Analysis of the Math Work Station Assignment

The Math Work Station Assignment can be utilized by mathematics teacher educators to assess teacher candidates knowledge and skills for teaching mathematics. For this assignment, we utilize the definition and description of math work stations as described by Debbie Diller (2011) in her book *Math Work Stations: Independent Learning You Can Count on, K-2.* Essentially, math work stations are areas within the classroom where pairs of students work independently on activities that promote mathematical thinking and learning. Math work stations can be utilized to reinforce and/or extend the mathematical ideas being taught during whole class instruction. Effective math work stations develop conceptual understanding and fluency, while also encouraging the use of mathematics vocabulary within student mathematics conversations. Elementary teachers can support mathematical discourse and vocabulary development by creating math talk cards with the students to be used at math work stations (Diller, 2011). Math talk cards might include vocabulary or simple sentence frames that students can use to guide conversations about the mathematics.

Prior to the assignment, teacher candidates explore and examine math work stations during the first six weeks of an elementary methods course. This includes reading about multiple examples of effective math work stations in *Math Work Stations: Independent Learning You Can Count On, K-2* (Diller, 2011). After reading each chapter, teacher candidates respond to a class discussion board. Each discussion board asks teacher candidates to address a set of questions aligned to the reading and also respond to at least one peer's post (Discussion board prompts and rubric can be found in Appendix A). The discussion board space allows the instructor to formatively assess and press on the ways in which teacher candidates think about math work stations and how this strategy supports students' mathematical thinking and learning.

Mid-semester, teacher candidates are introduced to the Ongoing Assessment Project (OGAP) Additive Framework (Hulbert & Ebby, 2017) and OGAP Multiplicative Framework (Hulbert, Petit, & Laird, 2017). These frameworks provide teacher candidates with a learning progression, specifically how students move from counting to additive reasoning and then to multiplicative reasoning. (These frameworks introduce teacher candidates to ways they can notice and describe students' mathematical thinking in the Math Work Station Assignment.) After being introduced to the frameworks the teacher candidates sort a set of OGAP additive student work samples and a set of OGAP multiplicative student work samples. As a whole class, we discuss how groups sort the work samples. This discussion includes how to think about student work that may have been challenging to sort. We also briefly discuss how using formative assessment with these frameworks would help a teacher make (whole and small group) instructional decisions. My instructional goal in using the OGAP Frameworks is to create exposure and initial understanding of what a learning progression is and how it might be used in a classroom. For more information regarding OGAP and professional development opportunities for teachers and school districts see https://ogapmathllc.com or http://www.ogapmath.com.

The Math Work Station Assignment involves teacher candidates planning, creating, and implementing a math work station that will engage students in mathematical practices and also aligns to the Common Core State Standards for Mathematics (NGA & CCSSO, 2010). The directions and rubric are located in Appendix B. Teacher candidates are responsible for communicating the requirements of the assignment to their field placement cooperating teacher, and making a plan regarding the topic of the work station, available time (i.e. math center time, a reward time for free choice, etc.) and which students will be involved. This type of communication is similar to the way teacher candidates typically communicate about planning and teaching a lesson during field placement.

Once the station is created, teacher candidates observe and document students as they participate. This includes taking photographs that capture the students' mathematical thinking (manipulatives, drawings, or even hands) to essentially "zoom in" on the mathematics. (Note: Teacher educators should check the school district's policy about taking photos/videos in K-12 classrooms.) Teacher candidates also document the speech students are using while engaged with the math work station. Lastly, the teacher candidates reflect on the experience by describing the students' mathematical thinking captured in three photographs (which may or may not include quotes from students) and considering how this information about students' thinking would inform their future instruction for each student. Teacher candidates also consider the ways students engaged in mathematical practices and used mathematics language at the work station.

Assessment Alignment to AMTE Standards

The main focus of the Math Work Station Project is for teacher candidates to demonstrate their ability to notice important mathematical aspects of students' thinking and to identify the mathematical practices students are engaged in during the station. These goals are directly aligned, and provide an opportunity of assessment, to indicators C.1.5 Analyze Mathematical Thinking and C.3.2. Understand and Recognize Students' Engagement in Mathematical Practices (Table 1 and Table 2 respectively).

In addition to these two primary indicators, C.2.2 Plan for Effective Instruction and C.2.4 Analyze Teaching Practice are tangentially addressed by this assignment too because the teacher candidates are responsible for creating a station that meets the needs of their field placement students, and for reflecting on student engagement and mathematical thinking at the station. Furthermore, many work stations incorporate some type of manipulative or concrete object that make the mathematical thinking more accessible to students, which may address indicator C.1.6 Use Mathematical Tools and Technology (Table 3).

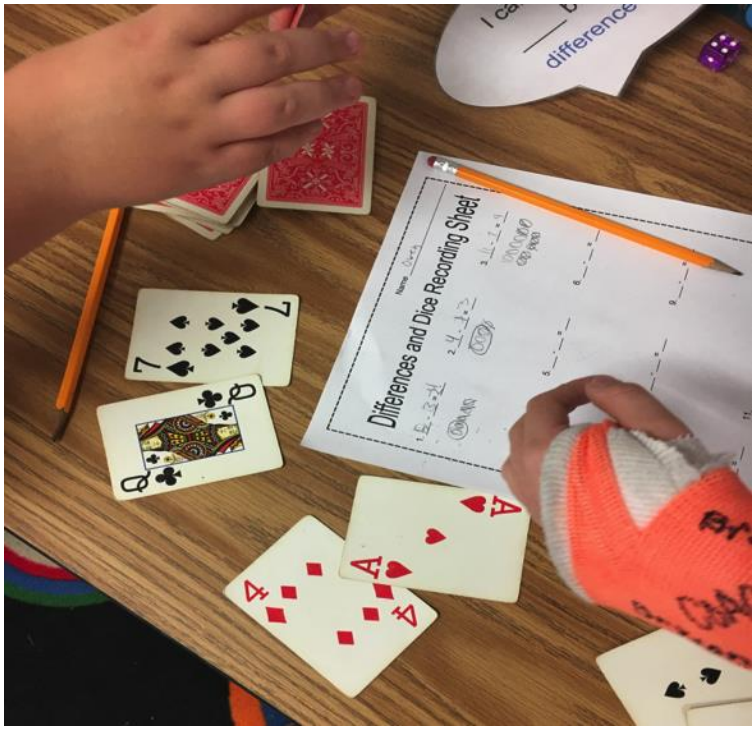
The following tables describe the alignment of the indicators and aspects of the assignments along with teacher candidate work illustrating how the assignment assesses each indicator. The teacher candidate work is from an elementary methods course. The teacher candidate was either in her/his second or third semester of a small university teacher preparation program, where student teaching occurs in the fourth semester.

Table 1: **Primary Indicators** Assessed in Math Work Station Project

Indicator & Description	Section of Assignment	Evidence of Indicator
C.1.5 Analyze Mathematical Thinking Well-prepared beginning teachers of mathematics analyze different approaches to mathematical work and respond appropriately.	**Task 4(A). Three Photographs with 2 Paragraph Captions** *(Primary Assessment)* After observing, select three photographs that demonstrate the various ways that students engaged and thought about the mathematics. These pictures may also highlight misconceptions or developing understandings. For each photograph, write a paragraph caption describing why you selected this photograph. Be sure to include the mathematical understanding that is being demonstrated by the student. What is the student demonstrating they can do or understand? What student understanding do you wish you had evidence of? If it is helpful, you might also include a quote from the student. As a teacher, you will need to observe students' mathematical thinking and make decisions about how to differentiate instruction particularly for that student. Based on your analysis of the mathematical thinking, write a second paragraph that describes what the next step would be for this child. You might draw from the OGAP progressions and other course readings for this section of your project.	The teacher candidate selects a photograph that s/he believe captures important mathematical thinking. Measuring the first part of the indicator (analyzing different approaches to mathematical work), the first paragraph unpacks the student's mathematical thinking that was captured in the photograph. The description of the photograph is detailed, focused on the mathematics, and highlights specific parts of the picture (essentially demonstrating that a teacher candidate can professionally notice student's mathematical thinking and has language to talk about what they notice). The second paragraph provides information about how the teacher candidate plans to respond (second part of indicator). Specifically the teacher candidate needs to identify how this data would inform their future instruction for this particular student.
	Task 4(C). Mathematics Language Paragraph *(Additional Assessment)* Write a paragraph describing how students used language specific to mathematics during your work station. How did your station support students' use of mathematical language? Was there language they used inaccurately? What changes would you make next time to the station to support even more student-to-student discourse?	The teacher candidate writes a paragraph unpacking the mathematical language students were using at the math work station and has a strong focus on supporting student discourse. This paragraph may include the mathematical vocabulary students used, patterns of how the terms are used correctly/incorrectly, as well as how students were engaging in using math talk cards (cards with phrases to guide students' conversations and encourage vocabulary use) at the station.

Example of Teacher Candidate Work:

Photograph #2 from Teacher Candidate Sample 1 (Appendix C):



I chose this photograph because in this picture you can see that the student is showing progression in learning. The student started off creating one-digit by one-digit subtraction sentences (5-3=2 and 4-1=3) in round 1 and 2; however, once the student had gotten acclimated to the game, the students chose to create a two-digit by one-digit subtraction sentence (11-7=4) using a face card from the deck during round 3. This proves that the student is able to solve one-digit by one-digit subtraction problems and at least some one-digit from two-digit subtraction problems. Another reason I chose this picture was because this student utilized the strategy of circling his answer to represent the difference in his hand-drawn models. This shows that the student understands what the subtraction sentence means and can identify the difference rather than the subtrahend or minuend as the answer. There is not evidence of the students' ability to subtract one-digit numbers from larger two-digit numbers or two-digit numbers from two-digit numbers. There is also not evidence that the student understands the array model as an efficient model for solving problems because the students solved all of his problems by counting by 1s.

This student is within the counting phase according to the OGAP additive framework; however, he is progressing into the transitional phase based upon his efficiency in problem solving and strategy use. The next steps for this student would be to introduce and begin subtracting one-digit or two-digit numbers from larger two-digit numbers and reviewing array models. This student proved that he was able to solve one-digit by one-digit subtraction problems accurately. I would want to challenge this student in a small group to start working on subtraction of larger numbers, while still practicing one-digit by one-digit subtraction in order to become fluent. Another step that I would take with this student would be related to this students' array model knowledge. This student did not utilize an array, but rather used unorganized groups of objects. I would want to work with this student in creating arrays and using them effectively to solve problems through story problems and simple addition and subtraction sentences.

Commentary about Teacher Candidate Work in Regard to C.1.5 Analyze Mathematical Thinking

Task 4(A) Commentary. The teacher candidate intentionally selected their second photograph because it demonstrated students' increased skills in moving from subtracting a one-digit number from a one-digit number to subtracting a one-digit number from a two-digit number. The teacher candidate used parentheses in the narrative to indicate the specific evidence that supports her/his claim. The teacher candidate also highlighted how the student circled their answer in the photograph, and how this provided evidence that the student understood what part of the numerical sentence is the difference. After the teacher candidate explained the evidence that indicated what the students knew and/or could do, the candidate discussed gaps of evidence. In other words, that "There is not evidence of the students' ability to subtract one-digit numbers from larger two-digit numbers or two-digit-numbers from two-digit numbers." In this instance I believed the teacher candidate was defining "larger two-digit numbers" as numbers above 11, since one of the limitations of this math work station was that the cards were not used in place value positions but instead that a face card (King, Queen, Jack) was 11. The teacher candidate also noticed that the student had counted by 1s for all of the problems, which meant there was no evidence if the student was able to count more efficiently with an array. In both of these instances, the teacher candidate used strength-based perspectives versus deficit language (Jilk, 2016), because s/he said that there is not evidence if the student has these particular skills based on the evidence versus that the student could not do these skills. The teacher candidate utilized the OGAP Additive Framework (2017), specifically the Additive Reasoning Progression – Subtraction, to identify where the student was at in the learning progression. This section could have been strengthened with a bit more explanation about why the teacher candidate believed the evidence in the work was in the counting phase, and specifically what "problem solving and strategy use" s/he noticed that suggested the student was progressing toward the transitional phase.

The teacher candidate stated the next steps for this student would be to subtract from larger two-digit numbers (numbers greater than 11) and to review array models. The teacher candidate made the instructional decision to work with the students in a small group in the future subtracting two-digit numbers, while having the student continue to practice single digit subtraction to develop fluency. What I was less clear about in reading the teacher candidate's narrative was the focus on arrays, which tend to support multiplication. It seemed the teacher candidate may have been focused on the "unorganized groups of objects," so perhaps more connected to counting skills or a tens frame. I also imagined there could have been some discussion here about how organizing objects in groups of ten might support the student to do double-digit subtraction more efficiently.

This example provided some demonstration of how the OGAP frameworks support teacher candidates to notice particular mathematical ideas when observing students. This work sample demonstrated the ways in which teacher candidates are exploring how to use the OGAP frameworks, both in regard to identifying where student work samples are at in a particular progression and where a student should be going with their development, but also the ways in which teacher candidates are still exploring language to describe these instances.

Moreover, Sherin and van Es (2003) encouraged teachers to experiment with photographs, video, and a written journal to reflect on instruction and develop their professional noticing skills. All of these mediums offer a space for teachers to make sense of the student thinking they observe while teaching to inform future lesson planning. It is important for teacher candidates to have experiences with multiple mediums in order to find tools that they can envision implementing in their own classrooms as beginning teachers and that have the potential to support them in continuous improvement of their mathematics teaching practice. Therefore, because teacher candidates already use video to record the enactment of their own lessons during field placements, I decided to have them utilize photographs in this assignment. I also felt photographs encourage the teacher candidates to "zoom in" and capture the details of student work that sometimes does not get captured when video recording a whole class activity. The photograph can act like a hard copy of student work, similar to written work samples that are analyzed in our methods course with learning progressions. Thus, my hope was that teacher candidates would consider the way they analyzed written work, and begin to generalize ways that these frameworks (i.e. OGAP learning progressions) support them to notice in the moment and with photographs, too. Furthermore, a video zoomed in on a student working at a math work station also has the potential to capture the mathematical thinking needed for the analysis section of this assignment.

Mathematics Language Paragraph:

Every student who engaged in my math work station used mathematical language during each round of "Differences and Dice." The students would fill in the stem, "I can take ___ and ____ because their difference is ____" before they wrote down their subtraction sentence on their recording sheet. The students shared this oral statement with their partner to explain their choice of cards based on the number that they rolled as the difference. My station supported students' mathematical vocabulary use because of this math talk card. In the directions for this math work station, the students were instructed to use the math talk card to share their sentence aloud before they recorded their subtraction sentence. This added support helped students clear up errors and misconceptions before they wrote them down and drew a model of their subtraction sentence. Initially, most students were confused about the word "difference" even though my cooperating teacher uses this academic vocabulary frequently. In the instructions I used the term "difference" and "equals" within the same sentence. This helped students better understand the term difference based on context clues. In the future I would want to encourage more student-to-student discourse by having students create subtraction sentences together. This station was set up more like a competitive game so the students were not working together and discussing as much as I wished they were. I would have had students work together to create either a subtraction sentence with the difference they rolled or had students try to each create a different subtraction sentence with the difference they had rolled. This adjustment would have had students engaging in discourse more frequently while also having students think critically and identify multiple ways to reach a certain difference. Another change I would have included to increase student-to-student discourse would be to include an extra element to the game where students are checking each other's work for correctness and explaining their thoughts aloud. On one occasion a student made an error and his partner did not catch it so I think this added support would have benefited most students.

Task 4(C) Commentary. In addition to analyzing the students' thinking that occurred in each of the three photographs, teacher candidates also investigated the mathematical language that students used during the work station. In this particular work sample, the teacher candidate described how the inclusion of a math talk card helped facilitate meaningful discourse and helped clarify math vocabulary. The teacher candidate observed, "most students were confused about the word 'difference'" even though it is term used in the classroom during instruction." The teacher candidate demonstrates that s/he understands the importance of students talking about mathematics to learn mathematics as s/he further discusses ways to better support student-to-student discourse and collaborative work in future iterations of this math work station.

While it did not happen in this particular Teacher Candidate sample, I could imagine that teacher candidates who witnessed other forms of mathematical communication, such as gesture, informal math words/descriptions, and pictures might also describe that as communication or language in this section. Expanding the prompts provided in the assignment might encourage teacher candidates to include these additional ways of communicating about mathematics in their projects, particularly if course readings and discussions have been about hearing the mathematical knowledge students express in emergent language (Moschkovich, 2016).

Table 2: **Primary Indicator (C.3.2 – Understand and Recognize Students' Engagement in Mathematical Practices)** Assessed in Math Work Station Project

Indicator & Description	Section of Assignment	Assessment of Indicator
C.3.2 Understand and Recognize Students' Engagement in Mathematical Practices Well-prepared beginning teachers of mathematics understand and recognize mathematical practices within what students say and do across many mathematical content domains, with in-depth knowledge of how students use mathematical practices in particular content domains.	**Task 4(B). Standards of Mathematical Practice Paragraph** *(Primary Assessment)* Write a paragraph describing what Standards of Mathematical Practice students were engaged in during your math work station. What evidence do you have to support this? *(Planning for Task 4 starts in Task 2)* Task 2: Include the Standards for Mathematical Practice in the math work station description.	The teacher candidate displays her/his knowledge of the mathematical practices in a written paragraph. The paragraph unpacks at least two Standards of Mathematical Practice (title, description, example). The teacher candidate specifically makes it clear why what the student did (example) can be classified as this Standard of Mathematical Practice. This paragraph of the assignment is used to assess that the teacher candidate was able to identify mathematical practices students were engaged in. The paragraph should include justification of the children using the mathematics practice based on evidence from the observation. The planning section will also have mathematical practices the teacher candidates anticipated the children would use.

Example of Teacher Candidate:

Standards of Mathematical Practice Paragraph:

The students were engaging in mathematical practice #1 (make sense of problems and preserves in solving them), #4 (model with mathematics), #5 (use tools strategically), and #6 (attend to precision) throughout this math work station. The students were engaging in making sense of problems and persevering in solving them throughout the work station when they had to create a subtraction sentence when only given a difference. This encouraged students to think critically and work with the numbers that they had to create an appropriate subtraction sentence. This can be a difficult task especially if students were using face cards (=11) or aces (=1) because they had the translate the symbol to a number and then create a subtraction sentence that would have the difference that they rolled; therefore, this process took perseverance from many students. For example, one student created the subtraction sentence 11-9=2 using a Queen; however, it took him significantly more time to create this sentence because he used larger numbers. The students were modeling with mathematics as they created their own models that matched the subtraction sentence that they created. This was an open-ended model; therefore, the students could use any type of model they wanted. Most students used an array or simple list of shapes and then marked out the appropriate number of objects. Some students circled their answer, which showed the use of another effective strategy. The students were engaging in using tools strategically when they used only pencil and paper to solve their subtraction sentences. Paper and pencil are tools that are often used; however, they must be used appropriately to solve problems effectively and efficiently. The students also utilized the tool of a math talk card strategically to share their subtraction sentences orally. Sometimes this oral exchange helped students identify errors in their thinking. For example, one student realized that he wrote the order of the numbers in his subtraction sentence incorrectly once he shared it aloud. The students had to attend to precision throughout the math work station as they created subtraction sentences. The students had to be precise in the creation of their subtraction sentences to create a sentence that had the appropriate difference. For example, one student chose to use an Ace (=1) and a 5 to create the difference of 4. This student had to be precise and thoughtful in the creation of his sentence to create a subtraction sentence that was accurate.

Commentary about Candidate Work in Regard to C.3.2 Understand and Recognize Students' Engagement in Mathematical Practices

Task 4(B) Commentary. The teacher candidate identified four Standards of Mathematical Practice (SMP), and indicated both the number and title of each practice. The teacher candidate then unpacked how s/he felt the students were engaged in each mathematical practice. The teacher candidate provided great details that demonstrated her/his understanding of the mathematical practices by including the practice, describing generally how students would engage in that practice, and then providing a specific example from the observation. For example, it was when the teacher candidate indicated "it took him [a student] significantly more time to create this sentence" that convinced me of students "persevering" in problem solving during this math work station. The teacher candidate then unpacked SMP4 - Model with Mathematics. S/he stated how students were able to create their own models and listed some of the models s/he observed students using as evidence to support this claim (i.e. array or row of

shapes). The teacher candidate included SMP5 – Use Tools Appropriately. The teacher candidate identified paper and pencil as being the tools the students used to solve the subtraction problems, however it was vague as to how these were mathematical tools versus recording items. I think in this case, the teacher candidate's justification that students were drawing models (SMP4) is stronger than that of using tools (SMP5). Another tool that did have an impact on the student discourse that the teacher candidate mentioned after the paper and pencil was the math talk card. The teacher candidate described how the talk card encouraged student-to-student conversations that supported learning growth (i.e. identifying errors). Finally the teacher candidate described how students were engaged in SMP6 - Attending to Precision, for creating correct subtraction sentences. Overall, this paragraph showcased the ways the teacher candidate was making sense of four of the SMPs and what it looked like for students to be engaged in each SMP.

As an instructor, I wrestled with this section between having teacher candidates only pick one or two SMPs and diving deeply into them versus listing all that they believe apply. I think there are pros and cons to both of these choices. In the example above, the student listed multiple SMPs and it helped to highlight the way they were thinking about pencils and paper as tools, which is not exactly the way the mathematical practice describes tools. This may not have surfaced if the assignment had only asked for two SMPs. Conversely, I have noticed across student samples that teacher candidates tended to focus on SMP1 and SMP6, which they sometimes overgeneralize as doing a math problem and getting a correct answer. Even in instances where they justified these two SMPs well, they may still be avoiding another SMP that related in a stronger way, for example in this case, it perhaps might have been the modeling with mathematics. While I have not found a solution to this dilemma, I do believe leaving it open tends to showcase more about the ways in which teacher candidates are thinking about and making sense of the SMPs.

Table 3: Secondary Indicators that may be demonstrated in Math Work Station Project

Indicator & Description	Section of Assignment	Assessment of Indicator
C.2.2 Plan for Effective Instruction Well-prepared beginning teachers of mathematics attend to a multitude of factors to design mathematical learning opportunities for students, including content, students' learning needs, students' strengths, task selection, and the results of formative and summative assessments.	***Task 2. Prepare a math work station*** Next you will need to create an interactive math work station for students. The station you create should not be busy work, but meaningfully engage students in mathematical thinking. This means your station needs to be aligned to a content standard and students should be engaged in some of the Standards of Mathematical Practice when they are engaged in the station work. Debbie Diller recommends that math work stations be stored in a plastic box that has a lid. The box should contain: • Instructions (Tells the student what to do at the station) • Material list (This helps students put the station away or know if an item is missing) • All of the materials to do the station (Students should not need to get anything) • Talk cards (Cue cards that help students use math language and discuss their math thinking with peers) After you have prepared the math work station, you should complete the first part of your binder/folder that describes the station. This section needs to include: <u>Math Work Station Description</u> 1. Name of station 2. Grade level/content standards/standards for mathematical practice 3. Directions 4. List of manipulatives/materials 5. Assessment 6. Keep an electronic copy of each station. You will also need to upload these to Canvas for me to score.	Teacher candidates demonstrate their skills for planning effective instruction when they plan and create the math work station for this assignment. Teacher candidates design a math work station that is aligned to a content standards, will engage students in mathematical practices, and is accessible and enjoyable for students in that grade level. The teacher candidates must also indicate in their planning what evidence will be collected for assessment purposes and how the assessment is aligned to the content standard.
C.1.6 Use Mathematical Tools and Technology Well-prepared beginning teachers of mathematics are proficient with tools and technology designed to support mathematical reasoning and sense making, both in doing mathematics themselves and in supporting student learning of mathematics.		Teacher candidates frequently include manipulatives/materials in the design of math work stations. Evidence of this indicator would be if the math tools and/or technology provide accessibility to the math/task and/or help make the math more visible for students.

C.2.4 Analyze Teaching Practice Well-prepared beginning teachers of mathematics are developing as reflective practitioners who elicit and use evidence of student learning and engagement to analyze their teaching.	**Task 4(D). Future Math Work Stations** Write a reflective paragraph sharing what you have learned from this project that you plan to apply to future math work stations.	The paragraphs includes specific details and examples of what the teachers plans to do next time, and bases these decisions on evidence from this experience.

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