CO-CONSTRUCTING "QUIET" THROUGH PEER INTERACTIONS: UNDERSTANDING "QUIET" PARTICIPATION IN A SMALL-GROUP MATH TASK

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To disrupt patterns of marginalization that play out through interactions in math classrooms, teachers need to identify and address inequities in student participation, both in terms of participation outcomes and processes. In this study, I take an expansive view of participation and examine how the "quiet" participation of one 9th grade student is co-constructed through small-group interactions during an Algebra task. Analysis reveals three features of the group's interactions that fostered the co-construction of Becca's "quiet" participation: 1. Becca was positioned as a non-contributing silent beneficiary of learning, 2. Becca's contributions received less support than her peers', 3. Disagreement with Becca was softer than with John. Findings suggest that the perceived issue of low verbal production did not reside within Becca, but rather was the result of inequitable participation processes that played out through peer interactions.

Keywords: Classroom Discourse, Equity and Diversity

Educational inequities come in all shapes and sizes and are enacted through classroom interactions in many different ways. Institutional level inequities connected to race, gender, and socioeconomics undoubtedly shape students' mathematical experiences (Esmonde & Langer-Osuna, 2013; Herbel-Eisenmann, Choppin, Wagner & Pimm, 2011). While teachers alone cannot fix these historical injustices, they *can* disrupt patterns of marginalization by supporting more equitable interactions among students (Boaler & Staples, 2008). In this paper, I focus on equity as it relates to student participation in a math task. I examine how the participation of one student, labeled as "quiet" by her math teacher, is co-constructed through group interactions.

Labeling students based on behavioral patterns is common and done often with good intentions. However, labeling can be harmful if behavioral tendencies are seen as inherent characteristics of students (Gutierrez & Rogoff, 2003). By accepting that some student voices will inevitably take up more space than others, we run the risk of endorsing different participation expectations for different students, leading to inequitable learning opportunities (Hand, 2012). In addition, labels can position certain students as being deficient or inferior, since the labels themselves are typically not neutral (McDermott, 2010). Being "quiet" in a math class is often associated with less-than-desirable traits, such as being timid, less confident, and less knowledgeable. Instead, if we acknowledge that "quiet" tendencies are a byproduct of human interactions within learning environments (Cole, 1998; Lave, 1996), we can then address participation disparities through interactional interventions. The goal is not to *fix* individual students, but rather to support more equitable interactions among students. To do this, we need a better understanding of how students labeled as "quiet" participate through interaction, and we must be careful not to assume all "quiet" students share the same backgrounds or have the same strengths or needs (Gutierrez & Rogoff, 2003).

This study explores the interactions of four 9th grade students during a small-group math task. I pay particular attention to Becca, a student described as "quiet" by her math teacher. Research

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questions are: 1) *What did participation look like for a "quiet" student working on a small-group math task?* 2) *How was "quiet" participation co-constructed through peer interactions?*

Theoretical Framework

My work draws on sociocultural and situated theories that claim learning happens through participation in cultural activities (Lave & Wenger, 1991; Rogoff, 1990; Vygotsky, 1978; Wenger, 1998), considering language and discursive practices as central to developmental processes (Lerman, 2001). In this study, my perspectives on equity, learning, and participation are based on those described by Esmonde (2009). Esmonde asserts that "in the context of cooperative group work and participation in mathematical practices, equity can be defined as a fair distribution of opportunities to learn or opportunities to participate" (p. 1010). She views mathematical learning as referencing both the development of content-related understandings *and* the development of productive positional identities. Esmonde takes a broad view of participation, noting that "Although talk is a valued form of participation in many mathematics classrooms, there may be other valuable forms of participation that are less visible" (p. 1033).

One key part of combatting participation inequities is understanding how opportunities for participation are constructed and taken up (or not) through classroom interactions, since equity is both a *goal* and a *process* (Martin, 2003). If opportunities for participation are unfair, then it is reasonable to assume participation (the process through which students learn) will be inequitable as well, since a person's participation in learning activities is a function of the opportunities that person is given to participate (Gresalfi, Martin, Hand, & Greeno, 2009). And those opportunities for participation are shaped by the roles and responsibilities that a student is assigned through acts of positioning (van Langenhove & Harré, 1999). Equitable learning processes require that each and every student be positioned as a competent learner and doer of mathematics who has ideas worth sharing and from whom her peers can learn. Students positioned with competence and authority have more opportunities to participate in consequential and influential ways during student interactions, and therefore, have better access to opportunities for rich mathematical learning in terms of content and identity development (Cohen & Lotan, 1995; Engle, Langer-Osuna, & McKinney de Royston, 2014; Gresalfi et al., 2009; Langer-Osuna, 2011).

Methods

Data Collection

Participants. The group consisted of two girls (Becca & Paloma) and two boys (John & Kyle) from an Algebra 1 class in an urban, public high school. Names were changed. Becca was identified as a focal student based on her being described by her math teacher as "really quiet." The students' math teacher taught the lesson and shared post-lesson reflections. This class used CPM curriculum (cpm.org) and worked in groups on a daily basis.

Task. I designed the task and lesson plan for this lesson with the goal of eliciting productive mathematical participation from all group members. The math task, Searching for Sequences, addressed content related to linear growth patterns. Task materials include 16 pattern cards and a playing board, shown in Figure 1. The image below shows the focal group's final task solution.

Figure 1: Searching for Sequences Task - Pattern Cards and Playing Board

At the start of the task, four pattern cards were dealt to each student and kept hidden. Students then took turns placing one card at a time on the board, trying to create 3-card pattern sequences. Students were instructed to justify card placements by explaining patterns they saw. Cards were designed to allow for multiple correct solutions.

Video. Using an external microphone, video recorded participants' speech, gestures, body movements, and eye gaze. The video was 15 minutes long, the time it took to complete the task.

Data Analysis

Video was transcribed for speech, card placements, and salient gestures then divided into talk turns. A *talk turn* was uninterrupted speech by one person. If two people spoke simultaneously, each person was assigned a separate talk turn with overlapping timestamps. Drawing on previous research (e.g., Reinholz and Shah, 2018), I coded two forms of verbal participation: explanations and questions. I also coded one task-specific form of non-verbal participation: card placements. Details of the coding scheme are organized by form of participation and described below.

Questioning. I started by identifying every question that was asked based on speaker's word choice and intonation. I then coded who the question was *asked by* and *answered by*. *Answered by* included any verbal response to the question asked, even if the response was "I don't know." If more than one person responded to a question, multiple people were coded as *answered by*. If no one responded verbally to a question, the *answered by* was coded as "no one". I then tracked to whom questions were directed. The content of the question, students' body positions and eye gaze, and the sequence of talk and action were used to determine *directed to*. If a question was asked without a clear target (e.g., the asker was looking at the board and the content of the question did not indicate who was expected to respond), *directed to* was coded as "everyone."

Sense-making. Initially, I coded sense-making participation based only on explanations of pattern growth. *Explaining growth* was when a student talked about how a pattern was growing / shrinking or described how another figure in the pattern sequence might look. Growth explanations were then attributed to particular sequences to determine who explained which sequences. I then flagged non-verbal indicators (i.e. suggesting the 2nd or 3rd card in a sequence) and non-explanatory verbal indicators (i.e. exclamations) for each sequence. *Suggesting 2nd / 3rd card* was assigned if a student made a verbal suggestion for or placed the 2nd or 3rd card in a mathematically correct pattern sequence. *Sense-making exclaiming* was assigned if a student gave verbal indication that she agreed with a 2nd or 3rd card placement or understood a completed sequence (e.g., "Yeah, that makes sense" or "Oh!" after a 3rd card was placed). These additional indicators assume sense-making happened internally even though the details were not shared verbally. *Explaining growth* is the clearest indicator of sense-making since we had access to how students were thinking about patterns. *Suggesting 2nd/3rd card* is a moderate indicator, since a mathematically correct placement was made, but we did not have access to exactly how students

were thinking about patterns. *Sense-making exclaiming* is the most speculative indicator, since nothing is known about how or what students were making sense of with regard to the patterns.

Card placement. For each card placement, I captured the card image, the starting and ending card locations, and the person placing the card. A *card placement* was when a pattern card was placed on the board from someone's hand, a card was moved from one location on the board to another, or a card was removed from the board. For each person, I totaled the number of placements made and the number of unique cards placed. A *unique card* was a pattern card that had not yet been placed by that student. For example, if a student placed a card then on her next turn moved that same card to a new location, that process would count as two placements and one unique card. I then determined if someone other than the student placing the card had suggested where to place it. If so, I coded it as a *placement suggestion*. I also coded how each student responded to the placements made by her peers. *Positive response* was coded with clear approval of placement, either verbal (e.g., "Yeah, that makes sense") or non-verbal (e.g., head nod). *Negative response* was coded with clear disapproval, either verbal (e.g., "No, I don't think that goes there" or non-verbal (e.g., head shake no). *Neutral response* was coded if no clear approval or disapproval was given but the student seemed to know the placement had been made based on eye gaze, body position, or subsequent talk. *Unaware response* was coded with no clear evidence the student knew the placement had been made.

Findings

Findings are divided into two sections and organized by research question: 1) *What did participation look like for a "quiet" student working on a small-group math task?* 2) *How was "quiet" participation co-constructed through peer interactions?*

Becca's "Quiet" Participation

Table 1 summarizes key participation metrics for each of the four students and the teacher. Students worked for 15 minutes on the task. The teacher joined for 90 seconds of that time.

Table 1: Participation Metrics by Person

	Talk Turns		Words Spoken		Words	# of Questions		# of Growth	# of Card Placements	
	#	%	#	%	per Turn	Asked by	Answered by	Explanations	Total	Unique Cards
Becca	**32**	**11%**	**98**	**5%**	**3.1**	**7**	**14**	**0**	**11**	**5**
John	111	37%	806	45%	7.3	20	32	2	20	12
Kyle	49	16%	240	13%	4.9	10	14	5	8	5
Paloma	100	33%	504	28%	5.0	21	17	5	8	5
Teacher	8	3%	141	8%	17.6	5	0	0	3	2
TOTAL	300	100%	1789	100%	6.0	63	77	12	50	n/a

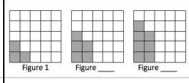
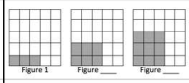
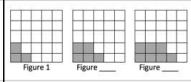
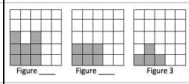
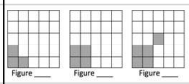
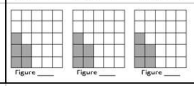
Note. Some questions received multiple responses, hence the number *answered by* exceeds the number *asked by*.

Becca spoke the least out of the four students in the focal group. She took the fewest talk turns (11%, 32 turns), spoke the fewest words (5%, 98 words), and had the shortest talk turns (avg. 3.1 words/turn). John and Paloma led the group with roughly the same number of talk turns (111 and 100 turns respectively), although John spoke the most words (45%, 806 words) and had the longest talk turns (avg. 7.3 words/turn). Becca also asked the fewest questions (7 questions) but answered the same number of questions as Kyle (14 questions) and just three fewer than Paloma (17 questions). John dominated the answering of questions by responding to twice as many questions as everyone else (32 questions). Becca made 11 card placements but did not offer any verbal explanations of growth patterns she saw. John made about twice as many placements as

everyone else (20 placements) and offered two explanations. Kyle and Paloma made the fewest card placements (8 placements each) but gave the most explanations (5 explanations each). We also see that Becca, Kyle, and Paloma each made placements with 5 unique cards, meaning they each touched the four cards originally dealt to them plus one additional card. In contrast, John made placements involving 12 unique cards, meaning he touched his four original cards plus eight more, accounting for 75% of all pattern cards.

After considering these metrics, much is still unknown about Becca's mathematical sense-making, a key part of her learning trajectory. We do not yet know if Becca's 11 placements were based on her own mathematical reasoning, someone else's, or no mathematical reasoning at all. If we use student explanations as an indicator of learning (e.g., Hatano, 1993), we see no evidence of sense-making by Becca. However, if we broaden our view of sense-making to include contextual non-verbal indicators (i.e., suggesting 2nd/3rd card in a sequence) and non-explanatory verbal indicators (i.e., sense-making exclaiming), there is evidence of Becca's sense-making for five out of the group's six sequences. Even though the final task solution included only four sequences, the group completed six mathematically correct sequences in the process of reaching their solution. Students formed two sequences that were later dismantled in favor of using the cards for other sequences. Table 2 shows the six pattern sequences the group formed in chronological order. The shaded blocks on the right represent the clearest sense-making indicator by person by sequence. The darker the shading, the clearer the indicator. For example, Kyle and Paloma's dark boxes in the top row of the table indicate they both explained growth for this first sequence. John's lightly shaded box indicates he made a sense-making exclamation, and Becca's unshaded box indicates no evidence of sense-making by Becca for this first sequence.

Table 2: Students' Mathematical Sense-Making by Sequence

				Mathematical Sense-Making							
		Time of Pattern…		Indicated by…				Enacting by…			
Order	Pattern Sequence	Completion	Dismantling	Explaining Growth	Suggesting 2nd Card	Suggesting 3rd Card	Sense-making Exclaiming	Becca	John	Kyle	Paloma
1		4:59	13:56	Kyle & Paloma	Kyle	Kyle	John & Paloma				
2		7:18	n/a **FINAL FOUR**	John	Kyle	John	Becca & Paloma				
3		7:33	20:10	No one	Becca	John	John & Paloma				
4		11:41	n/a **FINAL FOUR**	Kyle & John	John	John	Becca, Kyle, & Paloma				
5		13:46	n/a **FINAL FOUR**	Kyle & Paloma	Kyle	Becca, Kyle, Paloma	Becca & Paloma				
6		14:41	n/a **FINAL FOUR**	Paloma	John & Paloma	John & Paloma	Becca, John, Paloma				

Even though Becca did not explain any growth patterns, her 2nd and 3rd card suggestions for two different sequences, indicate she was indeed making some sense of those growth patterns. Becca made sense-making exclamations for three additional sequences. For example, Becca said, "Yeah, that makes sense," just after John placed the 3rd card in the fourth sequence and Kyle explained the pattern he saw. Considering all sense-making indicators together, we see evidence

that Becca made sense of at least five out of the six sequences, the same number as John and one more than Kyle. Paloma was the only student who indicated sense-making for all six sequences.

Participation metrics indicate that Becca was indeed the "quietest" student in the group, with Kyle coming in a close second. Becca spoke least often, said the fewest words, asked the fewest questions, and offered no verbal explanations of the patterns she saw. However, her card placement data were comparable to those of Kyle and Paloma, and a broader view of mathematical sense-making participation indicated Becca made sense of five out the six sequences the group created, the same number as John and one more than Kyle.

Co-Constructing "Quiet" Through Interactions

Three features of the group's interactions fostered co-construction of Becca's "quiet" participation: 1. Becca was positioned as a non-contributing, silent beneficiary of learning 2. Becca's contributions received less support than her peers', 3. Disagreement with Becca was *softer* than with John.

Becca was positioned as a non-contributing, silent beneficiary of learning. This task challenged all four students; they looked to each other for help and guidance. Well, they looked first to John for help, and then to Kyle and Paloma, but never to Becca. Out of 63 questions asked in this group, 26 were directed to everyone in the group and 37 questions were directed to a particular person. Out of the 37, only two were directed specifically to Becca. When students were deciding who should take the first turn based on birthdays, John asked Becca, "What day of December are you?" Later when they were determining whose turn was next, Paloma asked Becca, "You don't have any more cards?" Both questions elicited specific information from Becca related to task facilitation not to mathematics. Neither question required more than a one-word response. No one asked Becca for help, ideas, or approval, which therefore positioned Becca as a beneficiary of the group's learning as opposed to a contributor to it.

Throughout the process of task completion, Becca did much more listening than talking. By listening to her peers' explanations and not offering justifications for the placements she made or explaining patterns she saw, Becca reinforced her role as a non-contributing beneficiary. However, Becca answered 9 of the questions directed to everyone in the group, the same number as Paloma, three more than Kyle, and just four fewer than John. Becca also had the highest ratio of questions *answered by* compared to questions *directed to* (14:2), meaning she answered seven times as many questions as were directed to her. Becca's peers answered 1.5 to 2.5 times as many. Overall, interactions between Becca and her peers positioned Becca as a non-contributing, "quiet," beneficiary of the group's learning, though her willingness to answer questions directed to everyone or to people other than herself contradicted this positioning in subtle ways.

Becca's contributions received less support than her peers'. As an active member of the group, Becca's contributions included question asking, question answering, and card placements. However, many of these contributions received less support from her group than those made by her peers, as revealed by the responses Becca received to her card placements (Table 3).

Table 3: Card Placement Responses from Peers

	Total Placements	Responses from Peers	Positive		Negative		Neutral		Unaware	
			#	%	#	%	#	%	#	%
Becca	11	33	5	15%	3	9%	7	21%	18	55%
John	20	60	26	43%	1	2%	32	53%	1	2%
Kyle	8	24	11	46%	0	0%	12	50%	1	4%
Paloma	8	24	10	42%	0	0%	14	58%	0	0%

Note. **Responses** from **Peers = 3 *** Total Placements

John, Kyle, and Paloma had similar distributions of responses across categories, all very different from Becca. Over half the time, Becca's peers seemed unaware of her placements. Six out of Becca's 11 card placements, occurred while her teammates were talking with one another and making other card placements, resulting in the 18 unaware responses. Looking closer at Becca's placements that *were* noticed, we find that all five positive responses were in response to two placements that were made by Becca but suggested by John. For one placement, John pointed to a location on the board and described how the next pattern card should look, asking, "We don't have one that has three slots, or do we?" Becca responded, "Yeah," as she placed the card described by John in the location suggested by John. Becca's other positive placement occurred after John shared an idea for a new 3-card pattern sequence that required dismantling one of the previously created sequences. Becca helped enact John's suggested sequence by placing a specific card in the location John had suggested. John and Paloma responded positively to both of these placements made by Becca; Kyle gave a neutral response to the first and positive response to the second, accounting for the five positive responses. Becca received no positive responses for placement decisions she made on her own. In addition, she was the only student to make a placement that received negative response from everyone, described in the next section. Interactions within the group allowed many of Becca's contributions to be invisible and others unvalidated, perpetuating Becca's "quiet" participation.

Becca's silent, often subtle movements were not enough to attract the attention of or elicit validation from her peers. She made 10 out of her 11 card placements without saying a single word. The one time she spoke was to ask John, "This one here?" to clarify the placement he had suggested she make. Despite lack of support, Becca continued to engage with her peers' ideas throughout the task. She even made several verbal attempts to propel the group's learning forward. At one point, Becca said, "Let's try it," in response to a suggestion by John, and another time she said, "Show us what you mean," prompting Paloma to describe a pattern in more detail. Becca contributed to her group's collective work, though much of her work went unrecognized.

Disagreement with Becca was *softer* than with John. Two card placements during the 15 minutes of work time received negative responses from peers. One was made by Becca and the other by John. The interactions surrounding these two placements were quite different and led to different outcomes. The challenge to Becca's placement was relatively *soft*, and her card remained in the location she had chosen. The challenge to John's placement was *firm*, and his card was removed from the location he had initially chosen.

The interaction around Becca's placement began when John pointed to her and said, "Now it's your turn." Becca looked down at her cards. Paloma and John pointed to the same card on the board as Paloma suggested, "Maybe that goes there," pointing for a moment to another location. At the same time, John said, "Move this one, move this one, move this one to where you think it goes." Becca looked up to see them pointing. Becca put her finger on the card John was still pointing to. John responded, "Yeah, that one." Becca slid the card to a new location on the board, a different location from the one suggested by Paloma. Surprised by the move, Paloma and John turned to each other and smiled. Becca watched. Paloma said, "I think it goes-" and stopped. Still smiling, John turned back to the board and said, "Alright." Becca put her hand to her mouth, smiling slightly, and looked at the board. Kyle then said, "Ah, probably this one goes there," pointing to the location Paloma had suggested. Paloma responded, "Yeah." Becca whispered the words, "I don't know," audible only after close examination of the video. Paloma softened her

response by saying, "Maybe. I mean, you never know." This interaction was *soft* in that Becca's peers did not push too hard; their actions and words were gentle. They made their opinions known but did not put Becca on the spot by asking her about her placement decision. It was as if they all believed she was wrong, but did not want to make her feel bad, so they just let it go.

The interaction around John's negative response placement occurred immediately after Becca's. Five seconds after Paloma's "you never know" comment, John said, "I think this one goes over there," as he slid a different card from one location on the board to another. John pulled his hand away from the card, looked down at the two cards left in his hand and continued, "Cuz I have a card here." Kyle then rejected John's placement by saying, "No, I have a card that goes here." As Kyle said this, he slid John's card back to its previous location. For a moment, John put his fingers back on the card, saying "Nnnnno." Kyle said again, "I have a card that goes here," pointing to the now empty location where John's card used to be. John took his hand away and looking directly at Kyle's eyes asked, "Are you sure?" Kyle looked back at John and said confidently, "Yeah." John then continued his turn by placing an unrelated card. This interaction was *firm* in that Kyle challenged John's placement confidently and directly. Kyle moved John's card back to its previous location without waiting for approval and despite John's initial attempt to stop him. Ultimately, John accepted Kyle's rejection of his placement and moved on.

Becca's peers did not challenge her in the way that Kyle challenged John. They treated Becca as if she was fragile, sensitive, and less knowledgeable than they. These traits often go hand-in-hand with the label of "quiet" student. In response, Becca did not offer any defense of her placement even though it was mathematically sensible. She appeared timid and unsure of her decision, fulfilling the students' expectations of her. However, she could have moved her card to the location suggested by her peers, but she did not. Instead, she rejected the suggestion and left the card where it was. Becca stood her ground and exercised some agency, albeit silently.

Discussion

Teachers and researchers agree that in discourse-heavy classrooms student talk is important for student success (e.g. Barron, 2003; Engle & Conant, 2002; Langer-Osuna, 2011), but I argue there is more for us to learn if we expand our participation lens to include non-verbal indicators and underlying interactional mechanisms, as opposed to just isolated participation metrics. An expansive view of participation allowed me to look beyond Becca's lack of talk to understand more about a) Becca's mathematical participation b) the co-construction of "quiet" participation through interactions c) how inequitable opportunities for participation unfolded, and d) what might be done to support more equitable participation in the future. In addition, I argue that caution needs to be taken when labeling students based on easily observable participation metrics, because this non-neutral, often gendered and racialized process can be detrimental to students' learning experiences. In the case of Becca, her "quiet" label encompassed more than simply an expectation for limited verbal production. Becca and Kyle's "talk" participation in the task was similar in that they both spoke very little compared to John and Paloma. However, the *opportunities* they had for various types of participation were considerably different due to how they were positioned by their peers. Becca was positioned as an insecure, less knowledgeable, non-contributor to the collective learning; Kyle was positioned as a confident, knowledgeable contributor. Coincidentally (or not), Becca and Kyle were described differently by their teacher. Becca was described as a student who is "really quiet," "very shy," and "uncomfortable being in a group." Kyle was described as a student who is "independent" and "does not like working in

groups." Although both descriptions set low expectations for verbal participation, the underlying assumptions about students' self-beliefs and competences are quite different.

Students perceived to be "quiet" are an understudied group of young people who have strengths that are going unrecognized and potential that is going unrealized. I fear "quiet" students' contributions are going unnoticed and their participation is misunderstood. While I cannot claim this is true for *all* "quiet" students, I can claim this was true for Becca, a non-white, female student. I fear that these oversights and misunderstandings are happening in racialized and gendered ways that are perpetuating the status quo, allowing marginalized students to be further marginalized in our math classrooms. Our quest for more equitable educational outcomes through more equitable means, requires more in-depth study into the learning experiences of students who are perceived as "quiet" by their teachers, parents, peers, and/or themselves.

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