Simulated Teaching in Mathematics Teacher Education: Bridging the Space Between Coursework and Practice

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Author Note

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Abstract

This paper explores the perennial challenge Mathematics Teacher Educators (MTEs) face in connecting coursework and field experiences for their preservice teachers (PSTs). Four MTEs implemented an online simulated teaching task in their elementary mathematics course during COVID-19, when traditional ways to practice teaching were less available. We observed instruction, interviewed MTEs, and administered PST and MTE surveys. Most PSTs (93%) and all MTEs recommended simulated teaching for future use in courses. MTEs reported on how they used video records from the simulated teaching to reflect on their teaching practice. We argue that standardized simulated teaching offers unique affordances, including the afforded degree of control over the challenges PSTs encounter and the formative assessment information video records provide.

Keywords: Mathematics Teacher Educators, Simulated Teaching, Formative Assessment of Teachers, Preservice Teacher Learning

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Problem Statement

Mathematics teacher educators (MTEs) face a challenge that mathematics teachers do not. A mathematics teacher can prepare their students to take on mathematics problems, can offer them practice problems to work through under the teacher's watchful eye, can select those problems to provide particular challenges or reveal particular thought patterns, and can use formative assessment activity to provide both the teacher and the student insight into what more is needed. An MTE focused on a problem of teaching practice can prepare the preservice teachers (PSTs), but cannot select or easily monitor the teaching challenges they will encounter in the field, and may not know how to adjust instruction to better meet their needs.

This challenge is present in both the adequacy of PSTs' opportunities to learn from practice and the degree to which practice is connected to academic learning. Rehearsals and role playing with peers are under the MTE's control, relatively easy to enact, and flexible to fit pedagogical intent. They can, however, feel inauthentic to PSTs who, knowing that they are teaching their peers and not children, may struggle to represent student thinking authentically. Field placements are more authentic by virtue of taking place in real classrooms, although it could be argued that they embed inauthenticity associated with the PST not being the teacher of record. For example, the PST may be required to enact lesson plans they did not craft, or may not have the opportunity to establish norms and build trust from the start of the school year.

The learning opportunities present in field placements are also generally much less under the control of the MTE. Mentor teachers may or may not model the teaching practices that are the focus of instruction in methods courses, limiting PSTs' opportunities to observe and practice certain types of instruction.

Finally, MTEs often lack information about their PSTs' field placements, sometimes having to rely on the reports of colleagues, mentor teachers, or PSTs' self-report. In other cases, MTEs may observe PST instruction directly but must manage the challenge of observing multiple PSTs at multiple sites, often resulting in observations that that are brief or non-optimal in other ways. And even where direct observation, video records, or reliable reports are available, MTEs must grapple with variation among placement sites and contexts. At best it may be possible to draw conclusions about how an individual PST is doing within a particular context at a moment in time. It would be very difficult to conclude for a class of PSTs where they are struggling collectively with respect to particular practices. If MTEs cannot easily gauge how the PSTs are doing in their teaching practice, it follows that it would be difficult for MTEs to evaluate the success of their own instruction.

During the COVID-19 pandemic, this challenge was amplified for many MTEs. Many PSTs did not have access to opportunities to work with real children, while others worked with them under unusual conditions such as remote teaching or classrooms where social distancing requirements made sitting in rows rather than groups or circles the norm. Some university-based supervisors could not enter school buildings to observe teaching in an effort to limit personal interactions during the pandemic. And many MTEs had to teach in unfamiliar ways, fully or partially online, and with asynchronous instruction more common than has typically been the case.

These challenges, while unusually acute due to COVID-19, remain versions of challenges that MTEs have long faced in bridging the space between coursework and teaching practice. And in turn, solutions attempted during COVID-19 may prove useful more generally, and tools adopted in desperation may become tools we use routinely moving forward. In this manuscript, we describe one such tool, simulated teaching, that four MTEs used as part of methods coursework in the Fall 2020 semester as a way to help their PSTs practice teaching during a time of limited opportunity. We focus on two research questions; first, what evidence we have that embedding simulated teaching in the course was useful to the MTEs and their PSTs, and second, how the video records generated from the simulated teaching provided useful formative assessment information for the MTEs.

Background

(Teaching) Practice Makes Perfect

In recent years, scholars have called for a shift to more practice-based models of teacher education (e.g. Ball & Forzani, 2009), proposing tighter links between teacher development traditionally housed in coursework and the types of engagement traditionally housed in field placements or internships, via opportunities for "repeated opportunities for novices to practice carrying out the interactive work of teaching" (Ball & Forzani, 2009, p. 500). Professional standards note the importance of such opportunities. For example, the Association of Mathematics Teachers Educators' (AMTE) Standards for Preparing Teachers of Mathematics (2017) states programs should "include clinical experiences that are guided on the basis of a shared vision of high-quality mathematics instruction and have sufficient support structures and personnel to provide coherent, developmentally appropriate opportunities for candidates to teach and to learn from their own teaching and the teaching of others" (p. 26). This idea of practicing the work of teaching outside of and prior to entering the classroom is often referred to using Grossman et al.'s (2009) language, as the *approximation of practice*.

This shift toward a focus on practice is both subtle and dramatic. Approximations of teaching such as peer teaching have long had a role in teacher preparation. The underlying idea that teachers learn by practicing teaching is not new (Zeichner, 2012). What is new is the degree of emphasis on conceptualizing such approximation opportunities in more systematic and deliberate terms (Howell et al., 2019). Approximation is not just substitute for "real" practice; it is its own pedagogical structure. One type of approximation is standardized simulation, such as professors acting in the role of K-12 students (e.g. Shaughnessy et al., 2018), the use of technology to create a context for interaction (e.g. Herbst & Chazen, 2015), or the use of immersive technologies that seek to approximate the look and feel of interacting with children under more controlled conditions (e.g. Straub, 2018). Research suggests that it is not just engagement in simulated teaching that supports teacher learning but engagement in the cycle of activities around such engagement, including the support and feedback that a teacher educator provides (Benedict et al., 2016). And under COVID-19 constraints, simulated teaching has become more mainstream, as reflected in the endorsement of professional organizations such as the American Association of Colleges for Teacher Education (AACTE, 2020).

Simulated Teaching as Formative Assessment

Black and Wiliam (1998) offer the seminal definition of formative assessment as “all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged” (pp. 7–8). As noted in Penuel & Shepard (2016), definitions of formative assessment are somewhat controversial, with some scholars focused on formalized assessment while others interpret formative assessment as nearly synonymous with instruction that allows a teacher to understand what learners are understanding. The literature on formative assessment of teacher performance is relatively sparse, mostly representing teachers’ engagement in systematic reflection about their teaching (Howell et al., 2019; Tigelaar & Beijaard, 2013), with video records often an object of reflection. Video records of teaching under standardized conditions constitute an unusual object in teacher education because they allow comparison and allow the MTE to see patterns in the information that can inform the MTEs’ own teaching practice (Liebars & Howell, 2020), making it a form of formative assessment.

The Argument for Simulated Teaching as Approximation of Practice

We make two main arguments for the utility of the use of simulated teaching to approximate practice. First, simulated teaching affords the MTE a type of control rarely available to them over the types of teaching challenges their PSTs encounter. Second, the artifacts from simulated teaching sessions (in this case, video-recordings) constitute a form of formative assessment information that provides MTEs with an unusual comparative window into their PSTs' teaching practice and that can then be used to inform next steps. We illustrate these general arguments in the context of a specific study in which one simulated teaching task, the *Ordering Fractions* task, was implemented within an instructional cycle at four institutions.

Study Context

The *Ordering Fractions* performance task (Howell et al., 2021), designed as part of a prior project, engages an individual PST in leading a 20-minute discussion with five student avatars about strategies for ordering three given fractions. The discussions took place in an online, simulated teaching environment as part of the Mursion™ system (Figure 1), in which five avatars on the screen are controlled and enacted by one trained human actor behind the scenes. Our research team, through the actor training process, carefully crafted the student avatars' content understandings, ways of learning, and responsiveness (Howell & Mikeska, 2021). As described elsewhere (Mikeska et al., 2019) this does not result in an identical experience for each PST, as their choices about how to prompt the student discussion push that discussion in variable directions. It does, however, present each PST with an intentionally standardized teaching challenge, allowing for reflection across performances that would not be possible under more naturalistic conditions.

[Figure 1]

Each PST, in advance, received a written packet of materials to use in preparing to lead the discussion. This packet includes information about the five student avatars they will meet and their background knowledge with respect to fractions, describes a problem that the students have already worked on in small groups prior to the start of the simulated teaching, and provides the students' handwritten work on the problem (Figure 2). Each PST enters the simulation just at the moment that the five students are called together to discuss the work they have done independently, with the objective of engaging the students in an argumentation-focused discussion (Mikeska et al., 2019). The student work is designed to provide certain challenges and ideas. For example, two groups present correct solutions, but the generalization of their methods is complex in contrasting ways. One group has used a series of ad-hoc strategies for comparison that they (correctly) argue will not always work because for some fractions it would be "hard to compare" (Figure 2), creating space for the teacher to when and how the approach would work. Another group used a number line approach and claimed that it would always work, but if pressed will acknowledge the practical limitations of drawing a number line sufficiently accurately in all cases. The last group's answer is incorrect, relying on independent treatment of the numerator and denominator that does not account for the relationship between the two, a common student challenge that teachers can expect to encounter. By design, the ideas that are needed to address this challenge are available in the written work of the other two groups, making it possible for the teacher, by helping the students work together and connect ideas, to reach a satisfying resolution with respect to the mathematics without resorting to direct instruction.

[Figure 2]

Each PST planned for and led their own discussion in the simulated teaching environment at a scheduled time outside of class. The written packet provided support for this planning, including an analysis of each group's written work intended to help the PST unpack and make sense of the work and guidance about teaching moves that support student engagement in argumentation-focused discussion. Additionally, the PSTs had the support of their MTEs, who committed in this project to spending a minimum of one hour (and as much time as they wished to spend) preparing their PSTs for the simulated teaching session. A second commitment made by participating MTEs was to spend a minimum of one hour (and as much time as they wished to spend) debriefing their PSTs after the experience. In addition, each PST (and their MTE) received a copy of their video recorded performance, allowing the PST to review and reflect, the MTE to assign work around that process of reflection, and for the MTE to see video records from each PST in their course.

The MTEs were provided with a short guidebook describing the task, common patterns of PST engagement that project staff members had observed in prior work, examples of preparation and debrief activities the MTEs might consider, and a definition of the argumentation-focused discussion construct as conceptualized in the task design. Components of that conceptualization include attention to student voice, coherence of discussion, encouraging student engagement with other students and with their ideas, ensuring attention to content correctness and precision of language, and a focus on engaging students in constructing and critiquing arguments (Mikeska et al., 2019).

Methods

Sample and Data Sources

The four participating MTEs were selected based on an application distributed via professional organizations to represent a diverse set of sites with respect to geography, program type, and urban/rural locations, with oversampling on MSIs and HBCUs to the extent possible. Each MTE incorporated the simulated teaching experience into one section of an elementary mathematics methods or math for teachers course during the Fall 2020 semester. All enrolled PSTs utilized the simulation; PSTs who consented to participate in the research completed a survey. In total, 44% of the PSTs at site 1 consented and completed the survey, 55% at site 2, 59% at site 3, and 92% at site 4, for a total of 53 PSTs across the four sites. Demographic information is shown in Table 1.

[Table 1]

Three of the programs were public universities and one private. Because of COVID-19, one course was fully asynchronous, two were hybrid synchronous courses with some PSTs attending in person and others joining virtually, and one met online only in a fully synchronous format.

Primary data sources included the following. (1) Background questionnaires completed by each MTE and PST; (2) surveys completed by each MTE and PST reflecting on the experience and what was learned; (3) observations of preparation and debrief class sessions; and (4) a focus group of the four participating MTEs which took place after all sites had completed academic activity for the semester.

Analysis

Our analytic techniques included generating frequencies and descriptive statistics to represent yes/no questions, a general deductive analysis approach to coding the open-field survey responses (Miles et al., 2014), and thematic analysis (Braun & Clarke, 2006) of the focus group data. Coding analysis of the PST data began with the initial development of a provisional code tree based on a subset of the data. This provisional code tree was reconciled within the coding team, and then 25% of the data was double coded and reconciled, with the remaining responses single-coded. Because of the small n, all MTE survey responses were double coded for the purposes of calculating interrater reliability. Exact agreement and intraclass correlation coefficients (ICC) were calculated for double coded data and fell within acceptable ranges; these are noted below.

For the first research question, *what evidence do we have that the simulated teaching was useful to MTEs and PSTs*, we focused on survey questions asking MTEs and PSTs whether they would recommend simulated classroom discussions such as these for inclusion in future sections of the course and why (exact agreement 93% / 0.86 ICC for MTEs; 92% / 0.87 for PSTs). We also drew on PST self-report of what they had learned (94% agreement / 0.83

ICC), MTE report of what they believed their PSTs learned (88% agreement / 0.74 ICC), and the focus group responses for the MTEs.

To address the second research question we focused on responses to survey questions focused on the MTEs' engagement with the PSTs video-records. These questions asked how many videos each MTE had watched, what they hoped to learn by watching them, what they noticed in watching them, and what, if anything, was surprising. We also drew on the focus group data in which the MTEs discussed their use of the videos further and connected it to reflections on their own teaching practice. Rather than reporting coding frequencies, we used the survey responses in the findings section to create a description of each of the three MTE's approaches as a way of providing context for the themes that emerged from the focus group data. Thematic analysis was conducted in a multi-stage process, with different team members identifying relevant passages in the focus group transcript, classifying them under high-level themes, and writing analytic memos describing the themes, and each step was cross-checked by another team member before moving on to the next.

Findings

MTE and PST Self-Report on Utility of the Simulated Teaching Cycle

Both MTEs and PSTs responded overwhelmingly on the surveys that they would recommend inclusion of simulated teaching experiences such as the ones they had experienced in future occurrences of the methods course, with all four of the MTEs and 93% of the PSTs (49) responding yes to this question. The MTEs cited a number of benefits (Table 2), including the experience offering an opportunity "*to learn the core practice of facilitating a discussion*." (MTE03), seeing *"a depth of reflection that I have not seen before,"* (MTE04), and commenting that the consistency of the experience for all PSTs allowed them to *"practice the same thing and compare with each other"* (MTE04). PSTs cited the opportunity to learn and practice most frequently as the reason they would recommend it, but additionally cited reasons such as the simulated teaching being *“an accurate representation of how a classroom setting would be, especially when working in small groups”* (PST 120)*, “a great way to prepare for the future of online schools”* (PST 224), a context for *“implementing the skills that we learn in the classroom…”* (PST 207), and a way *“to get the student experience without potential harming real students' way of thinking” (PST 230).* Three PSTs reported that they would not recommend simulated teaching moving forward, citing a preference for working with real students, nervousness, and discomfort with the content.

[Table 2]

In the MTE focus groups, MTEs mentioned additional affordances and expanded on their prior responses, including noting the simulated teaching environment as “*a safe place for them to practice*” and “*cleaner in that you can isolate what you want to focus on*” (MTE01). One MTE commented on the degree to which observation rubrics can pick up other factors than the PST’s teaching, commenting that in contrast, the simulated teaching offers *“the same condition for every teacher candidate, so we can evaluate their readiness or performance regardless of their context or their strategy*” (MTE03). Another commented that because her course does not generally include field placements, “*as a course instructor, I don't have any opportunity to observe my pre-service teachers teaching, but this simulation allows me to see their performance, not about their written reflections. So, this is great opportunity to change more traditional methods course, to more practice-based teacher education course*” (MTE03).

MTE and PST Self-Report of PST Learning

Both MTEs and PSTs were asked to describe what the PSTs took away or learned from the simulated teaching activity cycle (Table 3). MTEs noted that it was a way for PSTs to learn “*a great deal about themselves as future teachers of mathematics.”* (MTE02), and that it “*improved their content knowledge”* (MTE01). A number of learnings they described were also coded as being strongly aligned to the argumentation-focused discussion construct as theorized by our project. For example, one noted that PSTs learned that "*it was difficult to continue to ask questions and engage the students rather than just defaulting to giving an explanation...*" (MTE04), which aligns to our construct focus on attention to student voice, and another noted that the PSTs "*gained pedagogical content knowledge and skills. For example, they learned common misconceptions that students have*…" (MTE01), which aligns to our construct focus on content correctness and precision of language. This coding was meant to help us gauge the degree to which reported learning was aligned to the intended learning embedded in the task design.

[Table 3]

PST's self-report of learning was less aligned to the construct (49% of responses were coded as aligned to some component of the construct) and varied to some degree from the MTE's report. Of note, the most frequent type of learning PSTs reported was the importance of preparation, in comments such as "*My main takeaway is to prepare yourself for the discussion. If you [are] well prepared, then the discussion will go smoothly…"* (PST 121). The importance of preparation was not called out by the MTEs as a strong takeaway. PSTs noted a few other types of learning that were not mentioned by MTEs. PST 226 noted the need to plan flexibly and "*…have "alternate routes" ready to take if not gone as planned*," and PST 403 noted the importance of emotional regulation, *"Be patient and confident in yourself."* Others reported learning about the importance and appropriateness of discussion in the classroom, commenting, "*It was definitely a learning experience. A math discussion activity can be a great tool for teaching in a classroom if the students are allowed to discuss with minimum participation from the teacher*." (PST 407) and *"Leading a discussion on students work is not the easiest but once you are able to get the students discussing among themselves academically it's a beautiful experience to witness"* (PST 305).

MTE Use of Videos

Three of the four MTEs reported having watched 100% of their PSTs' videos, while one noted not watching them due to time constraints but planned to watch them later as a way to reflect on the MTE's own practice. Each MTE described using slightly different frames of reference to monitor the videos, and each noticed and was surprised by different patterns, some aligned and some less aligned to what they were looking to see. Because the data set is relatively small and the MTEs were asked directly to follow up on their survey responses during the focus group, we report each MTE's use of the videos individually, drawing both data sources

MTE01 was interested in the patterns PSTs used when calling on students during the discussion, with particular attention to gender and race, the nature of the questions the PSTs asked, and the quantity and quality of student talk. In the focus group, MTE01 noted that the PSTs did not call on the students directly as much as the MTE had expected to see, leaving the more outgoing students to dominate the discussion. On the task survey, this MTE reported noticing whether or not the PSTs seemed prepared and that many of them were nervous. MTE01 also noted that some struggled with the content, naming this as a takeaway that was surprising, and adding in the focus group interview that there were "*just a few that really did not understand the content. We have already done our fraction unit at that point, and there was two people that glaringly taught it wrong, and it really scared me.*"

MTE03, who had previously engaged the PSTs in an exercise in eliciting student thinking one-on-one, was monitoring to see if there was improvement in terms of paying more and deeper attention to the student thinking rather than defaulting to yes/no questions and direct instruction. MTE03 noticed that while improvement was uneven within the group more specific and open ended questions were often present in the PSTs' discussions. This MTE was also curious to see how the PSTs managed student to student interaction, as that was not something they'd had the opportunity to do in the earlier exercise, and reported some disappointment on this point, stating, "*I noticed that my PSTs had difficulties with facilitating student-student interactions (mostly probing one avatar at a time) and with having a coherent discussion* *(shifting from one idea to another quickly).*" This idea of coherence came up again in the focus groups, in which this MTE stated, "*And they did not develop understanding about how to conclude, how to make a connection, how to compare different strategies.*"

MTE04 described their frame of reference as, "*I was watching, first just to get a sense of who they are as teachers. I have never seen any of them teach, so this was very informative for me. As far as the simulation goals, I was watching how they lead the student-to-student interactions and how well they were able to facilitate the conversation rather than take over the conversation*". Like MTE01, MTE04 noticed differences in the PSTs' level of preparation. Unlike MTE01, however, MTE04 reported surprise at the PSTs' relative poise, reporting that "*I was surprised by how comfortable many of them seemed and how they were able to fall into this role. This is the first time in front of students (for most), so this was a very intimidating experience, but many of them were able to display confidence.*"

MTE Reflections on Practice

Thematic analysis of the focus group data yielded four themes relevant to the MTE's reflections on their own practice.

As noted above, the three MTEs who watched their PSTs videos found them useful, and the MTE who had not regretted not having the time to do so. We described this theme as *Utility of the videos*, reflecting that the videos provided useful information the MTEs would not otherwise have had. MTE04 noted that the videos provided information that peer teaching just doesn't, in particular being able to observe them individually and seeing how they respond to "children" not peers. And the surprise evinced by MTE01's finding that some PSTs were still struggling with content drives this point home, suggesting that the MTE would not have known this absent the video. MTE04 also noted that having videos was "a treat", which was echoed by MTE02 who expressed the desire to have more practice opportunities embedded in the course, suggesting that these MTEs tend to feel more distant from opportunities to see how PSTs actually teach than they might prefer. MTE03, as noted previously, found that the videos also provided helpful information about what the PSTs had learned and taken away from earlier assignments as she saw them make use of it in practice.

Another theme was *Patterns of performance*. With the exception of MTE01's observation about content preparation, most MTEs characterized their observations, both from the videos they watched and from reading the PST's reflections, in terms of patterns across the group, focusing on broad takeaways like noting that many were underprepared or that in general the questioning was strong but the elicitation of student interaction was weak. While the videos were individual, the conclusions focused on what MTEs were learning about the class as a whole.

This focus on the whole class may relate to the third noted theme, which was *Responsibility adheres to the MTE*. There was broad consensus that the MTEs would do more to support the PSTs if they had the opportunity to do this again. Statements reflected, implicitly, that patterns of weakness were attributable to the MTE's instruction rather than to the PSTs or other contextual variables, and the MTEs commented in many cases on changes they would make to their instruction if they were to implement the simulated teaching again.

And the final theme in the MTE's reflections on their teaching practice was *Allowed MTEs to see what they had done (as opposed to what they had elected not to do), what they had done well, and what they had not*. Viewing the videos seemed to inform the MTE's sense of whether the preparation activities in which they had engaged their PSTs were adequate. In particular, some articulated noticing in the videos that PSTs had performed well with respect to things they had spent time on in class preparation, but less well with respect to things they'd not spent time on. These were not always the same aspects. For example, MTE03 spent more time on content and analyzing student work and saw payoff there but did not spend time on encouraging student to student interaction or discussion and saw PSTs struggle there, as previously mentioned. MTE03 also reported that PSTs had self-identified argumentation as more difficult and attending to students as easier and wondered if that was due to their differential support to the two areas. In contrast, MTE04 avoided discussing the content and student work samples associated with the simulated teaching ahead of time, anticipating that this might give too much away, but noted PSTs difficulty in transferring their discussion of a different content area to the task at hand. Similarly, MTE02 noted that the PSTs' reflection assignments made it clear they struggled to connect student ideas, which made sense to the MTE because that had not been an area they had focused on in class. In other words, the MTEs had a very clear idea of what their instructional goals had been and what had motivated their choices, and they used the PST videos to draw conclusions about the relative success of very specific aspects of their own instruction.

Discussion

We began by asking what evidence we have that embedding the simulated teaching was useful, and whether the video records provided useful formative assessment information. Most PSTs and all MTEs stated that they would recommend simulations in future iterations of the course, citing specific learning. PSTs most frequently reported learning about the importance of preparing for the discussion. MTEs did not note this as an important takeaway, although they did notice, in the videos, which PSTs were prepared and which were not. While we do not have direct evidence to explain this pattern, it is plausible that some PSTs might have believed preparation was not necessary for simulated teaching or might have underestimated the difficulty of leading discussions. Of note, relatively few responses to these questions were directly related to the constraints of COVID-19 with just a few responses coded as *Importance of having experience teaching via technology* or *Useful primarily as a substitute for field work*, suggesting that the perceived value of the simulated teaching was not just as a replacement for field work.

MTEs varied in terms of what they hoped to learn from the videos but noticed some things in common. The MTEs who watched the videos commented most strongly on general patterns in PST performance, suggesting that the task standardization revealed trends in the PSTs competence that the MTEs might not otherwise have noted. They interpreted what they learned as reflecting their own teaching practice, as shown in the ways they took responsibility for the PSTs' struggles, connecting them to actions the MTE might have taken or would take if they were to undertake the exercise again. The MTEs also made explicit reference to what the videos revealed about their relative success in meeting instructional goals and the effectiveness of instructional choices they had made. Their focus on how they would change future instruction suggests that future studies might focus the use of such information across multiple semesters.

Our study findings are limited by reliance on self-report. This research, funded as part of a direct and expedient response to the challenges of COVID-19, was designed to represent a "light touch" intervention implemented during a significantly disrupted semester. As a result, while we observed resourceful and meaningful instruction, we would not argue that it was an optimal use case. In fact, all four MTEs reported a wealth of changes they would make given the opportunity to implement the simulated teaching in a future course, suggesting room for improvement. While this light touch precludes us drawing strong conclusions about the amount of PST learning, it also demonstrates potential usefulness under significant constraint, and at a level of intensity that programs of teacher education could likely support financially. As such, despite the limitations of the study design, we find the results deeply encouraging.

Implications

We finish by revisiting our arguments for the utility of the use of simulated teaching. Our findings suggest that PSTs learned, even within a single cycle of simulated teaching. During the Fall 2020 semester, simulation afforded some PSTs their only opportunity to practice the interactive aspects of teaching. But the MTEs' and PSTs' enthusiasm for the use of simulation suggests that it is likely a valuable complement to field work that may bridge coursework and field work by giving the PSTs additional, structured practice in a safe environment and MTEs access to usable information about how they can better support their PSTs. Used throughout a program of teacher preparation, simulation has the potential to allow MTEs to construct a coherent series of learning opportunities for PSTs over which the MTE has control and visibility, something that naturalistic practice cannot provide. That we need stronger links between coursework and practice is hardly a new observation, nor is simulation the only potential solution, but it is one that has promise to help close the gap in a completely new way.

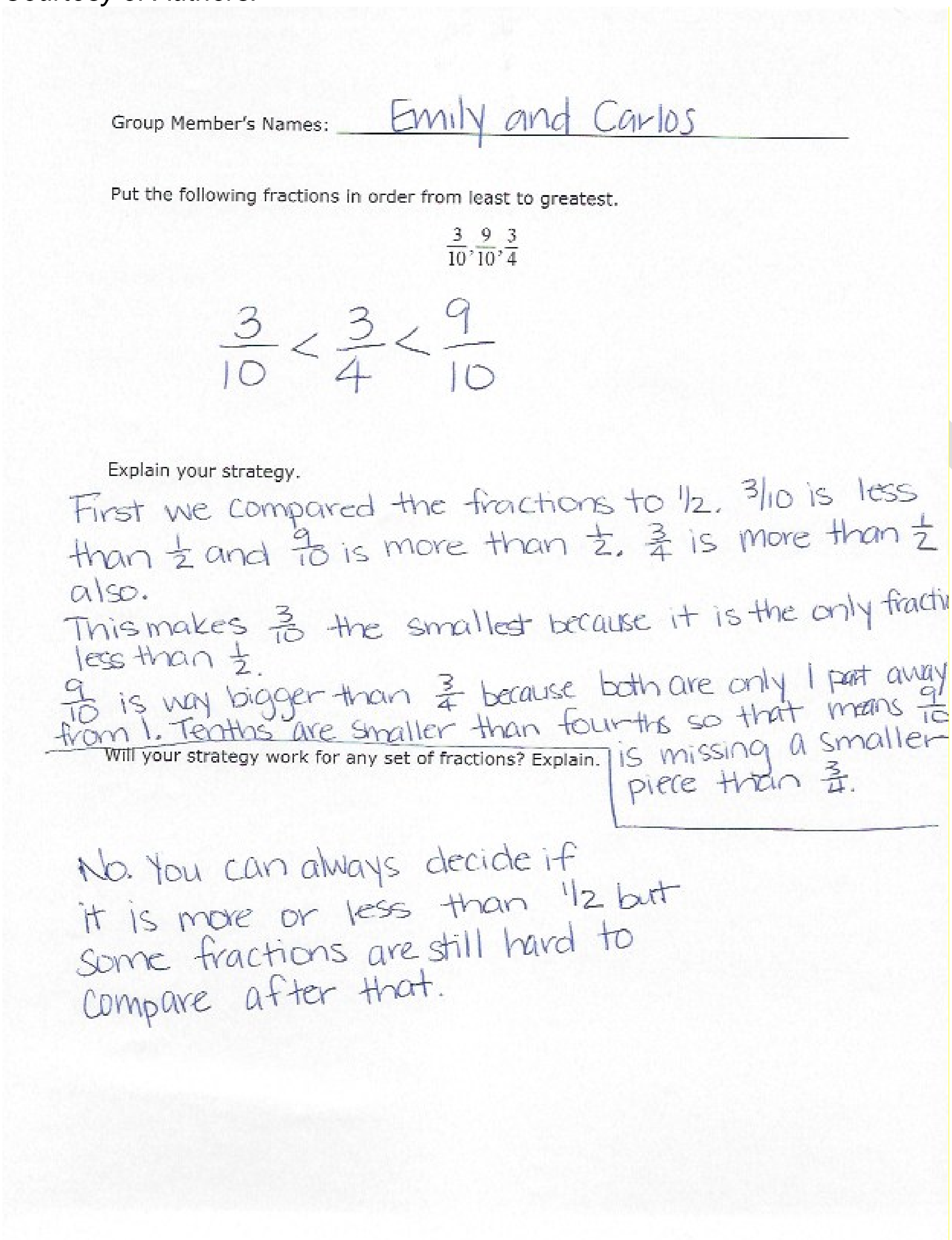
Our evidence also suggests that MTEs are hungry for, and make productive interpretations of, the type of formative assessment information that standardized simulated teaching can provide. In related work we have reported on formal feedback of recorded discussions as a driver of PST learning, and on formal scoring of discussion performances as a way to support MTEs in seeing patterns of performance (Mikeska & Howell, 2021). However, this study demonstrates that the video records alone, by virtue of their standardization, provide interpretable information for the MTE. This suggests that above and beyond the control simulations afford MTEs they provide a type of formative assessment information that is currently simply unavailable to most MTEs and that MTEs would make use of and value if it were more widely available.

Figure 1

Image of a Student Interacting with the Mursion Simulated Classroom. Image courtesy of Mursion™.

Figure 2

Example of Student Work Pages from the Ordering Fractions Simulated Teaching Task. Image Courtesy of Authors.



Group Member's Names: Emily and Carlos

Put the following fractions in order from least to greatest.

$\frac{3}{10}, \frac{9}{10}, \frac{3}{4}$

$\frac{3}{10} < \frac{3}{4} < \frac{9}{10}$

Explain your strategy.

First we compared the fractions to 1/2. 3/10 is less than $\frac{1}{2}$ and $\frac{9}{10}$ is more than $\frac{1}{2}$. $\frac{3}{4}$ is more than $\frac{1}{2}$ also.
This makes $\frac{3}{10}$ the smallest because it is the only fracti[on] less than $\frac{1}{2}$.
$\frac{9}{10}$ is way bigger than $\frac{3}{4}$ because both are only 1 part away from 1. Tenths are smaller than fourths so that means $\frac{9}{10}$ is missing a smaller piece than $\frac{3}{4}$.

Will your strategy work for any set of fractions? Explain.

No. You can always decide if it is more or less than 1/2 but some fractions are still hard to compare after that.

Table 1

Elementary Math Preservice Teacher (PST) Characteristics

Characteristics		PSTs (n=53) n (%)
Gender	Male	1 (2%)
	Female	52 (98%)
Ethnicity[a]	Hispanic/Latino	8 (15%)
	Black or African American	26 (49%)
	Asian or Asian American	3 (6%)
	Caucasian	19 (36%)
	Other	1 (2%)
Institution Type	Public	41 (77%)
	Private	12 (23%)
Institution Location	Urban	30 (57%)
	Suburban	0 (0%)
	Rural	23 (43%)
Course Format	Online Only	30 (57%)
	Face-to-Face Only	0 (0%)
	Hybrid	23 (43%)
Course Structure	Synchronous Only	25 (47%)
	Asynchronous Only	17 (32%)
	Hybrid	11 (20%)
Prior Experience Using Simulations	Yes	8 (15%)
	No	45 (85%)

[a]Six PSTs reported two ethnicities.

Table 2

Mathematics Teacher Educator (MTE) and Preservice Teacher (PST) Reasons for Recommending Simulated Teaching Experiences[a]

Code	MTEs (n=4) n (%)	PSTs[b] (n=46) n (%)
An opportunity to learn/practice	1 (25%)	28 (63%)
Connected to what would happen in a real-life classroom, and how students think	0 (0%)	6 (13%)
A safe environment to practice and potentially make mistakes.	0 (0%)	8 (17%)
An opportunity to reflect on their teaching skills/abilities	1 (25%)	8 (17%)
The importance of having experience teaching via technology	0 (0%)	5 (11%)
Useful primarily as a substitute for field work	0 (0%)	2 (4%)
Would be more useful with more opportunities to use it	1 (25%)	3 (7%)
Fun and engaging	0 (0%)	1 (2%)
An opportunity to apply skills/knowledge learned in their courses	2 (50%)	2 (4%)
Consistent in ways that supported comparison with others	1 (25%)	0 (0%)
Too vague to categorize	1 (25%)	6 (13%)
Other	0 (0%)	5 (11%)

[a]PST results from this analysis are presented in aggregation with results from PSTs in science methods courses in Mikeska et al., 2021.
[b]Four PSTs did not provide a written explanation to this question; three were not presented with the question because they previously responded that they would not recommend; responses could be assigned multiple codes.

Table 3

Mathematics Teacher Educator (MTE) and Preservice Teacher (PST) Perceptions of PST Learning from the Simulated Teaching Experience

Code	MTEs (n=4) n (%)	PSTs[a] (n=45) n (%)
General importance of preparing for the discussion	0 (0%)	17 (38%)
Being flexible when preparing for and/or leading the discussion.	0 (0%)	3 (7%)
Importance/challenge of including discussion in the classroom	0 (0%)	7 (16%)
Importance of emotional regulation in learning from this type of experience	0 (0%)	6 (13%)
Importance of knowing/responding to the students	1 (25%)	5 (11%)
A way to practice and gain experience for teaching real students or a way to gather information about one's practice	1 (25%)	4 (9%)
Related to the argumentation-focused discussions construct	3 (75%)	22 (49%)
Too vague to categorize.	0 (0%)	5 (11%)
Other	1 (25%)	0 (0%))

[a]Eight PSTs did not provide a written explanation to this question.

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