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Capstone Reflection – MSMME

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LOOK ACROSS: Experiences in MSMME

My time in MSMME has been challenging, but rewarding. I feel that as a teacher and a leaner of math, I grew in many areas. One area was the opportunity for insight into how my students may think or feel. Another was learning about the connections between different content areas. The third major area is understanding multiple student perspectives – both mathematically and otherwise. The following MSMME problems or activities exemplify my learning in these areas.

One significant problem that impacted me as a learner of mathematics was the infamous tea problem in the Ratio and Proportion course during my first term in MSMME. Before even

Part 2 – Reasoning with Fraction Multiplication For the problems below, make math drawings and reference the definition of fractions and multiplication as appropriate.

1. You made one pitcher of iced tea and one pitcher of lemonade for a party. Just before the party starts, you catch your little brother mixing the two beverages. He says he took one cup of the iced tea and put it in the lemonade. Then, he took a cup of the lemonade-tea mixture he just created and put it back in the iced tea, hoping no one would notice what he had done. Is there now more lemonade in the iced tea or more iced tea in the lemonade?

making sense of how the tea problem related to the definitions of fractions and multiplication, I struggled just making sense of the problem itself! After 6 drafts, I realized that the area model I had originally utilized did help me arrive at the correct answer. I also had noticed the definition of a fraction woven throughout the problem, with the whole changing throughout. First, the whole was a pitcher of 8 copies of $\frac{1}{8}$ cups of tea, then a pitcher of 8 copies of $\frac{1}{9}$ cups of lemonade and 1 copy of $\frac{1}{9}$ of tea, and then a pitcher of 7 copies of 1 cup of tea, 1 copy of $\frac{1}{9}$ of tea, and 8

Let a pitcher equal 8 cups.

Tea

Lemonade

Stage One: Add one-cup tea to the lemonade pitcher.

T	T	T	T	T	T	T

L	L	L	L	L	L	L	L	T

Now the lemonade pitcher has $\frac{8}{9}$ of a pitcher lemonade and $\frac{1}{9}$ of a pitcher tea.

Stage Two: Add one-cup lemonade-tea to the tea pitcher.

T	T	T	T	T	T	T	LT

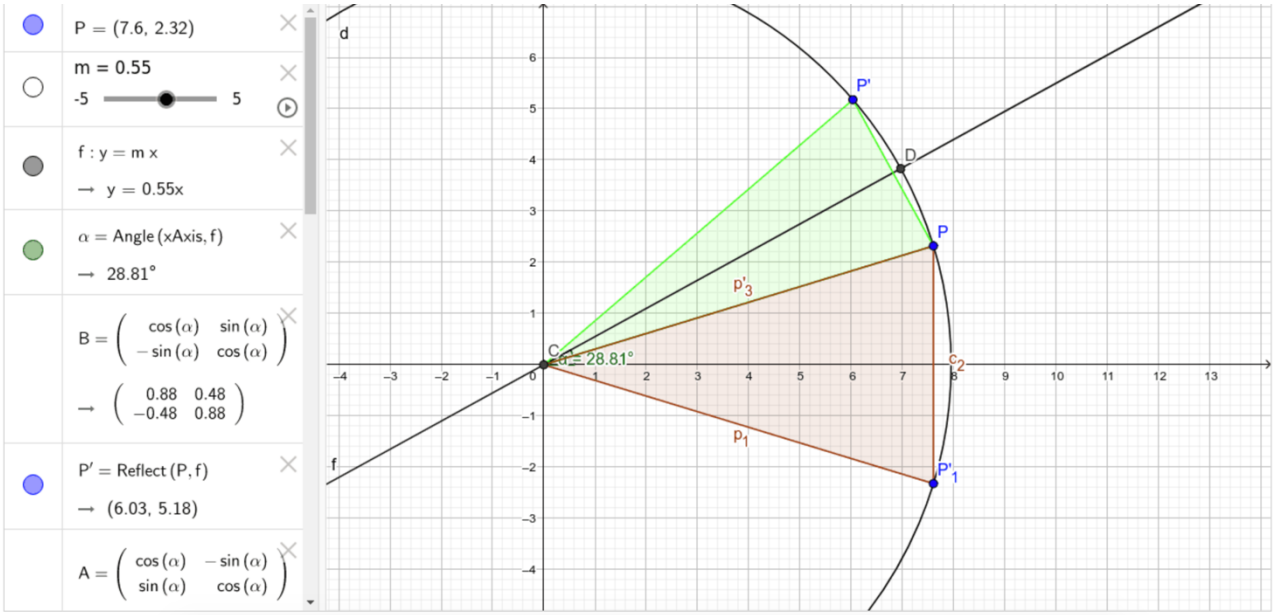
Now the tea pitcher has 7 cups tea plus $\frac{1}{9}$ cup tea and $\frac{8}{9}$ cup lemonade. Expanding those 8 cups into 9 parts yields 72 parts: 63 parts tea plus 1 part tea and 8 parts lemonade. Lemonade comprises $\frac{8}{72}$ of the tea pitcher, or $\frac{1}{9}$.

T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
T	T	T	T	T	T	T	T
L	L	L	L	L	L	L	L

Similarly, tea is still $\frac{1}{9}$ of the lemonade pitcher. There is an identical amount of foreign liquid in each pitcher.

copies of $\frac{1}{9}$ of lemonade. The main big idea presented in this problem, ratio, is useful for me as a high school teacher. For instance, in Algebra 1, we work with slope, which is a multiplier or unit-rate relating x to y when the line goes through the origin. Further, persevering as a student of mathematics had previously rarely been a necessity for me, but now it was! I felt that I had gained some insight into the struggles of my students. This opportunity for insight continued throughout other MSMME courses.

Another assignment that led to a big idea which challenged my notions of mathematics was in Linear Algebra for Teachers, again during my first term of MSMME. The big idea is the relationship between Algebra and Geometry. The two are related at a much deeper level than I ever imagined. For example, a vector can represent a coordinate point in any space, and a matrix is a function acting on a such a vector. I especially enjoyed the connections between isometries



and linear equations, such as y=mx. We found, in the assignment, that a clockwise rotation of a point by the angle of inclination of a line, then a reflection in the x-axis, then followed by a counterclockwise rotation by the same angle, was identical to reflecting the point in the x-axis and then rotating it counterclockwise by twice alpha. We proved the isometry identity through geometry via similar triangles, and also algebraically utilizing double angle formulas. This activity, among others, strengthened my geometry and trigonometry knowledge, which will help me as a secondary teacher. Most importantly, I think it is crucial to understand that Algebra and Geometry are two sides of same coin. I used to think they were separate! Again, other MSMME courses, especially History of Mathematics, continued to reinforce this connection between seemingly different content areas.

A new practice that impacted me as a teacher of mathematics was exit tickets for student-teacher dialogue. Articles by Robert Marzano (2012) and L. M. Baron (2016) and others support and explain the importance of exit tickets, and specifically of using exit tickets that are more reflective, instead of just another math problem. In Assessment Models and Issues, I

conducted a 6-day experiment where students did their daily quiz each day, followed by a few questions to answer on the back. For one of the prompts that was used 2-3 times, "What question did you find most difficult?" I followed it up with different questions such as, "How can I help you?" or "What did you try?" One challenge I faced was making sure students' felt their input was valued. Some students wrote "IDK" (I don't know) for their answer. With the knowledge and experience I have gained, I would alter these exit tickets in the future. I would utilize them more consistently, and start the year with the prompts, engaging students in this process at least once per week. I would model the difference between acceptable and exemplary answers, awarding points depending on participation, and the degree of reflectiveness of student answers. Overall, the experiment was rewarding – it reinforced that students are not empty containers to fill with knowledge, but rather they have their own perspectives to share and their insights can and do inform my teaching.

LOOK BACK: Self-Reflection

My perspective of what it means to know and do math has changed. I started out in my undergraduate experience wanting to be a language teacher, but chose math because it would be easier to procure employment in the field of teaching mathematics, and I knew I was capable of passing all of the required classes. Now, I am so grateful for that decision – and, now I realize anyone can do math. MSMME has given me tools for teaching mathematics that I never had before. Also, some of the more difficult courses, such as Linear Algebra, have been so much fun! Struggling through tough concepts and reaching an answer that made sense with my study group, were some of the most rewarding experiences I have had in mathematics. I want my

students to have that feeling. Further, I used to be terrified and adverse to teaching Geometry and Statistics as well. Now, I am not afraid, and I am willing to teach these content areas.

One change I have made to my instructional practice is to solicit justification from students. Instead of simply asking what the answer is, I ask follow up questions such as, "How do you know?" This is especially enlightening when the answer is correct, but the justification is off. For example, a student might say the beginning of the quadratic formula when solving $x^2 - 3x + 3 = 0$ is 3, and when asked to explain why, the student points to the *c* value, or constant in the equation, rather than the coefficient of the middle term. Instances such as this help me to write clearer examples that lead to less confusion. Further, an error such as this reveals what many students may be thinking, and offers me the opportunity to clear up a misconception. One challenge I face when asking students to justify their answer is students not having the tools to respond. For example, if a student has never been taught why adding 3 to both sides of the equation cancels the negative 3, they will often say, "that's just what you do". Again, this affords an opportunity to teach the entire class what many may not know. Further, a safe and supportive classroom must be in place before expecting *all* students to feel comfortable responding.

One instance when a topic in class challenged my beliefs about teaching was surrounding access and equity for assessment. I had previously believed that homework was an essential practice, but homework is an issue of access and equity. Some students have to work outside of school or babysit. Some students do not have a quiet place to work, and some have people in their life who can help them with math and some do not. As I get to know my students, more and more I believe in a no homework policy. I may be shifting gears and working at an alternative school soon, and may be able to enact my no-homework policy. Further, this school

does not have curriculum. With the knowledge gained in MSMME, especially but not limited to the Curriculum Design course, I feel confident I can develop some of my own curriculum. My priorities in such an endeavor would be to allow students multiple ways of accessing the material (entry points), multiple ways of showing their understanding (assessment), and most of all, head-scratcher problems that require students to work together but also have fun learning math together. Whatever school I end up at, I plan to incorporate some or all of these components.

Though the head of the math department (and one of my professional mentors) at the high school where I currently teach is a big proponent of direct instruction, MSMME has given me confidence to challenge the fact that direct instruction is the most effective. I have been an agent of change in encouraging more group activities, and more empathy towards students in the realm of classroom discipline. For example, with the interactive nature of the online courses in MSMME, I realized that I learned more when engaging in dialogue with my peers rather than simply reading through the content and performing the activities. Recently in the Geometry course, we utilized many different technologies to explore and criticize our work. Moreover, I read an article in Curriculum Design by Harper and Ford, which details a research study measuring the efficacy of discourse and journaling in mathematics. I read articles such as these throughout the program, and each one gave me more and more confidence to not rely on direct instruction, but to explore new modes of teaching.

LOOK AHEAD: Personal/Professional Improvement Plan

I plan to continue growing as a student of mathematics. To this end, I will encourage my department head to utilize me in new and different content areas. For example, I have never taught a Geometry course. In order to teach Geometry, I will need to really dig in and learn all

of the nuances of that content. I also tutor after school at the high school where I work, so students from all areas of math come in, and I often need to relearn concepts in order to help them. I will continue serving as the after school math tutor for my high school. Also, as I design more effective instruction, and find new and more engaging tasks, I am always discovering other mathematical connections between problems. Interacting with students reveals new approaches to problems and new ways of thinking about math.

As a teacher of mathematics, I plan to continue learning and growing in much of the same ways I will continue improving as a learner of math. If I were to teach geometry, I would collaborate with the other geometry teachers, just as I do now with the other Algebra teachers. Specifically, I will meet with one or more content PLCs at least once per week, and exchange one idea/strategy surrounding instruction every week. This is also one way I can share with my colleagues what I have learned in the MSMME program. I will also continue to grow as a teacher by reading at least 3 books about teaching math in the next year: *Making Number Talks Matter*, *Developing Thinking in Algebra*, as well as a few books on growth mindset and the neuroscience surrounding it.

The MSMME program, combined with my passion for the Jo Boaler conference I attended last November, has inspired me to move away from procedural knowledge and explicitly teaching kids shortcuts. Instead, I want to teach students how to think, how to problem solve, and how to connect mathematical topics together. To this end, I plan to utilize at least one challenging task each month where students are forced to problem solve, work together, and model with mathematics. I want to increase student-teacher dialogue via bringing back weekly exit tickets. Now that I have the experience of the MSMME program, and the MSMME community at my fingertips, I have the support and resources I need to accomplish anything.