

IDENTIFYING AND RECONTEXTUALIZING PROBLEMS OF PRACTICE IN LEARNING TO FACILITATE DISCUSSIONS WITH ARGUMENTATION

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Supporting teachers to facilitate discussions with argumentation is as complex as the practice of facilitating argumentation itself. In this paper, we describe how a community of teachers and one teacher within this community made sense of facilitating argumentation. We use the construct of problems of practice as an indicator of teachers' sensemaking and learning. We contend that problems of practice are highly situated within teachers' contexts. The teachers identified participation as a broad problem of practice for facilitating argumentation and we identify three aspects of participation salient for teachers. Moreover, we show how Amanda, one of the teachers recontextualizes these problems to her thinking and practice.

Keywords: Professional Development, Teacher Knowledge, Teacher Educators, Reasoning and Proof

Whole class discussions that focus on mathematical argumentation are central events of inquiry-oriented environments (Staples & Newton, 2016), and important for promoting conceptual understanding and developing mathematically proficient students (Osborne et al., 2019; Rumsey, 2012). Mathematical argumentation engages students collaboratively in a process where they make claims and justify them using reasoning that is based in disciplinary practices and in their existing knowledge and cultural and linguistic resources. Argumentation-based discussions, however, are uncommon in U.S. classrooms (Cazden, 2003). Studies of teachers' roles and responsibilities in these socially and intellectually demanding environments highlight various teaching practices that support mathematical argumentation (Lampert, 2001; Staples, 2007). However, this research also suggests that implementing these complex practices is not trivial. Teachers must judge how to elicit and respond to student thinking and how to facilitate students' engagement with each other's ideas around disciplinary content. Problems of practice are endemic to this work and how teachers understand them and what they do to address them reflect pedagogical reasoning that is deeply embedded in their context, students, and professional knowledge. In this paper, we investigate problems of practice emerging from a community of elementary teachers engaged in a practice-based professional development (PD) focused on facilitating mathematical argumentation. We also describe how one teacher in this community, Amanda, contextualizes these problems in her practice.

Problems of Practice

Problems of practice (PoPs) have been a focus of teacher education research. Lampert (2001) wrote extensively about problems of practice based on teaching mathematics over the course of a year in a fifth-grade classroom. Using a zooming metaphor, she described teaching as a complex web of relationships involving the teacher, students, and content on different levels. It is within

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these relationships she argued “problem spaces” lie. She elaborated, “the problem space in which the teacher works is full of ideals to be realized, full of worthy destinations... In the actuality of teachers’ work, however, the practices intended to realize these ideals are often incompatible” (p. 447). Thus, PoPs arise through these contradictions. Ghousseini (2015) framed these contradictions in “the way a teacher holds and deploys knowledge and coordinates instruction can constrain or promote what students can do with the content. Similarly, students and content can both constrain and open up what the teacher can do to teach, hence rendering the relationships inside the instructional triangle as both sources of problems of practice and resources for solving them” (p. 338). In other words, when teachers draw on a set of knowledge, beliefs, and identities to manage their practice, most often, their visions are reshaped by contextual factors.

Building on this work, we view a problem of practice as teachers’ perceived misalignment between idealized instruction and actual instruction as normalized by a community. This misalignment can be manifested through teachers’ interactions expressed as “troublesome, challenging, confusing, recurrent, unexpectedly interesting, or otherwise worthy of comment” (Horn & Little, 2010, p. 189). This view is based on a number of assumptions. First, it foregrounds teachers’ perceptions instead of the researchers given that problems of practice emerge from knowledge-in-practice where “teacher learning hinges on enhancing teachers’ understandings of their own actions—that is, their own assumptions, their own reasoning and decisions, and their own inventions of new knowledge to fit unique and shifting classroom situations” (Cochran-Smith & Lytle, 1999, p. 267). Second, this view assumes that PD is geared towards developing and leveraging teachers’ knowledge in practice-based contexts, where teachers may learn about and from practice, with support from “more knowledgeable others” such as university professors, PD facilitators, or cooperating teacher mentors. In fact, it is through such experiences that we can understand the genesis of teachers’ idealized instruction. Third, this view acknowledges the social aspect of teaching—although teachers teach largely individually, problems of practice can be embedded in broader principles and visions of teaching when they are normalized by colleagues and other stakeholders (Horn & Little, 2010). Research on teachers’ framing of problems of practice has painted a picture of teachers’ reasoning as collaborative sense-making situated in contexts of particular schools and districts, rather than purely cognitive individual acts that educators deploy (Thompson et al., 2015).

Teacher Learning and PoPs

We view teacher learning through a situative perspective where teachers’ engage in ongoing sensemaking and reasoning in a community of practice, using various types of available conceptual and practical resources and tools and/or representations. This view of teacher learning guided our PD structure which we elaborate in a later section.

Professional development, especially highly adaptive, collective professional development, supports teachers’ sensemaking. Following Schwarz et al. (2020), we view sensemaking as “wrestling with ideas, language, experiences, and perspectives to figure out how and why the world works; sense-making means proactive engagement in understanding the world by generating, using, and extending scientific knowledge within communities” (p. 1-2). As teachers make sense of their practice, such as through discussing and resolving PoPs, “they can come to know their practice in a way that enables them to construct meaning, make inferences, and solve problems” (Lampert, et al., 2015, p. 349). When teachers work together to address PoPs, they develop their ideas, knowledge, practice, and identities as well as their evolving commitments

about what it means to teach, learn, and engage in collective inquiry. Together they are able to generate knowledge including “how decisions are made, how strategies are selected, how disparate instances are connected to one another, how subject matter is conveyed, and how new occurrences are understood and framed” (Cochran-Smith & Lytle, 1999, p. 268). They consider problems of practice in particular situations, “intentionally and introspectively examining those situations, and consciously enhancing and articulating what is tacit or implicit.”

When the design of professional learning allows for the coevolution of participation between classroom practice and PD (Kazemi & Hubbard, 2008), individual teachers have the opportunity to recontextualize PoPs normalized in a community to their personal practice.

Recontextualization is “a process of disembedding, re-embedding, and change” of discourse from one social context to another (Ensor, 2001, p. 297). This is important within professional learning communities. Even though PoPs may bring the community into a shared problem space, when embedded into teachers’ practice, they are likely to change when teachers render them as part of familiar practice or their vision of practice (Horn & Little, 2010). Recontextualization as a process affords insight into teachers sensemaking beyond the setting of PD.

In this paper, we examine what PoPs emerge in a professional learning community and how they get recontextualized in a teacher’s practice. Specifically, we will address:

1. What are the problems of practice identified by a group of teachers learning to facilitate discussions with argumentation?
2. How are the PoPs recontextualized in one teacher’s practice?

Professional Development Structure and Focus

We co-designed and co-facilitated a PD environment called Learning Labs (LLs) focused on facilitating students’ practices of argumentation. LLs are organized to (1) be adaptive and responsive to local communities, (2) involve ongoing collaboration and inquiry, and (3) consist of cycles of investigation, enactment, and reflection (Lampert et al 2013; Kazemi et al 2018). Each LL included four phases: new learning, planning, enactment, and debrief (Kazemi et al., 2017). The new learning phase focused on an analysis and discussion of artifacts of practice, such as a video clip, to unpack the nature of productive argumentation. Lab members collaboratively prepared a lesson to enact in one of the teachers’ classrooms during the planning phase. In the enactment phase, they facilitated the lesson. As the lesson progressed, teachers would pause instruction to discuss instructional decisions using a routine called Teacher Time Out (Gibbons et al., 2017). During the debrief, lab members discussed insights from the enactment and set goals for argumentation in their own classrooms. Such a model of PD falls within Koellner & Jacobs’s (2014) description of adaptive models where we are responsive to “the goals, resources, and circumstances of the local PD context. These models are based on general and evolving guidelines rather than specific content, activities, and materials” (p. 51).

We designed LLs to support teachers to facilitate classroom discussions focused on argumentation. We frame argumentation as constructing a reasoned case for why a mathematical statement or claim is logical or true and deemed acceptable by the community, in this case, other students and the teacher(s) (Knudsen et al., 2018; cf., Toulmin 1969). Researchers have produced substantial reports on argumentation (and proof, a closely related concept) but most reports are focused on student conceptions and classroom-based research more than teacher knowledge and development around facilitating argumentation (Stylianides et al., 2016). In the sparse work on PD focused on learning to facilitate argumentation, researchers used models drawing on representations and in some cases approximations of practice (Grossman and McDonald, 2008).

For instance, Osborne et al. (2019) in a practice-based PD used classroom videos to support teachers in adopting a more dialogic approach to teaching and fostering argumentation from evidence. They identified a specific set of instructional practices to foster students' argumentation from evidence, which were modeled by PD leaders. They also tested an approach to support teacher learning in the form of a practicum where teachers had multiple opportunities to enact, collaboratively investigate, and refine their practices. While such PD models ground teacher learning in the context of practice, they do not clarify the nature of teachers' sensemaking and how the adaptive PD affords insight into how it unfolds over time.

We facilitated LLs at Lockwood Elementary which is situated in an urban area in the Midwest region of the United States. In 2018-2019, the school served 443 students. The demographic make up includes 10% Asian, 10% Black, 40% Hispanic, 32% White, and 7% identifying as two or more races. Moreover, 13% of students were labelled as "students with disabilities, 56% as "economically disadvantaged," and 41% as "limited English proficiency." We began our LLs in January of 2019. Across the LLs at Lockwood, two university-based mathematics educators worked with four third-grade teachers, a fourth-grade teacher, three fifth-grade teachers, two school-based mathematics instructional coaches, and a retired mathematics instructional coach who worked at Lockwood. Most of this group identified as white and the rest as people of color. We focus half of our analysis on one member of the LL. Amanda, a White teacher certified in bilingual and elementary/middle school education with more than 10 years of experience teaches fifth-grade mathematics in both English and Spanish as part of a Dual Language Immersion program (DLI) where native Spanish and native English speakers were placed in the same class with instruction in both Spanish and English.

Data and Analysis

We collected video and audio recordings and field notes from eight LLs spanning one and a half school years. In addition, we conducted teacher interviews at the beginning of the project (Fall 2018) and at the end of the first and second school year (Summer 2019 & Spring 2020) where we asked teachers about their conceptions of discussions, argumentation, and equity. Between LLs, instructional coaches conducted video-stimulated recall interviews (VSRIs) related to teachers' attempts to facilitate argumentation in their own classrooms.

Analyzing LL PoPs

Analysis consisted of multiple phases to identify PoPs relevant to argumentation and how they emerged. We first identified instances where teachers highlighted "classroom interactions experienced as troublesome, challenging, confusing, recurrent, unexpectedly interesting, or otherwise worthy of comment" (Horn & Little, 2010, p. 189). Two authors then condensed these instances into PoPs exhibiting similar concern or comments in the context or argumentation. We also distinguished between one-off comments and comments contributing to a PoP. In order for a comment to contribute to a PoP the contribution had to normalize an existing PoP (e.g., a teacher connecting another teachers' similar experiences or concerns in their own), discussing potential reasons for a PoP, or relating the PoP to a teaching principle (see Horn & Little, 2010).

Analyzing Amanda's PoPs

To analyze Amanda's recontextualization, we first needed to understand how Amanda made sense of teaching in general. To do this, we analyzed her three teacher interviews. We looked for general principles that Amanda held by finding instances where she made sense of a set of experiences (e.g., her instruction with multilingual students) or general principles of teaching. From this, we identified her idealized version of teaching. One researcher then analyzed her

VSRIs and participation in LLs and looked for experiences where Amanda expressed misalignment with her practice and idealized practice. These, similar to the previous analysis, were collapsed into PoPs and were mapped back to the set of PoPs constructed in LLs in order to see how Amanda's PoPs related to those discussed in LLs. This allowed us to describe what Amanda felt as familiar to the group's sensemaking. We acknowledge there is more complexity in recontextualizing than the directionality we are present i.e., Amanda recontextualizations PoPs constructed from LLs, but space limitations only allow us to present one direction.

Results

We found PoPs related to argumentation to be primarily focused on participation processes. Teachers generally agreed that argumentation and discussions are important mathematical practices; however, they viewed the ideal classroom discussion focused on argumentation entailed students participating in discussions. Thus, the three PoPs we identified in the LL were couched in social processes to get students to participate, mostly thought talk, and engage in other students' ideas. We also describe one PoP from Amanda and how it relates to her practice.

Learning Lab PoPs

As the teachers made sense of experiences of teaching with argumentation in LLs, they identified PoPs centered around the social aspect of argumentation—particularly participation and their role in it. Because of the adaptive nature of the PD, these concerns became a strong focus of the group and we structured experiences in the PD provided teachers the opportunity to investigate the relationship of participation and argumentation (see Kazemi et al, 2020).

Teacher involvement. Teachers were broadly interested in making sure their involvement in discussions were minimal. Ideally, teachers wanted students to have autonomous conversations where they would step back from directing the discussion; however, they found themselves constantly stepping in to ask questions and push on new ideas when students did not immediately contribute to the discussion. A desire to decrease teacher involvement related to a school-wide commitment to student-centered mathematical learning.

Decreasing teacher involvement was constantly normalized as teachers provided different accounts of similar sentiments. Christina recounted a few times she wanted students to carry on autonomous conversations by either moving to the back of class or averting her gaze while students were talking about each other's ideas. Others also provided accounts of how they decreased involvement when eliciting students' ideas. For instance, Alyssa described wrestling how she could revoice student ideas but also having students revoice. The teachers further specified the problem by indicating teacher involvement usually occurs when students are given free rein of the conversation, such as during turn-and-talks, where students may talk about tangential mathematical or off-task topics. Several teachers added more dimension to this problem by discussing revisions to the nature and causes of this PoP. Karla thought there is a difference in values—teachers viewed math talk communities as important, yet students did not see the relevance yet. Christina thought one potential reason is because she acknowledges how she tends to make assumptions about students' thinking.

Value of students' ideas. Teachers realized when students participate in discussions, they are put in an emotionally vulnerable position. Ideally, teachers wanted to make classrooms a space where students felt comfortable and confident in sharing their ideas. However, they found that many students were complacent to be silent, letting others share ideas they assumed would be correct. Some teachers described students who had something to contribute but were

uncomfortable sharing their ideas with the whole class because instruction was provided in a language different from their home language, especially in DLI classrooms.

The teachers normalized the PoP by recounting when students felt confident sharing their thinking with each other and in whole group discussions. For example, teachers shared accounts of students who shared ideas with a partner were asked to share their thinking with the whole class, but showed reluctance or resistance to sharing with the whole class. Teachers revised this problem of practice to consider how the activity itself encouraged or discouraged students from seeing their ideas as significant and the risk involved in sharing with others. Karla shared how in choral counts, “more kids would participate because we were part of a whole... So if I wasn’t sure if my next number was correct I could say it a little bit quieter and then I would notice it if I was not with the group”. Teachers generalized the PoP to principles of teaching, based on what moves would support students to see their thinking as meaningful within class discussion. The teachers wanted students to connect to their feelings on what it means to share and create space for vulnerability, recognizing that they can make mistakes and sharing an idea does not have to be an entire solution to the problem. For example, Melissa and Lea highlighted that making mistakes is part of being human and that mistakes can often help others learn. Similar to how the teachers talked about a math talk community for the sake of decreasing teacher involvement, the teachers talked about how a math talk community can create an environment where students feel comfortable sharing ideas. Towards the end of the LLs, Christina talked about how the environment (or math talk community) can be both nourishing and nurturing to better bring about student talk.

Students’ engagement with peers. Teachers wanted to know how they could support students to have productive conversations with their peers. In teachers’ classrooms, students were used to mathematics lessons in small groups while LLs were conducted in whole groups. Teachers recognized the challenge in how students engaged with their peers in this environment. Building on the first PoP, teachers were interested in making sure autonomous conversations were productive. The teachers continually returned to revise the problem of student engagement with peers and its possible causes. Olivia highlighted how students want to take ownership and connect with each other’s ideas, but teachers need to be explicit on what it means to share your work with others. Revisions of the question lent elements of complexity, considering the experiences and needs of individual students. Teachers discussed the power of listening to others as a form of engagement, the implications of diverse language needs, and what it means when students are not socio-emotionally ready to explain their thinking to a partner. Addressing this problem within principles of teaching heavily relied on the use of turn and talks and teachers being explicit in particular questions or expectations of what it means to share with others. Alyssa and Lea shared how teachers can ask questions about students explaining another student’s thinking or adding on to an idea proposed by a different student as a form of engaging students with each other. The growth in how students connected with one another individually in turn and talks and eventually in the whole group showed a greater number of students listening to and learning from one another. Karla noted in LL6 that there was more accountability for students in large group discussions as they engaged with each other’s ideas.

Amanda’s Recontextualization

Amanda’s view of discussions with argumentation, like her peers, hinged on having students being able to participate in discussions. In making these PoPs more familiar to her practice, she strongly envisioned these discussions to be “equitable” in order for argumentation to occur. She viewed equitable discussions as students viewing their ideas as valuable as others and

autonomously participating in discussions equally; however, in her classroom, students are not contributing to discussions equally especially when she reflected on her experience with emergent bilinguals in the DLI classroom. Thus, one of her PoPs is to support these students to talk at the same rate as their peers in order to achieve equitable participation.

Amanda frequently stated equitable participation as the ideal discussion to facilitate argumentation. During interviews, Amanda expressed equity as “feeling that each student in the classroom matters equally and what they have to say matters as much as anybody else in the classroom.” She also expressed her role as “responsible for keeping discussions equitable” and try to “draw out maybe students that aren't talking as much, um, to give, like to privilege their voice a little bit more because they don't have that experience all the time.” She also said she used drawing sticks where students’ names are on sticks and Amanda draws a random student’s name. During LLs, Amanda said one of her goals for equitable participation is how she can support students to join in on discussions particularly during whole-class discussions where she notices that students are comfortable sharing with a partner but not to the whole class. She viewed whole-class discussion as important for empowering students, “what feels good is honoring each student's perspective and having them communicate their ideas about math in front of the whole class is empowering to every student.”

Whenever Amanda talked about her class or looked closer at her class during VSRI, she notes the misalignment between her goal of equitable participation. She notes those larger societal inequities at play. For example, she notes gender during a VSRI, “I can see it's still not where I want it to be in this lesson. It seems like the boys, when they're in mixed gender pairs, the boys seem to talk a lot more. So yeah, just being more conscious of that and finding ways that they can participate. In front of everybody.” More importantly, she consistently drew from her experience as one of the bilingual teacher at the school who taught in DLI classroom and noted students’ home language as an inequity feeding into discussions, “I think English dominant students tend, I don't know, tend to feel more power in the school system for some reason, and they just tend to dominate space wherever they are..Spanish speaking students in summer school [where majority of students speak Spanish]... become a lot more lively and active and participate in the discussion.” Amanda noted that because of this inequity, she felt “responsible for keeping the discussion more equitable and trying to draw out maybe students that aren't talking as much—to give privilege to their voice a little bit more because they don't have that experience all the time.” Her goals for future work centered around cultivating equitable whole class discussion and to build a math talk community where equitable participation happens.

We largely saw Amanda’s PoP of equitable participation as a recontextualization of PoPs from LLs. Amanda expressed part of equitable participation is students’ seeing their contributions as valuable. During LLs, Amanda shared that one sticking point for discussions is figuring out how Amanda can build up students’ ideas as valuable in order for them to share during whole-class discussion. In order for students to participate, Amanda needed students to view their ideas as valuable, especially for emergent bilinguals. If they are valued, then students may participate more. She commented, during a VSRI, about how an interaction supported a student. She noticed student M, who she said does not normally participate, talking with her partner and nodding along as her partner built on what student M said. Amanda queried, “I'm curious about whether you know it's a language thing or she doesn't have that much language to explain it” but because her partner participates more in discussion, Amanda saw this interaction as reaffirming her and her ideas. Amanda’s PoP also was a recontextualization of students’ engagement with each other. Amanda noted students needed to view each other peers’ as

valuable, noting that if students engage with each other's ideas during discussions, students will build more confidence in sharing their ideas, in turn, participating more. She shared that she provided students with sentence stems in order for students, especially those needing language support, to be able to begin and carry on discussions with others.

Discussion and Conclusion

In this paper, we identified PoPs related to discussions with argumentation constructed by a group of elementary school teachers. PoPs are important for teachers' sensemaking because it provides them with a shared space to identify parts of practice they would like to work on. Because the shared space is tied to the contexts and experiences of the teachers, PoPs are also highly situated and are a reflection of the values of the community. At Lockwood, the teachers' saw an ideal classroom situation where students would almost independently carry deep mathematical conversations; however, in most teachers' classrooms, this was not the case. Thus, the three PoPs—reconsidering their position in discussions, valuing students' ideas, and supporting student-to-student interaction—allowed the teachers to map out how to improve their practice in order to better facilitate discussions with argumentation. We also described the relationship between one teacher's PoP and those brought up in LLs. Amanda saw equitable participation as the ideal space for discussions with argumentation, related to two of the PoPs brought up in the LLs. Her idea of equitable participation can be drawn from her values and her experiences as one of the bilingual educators teaching in a DLI classroom in thinking about equitable participation where she wanted to see all students talking at a similar rate.

There are some conclusions and implications we draw from this report. This work highlights the importance of the work of PD in supporting teacher learning. We structured LLs to be highly responsive to teachers' ideas and practice; thus, our PD design provided space for teachers to wrestle with supporting students' participation in discussions with argumentation. This does not mean teachers did not concentrate on components of argumentation as identified in the literature (e.g., claim-making, providing data, establishing warrants). In fact, teachers saw participation and argumentation as intimately tied together and were attuned to aspects of argumentation in LLs and designed tasks to support argumentation; however, the teachers elevated participation as a critical component for argumentation to occur. This marks a strong movement from knowing that an idea exists to knowing how to bring that idea to life (Mason, 2002). Such PD experiences not only support teachers in wrestling issues close to their practice but also provide teacher educators the opportunity to think alongside teachers and construct powerful experiences.

We also saw PoPs brought up in this group were situated. In a community of teachers, shared experiences provide material for teachers to construct PoPs rooted in these experiences and thus, they make sense and solve these problems together. In our case, teachers generally agreed with the work on participation that needed to be done to facilitate discussions with argumentation. They were all committed to honoring students thinking and creating communities where students can deeply talk to one other about mathematics. Having this group, can support teacher learning. As Mason (2002) asserted, "real change also requires the support of a compatible group of people whose presence can sustain individuals through difficult patches, and who provide both a sounding board and a source of challenge for observations, conjectures, and theories" (p. 144). Further, any work that needed to be done would be constrained and supported by the contexts the teachers were in as seen in Amanda's work. As a teacher attuned to the language needs of her students, Amanda saw some inequities, particularly with language, in her classroom connected them with the PoPs brought up in the group. Her recontextualization of the group's PoPs was

framed through, what she called, equitable participation, making something in one context, familiar in another. Further work needs to be done to examine the other direction (i.e., how teachers contribute to community PoPs). It is through this collective sensemaking in context that teachers learn—that we cannot refer to teacher learning as acquiring declarative knowledge, but rather as sensemaking from practice to change practice.

References

- Cazden, C. B. (2003). *Classroom discourse: The language of teaching and learning* (2nd ed.). Heinemann.
- Cochran-Smith, M., & Lytle, S. L. (1999). Relationships of knowledge and practice: Teacher learning in communities. *Review of Research in Education*, 24, 249–305. <https://doi.org/10.2307/1167272>
- Ensor, P. (2001). From preservice mathematics teacher education to beginning teaching: A study in recontextualizing. *Journal for Research in Mathematics Education*, 32(3), 296–320. <https://doi.org/10.2307/749829>
- Gibbons, L. K., Kazemi, E., Hintz, A., & Hartmann, E. (2017). Teacher time out: Educators learning together in and through practice. *Journal of Mathematics Educational Leadership*, 18(2), 28–46.
- Ghousseini, H. (2015). Core Practices and Problems of Practice in Learning to Lead Classroom Discussions. *The Elementary School Journal*, 115(3), 334–357. doi:10.1086/680053
- Grossman, P., & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal*, 45(1), 184–205.
- Horn, I. S., & Little, J. W. (2010). Attending to problems of practice: Routines and resources for professional learning in teachers' workplace interactions. *American Educational Research Journal*, 47(1), 181–217. <https://doi.org/10.3102/0002831209345158>
- Kazemi, E., Gibbons, L. K., Lewis, R., Fox, A., Hintz, A., Kelley-Petersen, M., Cunard, A., Lomax, K., Lenges, A., & Balf, R. (2018). Math labs: Teachers, teacher educators, and school leaders learning together with and from their own students. *Journal of Mathematics Educational Leadership*, 19(1), 23–36.
- Kazemi, E., & Hubbard, A. (2008). New directions for the design and study of professional development: Attending to the coevolution of teachers' participation across contexts. *Journal of Teacher Education*, 59(5), 428–441. <https://doi.org/10.1177/0022487108324330>
- Kazemi, E., Ghousseini, H., Cordero-Siy, E., Prough, S., McVicar, E., & Resnick, A.F. (2021). Supporting teacher learning about argumentation through adaptive, school-based professional development. *ZDM Mathematics Education*, 53, 435–448.
- Knudsen, J., Stevens, H., Lara-Meloy, T., Kim, H.-J., & Shechtman, N. (2018). *Mathematical argumentation in middle school: The what, why, and how*. Corwin.
- Koellner, K., & Jacobs, J. (2014). Distinguishing models of professional development: The case of an adaptive model's impact on teachers' knowledge, instruction, and student achievement. *Journal of Teacher Education*, 66(1), 51–67. <https://doi.org/10.1177/0022487114549599>
- Lampert, M. (2001). *Teaching problems and the problems of teaching*. Yale University Press.
- Lampert, M., Franke, M. L., Kazemi, E., Ghousseini, H., Turrou, A. C., Beasley, H., Cunard, A., & Crowe, K. (2013). Keeping it complex: *Using rehearsals to support novice teacher learning of ambitious teaching*. *Journal of Teacher Education*, 64(3), 226–243. <https://doi.org/10.1177/0022487112473837>
- Lampert, M., Ghousseini, H., & Beasley, H. (2015). Positioning novice teachers as agents in learning teaching. In L. B. Resnick, C. Asterhan, & S. Clarke (Eds.), *Socializing intelligence through academic talk and dialogue* (pp. 363–374). American Educational Research Association.
- Mason, J. (2002). *Researching your own practice: The discipline of noticing*. Routledge.
- Osborne, J. F., Borko, H., Fishman, E., Gomez Zaccarelli, F., Berson, E., Busch, K. C., Reigh, E., & Tseng, A. (2019). Impacts of a practice-based professional development program on elementary teachers' facilitation of and student engagement with scientific argumentation. *American Educational Research Journal*, 56(4), 1067–1112. <https://doi.org/10.3102/0002831218812059>
- Rumsey, C. (2012). *Advancing fourthgrade students' understanding of arithmetic properties with instruction that promotes mathematical argumentation*. PhD diss. Illinois State University.
- Schwarz, C. V., Braaten, M., Haverly, C., & de los Santos, E. X. (2020). Using sense-making moments to understand how elementary teachers' interactions expand, maintain, or shut down sense-making in science. *Cognition and Instruction*, 1–36. <https://doi.org/10.1080/07370008.2020.1763349>

Olanoff, D., Johnson, K., & Spitzer, S. (2021). *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. Philadelphia, PA.

- Staples, M. (2007). Supporting whole-class collaborative inquiry in a secondary mathematics classroom. *Cognition and Instruction*, 25(2-3), 161–217. <https://doi.org/10.1080/07370000701301125>
- Staples, M., & Newton, J. (2016). Teachers' contextualization of argumentation in the mathematics classroom. *Theory Into Practice*, 55(4), 294–301. <https://doi.org/10.1080/00405841.2016.1208070>
- Stylianides, A. J., Bieda, K. N., & Morselli, F. (2016). Proof and argumentation in mathematics education research. In Á. Gutiérrez, G. C. Leder, & P. Boero (Eds.), *The second handbook of research on the psychology of mathematics education: The journey continues* (pp. 315–351). SensePublishers. https://doi.org/10.1007/978-94-6300-561-6_9
- Thompson, J., Hagenah, S., Lohwasser, K., & Laxton, K. (2015). Problems without ceilings: How mentors and novices frame and work on problems-of-practice. *Journal of Teacher Education*, 66(4), 363-381. <https://doi.org/10.1177/0022487115592462>
- Toulmin, S. (1969). *The uses of arguments*. Cambridge University Press.