Crafting an online, digital portfolio to better understand the SMPs

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In the Spring of 2022 I had the opportunity to teach a graduate level math course for Middle School teachers obtaining an advanced degree for the University of Wyoming. While the class was focused on teaching middle school mathematics, the teacher-students came with a variety of backgrounds including elementary, high school math, science, and special education. My goal was not only to help teachers learn the concepts and pedagogy around middle school math, but to be able to recognize and apply the habits of mathematicians we attempt to impart on students. Given that the the Common Core Standards of Mathematical Practice (SMPs) apply to mathematics of all grade levels, the SMPs were a natural shared vernacular around which we could do and discuss math.

The students' final project for the course was the creation of an online digital portfolio of eight tasks, each aligned to a specific SMP. In this article, I'll discuss the portfolio process and share students' tasks and reflections. Also, you can check out the portfolios yourself with the links at the bottom of this article.

Why online portfolios and the SMPs?

The SMPs are the most underutilized resource we have in mathematics. The eight SMPs speak to the very heart of what mathematicians do and why mathematics is important. The answer to the age-old question of "when are we going to use this?" is best answered by pointing to the skills and habits promoted by mathematical thinking more so than any specific content application. Any adult would concede that "make sense of problems and persevere in solving them" (SMP1) is a skill that every student should have the opportunity to practice while in school. And yes, our tasks, units of instruction, and assessments are typically organized in a manner separate from the SMPs. This project intended to give teachers exposure and deep experience with each of the SMPs. The choice to make it an online portfolio was to encourage reflection on the standards themselves, task-oriented learning, and how to imbue the SMPs into their teaching practice.

Portfolio specifications and the portfolio process

[sidebar of the eight SMPs]

1. Make sense of problems & persevere in solving them
2. Reason abstractly & quantitatively
3. Construct viable arguments & critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for & make use of structure
8. Look for & express regularity in repeated reasoning

Graduate students of math education had to create an online portfolio consisting of eight middle school math tasks, including their solution, presumably taken from a myriad of curriculum resources. Each task was accompanied by a brief discussion of why the task was aligned with a particular SMP. Many quality mathematical tasks naturally apply to multiple SMPs at a time, but for this assignment I asked for a unique task for each of the eight SMPs. In addition, I asked students to write an overarching reflection on how examining the SMPs impacted their practice as teachers.

Many students were new to the portfolio process. For this reason, I carefully scaffolded the experience early and often. After introducing the project, I had students bring in one task the following week that they believed aligned with a SMP. After discussing the tasks, I had them repeat the process a couple of weeks later. After a few rounds of this, students had a bank of 3-4 tasks that aligned with an individual SMP. The discussions resulted in better understanding of the SMPs, particularly the thornier SMPs, such as SMP8: Look for and express regularity in repeated reasoning.

Week 1: Introduce the project
Week 2: Identify one mathematical task and an SMP or two it might align with

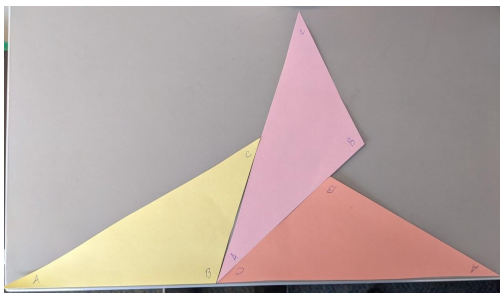
Week 3-4: Bring another mathematical task and SMP for discussion
Week 5: Showcase my portfolio as an example
Week 6: Discuss SMPs
Week 7: Create a Google Site and upload two tasks aligned with an SMP
Week 8: Share links to one another's Google Site
Week 8-13: Continued work on tasks, reflections, and websites
Week 14: Submit final version of the website

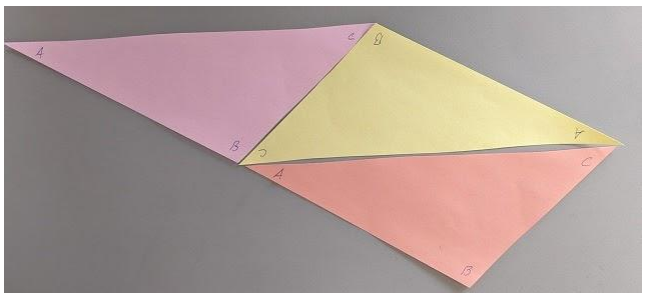
I then showed students how to craft an online portfolio using Google Sites. I directed students to the portfolio template in google sites and walked them through how to create a home page and subpages. Students uploaded a few tasks to their unique Google Site URL and we discussed their work in class a few weeks later.

Scaffolding the portfolio process is crucial, particularly for those new to the content and new to the medium. By introducing the project months before it was due and discussing it weekly, it helped reduce the stress level for what could be an overwhelming experience.

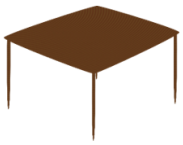
SMP aligned tasks

For SMP8, Josh showcased a task in which students construct physical triangles. By duplicating the triangles and pushing the three different vertices together, students recognize that they form a straight line. By engaging in this physical demonstration, students can identify, using multiple examples from multiple different students, that the angles of a triangle sum to 180 degrees. An intrepid student might even build upon that reasoning to conjecture that a quadrilateral must therefore sum to 360 degree.



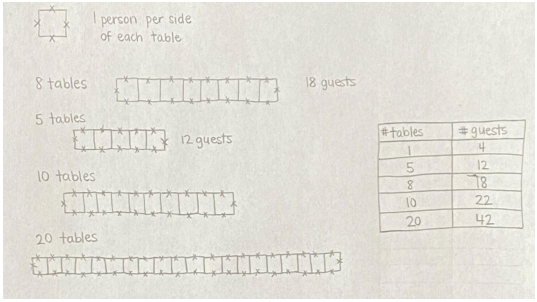


Staying with SMP8, Erica describes a task in which students are to generate a formula based on a pattern. Erica describes a table task where students have to determine the number of chairs to set up around a table. She suggests drawing a picture and making a table. After engaging in this repeated reasoning, students can identify a formula.

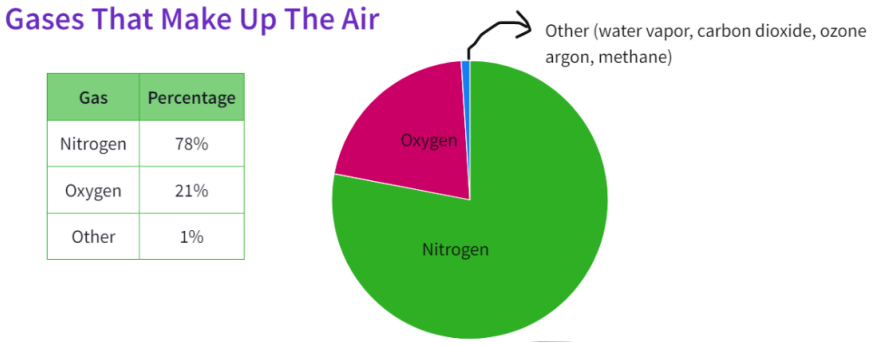


Mrs. Jones rented 8 square tables. Only 1 person could fit at each side of the tables. She pushed the square tables together to form 1 long row of tables.

a. How many guests can be seated at the row of 8 tables? How many could be seated at a row of 20 tables?
b. Can you find a rule to determine how many people could be seated at a row of n tables?



Necole is a practicing science teacher and for her approach to the SMPs, she generated tasks that were mathematical in nature, while drawing from a science background. For example, for SMP4, Model with Mathematics, she had students create visual representations of the gasses that make up our breaking air. She describes it as "doing math with purpose."



For MP3, Kaylee utilized a three act task (http://threeacts.mrmeyer.com/finalsweek/) for her task that aligns to SMP3. In this task, created by Dan Meyer, students are prompted to identify the most cost effective caffeinated drinks. After watching a video of Meyer downing various caffeinated beverages, they are given small bits of information to help them decide which beverage is the most cost effective for neglecting sleep.

Kaylee opted to organize her information in a table. Working through the task helped Kaylee identify some potential modifications for classroom implementation, including, giving students a worksheet to help them organize their thinking

Responses and reflections

By engaging in the deep, metacognitive work of portfolio development and reflection, teachers said it gave them a better understanding and appreciation of the SMPs. Kaylee reflected, “I consistently found myself finding places within my high school mathematical curriculum where I could implement these practices.” Teachers also noted that some SMPs appeared more often than others in their regular instruction. For example, Josh pointed out that SMPs 1, 4, and 6 appeared in his class regularly, while the others were more of a challenge to identify and teach.

Completing the math tasks yielded insight into the problem and problem-solving process. It is not uncommon for teachers to assign math problems to students without completing them for themselves first. Or, a math problem exists within a specific content section which gives heavy-handed prescriptions on how to solve it. By orienting tasks around the SMPs, rather than a content standard, and having teachers solve the tasks using multiple strategies, they were able to identify the “nooks and crannies” in which a

student may get stuck. Erica noted that "by doing the work of completing the tasks, I was forced to reflect on my method of solving the problems and identify potential stumbling blocks for students."

Summary

Generating portfolios of mathematical work accompanied with reflections led to a deep understanding of the material and yielded insights into their own practice. While this project occurred with practicing middle school teachers, it may be worth considering if generating portfolios within secondary classrooms is a worthwhile endeavor. To be sure, developing, maintaining, and building a portfolio of mathematical work and writing takes time. Thankfully, free online web platforms such as Google Sites have streamlined the process with templates. Many school districts use Google Drive already, offering a natural avenue towards imbuing technology in the math classroom.

The practice of portfolios continues to grow and evolve with emerging research and advances in technology. As the barriers to implementation shrink, the final hurdle of limited class time must be addressed. Perhaps a class period every month could be devoted to portfolio advancement. Perhaps once a unit a student might identify a piece of mathematical work they are proud of and write about it. Or you may wish to ask students to compare their evolution as a mathematician from, say, August to April. By looking back and reflecting upon both present and past work, we are engaging students in irreplaceable metacognitive processes, even if the "students" are practicing teachers.

See the portfolios yourself!

Permission was given by four graduate students to view their portfolios.

Kaylee	https://sites.google.com/view/smp-peterson/home
Josh	https://sites.google.com/view/andersonsmp/smp-home
Necole	https://sites.google.com/pcsd1.org/necolehanksportfolio/home
Erica	https://sites.google.com/view/eballoumathportfolio/home