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Handbook of Research on Advancing Teaching and Teacher Education in the Context of a Virtual Age

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Chapter 10
Preparing for an Effective Mathematics Teaching Practice Online:
The Case for Virtual Number Talks

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ABSTRACT

Field experiences are an important component of preservice teacher education. As educator programs prepare teachers for instruction in a virtual age, creative ways of providing these classroom opportunities must be developed. This chapter reports on the formation and the lessons learned from the implementation of a virtual number talks teacher learning cycle for mathematics preservice teachers. The practical connections of this work provide implications that may promote and inform general mathematics instruction in online classrooms and may extend to both the virtual education of preservice teachers and the development of online instruction in the field of mathematics.

Substantial shifts to virtual learning as a result of the COVID-19 pandemic required wide-ranging adjustments to teaching and learning in teacher education programs. Online course offerings are not new to teacher education programs, but nevertheless, teacher educators had to create new opportunities for preservice teachers to observe and teach virtually in K-12 classrooms during remote learning, often doing so with little notice. This required teacher educators to think creatively in order to develop virtual alternatives to field experiences traditionally offered in face-to-face settings. Although these changes to field experiences were intended to be a temporary solution to emergency remote learning, innovations

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generated by the en masse move to online education have the potential to advance the field of teacher education.

In response to the shift to online learning across pre- and post-secondary education, a virtual field experience was developed for mathematics teacher education courses. Initially out of necessity from school closures due to the COVID-19 pandemic, the Virtual Number Talks Teacher Learning Cycle was created by the authors and collaborators (Joswick et al., 2021) to provide a mathematics teaching experience in which preservice teachers can engage in research-based effective mathematics teaching practices (NCTM, 2014; Smith et al., 2017) while also learning and implementing technologies for teaching mathematics. This virtual field experience focused on an established classroom routine, Number Talks, and moved the delivery of this practice from in-person to the online space. This chapter reports on the Virtual Number Talks Teacher Learning Cycle as a field experience for PreK-6th grade mathematics preservice teachers. The chapter begins by providing background information on field experiences, technology in teacher education, Number Talks, and Number Talks in the virtual classroom. The chapter then describes the development and implementation of the Virtual Number Talks Teacher Learning Cycle and the lessons learned from this implementation, including adaptability of the virtual field experience, availability of technological tools for teachers and students, technological knowledge of preservice teachers, use of technology for specific pedagogical purposes, and equity considerations in virtual teaching and learning opportunities. Information provided from this project may add to the existing knowledge base for the development and facilitation of field experiences across modalities that prepare teachers for teaching in an increasingly technology-driven world.

BACKGROUND

Field Experiences

Field experiences have been a traditional mainstay of preservice teacher education. However, the ways in which preservice teachers engage with these experiences has changed over time, resulting in conflicting definitions of the practice (Caridad Arrastia et al., 2012). Still, providing high quality field experiences are a key component of teacher preparation program requirements across the country (Jacobson, 2017). Field experiences afford preservice teachers the opportunity to interact with curriculum, students, and teachers in natural environments–PreK-12 classrooms (Huling, 1998). These field experiences can take various forms such as in-class observations, clinical teaching, microteaching, tutoring, and mentorship (Archambault et al., 2016). Though field experiences are a vital component of teacher preparation programs, coordinating with schools, administrators, and inservice teachers to provide preservice teachers with these essential field experiences is a complex task. The challenge falls on teacher educators to create meaningful experiences that correspond to high-impact practices (Kuh, 2008) known for increasing student learning and engagement.

As online teacher education continues to grow significantly (Dunn & Rice, 2019), access to schools, locations for placements, and transportation in varying geographic locales must also be considered. Preservice teachers and teacher educator programs alike may have challenges gaining entry to schools to secure classroom placement sites due to the limits on time and human resources already faced by schools and teachers. Some administrators and in-service teachers can be hesitant to work with novice, preservice teachers, making entry to schools for field experiences even more difficult. Travel to and from placement site schools also presents another challenge for preservice teachers who do not have transportation to and from school sites, particularly in areas that lack public transportation. Scheduling can also present difficulties for pre-service teachers balancing fieldwork hour requirements, travel time, class time, coursework, outside employment, family matters, and other obligations.

As online or blended instruction in K-12 education has become increasingly common and accepted, Archambault et al. (2016) has advocated that transforming teacher education to meet 21st century needs requires the incorporation of field experiences that address K-12 online learning. These authors surveyed several teacher preparation programs across the United States for information on field experiences in online learning environments. While an increasing number of teacher preparation programs are offering opportunities for field experiences in online or blended formats, the growth has been modest (Archambault et al., 2016). By offering a variety of field experience formats and including virtual options, teacher preparation programs can increase access to field experience opportunities when circumstances (health or otherwise) prevent preservice teachers from being able to enter physical classrooms. Moreover, online field experiences may create opportunities for preservice teachers to work with diverse populations or underserved school systems that were previously not accessible due to distance between locations. This has the potential to be mutually beneficial for teacher preparation programs and schools–teacher preparation programs can become better equipped to prepare future teachers to work in a variety of school contexts by gaining access to a greater diversity of field experience sites, and schools can gain access to a broader pool of potential future candidates for teaching positions.

Technology in Teacher Education

Technological advances in the field of education have allowed field experiences to be provided in a multitude of ways, whether for online teacher education programs or when physical placements are unavailable. For example, emerging technologies are being used to create simulated classroom environments (e.g., Mullen et al., 2007) for the possibility of serving as field experience components. It has been argued that simulated classroom environments are "part of the evolution in teacher education" (Dieker et al., 2014, p. 21). Simulated learning environments have many affordances for impacting teacher education such as the ability to offer personalized learning, cyclical procedures that allow for reflection and coaching before, during, and after teaching simulation participation, and opportunities to work with varying student populations, such as students with disabilities (Dieker et al., 2014). However, technologies for teacher education in this form do not come without some caveats. Fruitful experiences using the simulated environment depend on the authenticity of and adherence to true classroom realities with actual students (Theelen et al., 2019). Areas that may prove problematic with this type of technology include the development of user-friendly program features and defects in audio or video displays (Theelen et al., 2019). Cost and access to these simulated environments may also be another barrier of this technology's use in teacher education programs (Kaufman & Ireland, 2016). Thus, alternative field experience opportunities that can be provided through virtual means must continue to be developed.

In addition to the advancements being made in technology for use by teacher educators, increased development of and access to technology for instructional use by the general teacher populace has expanded opportunities for learning (Eady & Lockyer, 2013). An assumed advantage of the virtual delivery of teacher education is the potential of this format to allow for the instruction of these technologies for teaching and learning through modeling of the practice in a virtual classroom. For example, if access to a variety of physical mathematics manipulatives by all online students is not feasible, use of virtual manipulatives, such as those provided by Smith (2020) through free websites, may be utilized. While technologies of these types abound, it is important for teacher educators to help preservice teachers learn how to make informed selections from the abundance of available tools and implement technologies that will support the learning goals of the classroom.

Number Talks

Number Talks were selected as the basis for the virtual field experience described in this chapter because the practice is short, adaptable across mathematics content areas and group sizes, does not require materials for students, and focuses on discussion and sense making. A number talk is a short classroom routine, usually five to 15 minutes long, during which a teacher presents a carefully designed sequence of problems to a whole class or small group of students, students solve each problem mentally, and the teacher facilitates a discussion about solutions and strategies (Parrish, 2011; Sun et al., 2018). The teacher poses open ended questions throughout the discussion such as “How did you get your answer?” and “How does this strategy connect to the previous strategy?” prompting students to communicate their own ideas about problems and consider the ideas of others (Parish, 2010). As students share their mathematical thinking, the teacher listens and records students’ strategies on the board using equations and visual models. This recording works to highlight the important mathematical ideas that arise during the discussion, to connect students’ explanations to mathematical notation and visual representations, and to make students’ strategies accessible to their peers—deepening students’ conceptual understanding of key mathematical ideas (Garcia et al., 2021).

The *Principles and Standards for School Mathematics* (NCTM, 2000) and the Common Core State Standards for Mathematics (CCSSI, 2010) outline standards for instruction that build students’ conceptual understanding and flexible use of strategies along with procedural knowledge. Both documents call for mathematics instruction to be implemented across the grade span to develop students’ abilities to solve problems, construct and communicate mathematical arguments, and analyze the mathematical thinking of others (NCTM 2000; CCSSI 2010). *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014) identifies eight research-based mathematics teaching practices to promote students’ development of these skills and to support mathematics learning: “establish mathematics goals to focus learning, implement tasks that promote reasoning and problem solving, use and connect mathematical representations, facilitate meaningful mathematical discourse, pose purposeful questions, build procedural fluency from conceptual understanding, support productive struggle in learning mathematics, and elicit and use evidence of student thinking” (p. 10). Number Talks integrate these effective teaching practices into a short but powerful classroom routine that can foster students’ deep learning of mathematics.

Figures 1, 2, and 3 depict examples of problem sequences that can be used in a number talk. The problem sequence shown in Figure 1 is designed to lead students towards decomposing addends and then recomposing to make a landmark or “friendly” number (Parrish, 2010). The use of the double ten-frame visual model in this number talk supports students’ development of conceptual understanding of number composition and decomposition. In Figure 2, the sequence of problems is designed to help students build their understanding of breaking factors into smaller factors, equivalence, and the associative property of multiplication (Parrish, 2010). The problem sequences in both Figures 1 and 2 are designed so that students can use strategies from earlier problems to solve subsequent problems. In Figure 3, the numbers selected for this number talk encourage students to use common benchmarks to compare and order decimals, and the use of the visual number line model helps students to develop their

Figure 1. Example of a Number Talk using double ten-frames.
Source: Adapted from Parrish, 2010.

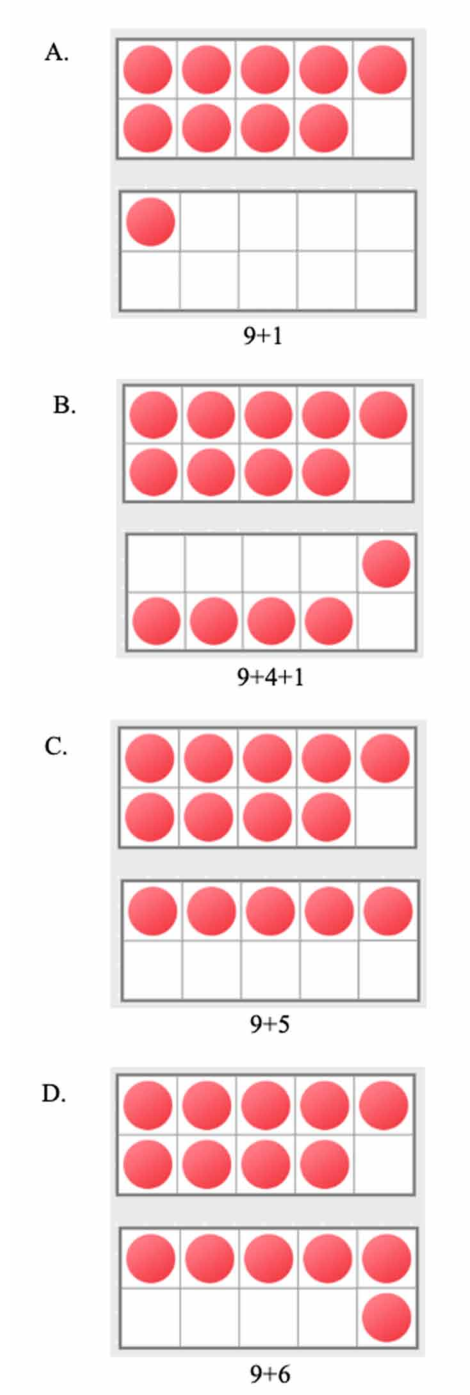


Figure 2. Example of a multiplication Number Talk
Source: Parrish, 2010

Example of a Multiplication Number Talk

A. $3 \times 5 \times 4$

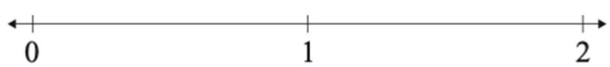
B. $2 \times 15 \times 2$

C. 15×4

Figure 3. Example of a Number Talk on comparing and ordering decimals.
Source: Parrish & Dominick, 2016.

Where would you place these numbers on the number line?
How do you know?

0.9 0.13 0.255



understanding of magnitude, density, and equivalence (Parrish & Dominick, 2011). In Number Talks, teachers use mathematically precise language and support their students in developing their use of the academic vocabulary to convey ideas and strategies. For example, the teacher and students would use mathematically precise language in the number talk depicted in Figure 3 to read the decimals (reading 0.9 as “nine tenths,” 0.13 as “thirteen hundredths,” and 0.255 as “two hundred fifty five thousandths”), fostering students’ use of fractional reasoning to consider the place value of each decimal and to locate the decimals on the number line.

Number talks can be implemented across grades PreK-12 in order to achieve several important goals. One of these goals is to help students develop number sense and understanding of numerical relationships (Sun et al., 2018). Ideas that are foundational to school mathematics, including number composition and decomposition, the base ten number system, and properties of operations, are central to Number Talks (Parrish, 2010). Another important goal of Number Talks is to shift focus towards making sense of strategies and away from a singular focus on solutions. This shift in focus can help students develop their understanding and use of strategies that are increasingly accurate, efficient, and flexible and move away from over-reliance on standard algorithms (Parrish, 2011). By centering students’ thinking, Number Talks also help to position students as creators of mathematics. Number talks contribute to the development of a community of mathematics thinkers, doers, and learners in which “mathematical authority” is no longer held solely by the teacher and is instead shared among students (Lambert et. al, 2017).

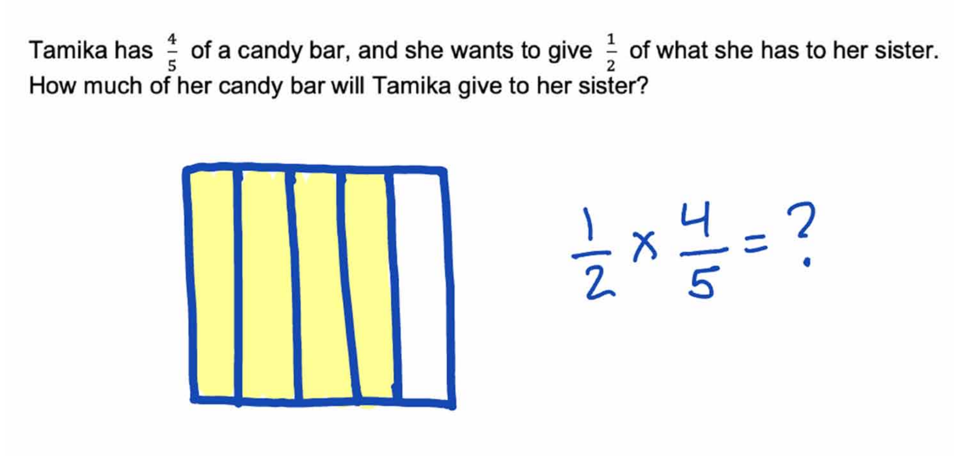
Number Talks in the Virtual Classroom

The Number Talks routine was developed for in-person teaching and learning, but the structure of the routine allows for it to be easily adapted for online teaching and learning. The Number Talks routine is short (five to 15 minutes long) and requires no tools for students to participate beyond a computer, tablet, or smartphone and an internet connection, making it well-suited for implementation in virtual classrooms. Because the routine incorporates the effective mathematics teaching practices identified by NCTM (2014) for supporting students' mathematics learning, including implementing tasks that promote reasoning and problem solving, posing purposeful questions, and facilitating meaningful mathematical discourse, Number Talks can help teachers address the challenge of how to focus on student thinking and build conceptual understanding in a virtual environment. Facilitating short mathematics discussions such as Number Talks as a component of online learning can help to maximize the impact of synchronous classroom time, which is sometimes condensed in virtual settings due to efforts to limit screen time or reductions in teacher capacity. Implementing the Number Talks routine regularly can help to maintain consistency and build connection and community in online mathematics classrooms.

To illustrate the implementation of Number Talks in a virtual classroom, an excerpt from Ms. Gray's classroom is presented. Ms. Gray is meeting with her fifth-grade class on zoom. She decided to facilitate a Number Talk with her students to explore standard 5.NF.B.4 "Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction" (CCSSI, 2010). Ms. Gray wanted to "highlight the shifting whole" (Parrish & Dominick, 2016, p. 225), the idea that when multiplying fractions, one must consider both the original whole and the new whole. Ms. Gray learned from previous formative assessments that several students are developing their understanding of equivalent fractions, and that some students could benefit from further exploration of earlier key concepts of fractional reasoning such as iteration of the unit fraction. Ms. Gray planned to use visual models to explore these ideas with students, so she made use of a digital whiteboard app to do so.

The problem $\frac{1}{2} \times 6 = ?$ was written on the white board along with one student-generated solution, 3. Ms. Gray moved quickly through this problem, which everyone in the class was able to solve easily, in order to focus time and attention on the next problem of the virtual Number Talk. Ms. Gray then displayed the following problem to the class and read the problem aloud: "Tamika has $\frac{4}{5}$ of a candy bar, and she wants to give $\frac{1}{2}$ of what she has to her sister. How much of her candy bar will Tamika give to her sister?" Ms. Grey wrote $\frac{1}{2} \times \frac{4}{5} = ?$ on the digital whiteboard and elicited solutions from the class. The solutions students offered, $\frac{2}{5}$ and $\frac{4}{10}$, were written on the board. Ms. Gray also displayed an area model depicting $\frac{4}{5}$ on the digital whiteboard (see Figure 4). Ms. Gray had anticipated potential strategies students might use to solve the problem when planning the Number Talk, and she decided to use the area model to help students make sense of each other's strategies. Ms. Gray asked the class, "Can someone share their thinking with us? Which of these solutions did you get, and what was your strategy?"

Figure 4. Problem context and area model displayed on a digital whiteboard during Ms. Gray's Virtual Number Talk



Asia: "I think the answer is $\frac{4}{10}$ because if you cut the candy bar in half, then all there would be 10 small pieces. So now Tamika has $\frac{8}{10}$, and if she wants to give half of the candy to her sister, she'll give her $\frac{4}{10}$ and she'll keep $\frac{4}{10}$ for herself."

Ms. Gray: "Ok, so you imagined cutting the candy bar in half. [Ms. Gray drew a horizontal line across the middle of the area model.] How did you know Tamika would have $\frac{8}{10}$ if you cut the candy bar in half?"

Asia: "Because there used to be 5 long pieces in the candy bar and now there are 10 shorter pieces when we cut it in half. Tamika had $\frac{4}{5}$ of the candy bar before, but all the pieces got cut in half, so now she has $\frac{8}{10}$."

Ms. Gray: "So you're saying that if we have $\frac{4}{5}$, or four pieces of a candy bar that are each $\frac{1}{5}$, and we cut four one-fifths in half, that would give us $\frac{8}{10}$. Was that your idea?

Asia: "Yeah."

Ms. Gray: "Can someone else explain what Asia is thinking here in your own words? What happened when Asia drew a line horizontally across the middle of the rectangle?"

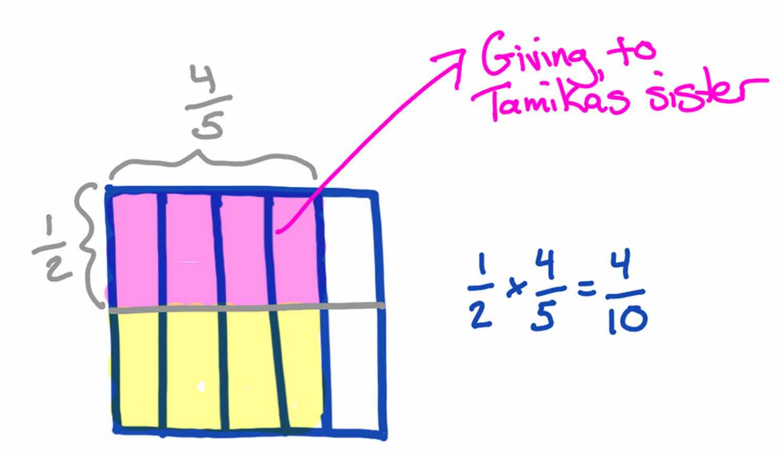
Juan: "Before the rectangle was cut into 5 equal pieces, but now we cut the pieces in half so it's cut into 10 pieces. And before the pieces were long but now we cut them in half so each piece made two pieces, so it's double."

Ms. Gray: "Ok. Now can someone use this diagram and explain Asia's strategy in your own words? How can we use this diagram to find $\frac{1}{2}$ times $\frac{4}{5}$?"

Jared: Asia made the $\frac{4}{5}$ into $\frac{8}{10}$, so Tamika still has the same amount of candy, she just broke all the pieces in half. Since she's giving half the candy to her sister, she's gonna give her four pieces and she's gonna keep four pieces. So she's giving her $\frac{4}{10}$ and she's keeping $\frac{4}{10}$, and if you put those together that's $\frac{8}{10}$.

Ms. Gray: "Ok. We started with $\frac{4}{5}$, and Asia cut the candy bar in half, so then we had $\frac{8}{10}$. And if Tamika is giving half of $\frac{8}{10}$, to her sister, she's going to give her $\frac{4}{10}$. [As Ms. Gray revoiced Asia's strategy, she shaded half of the $\frac{8}{10}$ and labeled this as being given to Tamika's sister. She also labeled the side lengths of $\frac{1}{2}$ and $\frac{4}{5}$ to make the connection to the area model of multiplication and wrote the corresponding equation, as seen in Figure 5.]

Figure 5. Asia's strategy recorded by Ms. Gray during the Virtual Number Talk



What do you all think? Does that strategy make sense to you?" [Many students used the thumbs up or heart reaction button and others wrote in the chat to show that they understood Asia's strategy.] Does anyone want to share a different strategy?"

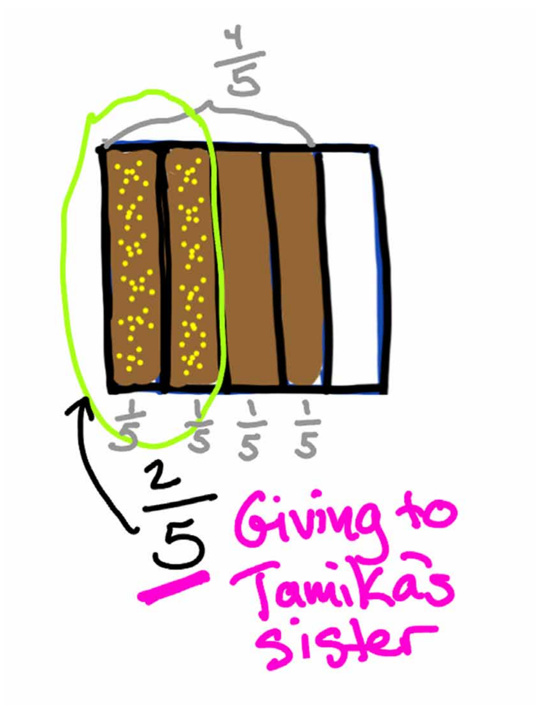
Hasan: "I looked at the first picture you had, and there were $\frac{4}{5}$ colored in. I thought if Tamika ate half of it, she would eat 2 pieces, and there would be 2 pieces left over to give to her sister, so it's $\frac{2}{5}$.

Ms. Gray: "So you looked at our original picture [Ms. Gray quickly copied and pasted the diagram showing $\frac{4}{5}$] and you saw there was $\frac{4}{5}$ of this candy bar, and if Tamika ate $\frac{1}{2}$ of what is here, she would eat 2 of those pieces that are each $\frac{1}{5}$ of the candy bar, and there would be two one-fifth pieces left? [Ms. Gray labels the diagram to match Hasan's strategy, shown in Figure 6.] Did I get that right?"

Hasan: "Yes."

Ms. Gray: "What do you all think of this strategy, does this make sense?" [Students shake their heads and give thumbs up reactions in agreement.] Both of these strategies made sense to us, but their answers look different. What do you think about that? How are these strategies similar or different?" [Ms. Gray drags the $\frac{4}{10}$ model and the $\frac{2}{5}$ model so they are side by side.]

Figure 6. Hasan's strategy recorded by Ms. Gray during the Virtual Number Talk

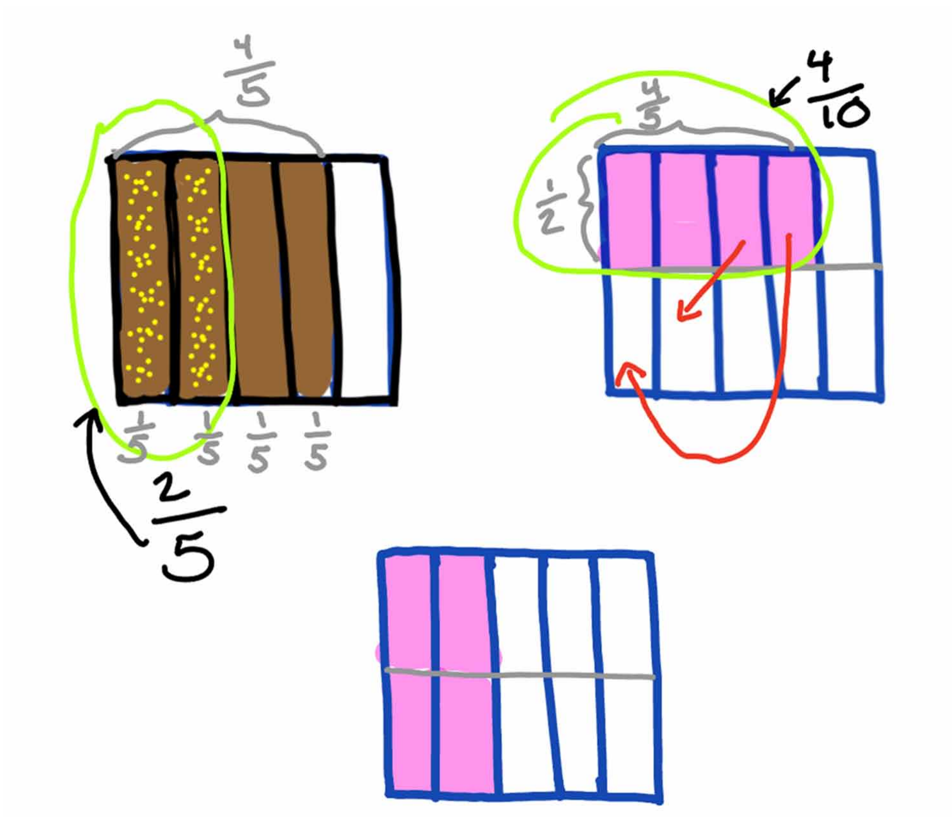


[Morgan types in the chat "*If you move 2 of the pink pieces on the right and put them under the 2 pink pieces on the left, they will look like the 2 long brown pieces.*"]

Ms. Gray: "Morgan wrote in the chat *If you move two of the pink pieces on the right and put them under the two pink pieces on the left, they will look like the two long brown pieces.*" [Ms. Gray draws arrows to demonstrate Student 6's description shown in Figure 7.] "Do you all see that? Morgan told us if we have $\frac{4}{10}$, we can imagine moving these two pieces on the right down so they are underneath these two pieces on the left, that our $\frac{4}{10}$ would now look just like the $\frac{2}{5}$ that Hasan showed us." [Ms. Gray copies and pastes the $\frac{4}{10}$ model, erases the $\frac{2}{10}$ on the right, and fills in 2/10 on the left in the bottom row.] "So if $\frac{4}{10}$ now looks just like $\frac{2}{5}$, if they have the same area, what does that tell us about $\frac{4}{10}$ and $\frac{2}{5}$?"

Chloë: "$\frac{4}{10}$ and $\frac{2}{5}$ are equivalent because they are really the same size."

Figure 7. Morgan's explanation of the equivalence of $\frac{4}{10}$ *and* $\frac{2}{5}$

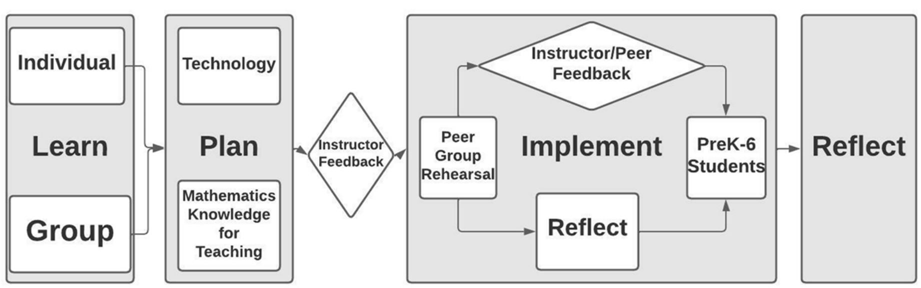


Ms. Gray's implementation of a virtual Number Talk allowed her to facilitate a rich discussion focused on students' sense making and reasoning about fractions. Ms. Gray employed several technological tools during the Number Talk: a laptop and video conferencing software to run the class meeting and a tablet, stylus, and digital whiteboard to record students' strategies throughout the discussion. Ms. Gray's use of technology to record student thinking allowed her to highlight key mathematical ideas throughout the discussion, such as equivalent fractions, iterating the unit fraction, proportional reasoning, and the "shifting whole." The digital whiteboard allowed her to quickly and easily copy and paste models to make connections between students' strategies. Because work on a digital whiteboard can be saved, Ms. Gray is able to revisit the visual models from the Number Talk in future discussions. Conducting the Number Talk using video conferencing software created opportunities for multiple means of student participation, including speaking, typing in the chat, and using reaction buttons. Video conferencing software gives all students a close-up view of the board and allows the teacher to "pin" the video of the speaker, supporting students in focusing their attention during the discussion. The Number Talk classroom routine provided a structure through which Ms. Gray facilitated a short but powerful discussion in her online classroom. By implementing virtual Number Talks, Ms. Gray is able to maximize synchronous class time and put student meaning-making and discourse at the center of virtual teaching and learning.

VIRTUAL NUMBER TALKS TEACHER LEARNING CYCLE

Number Talks were chosen as the framework for the virtual field experience because the practice is adapted easily to online environments and provides a structure in which preservice teachers can engage in several of the eight research-informed practices advocated by NCTM to support more equitable teaching, such as implementing tasks that promote reasoning and problem solving, supporting productive struggle, posing purposeful questions, and eliciting and using evidence of student thinking (NCTM, 2014; Smith et al., 2017). The Virtual Number Talks Teacher Learning Cycle was developed to guide preservice teachers through the virtual field experience in four phases: *learn*, *plan*, *implement*, and *reflect*. The design of the Virtual Number Talks Teacher Learning Cycle was based on an adaptation of Teacher Education by Design's principles and learning cycle (University of Washington, 2014) and can be implemented as a single cycle or multiple iterations of the cycle (Joswick et al., 2021). Figure 8 shows one iteration of the Virtual Number Talks Teacher Learning Cycle.

Figure 8. One cycle of the Virtual Number Talks Teacher Learning Cycle
Source: Fletcher & Meador, 2022



Development of the Virtual Number Talks Teacher Learning Cycle

The Virtual Number Talks Teacher Learning Cycle was developed during the summer of 2020 for initial implementation during the Fall 2020 semester (Joswick et al., 2021). The field experience project design was based on a teacher learning cycle because learning cycles provide a structure in which teachers can learn about ambitious teaching practices through collaboration with peers around a common professional goal or instructional activity (University of Washington, 2014). The cycle format serves as an iterative structure in which to learn about, practice, and reflect on teaching moves directly related to disciplinary content. This structure allowed for the design of learning activities in which preservice teachers could be introduced to the distinctive elements of Number Talks throughout the semester, such as implementing participation norms, facilitating discussions about purposeful sequences of problems, and developing a classroom community of learners (Parrish, 2011), and eventually put these elements into practice with PreK-6 students. To develop the Virtual Number Talks Teacher Learning Cycle, activities were strategically designed for each phase of the cycle to work towards the goals of the field experience, including engaging in effective mathematics teaching practices (NCTM, 2014) and building technological and pedagogical knowledge for teaching.

The cycle begins with the *learn* phase, in which preservice teachers complete readings introducing the Number Talks routine (Parrish, 2010, 2011) and watch videos of Number Talks facilitated in classrooms with students (e.g., Parrish, 2010). Preservice teachers responded to prompts, both in individual responses and in discussion board posts, reflecting on elements of the routine such as the routine's structure, the teacher's role, encouragement of student communication in the routine process, and opportunities to assess student thinking and learning. The instructors facilitated discussions of students' learning during class time (occurring either virtually or face-to face) to help students synthesize information learned through the readings, videos, and assignments.

In the next phase of the cycle, preservice teachers *plan* for their eventual facilitation of Number Talks with PreK-6 students. This phase begins with watching three videos: a video created by the first author that gives an overview of planning for Number Talks, establishing classroom participation norms, discussion prompts for students, facilitating questions, and visual models; a webinar video created by Cecilio Dimas (2020) that explored technologies and strategies for facilitating Number Talks virtually that keep the routine grounded in purposeful discussion and collaboration; and a video of a number talk facilitated in a PreK-6 classroom (a list of number talk videos across grades and content areas was provided, and preservice teachers selected a relevant video to watch). Preservice teachers then selected a set of problems for their number talk from a curated collection of problem sets and then completed a planning document in which they were asked to anticipate student strategies and plan for student learning goals, technology tools to be used (both for facilitating the number talk online and for recording student thinking on screen), discussion questions, and participation norms and tools. At the conclusion of the Plan Phase, the course instructors provided feedback so that any issues in the number talk plan developed by the preservice teachers could be addressed prior to implementation.

The *implement* portion of the cycle consists of two tasks: rehearsing a number talk with a group of peers and then conducting the same number talk with a group of PreK-6th grade students. Small groups of preservice teachers met together online to complete and video record the rehearsal assignment. Group members took turns taking on the role of "teacher" to practice facilitating their number talk and acted as students while other group members facilitated their Number Talks. In addition to facilitation practice, this assignment created the opportunity for students to help one another with technology tools and facilitation strategies. Preservice teachers then completed a short reflection on the rehearsal and made any needed adjustments to their number talk plans. After completing the reflection assignment, preservice teachers facilitated and video recorded their number talk with PreK-6th grade students. The Number Talks could be completed with either a small group of three or more students or a whole class, allowing for preservice teachers with classroom placements to plan for group size based on students' needs, while those without classroom placements could get the full experience with only a small number of participating students. Preservice teachers were strongly encouraged to conduct their Number Talks online, both as an opportunity to practice using technology tools for virtual collaboration and mathematics teaching and learning, and for health and safety reasons. After the number talk facilitation, preservice teachers watched a number talk video recorded by a peer and provided one another with observations and feedback on student learning, questioning and discussion facilitation, technology tool implementation, as well as general strengths and observations.

The final phase of the Virtual Number Talks Teacher Learning Cycle is the *reflect* phase, in which preservice teachers watch their number talk video, review their previous assignments and feedback received throughout the cycle from the instructor and peers, and complete a final reflection on their teaching and learning. Preservice teachers were asked to reflect on establishing participation norms, engaging students, using visual models, facilitating student communication, recording student thinking, and implementing technology, and then were asked to consider how their learning throughout the cycle would impact their teaching going forward. In courses in which the time frame allows for implementation of more than one cycle iteration, subsequent iterations are completed prior to the final reflection, with preservice teachers planning and implementing a new number talk with either the same or a new group of students. In each new cycle iteration, preservice teachers would be encouraged to modify or change their technology tools used depending on the mathematical representations needed for the selected problems and the plans for online collaboration based on group size and student needs.

Changes Made to the Virtual Number Talks Teacher Learning Cycle Following Initial Implementation

When schools transitioned to remote learning in early 2020, the focus of many teachers and schools was the logistics of teaching online (such as determining hardware and internet availability for teachers and students and learning new technology tools to deliver lessons online), and these logistics were also at the forefront of the authors' minds, as mathematics teacher educators, and preservice teachers' minds, as both students and new teachers. The initial implementation of the Virtual Number Talks Teacher Learning Cycle in Fall 2020 reflected this common focus on the logistics of teaching and learning online. Number Talks preparation assignments focused on selecting technology tools and developing online participation norms and routines. These preparation assignments also included prompts related to student learning, but the prompts were rather broad and did not elicit deep thinking about the mathematical goals of the Number Talk. The first version of the rehearsal assignment directed preservice teachers to rehearse their Number Talk with peers and discuss ways to improve the Number Talk but did not include any prompts to facilitate the discussion. The first version of the assignments asked preservice teachers to reflect on their own Number Talk videos or a peer's Number Talk videos and included a two-part question asking about how students participated and what students knew as mathematicians. However, preservice teachers' responses focused primarily on student participation methods. Preservice teachers were asked to reflect on how they elicited student thinking, but most focused on reporting basic, low press questions posed during their Number Talks, such as "What was your solution?" and "How did you solve the problem?"

Though this focus on logistics was understandable during the initial phase of remote learning, in subsequent implementations of the Virtual Number Talks Teacher Learning Cycle, the authors sought to move preservice teachers beyond logistics to thinking more deeply about the mathematics learning goals of their Number Talks, the ways students may engage with the mathematics, and pedagogical strategies that could support the mathematics learning goals. In the second implementation of the Virtual Number Talks Teacher Learning Cycle in Fall 2021, the Number Talks preparation assignment emphasized identifying the mathematics of the Number Talk (using the Common Core State Standards of Mathematics (CCSSM, 2010) and the course textbook (Bassarear & Moss, 2020; Van de Wall et al., 2019) as resources), anticipating student strategies (again using the course textbooks as a resource), practicing recording student thinking, and generating discussion facilitation questions specific to the selected problems. The preparation assignment also provided scaffolding for how to select problems for Number Talks based on grade-level CCSSM (2010) standards. To help preservice teachers conduct more fruitful discussions during their rehearsals, discussion prompts were added to the rehearsal assignment, guiding preservice teachers to discuss what went well, the establishment of participation norms, visibility of writing and visual models, use of technology, eliciting student participation and use of wait time, the effectiveness of recording student thinking, discussion facilitation, and mathematical accuracy of the teacher's language and recording.

In the assignments reflecting on Number Talk videos, prompts were revised and added, asking preservice teachers to give specific examples of students' mathematical thinking and make connections to course readings, reflect on the effectiveness of their recording of student thinking, and observe connections made by students across problems or strategies. The prompts in the peer feedback assignment were revised to focus on students' mathematical thinking, analyzing the effectiveness of questions to elicit student thinking and recording student thinking, and considering how the recording helped students to make sense of ideas. The final reflection assignment was also revised to emphasize students' mathematical thinking, pedagogical moves to support students' understanding, and the impact of the Virtual Number Talks Teacher Learning Cycle on future teaching practice. Overall, the revisions to the assignments throughout the Virtual Number Talks Teacher Learning Cycle helped preservice teachers to think beyond the logistics of online learning and towards thinking deeply about the mathematical goals of Number Talks, the pedagogical practices needed to achieve these goals, and the ways students engaged with the mathematics during the Number Talks.

IMPLEMENTATION OF THE VIRTUAL NUMBER TALKS TEACHER LEARNING CYCLE

Setting and Participants

This chapter explores the implementation of the Virtual Number Talks Teacher Learning Cycle in two different university contexts in 15-week semesters from Fall 2020 through Spring 2022. One university setting was an undergraduate level, elementary and middle school mathematics content course, offered in a hybrid format, at a medium-sized public university in the southern United States. The 48 students enrolled in the undergraduate content course included early childhood and elementary education majors, middle school (grades 4-8) general education, mathematics education, and mathematics/science education majors, and a small number of agricultural education students. The focus of the undergraduate content course was number and operations. As the course moved through content topics, the instructor embedded Number Talks into her teaching to demonstrate to the class how to facilitate discussions, pose questions, record student thinking, and use class discussions for formative assessment for each of the content topics. The Virtual Number Talks Teacher Learning Cycle implementation in the undergraduate content course was an introductory approach to Number Talks and mathematics teaching practice, with students engaging in one cycle of learning, planning, implementing, and reflecting, which included conducting one Number Talk with preK-6th grade students.

The second university context was a master's-level, elementary mathematics methods course offered in an online, hybrid synchronous and asynchronous format at a small private university in the northeastern United States. Many of the 29 students in the two sections of the course were enrolled in their fifth year of a five-year integrated Bachelor of Arts/Master of Arts program in elementary education, and others were in their second year of an elementary education Master of Arts program during the fall semester before student teaching. The Virtual Number Talks Teacher Learning Cycle was used as a virtual alternative to the fieldwork component typically required in the course. The course focused on elementary mathematics teaching methods through an equity and antiracist lens and used Number Talks to model teaching practices that "empower students, center students' thinking, and position students as creators of mathematics" (Meador & Fletcher, in press, p. 7). The Virtual Number Talks Teacher Learning Cycle implementation in the graduate methods course was a more in-depth approach to Number Talks than in the undergraduate course, with students engaging in two cycles of learning, planning, implementing, and reflecting, which included conducting two Number Talks with K-6th grade students.

LESSONS LEARNED: USING TECHNOLOGY FOR VIRTUAL MATHEMATICS TEACHING AND LEARNING

Development of the Virtual Number Talks Teacher Learning Cycle served a particular need during a specific time period–to provide preservice PreK-6 teachers with mathematics field experiences when access to schools was fluctuating and limited due to COVID-19. Though development was initially intended for temporary implementation, the Virtual Number Talks Teacher Learning Cycle presented benefits that make the practice one that is worth carrying forward beyond the COVID-19 context. The Number Talks routine focuses on several effective mathematics teaching practices, such as facilitating purposeful mathematics conversations, posing questions that elicit student thinking, and using and connecting representations such as visual models and equations (NCTM, 2014; Smith et al., 2017). As a virtual field experience, the Virtual Number Talks Teacher Learning Cycle created opportunities for preservice teachers to engage in these effective teaching practices in an online classroom environment and allowed for implementation of educational technology tools in authentic teaching and learning contexts. The lessons learned through implementation of the Virtual Number Talks Teacher Learning Cycle–including adaptability of the virtual field experience, availability of technological tools for teachers and students, technological knowledge of preservice teachers, use of technology for specific pedagogical purposes, and equity considerations in virtual teaching and learning opportunities–provide important insights into designing effective online learning opportunities in mathematics education and beyond.

Adaptability of the Virtual Field Experience

When considering the significance of this project and lessons learned for online teacher education, the adaptability of the Virtual Number Talks Teacher Learning Cycle field experience was a benefit that was uncovered after successful launches in different courses offered using different modalities. For example, the Virtual Number Talks Teacher Learning Cycle was utilized in both a graduate teaching methods course for preservice teachers offered solely online and an undergraduate mathematics content course for preservice teachers offered in a hybrid format. Although both courses had different goals and learning objectives for the project, analyses conveyed that preservice teachers enrolled in either course were able to participate in a field experience with students that positively contributed to their technological, pedagogical, and content knowledge (TPACK, Koehler & Mishra, 2009). Conducting Number Talks virtually created opportunities for preservice teachers to incorporate technology into their instruction of a specific content area, allowing for preservice teachers to develop their technological and pedagogical knowledge specifically, as well as TPACK as a whole (Fletcher & Meador, 2022).

In addition, the implementation of the Virtual Number Talks Teacher Learning Cycle through distinct course modalities, online and hybrid, demonstrates the versatility of the field experience design for use in varying methods of instructional delivery. Based on analyses of assignments from both course deliveries, when participating in the Virtual Number Talks Teachers Learning Cycle the preservice teachers taking the course online had an experience comparable to that of the preservice teachers taking the course in a hybrid format. Implications of this utility extend to offering the same field experience component across multiple sections of the same course for preservice teachers, without compromising the integrity of the experience due to differences in content delivery through online or face-to-face means. In their reflections on participating in the Virtual Number Talks Teacher Learning Cycle, preservice teachers foresaw a positive impact on their future teaching practice, noting their development of effective teaching practices for mathematics content with technology. This was especially true for preservice teachers who engaged in additional Virtual Number Talks Teacher Learning Cycle iterations.

The development of a highly adaptable field experience that can be implemented in or out of schools, with small or large groups of students, in the same or different locations, evolved out of necessity. For instance, during the initial semester of implementation of the Virtual Number Talks Teacher Learning Cycle, some schools were open for in-person learning but did not allow outside visitors, while other schools operated in a hybrid cohort model. The design of the field experience–virtual implementation of a short, discussion-focused mathematics classroom routine that is well-established and widely used–made it easier for in-service teachers to grant classroom access and reduced the time commitment usually required for hosting preservice teachers. This also proved beneficial for the preservice teachers as transportation to and from the school was not required and schedules could be more easily accommodated due to the short Number Talks task time frame.

For preservice teachers who were not able to secure classroom placements when schools were operating remotely, the adaptability and virtual delivery of the field experience enabled preservice teachers to work with groups of students of the same age or grade level from different schools, and sometimes even different geographic locations. In some cases, this created opportunities for preservice teachers to work with diverse populations of students and schools in varying locations, an opportunity they may not have had access to otherwise. For example, one preservice teacher coordinated their virtual Number Talk at their former rural, regional elementary school in another state with a high population of economically disadvantaged children. This contrasts with the university's partner schools, which are more affluent, urban schools near campus, and which typically serve as assigned field placement sites. The course instructors were also able to secure groups of students through connections with colleagues or after school programs for preservice teachers unable to find groups of students on their own, though this did require a considerable time investment from the instructors. While the adaptability of the field experience offered a number of advantages, especially given that online teacher education could occur in a host of locations across the globe, the time and coordination necessary to implement such field experiences should be taken into consideration.

Availability of Technological Tools for Teachers and Students

An important consideration for online teaching learned through the Virtual Number Talks project was the availability of technological tools for both teachers and students. After two years of pandemic teaching and learning, most preservice teachers have participated as a student in synchronous online courses taught using video conferencing platforms such as Zoom or Google Meets. The authors learned, first through online teaching and then through guiding students through the Virtual Number Talks project, that participating in an online class is quite different from teaching a synchronous online class. At a minimum, teachers need to manage admitting students to the online "classroom," sharing screens, establishing norms for online participation, monitoring the chat and reaction buttons, and managing breakout rooms. In addition to these basic elements of running an online synchronous class, teachers may wish to incorporate supplemental educational technology programs such as shared documents, polls, interactive whiteboards, and more. The Virtual Number Talks project allowed preservice teachers to gain experience selecting and implementing technological programs and tools in an authentic learning experience for PreK-6 students. Gaining experience using technological tools for teaching and learning is important for all preservice teachers and particularly for those whose programs may not offer an educational technology course.

Planning online instruction in mathematics has unique considerations, as teachers at all levels must be able to write equations and interact with visual models. These necessary components of mathematics teaching proved to be particularly challenging for our students. Many students assumed that access to a computer and internet would be sufficient for teaching mathematics online but learned through their experiences with implementing virtual Number Talks that writing with a mouse or trackpad was slower and more difficult than writing with a stylus and touchscreen device or with a physical whiteboard. One such undergraduate, middle school preservice teacher addressed this idea in their individual reflection following their first Number Talk.

I held my Number Talk over Zoom. My students were able to attend using multiple devices such as computers, ipads, or smartphones. I built a Powerpoint slide show and shared my screen with my students. As my students presented solutions and strategies, I recorded these strategies using the writing tools provided in the Powerpoint program. Next time, I may want to use an ipad or tablet so I can better use the writing tool. This will result in quicker and cleaner writing.

By watching students' videos of Number Talks, the authors learned that when preservice teachers relied on a mouse or trackpad for writing, their recording of student thinking was significantly limited (and at times eliminated altogether). Considering the tools available for writing equations and interacting with visual models is a crucial element of planning for virtual instruction. In the absence of access to a touchscreen device and stylus, teachers can write on a physical whiteboard or chart paper affixed to the wall behind them (ensuring that the camera angle and writing size are clearly visible to students) or use a document camera (or makeshift document camera fashioned with a smartphone) to display writing on paper.

Teachers must also consider the technological tools available to students. Teachers must ascertain whether students will be participating in online classes via a computer, tablet, or smartphone, whether students have access to reliable internet, and whether students' devices have cameras and microphones. Even when students have access to a device, teachers should consider that students may not be able to join online classes with a camera on due to internet connection strength or the number of devices connected to the same network, or they may not feel comfortable displaying their home environment for others to see (and their device may not support a virtual or blurred background). When planning class activities, teachers need to consider whether students will be writing or manipulating technological tools on a touchscreen device or with a mouse, trackpad, or keyboard, as well as whether students have the fine motor skills necessary to operate these tools. Teachers should work with families and school administrators to ensure students have the devices and internet connection necessary to engage in virtual learning, and teachers should work to design learning opportunities that are accessible to students using their available devices (TODOS, 2020). Mathematics teacher educators must support preservice teachers in learning to implement educational technology tools effectively *and* teach preservice teachers how to support their future students and families as they engage in online learning.

Technological Knowledge of Preservice Teachers

Preservice teachers had varied familiarity with and responsiveness to exploring technology tools. In some cases, preservice teachers were experimenting with new technology tools for the first time and during the rehearsal did not always have a wide enough technological knowledge base to assist one another, especially when not working with the same technology. Others did not have access to technology tools for representing mathematics, and some even expressed an aversion to using such tools. Though many teachers have successfully used digital and analog tools simultaneously to deliver effective online instruction, the preservice teachers who were lacking technological knowledge or averse to using technology often did not know how to ensure that their analog tools were adequately visible to students participating virtually. This minimized opportunities for students to access others' thinking and ideas or to make connections between problem solving strategies within the Number Talks.

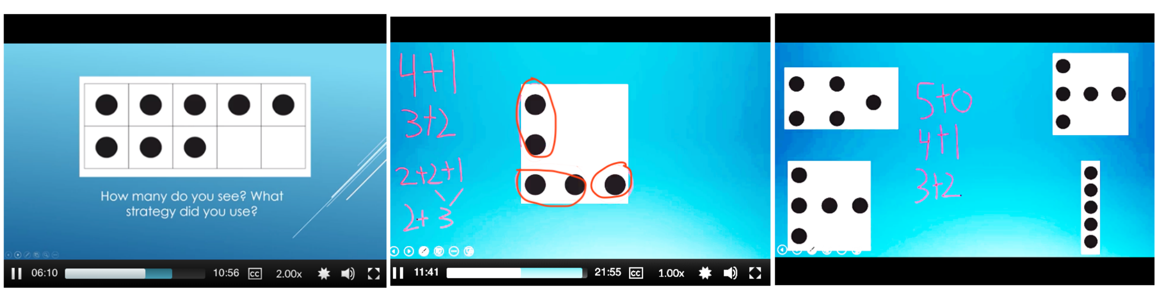
In addition, many preservice teachers were not aware of many of the features available within technology tools that would enhance the Number Talks experience, and it took a few iterations of the cycle for those features to be uncovered. Although students learned about technologies for facilitating virtual Number Talks through the Dimas (2020) webinar video and were provided with a list of available technological tools, more explicit instruction, further demonstration of tools, and additional interactions with educational technology in future iterations of the Virtual Number Talks Teacher Learning Cycle will help preservice teachers develop the technological skills needed to facilitate effective virtual teaching and learning opportunities.

Use of Technology for Specific Pedagogical Purposes

Through participation in the Virtual Number Talks Teacher Learning Cycle, preservice teachers learned about the use of technological tools for specific pedagogical purposes. Preservice teachers started the Virtual Number Talks Teacher Learning Cycle with varying degrees of technological knowledge. Some were learning the basics of running a Zoom meeting or designing a PowerPoint, and others were quite familiar with a number of educational technology tools and programs, such as Jamboard or Padlet. For preservice teachers at all points along the technological knowledge spectrum, development of their technological, pedagogical, and content knowledge (TPACK, Mishra & Koehler, 2006, 2009) and their use of technology in support of their pedagogical goals was an important outcome of the Virtual Number Talks Teacher Learning Cycle (Fletcher & Meador, 2022).

In a case study examining the development of preservice teachers' TPACK through the virtual Number Talks field experience, Fletcher and Meador (2022) analyzed the TPACK growth of two preservice teachers with markedly different backgrounds and technological knowledge. Alex, a preservice teacher who had worked previously as an intern in an elementary school, had basic general technology knowledge at the start of the Virtual Number Talks Teacher Learning Cycle. In Alex's first virtual Number Talk, Alex used PowerPoint and the screen sharing feature of Zoom to display dot images on the screen. Alex focused the activity on a verbal discussion and did not record students' strategies or make any gestures or cursor movements towards the dots, a missed opportunity for making students' ideas accessible to others. In Alex's second virtual Number Talk, Alex used the PowerPoint pen tool to circle dots and write equations corresponding to students' shared strategies (see Figure 9). At the end of the virtual Number Talk, Alex shared a slide displaying all of the dot images and facilitated a discussion of connections across the dot images, recording expressions offered by students to highlight various decompositions of the number five. Alex demonstrated development of both Mathematical Knowledge for Teaching (MKT, Ball et al., 2008) and TPACK, using the selected technological tools in order to focus the discussion on whole number decomposition.

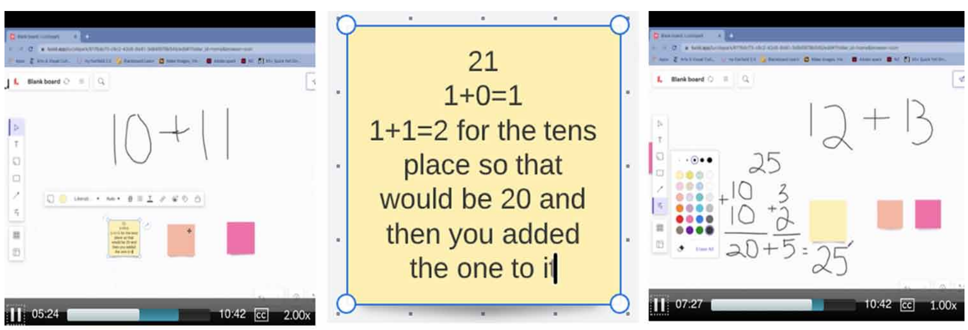
Figure 9. Images from Alex's first (left) and second (middle and right) virtual Number Talks Source: Fletcher & Meador, 2022



The second teacher analyzed in Fletcher and Meador's (2022) case study was Skylar, a preservice teacher with prior classroom experience and knowledge of more advanced knowledge of newer technological tools. Skylar initially used technological tools that did not help advance the pedagogical goals of the Number Talks and instead may have hindered students' learning. Throughout their first virtual Number

Talk and at the start of their second, Skylar used a virtual whiteboard app with "sticky notes" and typed students' strategies verbatim. Though Skylar attempted to honor students' thinking and share it with other students by typing what students shared, Skylar was unable to represent the number decomposition and place value understanding demonstrated in students' strategies with this method. The technological tools Skylar selected did not support student sense making or the mathematical goal of the Number Talk. At the midpoint of their second Number Talk, Skylar switched from typing students' words on virtual sticky notes to recording students' strategies by writing equations with the pen tool (see Figure 3). This change in the technological tool used to record student thinking allowed Skylar to connect students' ideas to formal notation and to highlight the place value concepts of the students' strategies. Similar to Alex, Skylar showed growth in both MKT (Ball et al., 2008) and TPACK as they moved from using "tech for tech's sake" to selecting technological tools that were best suited for achieving the desired mathematical goals of the Number Talk. Mathematics teacher educators must support preservice teachers not only in their knowledge of educational technology tools, but also in their ability to assess and select the tools needed to achieve their specific pedagogical goals.

Figure 10. Images from the beginning of Skyler's virtual Number Talk (left and middle) and the end of the Number Talk (right)
Source: Fletcher & Meador, 2022



Equity Considerations in Virtual Teaching and Learning Opportunities

When the authors were designing the virtual field experience in summer 2020 in anticipation of schools operating remotely or in a hybrid format due to the COVID-19 pandemic, Number Talks were selected as the focus of the virtual field experience because of the routine's potential to contribute to equity in mathematics teaching and learning. Equitable mathematics teaching and learning practices create opportunities to focus on students' thinking, build on students' mathematical resources, support students' development of deep understanding of mathematics, and foster students' mathematical agency (Aguirre et al., 2013), all of which are fundamental elements of Number Talks. The authors believed that facilitating virtual Number Talks would give preservice teachers the opportunity to engage in a practice focused on these elements while teaching in an online environment.

Through implementation of the Virtual Number Talks Teacher Learning Cycle field experience, the authors learned that Number Talks are not automatically an equitable mathematics teaching and learning practice. As the authors watched videos of our preservice teachers facilitating Number Talks with K-6 students, at times the authors observed inequities that plague mathematics being perpetuated rather than ameliorated through our students' virtual Number Talks practice. In one example, a white male preservice teacher facilitated a virtual Number Talk with three boys (one Black boy and two white boys) and called on the same boy, who was white, first for every problem, even when the Black boy had his hand raised to answer. Observing this example and others caused the authors to revisit the assignments and peer feedback prompts, and upon doing so, the authors realized that students were not asked to attend to equity at any point of the Virtual Number Talks Teacher Learning Cycle. TODOS President Linda Fulmore stated in her message from May 31, 2020, "We can no longer believe that a focus on curriculum, instruction, and assessment alone will be enough to prepare our children for survival in the world. We need antiracist conversations for ourselves and for our children." Moving forward, attending to equity and antiracism will be a central component of the virtual Number Talks field experience. The authors plan to integrate Herbal-Eisenmann and Shah's (2019) paper *Detecting and Reducing Bias in Questioning Patterns* into one of the early Virtual Number Talks Teacher Learning Cycle assignments. As students move through the Teacher Learning Cycle, they will be asked to reflect on questions such as:

What does equitable mathematics teaching and learning look like in Number Talks?

As you watch your Number Talks videos, who was called on to contribute to the conversation, and who was not called on?

Who was called on first or last? What types of questions did you ask, and to whom?

How have you contributed to creating equitable learning opportunities for your students during your Number Talks? Where there moments in your Number Talks where learning opportunities were inequitable?

How can we work towards antiracist mathematics teaching through our Number Talks practice?

In their position statement on Equity Considerations for Access, Design, and Use of Technologies for Teaching Mathematics, TODOS (2020), calls for mathematics teachers to "commit to critically examining our learning environments so that humane uses of technology are prioritized" (p. 5). Mathematics teacher educators must create opportunities for preservice teachers to develop these critical examination skills in mathematics teacher education courses to create equitable teaching and learning opportunities for their future students.

CONCLUSION

Originally created as a response to satisfy field experience requirements during the COVID-19 pandemic, the Virtual Number Talks Teacher Learning Cycle has since evolved into a sustainable practice for educating preservice mathematics teachers in a variety of platforms and instructional modalities. The case can be made for virtual Number Talks as a field experience option for the preparation of teachers' instructional facilitation in the online classroom. Not only are preservice teachers gaining knowledge and skills for online teaching by facilitating virtual Number Talks, they are also being provided with an opportunity to increase their knowledge of technologies for mathematics instruction. Based on successful implementation in differing courses, design of the Virtual Number Talks Teacher Learning Cycle also affords teacher educators the versatility to transition the field experience across different instructional contexts such as online, hybrid, or even face-to-face.

Carrying out instruction in a virtual classroom comes with its own nuances and considerations. Writing and displaying the various representations and symbols necessary for effective mathematics instruction (Dreher & Kuntze, 2014) can increase the complexity of online teaching. Therefore, understanding the technologies that can be used to display mathematics content in a virtual space is crucial for accurate representation of mathematical ideas. To prepare preservice teachers for the online environment, awareness must also be drawn to the technology demands of teaching in a virtual classroom, in addition to the general instructional requirements, and the various factors that must be considered in online teaching and learning, such as instruction facilitation via online collaboration platforms, technology for representing content, and technology for access to the virtual space.

Because the Number Talks were conducted virtually, options for securing placements were more accessible due to the short duration of Number Talks and the willingness of mentor teachers to allow entry to classrooms through online collaboration platforms. One advantage of this project extends to the consideration that online field experiences like the Virtual Number Talks Teacher Learning Cycle provide preservice teachers in different regions or locales not proximal to the university, access to a school or students that may not have previously been attainable through traditional placement methods. Additionally, adaptability of the field experience and the removal of physical location barriers allows for exposure to a wide range of schools and students that might not have been possible otherwise. This may also provide schools an opportunity to open their doors to a broader pool of potential teacher candidate hires.

The practical connections of this work provide implications that may promote and inform general mathematics instruction in online classrooms and may extend to both the virtual education of preservice teachers and the development of online instruction in the field of mathematics. Implementing and researching the Virtual Number Talks Teacher Learning Cycle with multiple cohorts of preservice teachers has afforded a knowledge base for the instruction of mathematics in the virtual sphere. The sudden shifts to online learning provoked the development of new and more effective models of teaching and learning for the future (Kaden, 2020). The lessons learned through the implementation of the virtual Number Talks field experience can inform mathematics teacher education, as well as teacher preparation programs more broadly, to better prepare preservice teachers for effective teaching and learning in a virtual age.

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