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ARTICLE TITLE:

Elementary Teachers Designing Culturally Grounded Cases for

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DIGITAL OBJECT IDENTIFIER: 10.5951/MTE.2023-0058

VOLUME: 12

ISSUE NUMBER: 3

Mission Statement

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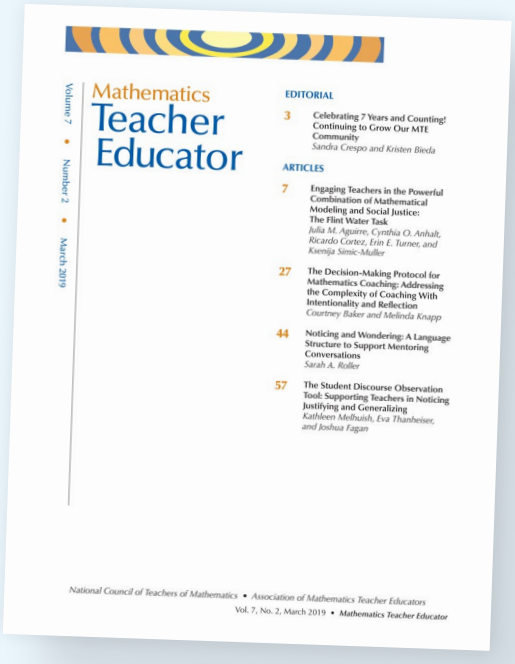

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Elementary Teachers Designing Culturally Grounded Cases for Preservice Teachers: A Process for Reciprocal Learning

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Connecting university methods courses and teacher daily practice is a persistent challenge in teacher education. Another challenge is preparing teachers to enact equitable instruction that meets the needs of an increasingly diverse student population. We take on these challenges by supporting practicing elementary teachers to design case-based teaching scenarios for preservice teachers that engage them with enacting culturally grounded mathematics and science instruction. We draw on data from workshops with teachers to illustrate how the design process elevates teachers' voices while also supporting their own learning. Workshop features that proved powerful for teachers included collaborating with colleagues, offering and receiving peer feedback, and working with a table describing key features of culturally grounded pedagogy in mathematics and science.

Keywords: elementary; equity; teaching cases; pedagogy

A primary challenge in elementary teacher preparation involves advancing preservice teachers' (PSTs') learning of teaching practices that mitigate deepening inequities in schools. Teaching that attends to the resources students bring to school and incorporates students' cultures and communities raises the achievement of all learners (Dee & Penner, 2017; Gay, 2002). However, attempts to support preservice teachers to teach equitably – in ways we describe as *culturally grounded* – often occur outside of methods courses where they learn to become high-quality content teachers, that is, where they learn to teach mathematics and science in research-aligned ways (e.g., Cohen, 2015; Stigler & Hiebert, 2009). Another challenge of elementary teacher preparation is what is sometimes called the theory-practice divide, which continues to trouble teacher education despite more than a century of effort (Carter & Darling-Hammond, 2016). This divide refers to teacher preparation taking place primarily in university courses, generally considered the realm of theory, while preparing teachers for PK-12 schools, the domain of practice (Zeichner, 2010). This divide is perceived by PSTs, who often struggle to negotiate what they see as a theoretical focus in their teacher preparation programs with the practical realities of teaching in classrooms.

Our work investigates a tool that can address both of these challenges by supporting PSTs to enact culturally grounded mathematics and science instruction in a way that connects them with practicing teachers. In particular, we work with current elementary teachers to design case-based teaching scenarios, or cases (e.g., Darling-Hammond et al., 2005; Shulman, 1992), that focus on dilemmas they have experienced at the intersection of equity and mathematics or science instruction. We then use those cases in our science and mathematics methods courses with preservice elementary teachers. This process allows PSTs to learn from practicing teachers' experiences, thus connecting theory and practice as PSTs grapple with the complexities of enacting equitable mathematics and science instruction.

As we have engaged in this work, questions have arisen about the process of working with elementary teachers to design these teaching cases. In this article, we investigate the following question: What practices support

elementary teachers to draw on their own experiences to design mathematics and science teaching cases likely to facilitate PST learning? We analyzed data from three sets of design workshops with elementary teachers to answer this question. Additionally, an incidental theme emerged from the data: teachers continually described how much they learned through the process of case design. Thus, we also highlight how designing cases for PSTs is an opportunity for reciprocal learning for teachers and how the same features that support teachers to draw on their experiences in the case design process can also enhance their learning.

Challenges in Elementary Teacher Preparation

This work responds to two primary challenges in PST preparation: 1) the responsibility of teacher preparation programs to respond to disparities in academic outcomes between historically underserved students and their peers, and 2) the perception of a divide between educational theory and educational practice that results in new teachers who are conversant in theoretical knowledge but experience challenges applying that knowledge to their classroom practice.

Regarding the first challenge (disparities in educational outcomes), only 26% of eighth-graders scored proficient on the mathematics portion of the 2022 National Assessment of Educational Progress (NAEP; National Center for Education Statistics, 2022). This by itself would warrant significant attention to the preparation of elementary teachers to facilitate the academic development of students in mathematics. However, the proficiency numbers for students from historically underserved groups are even more troubling. For example, only 9% of Black and 13% of Native American eighth-graders achieved proficiency in mathematics on the 2022 NAEP. On the same test, additional disparities exist, such as between students who qualify for free and reduced lunch (13%) and those who do not (38%). The NAEP is certainly not the only measure of U.S. student mathematical competency. Still, at minimum, the picture painted by this assessment should cause elementary teacher preparation programs to consider ways to improve their graduates' ability to facilitate academic achievement for all students in their classrooms.

Regarding the second challenge (the perceived theory-practice divide), Hollins and Warner (2021) posited that attending to university-school relationships is critical for supporting PSTs to address the aforementioned disparities in educational outcomes and facilitate the academic development of all students. Historically, PSTs have complained of a so-called theory-practice divide involving a disconnect between the generalizable academic knowledge and theory of university courses and the contextualized practical experience of PK-12 schools (Carter & Darling-Hammond, 2016; Zeichner, 2010). Because PSTs are often left to negotiate that perceived divide on their own, the development of their teaching abilities can be random and idiosyncratic (Hollins, 2015). The case-based scenarios developed in this project offer a pedagogical intervention to help bridge that perceived divide.

Reciprocal Learning

The concept of reciprocal learning often surfaces in discussions of PSTs' field experiences as part of their teacher preparation programs (e.g., Hollins & Warner, 2021; Patrick et al., 2010). Field work in PST preparation is usually conceptualized as involving a triad of actors: the university preparation program, often represented by a university supervisor; the PK-12 school practitioner, often represented by a cooperating or mentor teacher; and the PST. Hollins and Warner (2021) advocate redesigning PST preparation programs to facilitate the development of a community of practice (Wenger, 1998) hinging on reciprocal learning between those actors. In such a conceptualization, the PST learns professional academic knowledge from the university preparation program and how to contextualize and apply that knowledge in a particular setting from the PK-12 school practitioner; the university preparation program learns from practitioners and PSTs about new challenges and strategies for applying professional academic knowledge to practice; and the PK-12 practitioner learns new academic knowledge and practice derived from research in the university preparation program and coursework taken by the PST (Hollins & Warner, 2021). Typically, this kind of reciprocal learning is only fully actualized, if at all, during the student teaching semester of a program, which is the most expensive and labor-intensive component of PST preparation (Zeichner, 2021).

The work described in this article was initially intended as a way to bring two parts of the learning triad described above (the learning of university faculty and PSTs from PK-12 practitioners) into teacher preparation programs far earlier than the final semester of student teaching. In the process, we discovered that all three legs of the learning triad took place, as the work also served as a vehicle for professional learning for our PK-12 practitioners. Here, we examine how this type of reciprocal learning can take place as practicing teachers design case-based teaching scenarios, or *cases* (described further below), for PSTs. Designing realistic cases for PSTs offers a complementary path for university programs and teacher candidates to learn from PK-12 practitioners without as many logistical challenges as traditional field experiences. Engaging

teachers in case design combines the element of supporting future educators that is common in field experiences with the type of collaborative inquiry and activity that is so powerful in teacher professional development and learning communities (e.g., Cherkowski & Schnellert, 2018; Darling-Hammond & Richardson, 2009; Little, 1990).

Case-Based Teaching Scenarios

A body of work recognizes the benefits of the case method (also referred to as case-based inquiry, teaching dilemmas, snapshots of practice, video-based cases, and case-based instruction) for teacher learning. We define cases as narratives depicting specific teaching situations that represent broader theoretical claims and that critically engage and challenge learners (Shulman, 1992). These narratives include rich details about the instructional contexts, students, and interactions in particular situations. In this method, teacher-learners are the case audience. Through reading, engaging, and discussing cases, teacher-learners are positioned to critically engage with teaching dilemmas to support their professional learning.

The field has designed and employed cases for a variety of functions and purposes. Researchers have used cases to collect data on teachers' beliefs (e.g., Katsh-Singer et al., 2016), to illustrate either exemplary teaching practices or complex dilemmas for both pre- and in-service teachers (Carter, 1999; Markovits & Smith, 2008), and to enhance PSTs' moral reasoning skills (O'Flaherty & McGarr, 2014). Still others have focused on PSTs developing cases to promote their growth and reflection as future educators (e.g., Arellano et al., 2001; Hammerness et al., 2002; Sykes & Bird, 1992). Meanwhile, Schifter & Fosnot (1993) developed extensive cases highlighting the realities of teachers working to implement new pedagogical approaches in light of ongoing educational reforms. Varying analytic procedures further complicate the landscape of case research, with some studies investigating cases themselves (Bencze et al., 2001; Gunn et al., 2015; Southerland & Gess-Newsome, 1999) and others examining teacher responses to multiple choice questions (McNeill et al., 2016). Across all this research, a range of affordances of cases have been recognized, including representing the complexities of teaching (Doyle, 1990; Shulman, 1992); supporting PSTs in the social construction of knowledge (Sykes & Bird, 1992); creating opportunities for reflection (Abell et al., 1998; Grossman, 1992; Shulman, 1992; Southerland & Gess-Newsome, 1999); providing insights into PSTs' beliefs (Katsh-Singer et al., 2016; Pimentel & McNeill, 2013); enabling PSTs to build connections between theory, practice, and teaching contexts (Shin et al., 2019); and supporting growth in teachers' content knowledge (Günther et al., 2019; Yilmaz, 2022).

While affordances and uses of cases have been documented, there is little consensus on processes for developing cases. In many studies, the development of cases is neither discussed nor problematized (e.g., Katsh-Singer et al., 2016). Some important aspects of case development have been identified, such as authenticity and specificity (Bencze et al., 2001; Nemirovsky & Galvis, 2004). For instance, there is value in grounding case discussions in specific events that allow teachers to judge transferability to their contexts and cross the theory-practice divide (Nemirovsky & Galvis, 2004). While these perspectives are useful, the field lacks a robust process for developing cases that facilitate intended learning outcomes sought by implementing cases. Additionally, within this body of work, researchers often design cases (e.g., Bencze et al., 2001; Gunn et al., 2018; Nemirovsky & Galvis, 2004) without further problematizing the design process. The field needs a deeper understanding of effective processes for supporting practicing teachers to design authentic cases that forefront challenges of equitable mathematics and science teaching. This focus is imperative given the priority of supporting PSTs to address educational disparities, as well as the challenges that are often encountered in that process.

Culturally Grounded Pedagogy

To describe teaching that responds to students' cultures and lived experiences and seeks to shift inequitable classroom power imbalances, we use the term culturally grounded pedagogy (CGP). Our use of the term integrates concepts from Aguirre et al. (2013), Banks (2019), Gay (2002), Ladson-Billings (1995, 2014), and Paris (2012) to characterize teaching that (a) leverages students' multiple strengths and competencies; (b) explicitly values students' diverse lived experiences and ways of knowing or participating, including language and cultural practices; (c) attends to classroom power and status dynamics to create equitable learning opportunities; and (d) employs a transformation approach to curriculum development that "enable(s) students to view concepts, issues, events, and themes from the perspective of diverse ethnic and cultural groups" (Banks, 2019, p. 254). To ground the case design process firmly in CGP, we created a tool—the Features of Culturally Grounded Pedagogy in Math and Science table (see **Appendix A**). This table describes the four CGP features articulated above while also providing concrete examples and non-examples in mathematics and science teaching. Given the design-based research process we utilize in this work (described below), it is likely that this tool will continually evolve as we identify its strengths and weaknesses; the version in this appendix is from Fall 2023. We used this tool throughout the case design process to support shared understandings of the aims and guiding principles of our work with teachers.

Author Roles and Positionality

Our author team consists of two teachers, one graduate student researcher, and four full-time faculty. The two teacher authors were participants in different design workshops. At the time of writing, Galvez Sghiatti taught first grade at a Title 1 charter school serving majority Latine students, and Daniels taught fifth grade at a remote, rural Title 1 school with approximately 97% American Indian/Alaska Native learners. Their role in this manuscript consisted of writing reflections on the three focal themes discussed in this paper and offering edits to ensure that descriptions were true to their experiences. The graduate student researcher (Biddle) is a master's student pursuing secondary teaching licensure. She participated in both data analysis and writing/reviewing the manuscript. The four faculty members are all teacher educators, three of whom previously taught in K–12 classrooms. All faculty contributed to developing the design workshops and facilitated one or more workshops, while Dobie and Barth-Cohen taught the elementary methods courses that utilized the cases developed through this project. Faculty played varying roles in analyzing data and writing/reviewing the manuscript. The composition of this team was meant to ensure that teachers' voices remained centered throughout this work and account for biases inherent in faculty workshop designers/facilitators conducting analyses (by involving teachers and a graduate researcher in the process).

Case Design Workshops

This article draws from data gathered from three series of design workshops with teachers. We recruited elementary teachers from around Utah through snowball sampling (Merriam & Tisdell, 2015), starting by reaching out to our state and district contacts and making connections through professional organizations and conferences. Those contacts either put us in touch with specific teachers or passed along participation information to their networks. Interested teachers submitted a short application describing their interest in participation, teaching experiences, and perspectives on equitable mathematics and science teaching. Six teachers from various locations were selected to participate in each paid workshop series. Participating teachers had experience teaching grades ranging from kindergarten through 6th grade, and their years of experience ranged from 2 to 29 (median = 6). Three teachers in the first workshop series taught different grade levels at the same school; all remaining teachers had no familiarity with each other prior to participation.

Each workshop series consisted of three two-hour sessions conducted virtually via Zoom. Teachers completed a survey at the start of the workshop series to share additional information about their prior teaching experiences and demographics and at the end of the series to share their experiences in the design workshops. In this work, we use a design-based research approach (Cobb et al., 2003), meaning that we iterate on our process after each cycle to improve our design, and we aim to contribute to a theory that expands knowledge of how to support teachers to design cases. Below, we describe the process and materials that were used in the most recent workshop series (though all are similar to those used in the initial series).

In the first of the three workshop sessions, we began with participant introductions and sharing of discussion norms (e.g., commit to acknowledging anything said that offends you or feels problematic; dialogue through discomfort) and Zoom norms (e.g., keep your video on). Teachers were then briefly introduced to the idea of cases, explored a sample case, and learned about the research project's goals. For the remainder of the session, teachers worked with the aforementioned Features of Culturally Grounded Pedagogy in Math and Science table (see **Appendix A**), drawing on the research of Aguirre et al. (2013), Banks (2019), Gay (2002), Ladson-Billings (1995, 2014), and Paris (2012). Teachers individually read the table and wrote down their noticings and wonderings before moving into breakout rooms with partners to discuss aspects of the table that felt productive or problematic or resonated with their experiences. One facilitator was present in each breakout room with a teacher pair, though teachers guided discussions; facilitators primarily answered questions or helped with time management, as needed. We then continued the discussion as a whole group, with teachers sharing their experiences as a precursor to identifying situations around which to build cases during session two.

The second session began with a brief group check-in, a reminder of norms, and a refresher of the Features of CGP table. Teachers then explored one additional case before working in pairs to brainstorm dilemmas of enacting CGP in mathematics and science that (a) are based on real-life experiences, (b) highlight complexities of teaching, and (c) yield multiple solutions. Again, one facilitator was present in each breakout room; this time, facilitators sometimes asked probing questions or offered guidance to help teachers identify topics that could make for rich cases. Teacher pairs and facilitators then returned to the whole group to share two possible focal topics and get feedback from the group. The session concluded with each teacher pair returning to their breakout room, selecting one idea to build their case around, and beginning to design their case. Facilitators primarily answered questions during the case design process, occasionally interjecting to offer suggestions regarding information that could be added or to provide affirmation or encouragement.

In the third workshop session, facilitators began by reminding teachers of three goals for their case design: (1) forefront the tension in the case, (2) blend in relevant details from related experiences, and (3) focus on the complexity of the dilemma rather than finding a solution. Teachers then finished the first drafts of their cases, and teachers and facilitators read other pairs' cases and provided written feedback. The whole group then discussed that feedback, and teachers had the chance to answer questions about their cases or ask their peers about any feedback they received that was unclear. Facilitators then introduced a case checklist (see **Appendix B**) that could be used alongside peer feedback to support teachers in revising their cases, the last activity in the workshop. We gathered video recordings of all workshop sessions, including whole group and breakout room discussions, and all artifacts, including teacher notes, written feedback, and final cases. (See **Appendix C** for a sample case. Visit https://uite.utah.edu/teachingcases/ to access additional sample cases and associated materials.)

Our analysis began by reading through all teachers' exit survey responses to identify key themes emerging from their reflections on the case design experience. After organizing the teachers' comments by category, focusing on powerful aspects of the case design workshops, and then discussing emergent themes as a group, the faculty members and graduate researcher identified three impactful features of the workshops that surfaced repeatedly in teachers' written reflections: collaboration, peer feedback, and the Features of CGP table. We were initially interested in how these aspects of the workshops supported teachers to draw on their own teaching experiences to design cases. However, we also noticed numerous comments about how the workshops supported teachers' learning. Thus, we decided to examine how each feature helped teachers draw on their own teaching experiences to design cases, thereby enhancing their learning.

As the university-based research team began to develop our analysis plan, we shared the three themes with the two teacher-authors, asking them to write brief reflections on how, if it all, each aspect – collaboration, peer feedback, and the Features of CGP table – (a) helped them to draw on and share their own teaching experiences to design cases for PSTs, and (b) enhanced their learning. As they wrote their responses, the university-based research team engaged in the analyses outlined below, drawing from participating teachers' survey responses, transcripts of workshop discussions, and written notes and feedback during workshops.

Across all three areas of analysis, we used thematic analysis techniques for coding qualitative data (Braun & Clarke, 2006). For collaboration analyses, we reviewed and organized by theme all exit survey data in which teachers responded to questions about their experiences collaborating with partners. As collaboration occurred throughout the entire workshop series and is a part of the next two themes, here we limited our analyses to teachers' perceptions of the benefits of collaboration, as noted in their exit surveys. We examined two types of data for peer feedback analyses: teachers' written feedback on peers' cases and transcripts of teachers' verbal feedback offered during workshop sessions two and three. Two authors first reviewed all feedback individually and allowed themes to emerge organically. We then categorized feedback according to categories from (a) the case checklist shared with teachers and (b) the Features of CGP table. Finally, for analyses of the impact of the CGP table on teachers' case design process and learning, we examined two types of data from session one: teachers' independent reading notes on the Features of CGP table and transcripts of teachers' small and whole group discussions of the table. Two authors reviewed the data individually and categorized it thematically to identify how the table (a) drew out teachers' voices and expertise and (b) prompted new learning. Below, we describe findings from these analysis processes, interspersing comments from the teacher authors' written reflections to offer additional insights.

Powerful Aspects of the Case Design Process

We describe findings related to each of the aforementioned themes: collaborating with colleagues, offering and receiving peer feedback, and working with the Features of CGP table. In particular, we highlight how each aspect of the workshop series supported teachers to elevate their voices and draw on their own experiences and how it enhanced teachers' learning. We support all claims with evidence from the data.

Collaborating with Colleagues

Collaboration was one of the most common themes discussed by teachers as beneficial to the case design process. In the exit survey, teachers reported that it was helpful to "brainstorm" ideas for cases with partners (Melissa, Wes) and to "bounce ideas off of each other" (Tess, Amber, Collette). One teacher, Matthew, also noted how his partners helped him to articulate his ideas: "I am horrible with words and both my partners helped me turn the ideas and thoughts into actual well thought out sentences." Additionally, teachers appreciated how collaboration allowed them to discover shared experiences that could be the basis for a case. For example, Daniela reflected, "Knowing that another teacher had the same or a similar teaching experience as mine, it gave our case

design a bit more meaning. Our case design felt representative of a scenario a preservice teacher might actually experience in their teaching career."

Some teachers also reported that collaboration supported their learning. Wes noted that "listening to others' experiences and ideas was extremely helpful," while Collette appreciated "see[ing] things from a different perspective of other school cultures." Daniela echoed these sentiments as she reflected on how collaboration opened her eyes to the diversity of experiences across classes, teachers, and schools:

> **Collaborating with a partner helped me realize that there are certain pretty universal teacher experiences. But it also made me realize that all classes and students are different, and that all teachers are as well. It's important to recognize and celebrate these differences and to uplift them not only in the classroom but amongst colleagues and in your school community as well.**

Across all teacher groups, the power of collaboration for enhancing the case design process, as well as their own learning, was evident.

Peer Feedback

Peer feedback was another aspect of the case design workshops that proved especially powerful. During each round of peer feedback, teachers offered each other both supportive and critical feedback that their peers found beneficial. As with collaboration, peer feedback supported teachers in the case design process, drawing out their voices and expertise, and also contributed to their own learning.

Analyses of written and verbal feedback highlight several ways in which feedback supported teachers to draw on their own experiences in the case design process. First, when offering feedback, teachers drew on their own experiences to comment on which cases and aspects of cases felt authentic. For example, one teacher[1] commented on the authenticity of a case, writing, "I love the involvement of religion as a diversity factor – this is often under-discussed but yet highly relevant and impactful in our classrooms." Tess also drew on her own experiences to share how she personally connected with a case that highlighted how some textbook problems depict images unfamiliar to many students: "I grew up in a different country. So sometimes when people bring up stuff here, I go 'Huh? What are you talking about?' So, I do understand that . . . Someone needs to explain it to me." Related to that, teachers drew on their experiences to identify which topics would be fruitful for PSTs to explore. One teacher wrote, "I think the whole idea of group work is important for preservice teachers to think about and [the process of] pairing students and giving them roles to do in the project." When reflecting on the role of peer feedback in the case design process after the conclusion of the workshops, Daniela also noted how thinking about PSTs encouraged her to share constructive feedback with her colleagues: "I drew on my own teaching experiences to add input or ask clarifying questions because I knew preservice teachers might need further information, not having had those same experiences yet."

Additionally, teachers drew on their expertise to suggest edits to details that would make the cases richer, more authentic, or more culturally sensitive. For example, Micah shared verbal feedback about one case's description of a student from Rwanda who was described as not having had experience in a structured classroom environment. In particular, she encouraged her colleagues who designed the case to adjust their description to avoid stereotyping:

> **Looking at the student from Rwanda, who . . . has not had experience in a structured classroom environment, I guess I just am wondering what exactly that means . . . I want to double check and make sure that . . . as I'm reading this, I'm not falling into stereotypes that could be associated with refugee students from countries that are considered third world [by the dominant culture].**

After this contribution, a conversation between several teachers and the facilitator ensued. Micah's colleague who co-designed the case said he appreciated the comment and thanked her for sharing that.

In addition to supporting teachers' case design process, peer feedback also contributed to teachers' learning. In particular, the process of allowing teachers to verbally discuss and respond to the feedback they received proved fruitful. During that process, teachers asked each other questions, talked about what they took away from the feedback, and expressed appreciation for colleagues' comments. For example, while Tess and Kristin were responding to the feedback they received on their case, Kristin shared,

> **I like that the feedback was asking—people asked questions because it's kind of adding on to the**

[1] When written feedback is discussed, teachers are unidentified, as they were not asked to write their names next to their written comments. In contrast, teachers are named when verbal contributions are quoted.

scenario and it's kind of making you think deeper about what's happening or the what-ifs and you could expand the scenario or, you know, make it shorter based off of the questions, so that was really helpful.

Here, Kristin identified how peer feedback supported her to think more deeply about the focal situation in their case. In another instance, Matthew noted how Micah's feedback was helpful not only for considering the situation he and his partner designed their case around but also for his overall learning: "I just wanted to say a huge thank you for Miss Daniels because she's definitely educating me. And I am super thankful for your knowledge and background of this, and for bringing that to the table."

In Daniela's reflection after concluding the workshops, she brought together these two perspectives, describing how peer feedback positively contributed to her case design and reflections on her teaching. She wrote,

[Receiving feedback] helped me think about my case, and in turn, my own teaching experiences, in a different light. It was a very metacognitive exercise, prompting further personal feedback of my case, thus making me think further about the personal teaching experiences that my case was built on and how I responded to them.

Overall, including peer feedback in the case design process enhanced teachers' learning and encouraged them to draw on their own experiences to improve their cases in support of PSTs' learning.

Features of Culturally Grounded Pedagogy (CGP) Table

The Features of CGP table played an important role in the case design process. As with collaboration and feedback, working with the table afforded opportunities for drawing out teachers' voices and supporting teachers' learning. In analyzing transcripts and written artifacts, we identified three common themes around using the table.

First, engaging with the Features of CGP table often elicited teachers' own classroom experiences—frustrating experiences and moments of joy or success relevant to particular CGP features. For example, when discussing Feature #2 (*Honoring Students' Lived Experiences*), Cassidee shared her successes in validating and centering students' use of their home language and the joy she experienced in doing so. In contrast, when discussing Feature #4 (*Diversify Curriculum and Challenge Dominant Perspectives*), Cassidee described frustration in trying to find curricular materials that represented racial and gender diversity in science, especially examples relevant to her Latine student population. For eliciting these experiences, the examples and non-examples in the Features of CGP table seemed particularly useful. Daniela reflected, "Seeing an example or non-example triggered memories of past experiences that I might not necessarily have thought of on my own."

Second, the CGP table provoked teachers to consider constraints in their local contexts, leading to questions about enacting CGP. Typically, questions arose when teachers voiced a particular tension around implementing CGP. For example, when discussing Feature #4, Kaytlin surfaced tensions related to the current political climate of her district by saying,

One of the first things that jumped out to me is the tension with this one. Because I think [the CGP feature is] really important, but I think it's probably highly politicized right now. And that creates a challenge when you're being asked by district and administration to not bring that into the classroom.

Here, Kaytlin questioned how to diversify curriculum and challenge dominant perspectives at a time when doing so conflicted with district guidelines. Similarly, others raised questions of enactment, given the constraints of large class sizes, mandated curriculum, and parents with divergent views. In this way, the Features of CGP table elicited teachers' experiences operating in a system of constraints; it offered opportunities to reflect on those experiences and voice real tensions inherent to enacting CGP—tensions that often laid the groundwork for the designed cases.

Third, for some teachers, engaging with the Features of CGP table afforded critical reflection on their practice—reflection that could foster new learning. Some teachers saw aspects of their practice captured in the non-examples; this apparent misalignment with CGP pushed these teachers to grapple with their practice. For example, as Matthew discussed Feature #2 with his partner, he reflected,

Um, I felt like I was doing a really good job at [honoring students' lived experiences]. But when I looked over [a non-example] like building on negative stereotypes of the culture in the community or family – and I was like, well, oftentimes, I do relate to things based off of stereotypes that I know.

Matthew went on, saying that the non-example about stereotypes "really got [him] thinking." He then described an example of a math test that he created in an attempt to be inclusive of the many cultures of his students, sharing,

I have some Polynesian students in my class. So I thought I was being culturally respectful by mentioning some of their culture, like their . . . leis that they

> **wear, in some of my math questions. But, I mean, this could be a misunderstanding on my part—but I felt like that probably after reading [the table], this wasn't the greatest thing to do. I should really just focus more on like, how do I say it like, historical, positive influences in the cultures in their communities, rather than just things that I've heard off of the [cuff].**

The Features of CGP table appeared to support Matthew as he voiced and then critically reflected on his practice. We see this theme of critical reflection—apparent for some but not all teachers as they engaged with the Features of CGP table—as potential evidence for teacher learning, suggesting that the table can support grappling with one's practice. Furthermore, even though most teachers did not demonstrate the degree of reflection that Matthew did, many did mention in their exit survey that the table fostered new learning or helped to refocus their priorities. In her reflection, Daniela wrote: "The table reminded me, 'Am I really serving all my students as best I can?' and 'Am I making it a priority?'"

As a whole, our work suggests that the Features of CGP table is a key part of case design. It can elicit teachers' voices and expertise while also supporting new learning. As Micah summarized, "The table and sessions helped me to talk about [my] experiences in a safe environment, where I didn't feel afraid to speak up. In essence, the table helped validate my learning and unlearning within the system of education."

Discussion

Here, we offer some reflections on the process of supporting teachers to design cases that foreground challenges related to enacting CGP in mathematics and science. We begin by highlighting some key takeaways for teacher educators. Then, we discuss some lessons our team has learned through engaging in this work and some wonderings that have arisen for us. We conclude by sharing our next steps for this project.

Takeaways for Teacher Educators

The work shared in this article illustrates how case design can be a powerful vehicle for bringing teachers' voices and experiences into methods courses. Through engaging with situations experienced by practicing teachers, PSTs have a chance to grapple with the locally relevant complexities of enacting CGP in mathematics and science. At the same time, case design is new for most teachers, so supports are needed to scaffold them through the design process. This work highlights several valuable features of our case design process: collaboration, peer feedback, and a table describing the features of CGP. We do not claim that these elements are the only ones that are important or must be present in case design workshops; rather, these elements emerged as particularly supportive for the teachers with whom we worked. Incorporating collaboration throughout the process was useful for helping teachers draw out their ideas and brainstorm with others, while getting peer feedback helped teachers ensure that their cases were authentic and valuable for PSTs. Related to that, it is worth noting that the teachers in our workshops seemed to feel comfortable engaging in meaningful dialogue relatively quickly, particularly given the online setting, which certainly supported the peer feedback process. Although we cannot know for sure what elements of our workshops supported this community development (a question for future research), at least one teacher commented on the importance of the discussion norms for supporting critical dialogue. Finally, the Features of CGP table proved powerful as a tool that both surfaced teachers' experiences and has the potential to push their thinking related to equitable instruction, thereby fostering new learning.

Building on that idea, while designing cases was framed as an activity to support PSTs – which drew many of the teachers to this work – an added benefit was teachers' learning. As illustrated above, teachers frequently reflected on their teaching throughout the case design process and described ways in which their work with colleagues and with the Features of CGP table supported their learning. This finding suggests that case design is a valuable professional development activity that supports reciprocal learning (Hollins & Warner, 2021; Patrick et al., 2010).

Finally, guiding teachers to develop cases is, of course, filled with many tensions and questions about what makes a productive case. It is outside the scope of this manuscript to delve into these questions. However, we have previously shared two design conjectures for case development, along with associated tensions: case prompts should ask PSTs to make sense of situations, not solve them; and comparable demographic details should be included for all students in the case (Dobie et al., 2022). There will always be trade-offs when making decisions about case design; for us, the core focus is depicting authentic, complex issues related to ethical and learning dilemmas that have multiple solutions and will surface wide-ranging ideas.

Lessons Learned and Wonderings

While doing this work, we have learned several important lessons about supporting teachers through the case design process. First, teachers' one critique of the workshop series was that they wanted more time to edit their cases. Although we have not yet added a fourth workshop because of recruitment challenges and demands on

teachers' time, we believe adding a fourth workshop to the series would be ideal. Second, unsurprisingly, it can be difficult to recruit teachers given their busy schedules; however, it is worth putting in the effort to invite their voices to the table and encourage their participation. Teachers have appreciated the opportunity to support PSTs' learning, and they have developed strong cases that support the kinds of conversations we want to have in our methods courses. We, as teacher educators, have also learned so much from teachers sharing their experiences and developing their cases, both about the case design process and the challenges teachers encounter related to enacting CGP in mathematics and science. Finally, we noticed that similar themes have repeatedly emerged in cases across workshop series, such as challenges related to group dynamics. It can require intentional effort to encourage teachers to think outside the box and imagine topics for cases that go beyond the models provided to them.

Engaging in this work has also raised a number of wonderings for us. A few are as follows:

- We saw a lot of supportive but critical feedback in these workshops. Might engaging teachers in designing for PSTs provide a more comfortable space for critique than typical professional development settings?
- How can we support more teachers to engage in the kind of critical reflection on their practice that Matthew modeled?
- Are there ways we can further elevate teachers' voices in methods courses by sharing their reflections from the case design process? Might we be able to use such reflections to provide a model for PSTs of what it looks like for teachers to continually view themselves as learners and lovingly critique their own and each other's practice?

Next Steps

One next step for this work focuses on the analysis of existing data. In particular, we are currently analyzing PST responses to case prompts in mathematics and science methods courses, as well as individual student learning related to CGP over each semester. We are also analyzing survey data on how it impacted PSTs to know that teachers designed these cases. Anecdotally, we have found it very fruitful to bring these cases into our courses because they have generated valuable discussions and added authenticity to the CGP features by incorporating teachers' voices and experiences. Students have also expressed appreciation for learning from teachers' experiences.

Second, we are investigating the role of facilitators during the case design process. While many interactions in workshops were teacher-led we, as facilitators, felt there were times when it was important to intervene. As a team, we are working to analyze the roles we played as facilitators and the impact of our contributions. Based on those analyses, we will develop facilitator guides to help ensure consistency regarding the level of intervention as new facilitators engage in this work.

Finally, a key focus of this work, aligning with the design-based research approach (Cobb et al., 2003), is developing design principles for creating cases. Cases are frequently used in PST education, yet we know little about what features make cases most effective for generating productive discourse and enhancing learning. Our ongoing analyses will support the continued development of design principles that can guide the development of rich teaching cases (Dobie et al., 2022) and inform future iterations of our case writing checklist. These principles will allow researchers to support local teachers in developing cases that inspire productive discussion and are relevant and authentic for PSTs in their area.

Statements and Declarations

Acknowledgements: We wish to thank all participating teachers for sharing their time and expertise with us to support pre-service teachers. We are appreciative of their vulnerability and willingness to try something new. We also would like to thank Laurel Dias, former graduate researcher on this project who played a significant role in designing and facilitating the first workshop series, and the advisory board for our project, who provided helpful feedback and supported teacher recruitment. This material is based upon work supported by the National Science Foundation under Grant No. 2142136. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Declaration of interest: We have no conflicts of interest to declare at this time.

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doi:10.5951/MTE.2023-0058

Appendix A

Features of Culturally Grounded Pedagogy (CGP) in Math and Science[2]

CGP Feature #1: Leverage Students' Multiple Strengths and Competencies		
Description: Teachers prioritize student voice in their classrooms, honoring multiple ways of knowing and types of talk while attending to floor time. Teachers make space for students to express their thinking in a range of ways.		
Reflection Questions: 1. How do I identify and support contributions from students with different strengths and levels of confidence in math/science? 2. How do I structure my interactions with students to promote engagement and persistence with complex math/science problems? 3. How do I make connections in my lessons with students' previous math/science knowledge, draw on local community resources, and make content relevant to students' lives?	Math/Science Lesson Examples: 1. Listen to and build on student ideas for solving complex problems, welcoming a range of ways of representing thinking. 2. Present math/science tasks that offer multiple entry points and multiple modes of expression. Allow students with varying competencies and levels of confidence to engage with problems and make valuable contributions. 3. Engage students in frequent debates about math and science concepts. Encourage student-to-student interactions and whole-class participation during math/science lessons.	Math/Science Lesson Non-Examples: 1. Limit participation to a few students who have correct answers or are viewed as competent during math/science lessons. 2. Assume that some students do not have the knowledge or prior experience needed to engage with complex tasks. 3. Limit opportunities for students to engage in solving complex math/science problems through practices such as promoting memorization without building students' conceptual understanding. 4. Deny students ownership of their math/science learning by having them follow procedures step by step, emphasizing one solution strategy, or accepting only traditional ways of demonstrating knowledge of math/science.
CGP Feature #2: Honor Students' Lived Experiences		
Description: Teachers take a learning stance on the languages, cultures, and experiences that students bring to the classroom. Teachers honor the diverse lived experiences, and ways of knowing or participating, of students who are marginalized on multiple axes of identity.		
Reflection Questions: 1. How do I learn about my students' cultural backgrounds and experiences and draw on them to support my students' confidence in learning math/science in my classroom? 2. How do I affirm my students who have multilingual abilities to help them learn math/science? 3. How do I incorporate students' everyday experiences with math/science in the classroom and position their home experiences as valuable resources for learning math/science?	Math/Science Lesson Examples: 1. Connect with family and community members at local community events or through home communication to understand the knowledge and experiences students bring to math/science learning. 2. Affirm and support multilingualism by recognizing and strengthening multiple language forms. Make connections between math/science language and everyday language. 3. Center students' prior math/science knowledge and authentic experiences related to their cultures, communities, family, and history as legitimate intellectual spaces for the investigation of mathematical/scientific ideas.	Math/Science Lesson Non-Examples: 1. Limit sharing of student experiences or assume that students' everyday experiences are inconsequential to learning. 2. Support English as the only language spoken in the classroom. Discourage discourse around math/science concepts because it is deemed too difficult for students who have not mastered standard English. 3. Build on negative stereotypes of the culture, community, or family, preventing math/science lessons that connect with authentic knowledge and experiences of students. (Sample negative stereotypes: "Many parents are laborers–they can't help their children with math/science." "Asian students are so good and so quiet because they have family support." "Families in that culture just don't value education.")

[2] Integrates concepts from Aguirre et al. (2013), Banks (2019), Gay (2002), Ladson-Billings (1995, 2014), and Paris (2012)

CGP Feature #3: Dismantle Power and Status Hierarchies

Description: Teachers seek to identify power imbalances in the classroom, such as loud students' contributions being given priority over those of quiet students and White students' ideas being seen as more valuable than the ideas of Black, Latine, and Indigenous students. Teachers work to address issues of power and status to ensure that all students' voices are heard and ideas are valued.

Reflection Questions:

1. How do I structure classroom interactions so that all students have ownership of their learning and opportunities to demonstrate their math/science content knowledge during the lesson?
2. How do I support group work such that all students are given the opportunity to participate meaningfully, and all students' contributions are valued?
3. How do I help students in my class to challenge their assumptions about which of their classmates will be successful in math/science?

Math/Science Lesson Examples:

1. Structure collaboration in ways that encourage students to use varied math/science knowledge and skills to solve complex problems.
2. Monitor students and groups for participation, seeking to identify students or groups of students whose voices are continually silenced or who are given fewer or less deep learning opportunities.
3. Value mathematical or scientific ideas that come from students who belong to groups marginalized by systemic inequalities. Publicly label those ideas as valid and worthy of investigation to dismantle assumptions about who is smart and who will be successful in science and math.

Math/Science Lesson Non-Examples:

1. Structure group work and class discussions by ability during math/science lessons. Segregate specific students ("low ability" or "English language learners") from main activities and/or remove the challenge or demand from difficult math and science tasks.
2. Allow students with louder voices and students who belong to the dominant group to monopolize conversation and group work.
3. Associate speed with "smartness" and prioritize ideas from students who answer questions quickly.
4. Reinforce or echo the ideas of students from dominant groups while ignoring the contributions of students who are quieter or belong to groups marginalized by systemic inequalities.

CGP Feature #4: Diversify Curriculum and Challenge Dominant Perspectives

Description: Teachers support students in questioning whose ways of knowing have historically been valued in math and science. Teachers analyze and revise curriculum materials to include perspectives from women and people of color marginalized by systemic inequalities based on race, ethnicity, and language.

Reflection Questions:

1. How do I challenge traditional assumptions about whose knowledge matters in math/science?
2. When and where in my classroom do I incorporate mathematical or scientific ideas from women and people of color marginalized by systemic inequalities?
3. What impact do my own identity and my students' identities (race, ethnicity, gender, language, social class, religion, etc.) have on my math and science lessons, and how do I adapt the curriculum to be more inclusive?

Math/Science Lesson Examples:

1. Emphasize diverse voices in math and science and share with students how women and people of color have been central in both fields (e.g., through classroom bulletin boards).
2. Discuss the historical background of science and mathematics, including non-Eurocentric development of the discipline.
3. Recognize there are multiple ways of knowing math and science.
4. Analyze and revise curriculum tasks to ensure broad representation of identities and perspectives.

Math/Science Lesson Non-Examples:

1. Attribute all math/science knowledge to White males (e.g., Rosalind Franklin was not credited for her role in discovering the DNA double-helix model; instead, Watson and Crick received all the credit).
2. Solely present math/science concepts from a Eurocentric perspective.
3. Ascribe all knowledge and power to textbooks and mainstream ways of doing math and science (e.g., using traditional algorithms, adhering strictly to the traditional scientific method).
4. Use curriculum lessons without first evaluating whose perspectives and identities are included and whose are left out.

Appendix B

Checklist of Case Writing Guidelines

Authenticity of the Dilemma (Gunn et al., 2018)		Based on a real-life experience that can generalize to some idea, principle, or theory (Darling-Hammond & Hammerness, 2002)
		Reflects the uncertainty and complexity of the dilemma (Sykes & Bird, 1992)
		Encourages focus on the context of the dilemma rather than simple problem solving (McNeill et al., 2016)
Detail of Descriptions (Markovits & Smith, 2008; McNeill et al., 2016; ETS, 2020)	Note: Be sure to include context descriptions for any of the four items below that apply to your case. Each item includes suggested examples; however, all examples listed may not apply to your case, and you may choose to include additional details not listed.	
		Includes rich description of the academic context and general classroom information (e.g., students' grade and developmental levels; classroom culture; relevant content standards; curricular context; lesson goals; student-centered learning goals and strategies; relevant power dynamics)
		Includes rich description of individual students involved (e.g., students' lived experiences/personal histories; cultural and linguistic assets; home languages; academic/nonacademic strengths; unique learning needs; prior learning experiences; areas of interest)
		Includes rich description of school (e.g., school culture; school norms and policies; school-wide expectations; family and community engagement; whether the area is urban, suburban, or rural; socioeconomic information and demographics)
		Includes information about the interactions between teachers and/or students including relevant details about what was done, said, and felt (Hammerness et al., 2002)
Writing Style		Crafted to critically engage and challenge the reader as dramatic tensions in the plot unfold (Shulman, 1992)
		Allows preservice teachers to picture themselves in the situation to make it personal rather than vicarious (Abell & Bryan, 1997)
		Highlights perspectives and practices preservice teachers are less likely to encounter before entering schools (Bencze, Hewitt, & Pedretti, 2001)
		Has multiple entry points; can be viewed and discussed from multiple perspectives (Darling-Hammond et al., 2005; Gunn et al., 2018; Mikeska et al., 2019; Sykes & Bird, 1992)
Structure of the Case		Is written as a narrative with a sequence of events (Shulman, 1992)
		Illustrates a dilemma at the intersection of math/science and equity (Gunn et al., 2015; Gunn et al., 2018)
		Is multidimensional and open to diverse interpretations; yields multiple solutions (Shulman, 1992)
		Foregrounds social and cultural dimensions of the experience (Shulman, 1992)
Discussion Prompt Design		Provides opportunities to consider alternative perspectives on the cases rather than solutions (O'Flaherty & McGarr, 2014)
		Draws attention to tensions in the case that can guide discussion (Gunn et al., 2018)
		Facilitates discussion grounded in specific case details, rather than generic descriptions or opinions (Nemirovsky & Galvis, 2004)

Appendix C

Clocks Case

You are a first-grade teacher in an urban Utah elementary school. Your classroom has 32 students seated in groups of four at eight separate small, square tables. You have just taught a math lesson about time, focused on Standard 1.MD.3 (Tell and write time in hours and half-hours using analog and digital clocks) and are now transitioning to a small group activity. You have given each group 20 cards depicting analog or digital clocks to either the hour or half hour and have told students they must work together to sort these time cards under the correct labels of "Hour" or "Half Hour."

The following four students are seated at a table together:

- Robert is a Chicano student who has attended your school since kindergarten. He was born in Utah, and English is his home language. He is confident in his math abilities and scores well on math assessments.
- Maria is a white female student who recently moved to Utah from Venezuela. She speaks mostly Spanish and has limited English proficiency. She scores well on math assessments but rarely expresses confidence in her abilities.
- Naomi is an African-American female student who has attended your school since kindergarten. She was born in Utah, and English is her home language. She is confident in her math skills but sometimes struggles with math assessments.
- Don is a Chicano student whose family recently moved into your school district from the rural Utah town where he was born. English is his home language. He struggles with math assessments and, as a result, is not confident in his abilities.

As you circulate the room, you pause to watch and listen to the group's interaction.

Naomi: Let's start out by putting the titles here. She points to a spot right in front of her.

[Robert starts sorting the cards on his own.]

Naomi: We're supposed to work together.

Don: What are we supposed to do?

Robert: I'm sorting the cards, and the ones that show an hour go here in this pile. The half-hour ones go over there.

Don: Oh, does this card go in this pile then?

Naomi: No, we're supposed to put them under the titles.

[Maria grabs a card near her to sort and places it under the correct label.]

Robert: Teacher, we're done!

Naomi: He did all the work! She is visibly frustrated.

Please discuss the following questions:

1. What tensions do you notice in the group's interactions? What are some possible reasons for those tensions?
2. From this conversation, what concerns do you have about student learning for each of the students?
3. Brainstorm 2–3 next steps you could take to better facilitate group interaction and cooperative learning.