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# The work of equitable mathematics teaching: Leading a discussion of student solutions

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*Mathematics teaching produces and reproduces social injustice. It also has the potential to disrupt patterns of inequity and advance just communities of practice. Drawing from literature on equitable mathematics teaching, we analyze the work of leading a discussion of student solutions in ways that nurture healthy identities, relationships and societies. From a conceptual analysis of a Norwegian mathematics lesson, we first identify dynamics of race and gender at play, then identify three key aspects of mathematics teaching that can serve to disrupt these dynamics while creating opportunities for alternative identities, relationships and futures: (i) having regard for property and its use; (ii) taking up student thinking as participatory citizenship; and (iii) orchestrating collective mathematical work. We discuss nuances of this work and implications for research on teaching.*

*Keywords:* Research on teaching, equity, work of teaching, mathematics teaching.

Inequities that play out in classrooms are well documented and a growing body of literature has proposed ways of teaching attentive to social differences (e.g., Ladson-Billings, 2014; NCTM Research Committee, 2018). Nevertheless, conceptualizations of equitable teaching are nascent. We need specifications that can undergird professional practice in a coherent educational system. At the same time, specific dynamics of oppression are intimately contextual. We need to more fully understand the dynamics of marginalization and privilege as they play out in classrooms and the work involved in altering those dynamics. In this study, we analyze a discussion of students' mathematical solutions to conceptualize further the work of equitable mathematics teaching. Video and transcript of this discussion was part of a collection of data shared with TWG19 participants at CERME11. Accordingly, descriptions given in this paper are abbreviated.

## Conceptual and contextual background

We view teaching as responsible design and management of instructional interactions. We draw on features visible across developing theories of teaching — the didactical/instructional triangle, emphasis on interaction and joint action, and regard for milieu and broader environments (Brousseau, 1997; Cohen, Raudenbush, & Ball, 2003; Jaworski, 1994; Wickman 2012). We see teaching as professional practice identified through logical analysis in professionally useful domains and decomposable into constituent tasks for the purpose of examining, learning, and reconstituting new knowledge and skill into practice (Ball & Forzani, 2009; Grossman & McDonald, 2008; Hoover, Mosvold, & Fauskanger, 2014).

In this work, we focus on specifying teaching in ways that disrupt patterns of inequity and advance healthy communities of practice. We understand equity to mean being equal, fair, and even-handed, with “reasonableness and moderation in the exercise of one's rights, and the disposition to avoid insisting on them too rigorously” and with “recourse to general principles of justice (the *naturalis*

*æquitas* of Roman jurists) to correct or supplement the provisions of the law" (Equity, 2018). While recognizing no definitive authority for deciding what is equitable, we understand regard for equity as integral to teaching. In order to decide questions of equity, we draw on our sense of humanity and invite readers to do the same. Further, we want to be explicit that we understand education to be both a matter of development of the child and an invitation to children to reimagine the world. Equitable teaching is more than just not being inequitable. We understand teaching to be about engagement in and creation of a healthy learning community — one that both enriches without oppressing and is open and responsive to individuals, their experiences, and their spirit.

## **Design of the study**

To understand the work of leading of a discussion of students' mathematical solutions, we analyzed a session from a national study in Norway. Intervention schools were provided an additional mathematics teacher, with the goal of evaluating whether increased teacher-student ratios, with increased small-group instruction, will increase student learning. For the session we analyzed, the additional teacher is experienced and locally recognized as skilled. At this school, rotating groups of 4-6 students leave their regular mathematics class to work in a small group with this teacher. The session is 21.5 minutes, with 5 year-four students, two boys (B1 and B2) and three girls (G1, G2, and G3). It occurred in 2017 on the 80<sup>th</sup> birthday of the King of Norway. The teacher asked students to determine the year in which the king was born. Sitting around a large table, students work on their own for about 6 minutes, at which time the teacher has students share solutions.

Our analysis is empirical yet focused on concept formation (Gerring, 2001). It is conceptual-analytic research in line with Sleep (2012). Drawing on our experiences, literature, and records of teaching practice (such as video, transcript, lesson plans, student work, and interviews), we generate and test ideas about recurrent tasks of teaching. We build, revise, and discard ideas based on logical coherence with purpose, enactment, and learning of teaching and on coordination of different perspectives, in particular of the discipline of mathematics and of pedagogy (Thames, 2009). In this study of entailments of equitable teaching, we first examined potential patterns of structural oppression and marginalization. Then we analyzed opportunities for disrupting these patterns.

## **Potential patterns of structural oppression and marginalization**

First we examine interactions in the classroom that might be indicative of the reproduction of societal patterns of marginalization and oppression. The teacher begins by encouraging students to cooperate, yet during the first six minutes of the video, G1 and B2 dominate the verbal bandwidth, primarily talking to themselves, or no one in particular, with occasional, mostly ignored responses. As the task is launched, B2 announces that the problem is "child's play" and that the answer is 1933, which he then amends to 1923. G1 says, "21<sup>st</sup> of January," to which G3, the one identified black student, says, "It's not the 21<sup>st</sup> of January, he has his birthday on the 21<sup>st</sup> of February." G3's comment is participatory in the sense that she has listened to G1 and is responding substantively to her, yet G1 dismisses her concern, adjusts her thinking, and covers her statement with, "But, I'm writing when he was born, so the 21<sup>st</sup> of February...January...." Perhaps her response is sincere and responsive, but its forceful expression seems to shut down and end the exchange. Sexism and racism are well-documented societal issues. Might they bear on these classroom interactions?

A similar dynamic plays out again two minutes later when G3 announces, “I know! It’s 1937!” to which G1 puts up a hand to stop her and shouts, “You can’t say it out loud! We’re trying here....” The teacher also counters G3, “But remember, you remember what we’ve been saying. It’s not the answer that’s going to impress me. What’s going to impress me the most is the way you got the answer.” After a brief flurry then of students all wanting to explain and the teacher saying to wait, G3 reflects further, quietly stating, “It has to be 1937. I’m certain.” This time, B2, sitting next to her says, “No, it isn’t.” This sequence is striking in several ways. G1 objects to G3 for announcing her answer, when B2 has announced his several times without objection. Likewise, each of the boys indicated that he has an answer, but the teacher did not counter them. G3, a black girl, is shut down by a white girl, white teacher, and white boy in succession. Given the documented marginalization of people of color internationally, this exchange warrants consideration. Might it be a case of the reproduction of patterns of marginalization and oppression that occur in the larger society? Whether it is or not, noticing it matters for teaching and can inform the development of disruptive practice.

Turning to the teacher’s engagement with student solutions, several other observations can be made. Following the explanation of G1’s approach (reducing 80 by 17, then subtracting 63 from 2000), the teacher praises her ability to figure out the calculation, when “you haven’t really learned this.” He again repeats that he is “extremely impressed” and “should almost write an article” about her solution. Then, following B1’s explanation (removing 17 from 2017, subtracting 80, then adding 17 back in), the teacher characterizes it as a “clever way”. In contrast, following G2’s explanation (conventionally subtracting 80 from 2017), he acknowledges that she did it “elegantly and nice”, but then makes the point that B1’s approach is easier and “really smart”. Given the lavish praise given to G1, the teacher’s qualified praise for G2’s work seems inconsistent, as G2 performed the “difficult calculation” and did so flawlessly. G2 began the session expressively, but with the dominance of the talk of G1 and B2, her voice remains muted for the remainder of the lesson.

The last student to present was G3. She says, “What I did was first: Nineteen... [Writes 1900.] And then I did... Plus... 20 since the King is 80 years old. Then I added 17. [Writes 1937.]” On the board, she now has, “ $1900 + 20 = 1920 + 1937$ ”. The teacher says she started with the year 1900, “But now you’re challenging me, I’m actually not entirely sure how you thought. Why did you start at 1900 and why did you add 20?” The teacher has an exchange with G3 and ends by saying he sees and that it is pretty clever, but a full explanation is not elicited, and the teacher does not offer a recapitulation to the other students as he does with each of the approaches.

These exchanges suggest societal dynamics of power and privilege that might be forming and playing out. Both boys in the class speak with authority and a sense of entitlement, without hesitancy and with an expectation that others care and will listen. One talks extensively, with limited regard for others around him and little apparent understanding of the problem or its solution. The other works independent of the group, quickly generating a correct answer and presenting his solution with conviction and little attention to audience. These ways of being are consistent with what McIntosh (1988) identifies as white male privilege — where privilege is unearned benefits resulting from societal patterns of discrimination and oppression. Dynamics of privilege are central to sexism and racism (Collins, 2018; Keith, 2017; Lipsitz, 1998) and deserve thoughtful consideration in teaching and learning.

Turning to the girls, the first also talks extensively, forcefully inserting herself into exchanges about the problem, in contrast to the second girl, who seems to retreat after a few early comments. These two ways of being in the classroom are suggestive of the overbearing woman and the deferential woman sub-stereotypes respectively (Kite, Deaux, & Haines, 2008). They exist in relation to one another within two core dimensions of gender stereotypes: agentic being more male (active, confident, competent, and independent) and communal being more female (emotional, expressive, understanding, and concerned with the welfare of others) and remain relatively consistent across age and nationality (see Kite, Deaux, and Haines, 2008 for a review). How might these dynamics of privilege and enacted stereotypes be symptomatic of larger societal patterns? How might they be creating such patterns? How do they shape these students' identities and what sort of patterns do they establish for relationships these students have with others in the future?

Also noteworthy are patterns related to racial discrimination. In the wake of the WWII, reference to race became taboo in European politics and academia (Wodak & Reisigl, 1999). Rising immigration, though, has resurfaced its visibility and prompted policies aimed at monitoring racism and advancing integration and cultural diversity. As Maeso and Araújo (2017, p. 29) argue, though, these anxieties and policies "fail to address its [racism's] embeddedness in political culture, and therefore in institutional structures and practices." Or, as De Genova (2018, p. 1765) contends, the "migrant crisis" is an "unresolved racial crisis that derives fundamentally from the postcolonial condition of 'Europe' as a whole." Norway is implicated in this history. In their analysis of the 2011 attack in Oslo, Mulinari and Neergaard (2012, p. 15) point out that Norway has parliamentary representation for culturally racist parties and that mainstream discourses, policies, and practices make this permissible, again implying that racism is alive and well in Norway and in its institutions.

Might dynamics of sexism and racism be playing out in these classroom interactions? The boys act with entitlement and are treated in kind. The girls navigate in relation to the boys. G3 is negatively critiqued and her approach devalued. It is unclear whether her solution has been understood. It is not sufficiently supported to be useful to others. How is this experience likely to shape her sense of self? What does it suggest about how these children are likely to engage across gender and race in the future? Blacks are often seen as less capable; Black women as invisible. The enactment of privilege, stereotypes, and discrimination is hard to dismiss in this session.

## **Opportunities for equitable teaching**

Next we examine teaching's possibilities for disrupting patterns of inequity and advancing healthy communities of practice. Teaching is a powerful force. It shapes learning and lives. The children's experiences shape their sense of themselves as doers of mathematics, as capable or not. It shapes their sense of their relations to others, with regard to both connection and power. How do they work together? How do they contribute their ideas, take up the ideas of others, and develop new thinking? In many ways, participation in this class is practice for participation in the world. How might teaching shape that practice and the future world? We start by observing that the potential power of teaching in this session is extensive in large part because of the choice of the problem for these students, the orchestration of the session as problem solving, and the focus on explanation. These could be used to create rich opportunities for forming identities, relationships, and ways of working

together in the world. Within teaching, though, are discretionary spaces, often filled with habitual talk and actions, unconsciously accumulated from being in the world as it is (Ball, 2018).

Teaching is a complex space, with much to consider. Our focus on disrupting patterns of inequity and advancing healthy communities led us to identify three key aspects of teaching as it plays out in this session: (i) having regard for property and its use; (ii) taking up student thinking as participatory citizenship; and (iii) orchestrating collective mathematical work. These are related in significant ways, but we distinguish them as offering different lenses on the dynamics of the work of teaching related to this session.

First is an issue of property. Who has say over what? At the start of the session, the teacher tells students to “close the book for now.” G1’s book is open and she is looking between her book and a worksheet. While talking, the teacher nonchalantly reaches down, closes her book, and slides both it and the worksheet away from her and into table space in front of him. Whose property is this? Respect for personal space and personal property are important, as are agency and skills of self-monitoring, transition, and collaboration. What message does this action send? This may seem like a small matter, but it continues throughout the lesson. For instance, to whom does the whiteboard belong? The teacher? Or is it the class’ whiteboard and a resource for collective work? Extending this to intellectual property, who has authority when it comes to student explanations? The teacher maintains extensive control over G1’s explanation. He stands at the whiteboard, creates a representation for her approach, and makes claims about her thinking. It is as if he uses her work as a medium for presenting his own thinking, in a way that might be experienced and seen as co-opting her thinking for his purposes. Who owns ideas and how do we know?

We do not mean to imply that any one of these actions is good or bad. Our point is that issues of property in classrooms are important sites of power and that without thoughtful consideration will likely be places where patterns of marginalization play out. On the flip side, they are sites for disruption. Providing a sense of property in a classroom, where respect for property is accorded, can give students, who may otherwise feel marginalized, a sense of belonging, of being valued, of having a legitimate place at the table of knowledge. While implicit and explicit messages tell girls and children of color they do not belong in mathematics, being a property owner in a mathematics classroom can create a strong counter narrative. Teaching can help this happen. Equitable mathematics teaching reflects on the multiple forms of property that exist in a mathematics classroom, ways property might be distributed, with what effect, and how to ensure respect for it.

This leads us to a second important aspect of teaching: taking up student thinking. Whether student thinking is taken up, and how it is taken up, matter. As already mentioned, the teacher dominates the presentation of G1’s work. It is then striking to watch B1 stride to the whiteboard, take the pen from the teacher’s hand, and explain his approach. With white male privilege, B1 claims the space and his ideas. He begins, “I thought like this. We remove 17 so there’s only 2000 left.” Then, midway in B1’s presentation, the teacher steps in to “repeat” what B1 said for the benefit of others. The teacher says, B1 “didn’t bother about the 17 at first,” but thought, “What if it we’re in the year 2000 now?” This differs from what B1 actually said and is likely confusing for other students. B1 began by “bothering” about the 17. He began by removing 17 to simplify the subtraction, with the

idea of compensating later. This is left implicit in B1's explanation but is consistent with what he said. Greater focus on B1's thinking, perhaps with questions to ask why he removed 17, or at least checking in with him about an interpretation, might push back on the low demand placed on his explanations as a privileged white male. It might also create for other students, more equitable access to his thinking. In contrast, for a marginalized student, focus on their thinking might serve to include them more fully and communicate value for their thinking. Either way, the work of hearing students and interpreting and treating their thinking with integrity is crucial to equitable teaching and opportunities for disrupting patterns of privilege and marginalization. Our point here is that everyone suffers from oppression, in different ways and to different extents. If teaching acquiesces to white male privilege and skips over marginalized students, it may routinely fail to provide learning opportunities — prematurely accepting explanations of white males and dismissing the explanations of others.

For the first three students who explain their approach, the teacher steps in to explain the student's thinking, often couched as necessary for other students' understanding. We suspect that this is a pedagogical impulse that many teachers feel. Teachers often feel responsible for students' understanding and know they are, as the teacher, the one who is supposed to know the content. As they struggle to understand unconventional, emergent thinking, they may feel compelled to explain each student's thinking to the other students. Unfortunately, the demands of knowing intimately what others think are great and such a teaching practice often serves to reenact dynamics of privilege for some and marginalization for others. It runs a risk of causing students to feel unheard, silenced, and invisible. And it can undermine students' opportunities to learn from and with their peers. It is also a missed opportunity in the sense that a focus on student thinking can be used to counter patterns of oppression. Honoring each student's thinking as offered, with support for its expression and its respectful, authentic reception by other students, can nurture the healthy communities of practice that can rebuild our world.

This relates to the third key aspect of teaching implicated: the nature of the collective mathematical work. Collective work is an obvious avenue for addressing identities, relationships, and future worlds. This session again suggests challenges and opportunities. The teacher starts by characterizing the task as challenging and encouraging students to "cooperate". What, though, does it mean to cooperate on this problem? What might students need to be taught about how to cooperate for this work? A minute later, as a way to encourage students to focus on thinking about the problem and not jumping quickly to an answer, the teacher says, "A good tip right now is not to trust that one sitting beside you ... only trust yourself ... think for yourself." At this point, students are working relatively independently, and this comment reinforces independent work.

As the class shifts from problem solving to presenting their approaches, the nature of the collective work changes, as does the work of teaching. To prepare productive citizens, schools need to provide students with skills and experience crucial to public engagement, even in mathematics classes. Students need to learn how to present their mathematical ideas to an audience, be aware of who has and has not had airtime, and respond substantively to other's mathematical ideas. Mathematical work has a specific form and function. Students need to learn what counts as a mathematical explanation and how mathematical claims are decided, but many of its features extend broadly to

public discourse — clear communication, attention to audience, space for others to express themselves, thoughtful listening, respect for differences, and so forth. Equitable mathematics teaching creates opportunities for collective mathematical work and accountable discourse. In addition, it supports students' contributions, making sure students are ready to contribute, instructing them on how to present, teaching others how to listen, and supporting productive response. The teaching in this session creates opportunities for collective work and public discourse, but it provides inadequate student support (e.g., not teaching students how they might cooperate), inserts itself in ways that close off opportunities (e.g., explaining students' thinking for them), and truncates exchanges in ways that undermine authentic public discourse (e.g., providing a teacher summation in lieu of responses from others and collective resolution).

Our analysis of leading a discussion of student solutions in this brief session reveals three key aspects of teaching that can serve to disrupt inequitable dynamics. Each involves nuanced work, operating in big and small ways in classrooms. Together, they provide an image of sensibilities and skills that would serve teachers well. They also suggest the depth that would be required to disrupt patterns of privilege and marginalization and avoid reproducing them.

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