Responding to Current Field Experience Challenges with the Virtualization of Number Talks

Candace Joswick, University of Texas at Arlington, Audrey Meador, West Texas A&M University
Nicole Fletcher, Fairfield University, Kimberly Conner, University of Northern Iowa, &
Brandon McMillan, Brigham Young University

As mathematics teacher educators, we describe here the virtualization of a traditionally face-to-face, commonly used classroom practice as a response to the current COVID-19 health crisis and the accompanying shift to online field experiences. We report aspects of our "virtualization" of Number Talks, describing "Virtual Number Talks" and a Teacher Learning Cycle specific to taking up this practice in the context of mathematics teacher education courses. We deliberately chose Number Talks because of the potential to focus on student discourse and mathematical thinking (e.g., Parrish, 2011) and widespread use in PreK-12 schools (Matney, Lustgarten, & Nicholson, 2020).

Number Talks

The use of Number Talks supports student investigation of multiple solution strategies and allows for conversations that are focused on student thinking and sense making (SMP 2: Reason Abstractly & Quantitatively, National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). In these 5- to 15-minute classroom discussions about an intentionally designed problem or sequence of problems (Humphreys & Parker, 2015; Parrish & Dominick, 2016), students first solve the problem(s) using mental math and then share their solutions and strategies with the class, allowing for discussion of their developing conceptualizations, comparison of their ideas with one another, and making connections between strategies (Parrish, 2011; Sun, Baldinger, & Humphries, 2018). For teachers, facilitating this mathematical routine provides an opportunity to practice: establishing productive classroom norms, eliciting students' strategies, recording strategies in a way that makes sense for all students, and then responding with questions to further reveal students' thinking and make connections between strategies (Parrish, 2011). For these reasons, and since the use of Number Talks need not be directly tied to regular classroom content (Sun et al., 2018), this particular routine is especially suitable for mathematics teacher education courses and virtualization.

Virtualizing Number Talks

For our virtualization of Number Talks, we describe a "Virtual Number Talks" routine (VNTs) and a Teacher Learning Cycle (TLC) for developing PreK-12 pre-service and in-service teachers' capacity for implementing VNTs. We first explain the latter.

Virtual Number Talks Teacher Learning Cycle

We implemented the VNTs TLC in four mathematics teacher education courses that varied in: audience, including initial teacher preparation and the continuing education and professional development of practicing teachers (most of whom were unfamiliar with Number

Talks); grade/content bands of K-6, PreK-8, and PreK-12; institution location; and course modality, including asynchronous and synchronous online and hybrid learning environments. The TLC is a variation of what would be done in traditional, face-to-face mathematics teacher education that we adapted for online implementation, utilizing learning management software (e.g., Canvas), without relying on synchronous meetings.

Our VNTs TLC, modeled after Teacher Education by Design's (2014) principles and learning cycle, has four main iterative components: *learning*, *planning*, *implementation*, and self- and peer-*reflection*. The cycle components can be repeated with varying goals and purposes. For example, one iteration of the cycle may have an overarching goal of a rehearsal to prepare for a VNT with students. In this iteration, teachers may *learn* about Number Talks, *plan* for a VNT that they would like to do with students, and then *implement* their VNT with peers and colleagues as a rehearsal (Horn, 2010). Finally, teachers would *reflect* on their implementation, gather feedback from their peers and colleagues, and begin the TLC again. The next iteration may have the goal to refine the VNT plans from the rehearsal to actual implementation with PreK-12 students.

For our courses, teachers repeated the TLC three to five times, depending upon the duration and goals of the course. The VNTs TLC is generally described in Table 1, which shows a description of each component in row one and comments on the virtual implementation and how it differs from traditional, face-to-face Number Talks TLC implementation in row two.

Table 1: *Virtual Number Talks Teacher Learning Cycle*

	Learning	Planning	Implementation	Reflection
Description	• Read about the theoretical basis of Number Talks • Watch and discuss videos of PreK-12 Number Talks	• Select problems for VNTs from provided resources • Identify technology to use when enacting VNTs	• Implement rehearsal VNTs with peers/ colleagues or implement VNTs with PreK-12 students • Video record for peer- and self- review	• Reflect on VNTs videos: student thinking and how teachers elicited this thinking and supported students to make sense of each other's thinking. Identify what went well and changes for future iterations • Give and receive feedback from peers/colleagues
Virtualization	*In lieu of modeled Number Talks by the course instructor, videos were used. Learning management discussion boards were also utilized.*	*Added supports for teachers' use and mastery of technology tools for VNTs, especially video conferencing.*	*Rehearsal with peers/colleagues in virtual format to test technology plans. This modification was in lieu of teachers demonstrating Number Talk routines in class.*	*Reflection included comparison of efficacy of virtual implementation to traditional implementation, pedagogical elements (e.g., setting norms, questioning, recording student strategies, connecting strategies).*

Virtual Number Talks

Through the implementation of the TLC, two model types of VNTs were evident by our teachers. One involved *replication* (Wang & Torrisi-Steele, 2015), where technology was chosen that allowed for close imitation of face-to-face implementation of Number Talks. The other involved *transformation* (Baran, Correia, & Thompson, 2011), where affordances and limitations of the technologies used made the experiences of VNTs distinct from face-to-face implementation, while maintaining the essential pedagogical elements.

Replication-type Use of Technology

Teachers who replicated Number Talks as closely as possible in an online environment used video conferencing tools such as Zoom or Microsoft Teams and recorded student answers and thinking on a whiteboard-like space (e.g., Whiteboard.fi, Google Slides, or their classroom white board). Methods of presenting the problems and soliciting students' solutions and reasoning were varied. For example, one teacher facilitated a VNT from her classroom, writing the problems on her classroom whiteboard for students to solve and recording their answers and thinking on the board. Students watched as if they were in the classroom, seeing their teacher at the front of the room. Because the Number Talk was live-streamed, her students used traditional Number Talk hand signals to show when they were thinking, had a solution, and had multiple strategies. Students unmuted themselves when called on by the teacher and used hand signals to show agreement with their peers.

Another teacher used Google Slides to show the problems to students and to record students' solutions and strategies. This teacher also adopted the use of conferencing software reaction features, specifically having students use the 'thumbs up' on Zoom to indicate when they had an answer and a strategy. Other teachers used the chat function in their conferencing software, allowing students to keep cameras off but to share through comment that they were ready to unmute to offer an answer or reasoning. Students could comment through the chat to share agreement with their peers. Other teachers used breakout rooms to emulate "turn and talk" (Chapin, O'Connor, & Anderson, 2009) procedures often implemented in face-to-face Number Talks.

Transformation-type Use of Technology

In Number Talks facilitated in-person or with replication-type use of technology in a synchronous online environment, a small number of students usually share their thinking with the class. In contrast, some of the teachers leveraged technology to allow all students to share their thinking simultaneously. This shift transformed the Number Talks routine from strictly verbal participation to engagement through writing, drawing, and speaking; students developed strategies and solved problems mentally and then used technology tools to communicate their thinking through writing and drawing.

For example, NearPod allowed teachers to capture *all* students' strategies before selecting a few students to share verbally. To do so, teachers first allowed students to solve mentally, then collected all students' answers through an open-response prompt. Next, teachers provided a problem slide (that is, another, but dynamic and collaborative, display of the problem, be it an arrangement of dots, or an operation, for instance) and asked students to draw on their slide copy, effectively capturing student thinking and reasoning for all students in real time. After every student submitted a strategy, the teacher could be intentional about which students were selected to describe their thinking and the order in which students shared, ensuring the strategies were distinct while also allowing for rich conversation connecting approaches and ideas. Further, this technology use also transformed students' ownership of visually representing their own strategies, which is traditionally done by the teacher under student direction and not usually done by *all* students in attendance.

Final Thoughts

Few, if any, of the commonly emphasized classroom routines or practices from our initial teacher preparation and continuing education and professional development courses for undergraduate and graduate students account for virtual teaching and learning. We embraced our need for more virtual routines and practices for mathematics teacher education and PreK-12 student learning, choosing to virtualize Number Talks. This virtualization had two components, resulting in models of VNTs and a TLC that allow us to continue to support teachers' online field experiences in meaningful ways.

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