the journal prompts I provide based on student feedback if I did this. As with all aspects of teaching, journaling is a reflective process that allows for continuous growth and improvement.

Lastly, the study would benefit from short follow-up interviews of students whenever their responses were a bit ambiguous or curious. The best way to interpret someone's words is to directly ask them what they meant; I haven't done any student follow-ups in this study but I would make a point to do so in the future. I personally felt that students in all of my classes became more talkative during academic discussions, especially my seventh period class, which was nearly silent at the beginning of the study. Providing journal prompts or follow-up interviews with students to ask how they feel about speaking in class at the end of the study would help me to more clearly describe this shift in student confidence, as simply describing a class as "participating more" and "being more talkative" is rather vague on its own. Still, I had hoped students would speak up more in class, and my CMT and I both agree that the students across the board have contributed to academic discussion progressively more over the course of this study. Overall, I can't be certain that journals and vocabulary learning tools were the primary cause of the collective increase in my students' confidence and participation this fall, but I do know that they have plenty of other benefits in the classroom, and I would certainly be willing to implement them again in the future to learn more about my students and how best to teach them.

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Crouch, C. L. (2007). The use of journaling in a math lab class (Order No. EP30531). Available from ProQuest Dissertations & Theses A&I; ProQuest Dissertations & Theses Global. (304704766). Retrieved from https://doi.org/10.3102/0034654308321456

This dissertation based on action research with journaling in an Algebra classroom is a great example from which to set up journal research. The paper discusses many aspects of journaling, from planning the questions asked to setting expectations for students as they use the journals for reflection. It also includes reflection from the instructor who implemented the journals, giving more insight toward effective and ineffective practices with the journals. The study took place in a high school classroom, and was based on research from a wide range of sources, making it a very relevant and credible source of ideas for the journaling portion of this research study.

Jensen, E. (2013). Engaging students with poverty in mind: Practical strategies for raising achievement. Alexandria, VA: ASCD.

This book, written by a teacher who was once a student in poverty, provides an extensive look at student engagement. While the author frequently highlights the importance of considering different SES backgrounds for students, each of the ideas listed in this book are usable for any given student. Jensen starts with the basic needs of a given student, which he calls engagement factors, and after describing them breaks down what is necessary to support and grow each of these factors for students in the classroom. There is a particularly high focus on student mindset, teacher mindset, and the role of vocabulary in achievement and motivation. The book moves on to specific techniques which can improve student engagement, including a detailed overview of using music for various purposes in the classroom. Jensen's writing is supported by well over 100 sources and studies with frequent reference to them as he makes statements and suggestions. This book is a highly credible and interesting source of information for teachers of all subjects and grade levels who are interested in understanding the specifics of student engagement.

Kersaint, G. (2018, February 06). Talking Math: How to Engage Students in Mathematical Discourse. Retrieved from https://www.gettingsmart.com/2015/09/talking-math-how-to-engage-students-in-mathematical-discourse/

This article from a professor of mathematics education breaks down the various aspects of classroom discourse; what it is, why it benefits students, how best to facilitate it, and what role the teacher plays in a discourse-rich environment. There are several great diagrams breaking down the mental processes and effective ways to organize both student thoughts and teacher strategies, as plenty of examples are given defending the implementation of discourse in the classroom. This professor also provides specific examples of scenarios with rich discourse and effective facilitation of discussion. The entire article is rooted in ideas from the National Council of Teachers of Mathematics and their Standards for Mathematical Practice, which translate directly to the intended work in this research study.

Knox, H. (2017). Using Writing Strategies in Math to Increase Metacognitive Skills for the Gifted Learner. Gifted Child Today, 40(1), 43–47. https://doi.org/10.1177/1076217516675904

This journal article addresses metacognition in the classroom and how it affects student performance, which ties directly in to the concepts of academic language mastery and journaling. In fact, the article breaks down strategies for journal implementation and vocabulary acquisition as part of its analysis. The examples given and conclusions drawn act as great references for the methodology of this

research study, and the heavily researched ideas found in the article directly relate to the basis of the motivation, that students benefit more from class when they are reflective of their learning and feel capable in that environment. The insight this article provides can help to establish more effective journaling routines and emphasize the importance of students thinking about their own thoughts.

Morán-Soto, G. & Benson, L. (2018). Relationship of mathematics self-efficacy and competence with behaviors and attitudes of engineering students with poor mathematics preparation. International Journal of Education in Mathematics, Science and Technology (IJEMST), 6(3), 200-220. DOI: 10.18404/ijemst.428165

This journal article is based on an extremely recent study about student mathematical attitudes and how they correspond to performance in the classroom. The authors cite many credible sources and consider mathematical learning from a perspective similar to that of this project. Their conclusion that students perform more successfully and persevere more aggressively when their self-concept is higher in mathematics directly aligns with the topic of this project, in which strengthening academic language competency will hopefully boost confidence and lead to higher student performance. The article provides great examples of how to assess student confidence and what questions to ask when considering a study in this area of interest, lending plenty of guidance to this research study as needed.

S. Strong Links between Self-Confidence and Math Performance. (2011, March/April). Retrieved from http://singteach.nie.edu.sg/issue29-mathed/

This journal article is from the National Institute of Education in Singapore; in other words, a leading education resource in a country that is leading the world in education. It addresses the connections between student confidence, willingness to learn, and general performance in the classroom. Additionally, it provides a clear breakdown of some important terms in the study of student motivation. While the article is brief, it makes many great points and is based on countless studies from several esteemed professors of educational practice.

Standards for Mathematical Practice. (n.d.). Retrieved from http://www.corestandards.org/Math/Practice/

The Standards for Mathematical Practice are eight ideal practices that students enact when, according to the National Council of Teachers of Mathematics, they are truly learning and exemplifying their understanding of mathematical content. The NCTM is the most reliable source of information on math education in the United States today, and the Standards for Mathematical Practice are goals to move students toward for any math teacher, especially as a research goal. The third SMP directly relates to the intentions and ideas of this project, and addressing this practice throughout the process should lead to more relevant results in this study.

Supandi, S., Waluya, B., Rochmad, R., Suyitno, H., & Dewi, K. (2018). Think-Talk-Write Model for Improving Students' Abilities in Mathematical Representation. International Journal of Instruction, 11(3), 77-90. https://doi.org/10.12973/iji.2018.1136a

This is a journal article from a recent (2018) international publication on instruction and pedagogy. Their focus was on using a form of journal reflection to improve students' ability to share ideas and represent their thinking. This ties in to the previously mentioned NCTM source, the Standards for Mathematical Practice, and the heavily researched ideas of their study are directly related to the goals of this project. The specifics of their reflection process can modeled in the journaling portion of this project, as they provide feedback on what seemed to work and what didn't in terms of effective questioning and useful data collection. The article supports the motivations of this project while also acting as an example from which to pull ideas in methodology.

Taylor, J. A., & Brickhill, M. J. (2018). Enabling mathematics: Curriculum design to support transfer. Australian Senior Mathematics Journal, 32(1), 42–53. Retrieved from http://ezproxy.bgsu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=130348163&site=ehost-live&scope=site

This is a recent (2018) journal article from an Australian math education journal, discussing how mathematics education is naturally daunting to students and, as a result, that educators need to be cognizant of the environment they create and work to boost student confidence. There is a strong discussion of anxiety and self-efficacy, both of which will be strong factors in this project. The heavily researched article provides many great examples of beneficial classroom practices and ways to break down student behavior and performance, which can be used to help develop journal questions for this project.

Todd, J. (2018, August 13). How to Improve Mathematical Discourse in Your Classroom. Retrieved from https://www.sadlier.com/school/sadlier-math-blog/how-to-improve-classroom-discourse-in-your-math-classroom

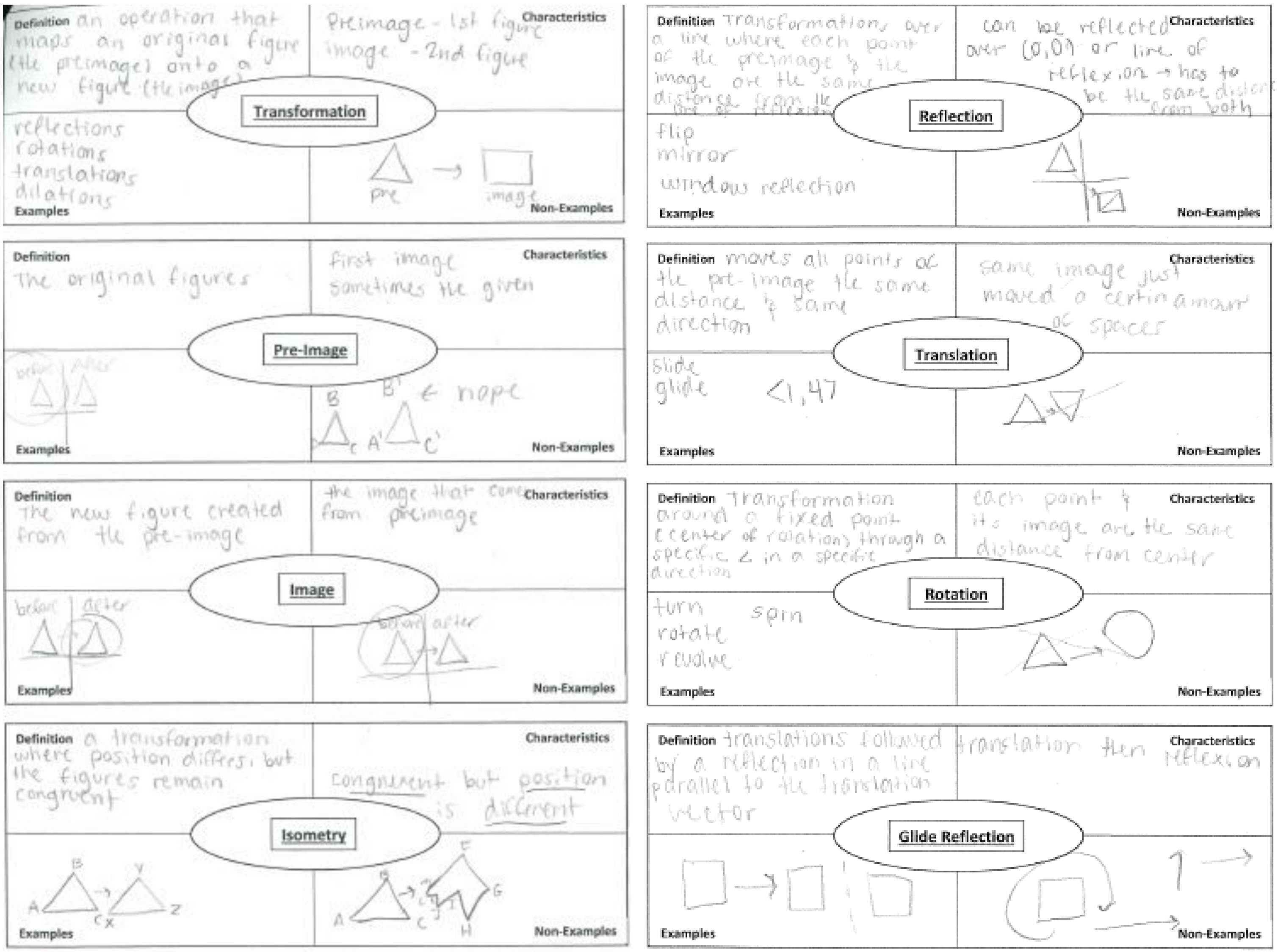
This post on a mathematics education resource site is an in-depth analysis of mathematical discourse in the classroom. Not only does it discuss the benefits of discourse, but it describes the role of a teacher in creating these conversations with students. There are many provided examples of rich conversation, and specific advice for different strategies such as Think-Pair-Share and written reflection. The author clearly references NCTM and the SMPs, which are in heavy alignment with this project as well. Additionally, the recency of this post (August 2018) helps keep it relevant to current conversations in the math education community, especially in regard to discourse.

Usher, E. L., & Pajares, F. (2008). Sources of Self-Efficacy in School: Critical Review of the Literature and Future Directions. Review of Educational Research, 78(4), 751–796.

This is an article from an education research journal, reviewing the fundamental aspects of motivation. The focus is mostly on breaking down Albert Bandura’s ideas, but it relates to recent conversations in motivation and provides examples of student motivation scenarios. This resource is particularly detailed in its discussion of impactful ways and specific times to change a student’s self-efficacy, relating components like academic language to the process. There is also a good description of evaluation techniques for student confidence, which can be useful when generating journal questions to assess self-concept for students. The article is a great resource for motivation theory and facilitation of discourse, providing plenty of research examples and possible strategies to implement in the classroom.

Appendix A

Frayer Model Student Sample (High Quality Work)



Appendix B

Initial/Final Journal Questions

Math Language Reflection

On a scale from 1-5, how confident do you typically feel when using vocabulary in your math classroom or on math assignments? Do those mathematical words come naturally to you? Please take a sentence or two to explain both responses and why you feel this way.

When someone uses a lot of mathematical vocabulary to share their thinking, we can say that they're really 'speaking the language'. If a teacher or a classmate is 'speaking the language' while discussing a math problem, do you tend to follow their thinking well, or feel lost? Why do you think that is?

A lot of people say that they are 'good' or 'bad' at mathematics. What do you think it means to be 'good' at mathematics? By that definition, would you describe yourself as 'good' at mathematics?

Appendix C

Frayer Reflection Questions

Use complete sentences to respond to each of these questions about using Frayer Models in this unit. These questions are not for a grade, so please be honest and write exactly what you are thinking. This is a chance for you to give feedback on an assignment that we may or may not use in the future.

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1. Did you think that filling out Frayer Models helped you to practice and remember the vocabulary from this unit? Did you use them to help you study after you filled them out?

2. How confident did you feel about the academic language (vocabulary) in this unit, both throughout the lessons <u>and</u> as you took the quiz? Do you think Frayer Models played a part in this?

3. The previous two packets before Congruence Transformations didn't have Frayer Models. Do you think it would have helped you learn some of the terms and theorems more clearly if you had done Frayer Models for them and made examples/ non-examples for yourself?

4. How do you feel about Frayer Models compared to other vocabulary learning tools used in the past, like LINCs tables or flash cards? Would you ever consider using Frayer Models to help you learn/practice vocabulary in another class?

Appendix D

Other Journal Reflections

Journal 2 (Check-In, printed on half-slip of paper passed out at end of class)

Reflect on the following questions. Please explain your response with a sentence or two.

"What questions do you have about triangle congruence (today's lesson)? What about what we learned on Monday or Tuesday? Is there anything you would like to discuss more before moving on? If you have no questions, write about something you are understanding well and why you think that is.

Journal 3 (Content Application, printed on half-slip of paper passed out at end of class)

When deciding if two triangles are congruent, there are six pairs of corresponding parts to consider: Three pairs of corresponding angles and three pairs of corresponding sides. In your own words, explain how if you know that <u>two</u> of the pairs of angles are congruent, then you only need <u>one</u> pair of sides to be congruent in order to prove that the two triangles must be congruent.

Explain why <u>it doesn't even mater which pair of sides is congruent</u> if two angle pairs are congruent. Try to use some of the rules and ideas you know about triangles to justify your reasoning.

Journal 4 (Content/Vocabulary Application, projected on board at end of class, answered on paper)

On a blank piece of notebook paper:
Take three minutes to write as many properties, rules, or relationships you can think of for isosceles and equilateral triangles. Be sure to distinguish what rules apply to which type of triangle, and if there is any overlap.

Journal 5 (Content Application, bell-ringer question on their bellwork sheet)

In your own words, explain WHY the exterior angle sum of a polygon is equal to (n-2)180, where n = the number of sides. Feel free to draw a picture if you would like.

Journal 6 (Check-In, part of a larger set of questions asked on a paper at the end of class)

Related to preparing for your test on Friday – consider all the learning objectives from the last three weeks. What would you like to practice more during workshop on the block day? What questions do you need answered before the test on Friday?

Journal 7 (Content Application, projected on board at end of class, answered online via Desmos)

In the text box on Desmos, answer the following question:

How does a 180° rotation about the origin compare to reflecting the preimage over BOTH axes (Two reflections in a row)? Explain WHY this relationship exists using coordinate notation.

Feel free to use your notes, especially the rules concerning what happens to the pair of coordinates (x, y) during each type of reflection and rotation.

Appendix E

Cooperating Mentor Teacher (CMT) Post-Interview

(Conducted by phone call, recorded conversation with laptop)

Do you feel that the Frayer Models and journals affected students' confidence? If so, was there ever a particular situation or piece of evidence that made this clear to you?

Her response: I think the journals overall… yes. They made them (the students) overall more reflective and more aware of what they know and what they don't know. I'm not sure about the Frayer Models, though. I think they (the students) have been more aware (from journaling)… it sounds like they have gotten better at identifying what things they know and don't.

Do you feel that the Frayer Models and journals affected students' performance? If so, was there ever a particular situation or piece of evidence that made this clear to you?

Her response: I don't know. I think it was a hard time of the year… um, I think, they did not do as well on the Transformations Quiz as I had hoped overall, but um, the Frayer Models specifically… I think maybe with a little more guidance. I feel like there's potential there for the Frayer Models, I think they just need maybe more classtime to work on them or something, guidance to build the skill more, I just think it's, they need more practice to really… I'd be curious if we did another cycle what they'd do. I noticed when I was grading that there were lots who had only filled out the example one that we all did together, but that's always true for the LINCs tables too, so I think maybe with more specific time to work on it they could get it done.

How easy/difficult did you feel it was to implement reflective journals two or three times a week and to assign/use Frayer Models?

Her response: I think that was really easy to do, did not take a lot of time, maybe had to adjust timing/teaching a little bit but I think the benefits are worth it.

Are there any other factors that you feel could have affected students over the course of this study?

Her response: I think definitely the fact that the Thanksgiving holiday was in there had an effect on their focus, both leading up to and when they got back. Then we had that messy snow day and PENTA trip; we just had a disjointed couple weeks. That probably impacted it because we were constantly trying to shift things to make it work, fit what we had. I think that definitely played a role. I think if you had a little more time… If we were to increase the length of the study, I think a couple more cycles would be cool to see where we ended up. At least with the Frayer models. The journaling, I've already been journaling with them, so I think they had practice with that already, so that probably also helped get clearer results because they had some previous practice with that, part of what made them more effective. I'm looking forward to seeing what you find…

I would say that (the fact that the transformations unit is 'easier' than most) is probably true. I would say they had some familiarity, they've at least heard of some of those terms before, so maybe they didn't feel as much need to fill out the vocab sheets (Frayer Models) as before, in one sense we definitely require a more rigorous understanding of those terms (than previous years working with transformations), so maybe with a little more guidance, we could reach that level of rigor, but I think that's probably true. If we'd done a unit with some more vocabulary they weren't already familiar with, maybe they would have been more receptive to Frayer Models and focusing on the vocabulary.

I think that (the unit was easier so it's hard to say what would have made test scores increase for sure) is true too.

You have previously used reflections and LINCs tables in your classroom; between those prior experiences and this study, would you like to apply journals and/or Frayer Models in the future? Why or why not? Were there benefits you observed beyond direct increases in student confidence, motivation, and/or achievement?

Her response: Yeah… yes is the short answer. Journals we talked about a bit already, but I like the Frayer Models as a different vocabulary tool, I would think more about the difference between LINCs tables and Frayer Models, I think both are appropriate in different… they have some different components, like 'examples and non-examples', versus connecting it to real life like a LINCs table does, but I definitely think kids would like to choose, they probably tend to gravitate more toward one than the other, but overall I think strategies for vocabulary are important, anything we can do for that.

Yeah, I think we could do that (create a version of Frayer Models where students can fill the charts out as LINCs tables instead, because both have four boxes), and they could choose which way to do it. There's probably some value in, instead of saying, "Here are all of the words, do a LINCs or Frayer for each", saying, "Here's a list, we're expecting that you do at least four of them." So students choose which ones are important based on what they know or what they're finding. Create a little more choice, but yeah, I think that emphasis on vocabulary… even kids will say that in Geometry, "there's SO much writing, there's SO much vocabulary," it's a little bit different for them. It's not that Algebra is not vocabulary-ridden, I just think it's… a little bit different.

Yeah I don't think I noticed anything major change in the students while we did this. But yes, I would agree (that if we had done this in a classroom that didn't already use vocabulary learning tools and reflective journals beforehand, there probably would have been more of a noticeable change).

Several students said they like Frayer Models over flashcards or LINCs tables because Frayer Models were "easier", do you think that means they just think Frayer Models take less effort?

'Easier' is often an interesting word to unpack for some kids, because sometimes for them easier means it took less effort, but it can also mean "I understand it better, so I can complete the process more effectively." You know, 'easier' without a follow-up can mean a lot of things.