

UC Santa Barbara

UC Santa Barbara Previously Published Works

Title

Facilitating Science and Mathematics Teachers' Talk About Equity: What Are the Strengths and Limitations of Four Strategies for Professional Learning?

Permalink

<https://escholarship.org/uc/item/8jm6k72b>

Journal

Science Education, 99(3)

ISSN

0036-8326

Authors

BIANCHINI, JULIE A
DWYER, HILARY A
BRENNER, MARY E
et al.

Publication Date

2015-05-01

DOI

10.1002/sce.21160

Peer reviewed

Science
Education

Facilitating Science and Mathematics Teachers' Talk About Equity: What Are the Strengths and Limitations of Four Strategies for Professional Learning?

JULIE A. BIANCHINI, HILARY A. DWYER, MARY E. BRENNER,
ALAYNA J. WEARLY

Department of Education, University of California, Santa Barbara, CA 93106-9490, USA

Received 9 June 2014; accepted 16 January 2015

DOI 10.1002/sc.21160

Published online 15 April 2015 in Wiley Online Library (wileyonlinelibrary.com).

ABSTRACT: We investigated a 2.5-year professional development effort designed to support practicing science and mathematics teachers in understanding equity and enacting equitable practices. Our purpose was to inform the research base on effective equity professional development, toward the goal of better supporting science and mathematics teachers in transforming their views and practices. Because talk is central to learning, we examined how four strategies for professional learning facilitated or constrained teachers' shared equity talk: (1) engagement in teacher research, (2) reflection on personal experiences, (3) modeling of reform-based instructional practices, and (4) examination of school/state/national data on student course taking and achievement. We asked: How did teachers' shared equity talk vary across these strategies? To answer this question, we qualitatively analyzed recorded seminars, teacher interviews, and written reflections to determine the opportunities each strategy afforded teachers to talk about equity, and the length and substance of teachers' equity talk as a result. We found that, despite teachers' construction of a shared equity discourse and the iterative implementation of professional learning strategies, the type of strategy implemented did indeed matter. Although all four

Correspondence to: Julie A. Bianchini; e-mail: jbianchi@education.ucsb.edu

A draft of this article was presented at the annual meeting of the National Association for Research in Science Teaching, April 2006, San Francisco, CA.

Supporting Information is available in the online issue at wileyonlinelibrary.com.

strategies provided teachers similar opportunities to discuss equity, some strategies were more effective than others in facilitating equity conversations. © 2015 Wiley Periodicals, Inc. *Sci Ed* 99:577–610, 2015

INTRODUCTION

Reform documents in science and mathematics education call for transforming the structure and substance of schooling so that *all* students can achieve excellence (National Council of Teachers of Mathematics, 2000; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; National Research Council [NRC], 2012; NGSS Lead States, 2013). Central to these reform efforts is the professional development of practicing science and mathematics teachers (Banks et al., 2001). Professional development projects intent on promoting equity must encourage teachers to interrogate and change both their ideology and their pedagogy (Rodriguez & Berryman, 2002)—to help teachers recognize the resources diverse students bring to the classroom and implement reform-based curricular and instructional practices. However, despite this critical and persistent need to support science and mathematics teachers in learning about equity issues, the research literature on equity professional development remains limited (Lee & Buxton, 2010; Strutchens et al., 2012).

In our study, we examined practicing secondary science and mathematics teachers as they engaged in a 2.5-year professional development effort to understand and address equity issues in their classrooms. We collected a large amount of data: video records of professional development seminars, audio records of individual interviews with teacher participants, drafts and final presentations of research projects teachers conducted in their classrooms, and teachers' written reflections about project activities. In an initial set of papers (Brenner, Bianchini, & Dwyer, in progress; Brenner, Bianchini, Goto, Cavazos, & Kelly, 2006), we examined changes in teachers' interview responses and classroom research products over time to determine teacher outcomes. We found that five of the seven teacher participants who completed our professional development project changed their views of equity and six of the seven changed the ways they taught science and/or mathematics in their classrooms. This initial investigation of teachers' outcomes provided evidence that the professional development project was effective; however, it did not offer much insight into what made it so.

In this paper, then, we report findings from a second set of analyses that focused on the strengths and limitations of the professional development process itself. Our purpose in doing so was to inform the research base on effective equity professional development, toward the goal of better supporting science and mathematics teachers in transforming their views and practices. Because shared teacher talk is considered central to teacher learning (Grossman, Wineburg, & Woolworth, 2001; Putnam & Borko, 2000), we examined how four different strategies for professional learning—teacher research, personal experiences, reform-based instructional practices, and examination of school/state/national data—promoted and constrained science and mathematics teachers' equity talk. We borrowed the construct *strategies for professional learning* from Loucks-Horsley, Stiles, Mundry, Love, and Hewson (2010), who defined a professional learning strategy as a way to support teacher learning through immersing in content, standards, and research; examining teaching practices and student learning; or aligning and implementing curriculum. We posed the following research question: How did teachers' shared equity talk vary across these four strategies? More specifically, (a) across the four professional learning strategies implemented, what were the similarities and differences in the opportunities afforded science

and mathematics teachers to talk about equity issues? (b) Across strategies, what were the similarities and differences in the resulting structure and substance of teachers' equity talk?

Our investigation builds on the small number of equity studies in science and mathematics education that have examined the professional development process itself (Planas & Civil, 2009; Taylor, 2012). Such studies explore the in-the-moment ways a particular project enhances or constrains science and mathematics teachers' shared equity talk, their collective understanding of equity issues, and/or their commitment to pursuing curricular and instructional transformation. These studies are important because they help other science and mathematics educators make informed decisions about the design and implementation of equity professional development efforts to ensure such efforts do indeed effect change in participating teachers' views and practices.

Our investigation also provides new insights into what counts as effective equity professional development for science and mathematics teachers. While previous studies have examined teacher participants' construction of a shared equity discourse over time (see again Planas & Civil, 2009; Taylor, 2012), we explored whether and how this shared talk shifted as teachers moved across different types of professional learning strategies. We teased apart the strengths and limitations of different strategies used to facilitate teachers' identification, questioning, and analysis of equity issues in science and mathematics classrooms to help make sense of the complexities and challenges encountered when designing and implementing effective efforts.

CONCEPTUAL FRAMEWORK: EQUITY AND TEACHER TALK

Conceptions of Equity

The first half of our conceptual framework is grounded in conceptions of educational equity. In the literature, there exist numerous, often disparate, definitions of what should count as equity (Cochran-Smith, 2003). In this study, we defined equity in two different, but related, ways. For the professional development effort itself, teacher participants were encouraged to construct their own definition(s) of equity tied to the needs and interests of their students. They read and discussed a range of scholars concerned with equity issues (e.g., Kohl, 1994; McIntosh, 1995; Nieto, 1999; Secada, 1994) and fashioned their definitions in light of their own inquiry into practice and their particular school context. For our analysis of data, however, we conceived of equity as existing along three dimensions: (a) teachers and their teaching, (b) students and their learning, and (c) home and community contexts. We note that although the professional development project and the analyses were conducted almost a decade apart (2003–2005 versus 2012–2014) and although the definitions of equity used for the two efforts were not identical, the three dimensions of teachers, students, and home were held in common. In our discussion of each of these areas of equity below, we make visible this overlap between professional development and analytic efforts by citing both early and more recent studies.

Teachers and Their Teaching. To achieve science and mathematics for all, teachers must enter the classroom as change agents; they must examine their own practice, acting as learners as well as teachers in their classrooms, so as to empower their students and transform existing institutional structures (Cochran-Smith & Lytle, 2009; Nieto & McDonough, 2011). More specifically, science and mathematics teachers should present science and mathematics as discrete cultures with their own languages, habits of mind, practices, and histories of privileging and excluding certain groups (Stanley & Brickhouse, 1994, 2001). They should view themselves as guides, facilitating the crossing of borders that separate their discipline from their students' everyday lives (Aikenhead & Jegede, 1999).

They should also emphasize the discourse-intensive nature of science and mathematics, implementing strategies to facilitate the development of language and literacy in and through engagement of core concepts and practices for both students fluent in English and English language learners (ELLs) (Brown & Spang, 2008; Bunch, 2013; Lee, Quinn, & Valdes, 2013). Furthermore, teachers should move beyond acting as guides who help students navigate the foreign terrain of science and mathematics disciplines as they currently exist to enacting instructional practices useful in refashioning these disciplines through critique and challenge (Delpit, 1988; Kumashiro, 2001).

Students and Their Learning. Transitioning from discussion of teachers and teaching to students and learning, teachers intent on teaching science and mathematics for all are encouraged to use their students' lives and interests to inform their curricular and instructional decisions (Calabrese Barton, Tan, & Rivet, 2008; Khisty, 1995). To do so, teachers must see their students both as individuals and as members of diverse gender, cultural, socioeconomic, and linguistic groups (Bianchini, Cavazos, & Helms, 2000; Nieto, 1999). They must come to know and value the diverse funds of knowledge students bring to the classroom as *resources* to explore and build upon (Delpit, 2003; Rosebery, Ogonowski, DiSchino, & Warren, 2010; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001). They must also attend to the normative identities promoted in their classrooms, so that each student is eager and able to call herself or himself a science or mathematics person (Brickhouse, Lowery, & Schultz, 2001; Carlone, Haun-Frank, & Webb, 2011). Moreover, teachers must establish relationships with their students based on rapport and respect, using these relationships to transform their classrooms into spaces where science and mathematics education "can be a *fit* for all children in all contexts" (Yerrick, Schiller, & Reisfeld, 2011, p. 14).

Home and Community Contexts. Finally, multicultural and equity-focused education advocates recommend that science and mathematics teachers identify, celebrate, and use the diverse resources present in their students' homes and communities to transform their curricular and instructional practices (Moll, Amanti, Neff, & Gonzalez, 1992). As one example, to make science and mathematics instruction more relevant and meaningful, teachers can include the examination of local indigenous knowledge and practices in their curriculum (Chinn, 2007; Kisker et al., 2012). As a second example, teachers and their students can leave the confines of their school walls to investigate an aspect of their place, toward the goal of improving their own lives and the lives of other community members (Gutstein, 2003; Mallya, Mensah, Contento, Koch, & Calabrese Barton, 2012). As a third example, teachers can invite parents and community elders into their schools, working together to integrate diverse cultural knowledge and practices into school science and mathematics experiences (Hammond, 2001).

The Importance of Teacher Talk

The second half of our conceptual framework focuses on the importance of talk. Talk is considered central both to student learning in science and mathematics classrooms (Kelly, Crawford, & Green, 2001; Lee et al., 2013; Lemke, 1990) and to teacher learning in communities of practice (Putnam & Borko, 2000; Wilson & Berne, 1999). In a classroom context, student learners co-construct a community through their interactions with each other, making collective decisions across time and events about what it means to talk and act like a member, what counts as knowledge, and whose knowledge counts as important (Dixon, Frank, & Green, 1999; Santa Barbara Classroom Discourse Group, 1992). This collective

classroom talk, including students' movement between everyday and academic language, often across their home and second languages, is understood as fundamental to science and mathematics sense-making practices (Rosebery et al., 2010; Warren et al., 2001). In a professional development context, teacher learners co-construct a shared discourse as part of their work in establishing and maintaining a professional learning community (Grossman et al., 2001; Horn & Little, 2010; Planas & Civil, 2010). Changes in this shared discourse over time—the terms accepted or rejected and the interaction patterns adopted or ignored—help shape the changes teachers do and do not make to their views and practices.

Two constructs related to teachers' shared talk helped to shape the investigation conducted here. One construct was developed by Putnam and Borko (2000). They discussed the strengths and limitations of *mini discourse communities*: the idea that any one teacher is a member of and interacts with several different communities of educators at the same time. They argued that the existence of mini discourse communities helps to explain why student teachers struggle to integrate ideas learned in teacher education courses into their classroom teaching experiences. In our paper, we translated this idea that opportunities to talk and learn differ across community contexts to examine how such opportunities differ within the same community across professional learning strategy contexts.

A second construct was drawn from Horn and Little (2010), who argued that some kinds of teacher talk are more *generative for learning* about practice than others. They defined generative for learning as the ways teachers' talk “enhanced or limited opportunities for the in-depth examination of problems of practice and hence shaped opportunities for teacher learning” (p. 183). They used this construct to explain how the conversational routines of one professional learning community, or the ways this community structured its work-related talk, provided teachers opportunities to generate new insights into problems of practice and to enact instructional innovation, while a second community's routines constrained teachers' talk and thus their learning. We used this generative-for-learning construct to frame our comparison of the quality of teachers' shared equity talk across strategies. More specifically, we used this notion to assess how well conversations within a given strategy helped teachers attend to equity in relation to teaching, learning, and/or context (e.g., helped teachers recognize multiple kinds of diversity or move away from a deficit perspective of students and families)—to determine whether teachers' talk within a strategy was generative, somewhat generative, or not generative for learning about equity. (See sections Analytic Cycle 2 and Generative Nature of Equity Conversations for further details.)

RESEARCH DESIGN AND METHODS

The Professional Development Context: Teaching for Equity in Mathematics and Science Education

The professional development project studied here, Teaching for Equity in Mathematics and Science Education (TEMSE), attempted to assist science and mathematics teachers at local middle and high schools in understanding and addressing issues of equity at the classroom level. TEMSE was located at a university in Southern California and ran from January 2003 to June 2005. Twelve teacher participants were purposefully recruited from three schools considered high need. The 12 project staff included university faculty, professional developers, postdoctoral scholars, and graduate students; it was large in size so as to individually support teacher participants in conducting time-intensive teacher research projects in their classrooms. Over TEMSE's lifetime, the composition of participants and staff changed; this is discussed below.

TEMSE's goals, sequence, and substance were thoughtfully designed by the professional development team. TEMSE exhibited the five features of effective professional development later identified by Desimone (2009): The effort (a) had a focus on subject matter content and how students learn that content; (b) provided opportunities for teachers to engage in active learning; (c) was of sufficient duration; (d) included the collective participation of teachers from the same school, grade, or department; and (e) built from teacher participants' existing knowledge and beliefs and aligned with school, district, and state policies. Professional developers and teacher participants attempted to build a learning community where issues of equity and diversity were placed front and center and where the building of critical collegiality was encouraged as a way to disrupt and move beyond the status quo (Cochran-Smith & Lytle, 1999; Kumashiro, 2001; Nieto & McDonough, 2011). As stated above, TEMSE did not present teachers with one definition of equity; rather, teachers were encouraged to revise their own definition of equity and to better tie their definition to the needs and interests of their students. (See Supplemental Materials 1 in the Supporting Information for an overview of TEMSE's structures and strategies.)

Structures for Professional Learning. TEMSE included four *structures for professional learning*: whole-group professional development seminars, school site meetings, individual research consultations, and participation in teacher research conferences. (We note that while Loucks-Horsley et al., 2010, identified professional development structures as a category of professional learning strategies, we viewed them as separate from strategies instead.) We focused our investigation on one of these structures, the whole-group professional development seminar, because it was the only structure that spanned the entire professional development effort and that included all teacher participants in collective conversations.

TEMSE's primary professional learning structure was the professional development seminar. Teachers came to the university to participate in these seminars approximately every 3 months. There were 22 seminars for a total of approximately 130 hours: These included two summer institutes in August of 2003 and 2004, as well as one-to-two day seminars distributed across the 2003, 2004, and 2005 academic years. A typical seminar lasted 6–7 hours and included an introduction, one or two activities with a break, lunch, a third activity or individual work time, and a wrap up.

The other three structures for professional learning occurred less regularly. The second of these structures, school site meetings, was convened during the first five months of the project. There were three site meetings at each of the three participating schools, for a total of nine 2-hour meetings, or 18 hours in all. Each site meeting included teachers from that school as well as a subset of professional development staff, and attempted to assist teachers in translating classroom concerns into questions to guide their teacher research projects. Site meetings were phased out in the second half of the first year, as teachers began their classroom teacher research efforts in earnest. They were replaced with a third structure, individual research consultations. For consultations, teachers selected a faculty member or graduate student mentor to help support them in their research. Consultations occurred whenever teachers requested assistance in collecting data in their classrooms and/or in analyzing data they had collected, from June 2003 to June 2005. Some teacher participants met with their mentors more often than others. As a final structure, seven teacher participants presented their research findings at either a state or international teacher research conference during the second year of the project.

Strategies for Professional Learning. TEMSE not only included four types of professional learning structures, but included four types of professional learning strategies

as well: teacher research, personal experiences, reform-based instructional practices, and examination of school/state/national data. The structures provided a place for the strategies to be enacted. All four strategies were implemented within the structure of the professional development seminar. The teacher research strategy was emphasized in the other three structures of school site meetings, individual research consultations, and teacher research conferences. As such, we focused our investigation on teacher participants' talk across the four strategies in the one structure of the professional development seminar.

Teacher Research. To facilitate the critical examination of equity issues, first and foremost, the TEMSE professional development project instructed and supported teachers in their efforts to conduct research on their own practice. Teacher research was made central to TEMSE because it has been found to promote the interrogation, critique, and transformation of teachers themselves, their classrooms, and their schools (Capobianco, 2007; Cochran-Smith & Lytle, 2009; Noffke, 1997; van Zee, Lay, & Roberts, 2003). Adopting the stance of researcher allows teachers to learn from their teaching, and in turn, teach from their learning (Lippincott, 1999). During the professional development seminars, professional developers helped teacher participants move from understanding what counts as teacher research (see Hubbard & Power, 1993), to how to pose a researchable question, to different kinds of methods to use in collecting and analyzing data, to how to analyze data collected about their practice. During site meetings and individual research consultations, teachers were supported in developing specific research questions grounded in their own practice, revising those questions in light of equity concerns, and collecting and analyzing classroom and school data. Finally, during state and international research conferences, teachers presented initial findings from their teacher research projects to a larger audience.

One example of a teacher research activity implemented as part of a TEMSE professional development seminar was Activity 12: Conducting Focus Groups. A faculty member moderated a focus group interview (Morgan, 1997) with a subset of teacher participants on their current practices with ELLs; the remaining teachers observed this exchange. The faculty presenter and teachers then discussed ways to productively organize and lead focus group interviews with student participants in their research projects.

Personal Experiences. As a second strategy for professional learning, teacher participants interrogated their own and others' personal experiences with inequities in society, in general, and in science and mathematics education, in particular. Weissglass (2000) argued that the examination of personal experiences encourages teachers to more thoughtfully consider how their own backgrounds and experiences with different forms of prejudice and discrimination, such as racism, classism, and sexism, affect them personally and professionally. Such discussions are intended to deepen teachers' "understanding of how school and classroom practices can perpetuate inequity and [to] help them implement strategies for ending those practices" (p. 7). The importance of attending to teachers' personal experiences in the process of learning to teach for equity is argued by additional scholars as well: To teach diverse students, teachers are asked to become conscious of their own identity (Nieto & McDonough, 2011; Rivera Maulucci, 2013), to develop a sense of empathy for students who might be culturally or racially different from themselves (McAllister & Irvine, 2002), and to personally connect to their students' experiences (Moje, Collazo, Carrillo, & Marx, 2001).

An example of a TEMSE personal experiences activity conducted during a professional development seminar was Activity 90: Teachers' Own Life Graphs of Science or Mathematics Experiences. Teacher participants and professional developers individually graphed their own life experiences related to science or mathematics, both in and out of school, from kindergarten through college. They marked each memory recorded on their graph as

positive, neutral, or negative. They then presented their individual graphs to the rest of the group.

Reform-Based Instructional Practices. As a third strategy for professional learning, TEMSE teachers and professional developers examined reform-based instructional practices considered effective in teaching science and mathematics to diverse students. These practices spanned ways to support disciplinary content and language development for ELLs (Lee et al., 2013; Warren et al., 2001), to present science and mathematics as multicultural (Kisker et al., 2012; Stanley & Brickhouse, 1994, 2001), and to connect school science to students' experiences, interests, and communities (Mallya et al., 2012). This strategy, more so than the other three, attempted to facilitate "an in-depth understanding of the science or mathematics content, knowledge of . . . how students learn the content, and the teaching strategies and activities that will lead to student learning" (Loucks-Horsley et al., 2010, p. 161).

For example, in an early professional development seminar, teachers participated in an instructional practices activity: Assessing ELL Students' Writing About Science. They were asked to use rubrics to score three ELL students' essays on ecosystems. The rubrics separated the assessment of language proficiency from science understanding. Assigned student scores were then plotted on an overhead and variations were examined and discussed.

Examination of School/State/National Data. Because educational inequities span personal, classroom, and institutional levels, as a fourth professional learning strategy, teacher participants and professional developers examined school, district, state, and national demographic, course taking, and achievement data. Teachers were encouraged to identify patterns in these data so as to better understand how policies and achievement practices differentially affect students (Confrey, Makar, & Kazak, 2004; Love, Stiles, Mundry, & DiRanna, 2008; Makar & Confrey, 2007). TEMSE staff members also provided instruction in basic statistics because such knowledge has been shown to help teachers use achievement data to inform their views and practices related to equity.

For example, in Activity 60, Disaggregating Student Data at the School Level, teachers began by examining ways to disaggregate student achievement data and to make cross-tabulation tables for analysis. Teachers then moved into teams to analyze data from their own school on a topic of their choosing; the data were either from their own research projects or a state database. One group explored the relationship among students' ethnicity, their course grade, and their liking (or not) of mathematics.

Teacher Participants, Professional Developers, and Researchers

Twelve teachers from three schools in Southern California participated in TEMSE: There were four teachers from each of De La Vina Middle School, John Muir Middle School, and Prairie High School. (See Table 1 for teacher demographics.) One of these 12 teacher participants was an African American female; one was an African American male; two were Asian American males; four were European American females; two were European American males; one was a Latina; and one was an American Indian female. Teacher participants entered the project with 3–39 years of teaching experience; the median time in a classroom at the start of TEMSE was 10.5 years. Two taught all subjects in the sixth grade; the others, courses in secondary school mathematics and/or science. After 5 months of participation, three teachers from Prairie High School, Bill, Marcella, and Rachel, withdrew from the project. Two other teacher participants, Walter from De La Vina and Diane from John Muir, left the project in the second year.

TABLE 1
TEMSE Teacher Participants

Teacher Participant's Name	Name of School	Primary Subject(s) Taught	Years Taught	Ethnicity and Gender	Time in TEMSE
Brent	De La Vina	Science	20	European American male	2.5 years
John	De La Vina	Mathematics	39	Asian American male	2.5 years
Trisha	De La Vina	Science	5	European American female	2.5 years
Walter	De La Vina	Mathematics	3	Asian American male	1.5 years
Desiree	John Muir	Sixth grade ^a (science and mathematics)	20	African American female	2.5 years
Diane	John Muir	Mathematics	11	European American female	1.5 years
Michelle	John Muir	Science and mathematics	10	European American female	2.5 years
Shawn	John Muir	Sixth grade ^a (science and mathematics)	6	African American male	2.5 years
Bill	Prairie	Science	7	European American male	5 months
Marcella	Prairie	Mathematics	7	Latina	5 months
Rachel	Prairie	Science	13	American Indian female	5 months
Suzie	Prairie	Mathematics	14	European American female	2.5 years

^aSixth-grade teachers taught all subjects, including science and mathematics. All other teachers taught courses specific to science and/or mathematics in Grades 7–12.

Teacher participants taught in schools that served substantial numbers of ELLs and students from low socioeconomic backgrounds, and that faced challenges in meeting state testing and accountability requirements. Each school was located in a different Southern California city: De La Vina was located in the same small city as the university; John Muir, in the largest of the three cities with an economic base of agriculture, defense, and industry; and Prairie, in a small city with an agricultural economic base. (See Table 2 for school demographics.)

The 17 members of the TEMSE professional development staff were participants in as well as organizers of activities. As with teacher participants, the project began with

TABLE 2
Demographic Information About Participating Schools

School Name	Students Served	Students by Ethnicities	ELL Students (%)	Students on Free/Reduced Lunch (%)	Parents With High School Diploma or Below (%)
De La Vina Middle School	557 7th and 8th graders	85% Latina/o 12% European American 2% African American 1% American Indian or Alaska Native	56	66	72
John Muir Middle School	1203 6th through 8th graders	72% Latina/o 17% European American 5% African American 3% Filipino 1% each American Indian or Alaska Native, Asian American, and Pacific Islander	20	62	68
Prairie High School	2948 9th through 12th graders	79% Latina/o 13% European American 4% Filipino 2% African American 1% Asian American	35	44	67

Note. Data presented are from 2003 to 2004, the first year of the TEMSE project.

12 staff members. Over time, four professors, one postdoctoral scholar, and one graduate student left the project; one additional postdoctoral scholar and four other graduate students joined for varying lengths of time. Eleven of the 17 staff members were faculty, professional developers, or postdoctoral scholars: Six were European American females; three, European American males; and two, Asian American females. Six were graduate student researchers: One was an African American female; one, an Asian American female; one, an Asian American male; one, a European American female; one, a Latina; and one, a Latino. Furthermore, to provide teacher participants access to a greater diversity of perspectives and

experiences, additional university faculty, professional developers, and teacher researchers served as guest presenters.

Finally, four researchers analyzed the data presented here. The first and third authors were part of the TEMSE professional development staff: Bianchini was a science educator and European American woman; Brenner, a mathematics educator and European American woman. The second and fourth authors were European American women pursuing doctorates in mathematics education. Neither participated in the professional development project itself.

Data Collection

We collected three types of data. One data type was video records of all 22 professional development seminars. We recorded these seminars because they included all participants and all four professional learning strategies; we did not record site meetings, research consultations, or research conferences because they included only a subset of participants and strategies. Seminars lasted 6–7 hours. They included warm-up exercises, activities related to the four professional learning strategies, individual work time, the review of logistical information, and wrap up discussions. In the final few seminars, teachers engaged in a *reflection activity* for each professional learning strategy. Reflection activities included time for teachers to write individual reflections on the strategy's strengths and limitations and for the whole group to share their reflections. We used two video cameras to record each seminar: One captured the whole group; the second, a small group. Groups were reconfigured in size and location for each activity. In total, the two cameras recorded approximately 200 hours of video.

Individual teacher interviews constituted our second data type. Twelve staff members conducted individual semistructured interviews (Brenner, 2006) with teacher participants at the beginning of the project in January 2003, during the first summer institute in August 2003, and at the end of the second summer institute in August 2004. During the first round of interviews, all 12 teachers shared their professional backgrounds, goals for the professional development program, and views about equity issues in their classrooms and schools. In subsequent interviews, nine teachers discussed their evolving views of equity, the kinds of equitable practices enacted in their classrooms, their individual teacher research projects, and their experiences in the four professional learning strategies. The 30 interviews conducted ranged in length from 21 to 64 minutes.

Our third data type was teachers' written work. This work included draft and final posters and/or PowerPoints of their teacher research projects. It also included individual reflections for each of the four professional learning strategies; these were collected during seminar reflection activities implemented from August 2004 to February 2005 (see Supplemental Materials 2 in the Supporting Information for additional information about the recorded seminars, the final interview protocol, and the written reflection questions).

Data Analysis

We drew from narrative frameworks (Cortazzi, 1993)—which examine participants' stories to understand how their experiences and actions positively and negatively contribute to the attaining of goals—to inform our analysis. We began by creating verbatim transcripts of the three sets of individual teacher interviews. After review of these transcripts, we decided to focus on teachers' final interviews because they were explicitly asked to discuss the strengths and limitations of each professional learning strategy.

We then created transcripts for a subset of activities conducted during the seminars. We reviewed videos of the 22 seminars to create a detailed log of the 121 activities implemented. Activities in these seminars ranged in length from 10 minutes to 2.5 hours. Each activity was labeled one of five types: teacher research, personal experiences, reform-based instructional practices, examination of school/state/national data, or other. All told, TEMSE participants engaged in 19 teacher research activities, 14 personal experiences activities, nine reform-based instructional practices activities, and six examination of school/state/national data activities. We note that teacher research activities were implemented more often than the other three professional learning strategies because teacher participants needed a great deal of support in learning how to conduct research in their own classrooms, and that examination of school/state/national data activities were implemented less often than the others because, at the time of this study, it was a relatively new professional learning strategy with which the professional development staff had less experience.

Next, for each of the four professional learning strategies, we created comparable subsamples of five target activities (see Table 3). Three selection criteria were used: We ensured each subsample (1) spanned the entire 2.5-year professional development project; (2) contained lengthy conversations about equity; and (3) included the reflection activity. Target activities ranged in length from 26 to 151 minutes. Detailed transcripts of these four sets of five target activities—20 activities in all—were then constructed.

We qualitatively analyzed (Saldaña, 2013) interview transcripts, activity transcripts, and teachers' reflection responses to answer our research question posed above. We conducted two cycles of analysis to identify patterns in teachers' talk about equity made visible across the four professional learning strategies. The first cycle identified opportunities for teachers' talk; the second, resulting equity conversations.

We ensured the trustworthiness (Brenner, 2006) of our findings in a number of ways. One, we double-checked our interview and activity transcripts against the digital recordings to ensure the accuracy of text. Two, for each of our two analytic cycles, the four researchers collectively constructed coding schemes and practiced employing these schemes until reliability in assigning codes was reached. Two coders then independently coded all relevant pieces of data, compared their resulting codes, and discussed differences in coding until consensus was reached. Three, we created an audit trail to keep track of all analytic decisions made (Guest, MacQueen, & Namey, 2012). Finally, we triangulated our findings by searching for negative cases, tracking changes in participants' talk over time, and comparing themes that emerged across different data types—in particular, whole group conversations, individual interviews, and written reflections.

Analytic Cycle 1. To identify opportunities for teachers to talk about issues of equity, we divided our efforts into two parts. (a) We first examined the organization of target activities. We searched for similarities and differences across professional learning strategies in terms of time allocated (in minutes), types of tasks completed, and total amount of teacher–professional developer talk. To determine total talk, we placed each of the 20 target activity transcripts into a standard template with numbered lines. We argue that transcript line numbers more accurately measure participants' conversation than time (see Horn & Little, 2010). For example, as participants talked with each other during an activity, the transcript lengthened; however, if participants read silently, the transcript remained the same. If we had analyzed only length of activity in minutes, both scenarios would have appeared similar and we would have lost a crucial nuance in equity conversations. (b) We also examined invitations to discuss equity. For each target activity, we determined when the topic of equity was introduced, who prompted the topic, and what the substance of this initial prompt was.

TABLE 3
Name, Date, and Length of Target Activities by Professional Learning Strategy

Professional Learning Strategy	Seminar Session No. (1–22)	Date	Target Activity No. (1–121)	Target Activity Title	Activity Length (minutes)
Teacher research	2	1/25/03	Activity 7	Generating Good Research Questions	45
	3	5/30/03	Activity 12	Conducting Focus Groups	65
	6	8/05/03	Activity 30	The Research Process With a Focus on Equity	101
	15	5/14/04	Activity 80	Reflecting on Teacher Research Conferences	45
	20	11/12/04	Activity 113	Learning From Teacher Research	77
Personal experiences	2	1/25/03	Activity 5	What Does Equity Mean to You?	45
	10	10/03/03	Activity 54	Working With Diverse Students	26
	12	11/15/03	Activity 67	White Privilege	78
	16	8/02/04	Activity 90	Teachers' Own Life Graphs of Science or Mathematics Experiences	112
	21	2/04/05	Activity 117	Experiences With Racism	54
Instructional practices	2	1/25/03	Activity 4	Assessing ELL Students' Writing About Science	56
	4	5/31/03	Activity 17	A Mathematics Lesson in Spanish	81
	6	8/05/03	Activity 29	Examining Multicultural Science and Mathematics Lesson Plans	79
	12	11/15/03	Activity 64	Discussing Equity Issues in the Context of a Mathematics Activity	90

(Continued)

TABLE 3
Continued

Professional Learning Strategy	Seminar Session No. (1–22)	Date	Target Activity No. (1–121)	Target Activity Title	Activity Length (minutes)
	17	8/03/04	Activity 96	Geometric Visualization Activity	151
Examination of school/state/national data	4	5/31/03	Activity 18	ELL Student Enrollment at the School, District, and State Levels	97
	5	8/04/03	Activity 23	Examining State Data on Students Through an Equity Lens	117
	11	10/04/03	Activity 60	Disaggregating Student Data at the School Level	70
	15	5/14/04	Activity 81	Gender in Math and Science—Beyond Counting Boys and Girls	100
	19	10/01/04	Activity 107	Using Online Databases	90

Analytic Cycle 2. To examine teachers' resulting equity talk, we divided our efforts into three parts. (a) For each set of activity transcripts, we determined how often teachers talked about equity issues (in contrast to how often they talked in general as determined in the section Analytic Cycle 1). We began by dividing all transcripts into small, discrete conversational chunks demarcated by shifts in topic. Two researchers independently coded these conversational chunks using one or more of nine descriptive codes: definitions of equity, teachers and teaching, students and student learning, parents and local community, schools and school policies, subject matter, lived experiences, cultural and societal impacts, and administrative or logistical information. We note that the first six of these nine codes were determined a priori; the latter three emerged as we coded the data.

To separate equity talk from nonequity talk, these coded conversational chunks were divided into two groups: *useful* and *not useful*. A chunk was defined as useful if teachers contributed to the discussion (in addition to or instead of professional development staff) and if equity was discussed in relation to teachers, students, and/or parents and community (the three dimensions of equity presented in our conceptual framework). For a given professional learning strategy, we used the transcript line numbers to sum the total number of lines for useful chunks and for all chunks. We then divided total lines for useful chunks by total lines for all chunks to calculate the percentage that equity was discussed in that strategy.

(b) Continuing with our second analytic round, to identify similarities and differences in teachers' shared equity talk across strategies, we changed our unit of analysis (Patton, 2002). For each of our 20 target activities, we aggregated chunks by topic into

conversations; these conversations were longer than chunks, but smaller than activities. As with chunks, we then divided conversations into two groups: useful and not useful. A conversation was defined as useful if teachers contributed to the discussion and if equity was discussed in relation to teachers, students, and/or parents and community. We constructed a second set of emergent descriptive codes to trace participants' talk about equity in relation to teachers and teaching, students and their learning, and home and community contexts in these conversations: sharing one's own or others' experiences with inequities; challenging one another's ideas about equity; focusing on problems (in relation to students, parents, school policies, etc.) encountered in teaching; gaining deeper insight into students, colleagues, parents, or communities; sharing existing reform-based practices; and/or offering suggestions for ways to enact curricular or instructional transformation. Over time, as a result of successive passes through these conversations, codes were refined, eliminated, and synthesized into two or three relevant themes per professional learning strategy. We then checked each theme for differences by subgroups of teachers (by gender, ethnicity, and school).

Furthermore, as did Horn and Little (2010), we looked across the themes for each strategy to determine the strategy's generative nature. We paid "particular attention to the nature of each group's 'take-up' of expressed problems . . . —the degree to which the group's response oriented teachers' collective attention toward or away from a deeper investigation of teaching" (p. 190). Depending on the extent to which conversations pushed teachers' attention toward interrogating equity, the extent to which equity was framed in promising and/or problematic ways, we placed each strategy on a continuum from generative, to somewhat generative, to not generative. Examples of themes in teachers' talk that were deemed generative included teachers considering multiple forms of diversity, viewing diversity as a resource rather than a challenge, and discussing how teachers and schools contribute to inequities experienced by students. Examples of themes that were deemed not generative included teachers blaming students and/or their parents for students' academic struggles, redirecting discussions away from equity, and avoiding sharing personal experiences related to inequities.

(c) To triangulate our findings on teachers' shared talk, we examined teachers' final interview transcripts and written reflection responses. We created a third set of emergent descriptive codes for each strategy, refined these codes into themes, and then clustered these themes into two types: those that resonated with teachers' shared talk in seminars and those that were specific to the individual reflections. We also counted how many teachers referenced each theme and checked each theme for differences by teacher subgroups (by gender, ethnicity, and school).

FINDINGS

As with our analysis, our findings are presented in two parts. Across the four strategies for professional learning, we compared (1) opportunities for teachers to talk about equity and (2) teachers' resulting equity conversations.

Finding Set 1: Opportunities for Teachers to Talk About Equity

Overall, we found each professional learning strategy provided consistent and repeated opportunities for teacher participants to discuss equity issues. Our analysis of (a) the structure of activities and (b) the invitations to discuss equity yielded only two differences—a difference related to the personal experiences strategy. (See Table 4 for a summary of Finding Set 1.)

TABLE 4
Summary of Finding Set 1: Opportunities for Teachers to Talk About Equity by Professional Learning Strategy

Professional Learning Strategy	Length of Activities (minutes)	Length of Transcripts (lines)	Initial Equity Prompt ^a	
			Topic	No. of Times
Examination of school/state/national data	474	4644	ELLs	1
			General equity issues	1
			Gender	1
			Race/ethnicity	1
			Socioeconomic status	1
Teacher research	333	4167	Underrepresented students	1
			Culture	1
			ELLs	2
			General equity issues	1
			Gender	2
Reform-based instructional practices	457	4729	Socioeconomic status	2
			ELLs	3
			General equity issues	2
Personal experiences	315	2449	Multicultural education	1
			ELLs	1
			General equity issues	3
			Gender	1
			Privilege	2
			Race/ethnicity	4
			Socioeconomic status	1

^aBecause more than one topic could be introduced in a given equity prompt, the number of topics per professional learning strategy (6–12) exceeds the number of activities examined (five).

Difference by Amount of Talk. Our examination of the structure of the four professional learning strategies—in terms of time allocated (in minutes), types of tasks completed, and total amount of teacher–professional developer talk (in transcript line numbers)—identified one primary difference. Teachers and staff talked less during personal experiences activities (2449 lines) than during the other three professional learning strategy activities. Teachers and staff talked approximately the same amount in activities for instructional practices (4729 lines), examination of school/state/national data (4644 lines), and teacher research (4167 lines).

Personal experiences activities engendered shorter conversations than the other three strategies for two reasons. One, personal experiences activities were shorter in total minutes (315 minutes) than examination of school/state/national data activities (474 minutes) or instructional practices activities (457 minutes). Two, although personal experiences activities were similar to teacher research activities in terms of total minutes (315 and 333 minutes, respectively), they included more tasks. Across the five personal experiences activities, there were two individual hands-on tasks, three silent readings, and one written reflection. In contrast, teacher research activities included only one silent reading and one

written reflection. Teacher research activities also included more time for participants to engage in small group conversations about their research and/or to present their work publically to elicit feedback.

Difference by Topics. Our examination of invitations to discuss equity—in terms of timing, initiator, and equity prompt—also yielded one difference. The related topics of race/ethnicity (four times) and privilege (two times) were included in the personal experiences initial equity prompts much more often than in the other three strategies combined (race/ethnicity one time in examination of school/state/national data). In contrast, all four strategies included prompts to consider general equity issues (1–3 times each) and ELLs (1–3 times each), and three of the four, prompts to consider gender (1–2 times each) and socioeconomic status (1–2 times each). Furthermore, prompts that were unique to the other three strategies were introduced only once: Examination of school/state/national data introduced underrepresented students (1 time), teacher research, culture (1 time), and instructional practices, multicultural education (1 time). We include the cautions that a single prompt could include more than one topic and that equity conversations often moved beyond those topics introduced in the prompt.

This one difference in the personal experiences initial prompts did not obviously connect to when the topic of equity was introduced in an activity or who the initiator of the equity topic was. We found no differences by professional learning strategy in when equity was introduced, typically at the beginning of an activity. We also found no differences in who invited participants to consider equity as an issue, typically a professional development staff member.

Finding Set 2: Teachers' Resulting Conversations About Equity

Our analysis of opportunities for teachers to talk about equity yielded two ways that the personal experiences strategy differed from the other three. In this section, we report similarities and differences in resulting conversations about equity across professional learning strategies. Despite the long-term nature of the professional development project, teachers' construction of a shared equity discourse, and the iterative implementation of these four strategies for professional learning, we found that some strategies were more effective than others in fostering (a) lengthy and (b) generative conversations about equity. (See Table 5 for a summary of Finding Set 2.)

Amount of Equity Talk. We found that the amount of equity talk varied by professional learning strategy. Teachers and professional developers were most likely to engage in equity talk when participating in examination of school/state/national data activities and least likely when completing reform-based instructional practices activities. As stated in our Methods section above, we determined the quantity of equity talk by strategy by dividing our 20 target activity transcripts into conversational chunks and deciding which chunks were useful (where teachers talked about equity issues in relation to teaching, learning, and/or parents and community). We marked 25 out of 62 chunks from examination of school/state/national data target activities as useful, 17 out of 51 chunks from teacher research target activities, 11 out of 71 chunks from instructional practices target activities, and 16 out of 54 chunks from personal experiences target activities. Then, for each strategy, we divided the number of transcript lines in useful chunks by the total number of transcript lines. The examination of school/state/national data strategy elicited the highest percentage of teacher–professional developer talk about equity at 59%; personal experiences and teacher research were in the

TABLE 5
Summary for Finding Set 2: Teachers' Conversations Generative (or Not) for Learning About Equity by Professional Learning Strategy

Professional Learning Strategy	Percentage of Equity Talk ^a	Conversation Generativity	Conversation Themes	Alignment of Conversation Themes With Individual Reflections
Examination of school/state/national data	59	Generative conversations	(1) Teachers considered multiple kinds of diversity. (2) Teachers considered how their own actions as well as school policies contributed to patterns of differing achievement.	(1) Teachers' reflections aligned with conversations. (2) Teachers' reflections aligned with conversations.
Teacher research	36	Somewhat generative conversations	(1) Teachers saw research as a powerful tool to learn about equity. (2) Teachers vacillated between blaming students and considering the impact of classroom instruction and school structure. (3) Teachers viewed diversity as a challenge rather than as a resource in the classroom.	(1) Teachers' reflections aligned with conversations. (2) Teachers did not blame students; rather, they focused on ways they could promote equity. (3) Teachers' reflections neither supported nor contradicted conversations.
Reform-based instructional practices	24	Somewhat generative conversations	(1) Teachers expressed deeper empathy for their students' struggles. (2) Teachers drew from their own practice to recommend strategies effective in reaching all students.	(1) Teachers' reflections aligned with conversations. (2) Some teachers drew from existing strategies; others discussed new strategies implemented.

(Continued)

TABLE 5
Continued

Professional Learning Strategy	Percentage of Equity Talk ^a	Conversation Generativity	Conversation Themes	Alignment of Conversation Themes With Individual Reflections
Personal experiences	42	Few generative conversations	(1) Teachers focused more on blaming students and their parents than on identifying solutions. (2) Teachers routinely ignored or redirected equity prompts. (3) European American teachers were less likely than teachers of color to share personal experiences tied to in/equity.	(1) Teachers did not blame others; they focused on ways they could change their own instruction. (2) Teachers explained these conversations were challenging. (3) Regardless of race/ethnicity, teachers cited benefits of hearing others.

^aThe percentage of teacher and professional developers' equity talk was calculated by dividing the number of transcript lines in useful conversational chunks by the total number of transcript lines.

middle, at 42% and 36%, respectively; and reform-based instructional practices elicited the lowest percentage of equity talk at 24%.

The Generative Nature of Equity Conversations. We found that the generative nature of equity conversations varied by professional learning strategy as well. This subset of findings related to the generative (or not) nature of teachers' shared equity talk did not neatly map onto the subset of findings about the amount of total equity talk reported above. Specifically, teachers and professional developers engaged in generative conversations about equity during examination of school/state/national data activities, where equity was talked about the most. They engaged in conversations that were somewhat generative for learning about equity in teacher research and reform-based instructional practices activities, where equity was talked about the least. Furthermore, the generative nature of conversations was least obvious in personal experiences activities, the strategy that elicited the second highest amount of equity talk.

Examination of School/State/National Data: Generative Conversations. Conversations facilitated as part of the examination of school/state/national data strategy were the most generative for exploring equity issues. We identified two themes in these conversations that made them so. One, teacher participants regularly considered multiple kinds of diversity (e.g., gender, race, ethnicity, and socioeconomic status) as well as the intersection of these categories (e.g., Latinas) when examining, describing, and attempting to explain student

enrollment, course taking, and achievement data. Two, teachers routinely discussed how teacher actions and school policies contributed to the production of the disparate patterns they found in the data, rather than pointing to perceived deficiencies in students, their parents, and/or their communities. We also found that teachers' individual reflections (from interviews and written responses) about this professional learning strategy resonated with the two themes we identified in their conversations.

We provide a detailed analysis of teachers' shared talk in relation to Theme 1. (See Supplemental Materials 3 in the Supporting Information for a detailed analysis of teachers' shared talk in relation to Theme 2, and of teachers' individual interviews and written reflections for Themes 1 and 2.) As introduced above, across the examination of school/state/national data activities, teacher participants spoke about diversity in terms of various groups of students, demonstrating their growing understanding of the ways students' gender, race/ethnicity, socioeconomic status, and/or first language intersected with opportunities to learn science and mathematics. Teachers neither focused their attention exclusively on one dimension of diversity (e.g., race/ethnicity) nor attempted to categorize students as members of only one group (e.g., girls). Furthermore, they readily and repeatedly noted patterns in the data that challenged their existing ideas of students, schools, and communities. They noticed both that a given student group's percentages for course taking and achievement and that a given school's success rates with particular student groups were different than they had expected.

In Activity 23, for example, teacher participants met in small groups to generate questions they had about the course-taking patterns of high school students in college preparatory science and mathematics. They were then given hard copies of student data for the high schools in their own school districts, printed from the state education data system, so as to pursue answers to these questions. After examining these district data in their small groups, teacher participants reconvened as a whole to present and discuss their findings. We note that in the following transcript excerpt, as in all excerpts in this article, we used pseudonyms for teacher participants and initials for professional development staff.

- 1 Trisha: So one of the things that we looked at was our two main feeder [high]
 2 schools which are Cabrillo [High School] is probably 60% of our kids [from
 3 De La Vina Middle School attend] and Serra High is about 40% of our kids.
 4 So it's very comparable that we look at both. We looked at the females
 5 versus the males [enrollment in math and science courses]. We looked at
 6 the White versus the Hispanic. And then we also looked at who was
 meeting those [the state university] requirements.
- 7 Brent: We didn't look at the African Americans [as a group] because in our district,
 8 as I said, it's like, it's like 60 to 80% are going to college. And so we're
 9 having a very good deal of success with the small percentage we have
 [here]. So these are our real subpopulations that have a disparity.
- 10 JR: And the distribution of African Americans seems to—we started talking
 11 about the issue you guys raised, is the socioeconomic issue, in the sense
 12 that most African American families who tend to live in [this] county are
 affluent or socioeconomically higher . . .
- // //
- 25 JR: . . . So we did it in comparisons. Females versus males. So, for example, at
 26 Cabrillo [High School], Hispanic females there are 45 [enrolled in the first
 27 year physics course] and the percentage is 28.8% females are in first year
 28 physics, as compared to Serra High, there's 103 Hispanic females in first
 year physics at 36.4%.

- 29 Brent: Serra High's doing quite a bit better.
 30 Trisha: Serra High definitely seems to be doing better according to our data for science.
 31 JR: And if you notice, there's a disparity between the females at Cabrillo, the
 32 Hispanic females, and the Hispanic females at Serra taking first year
 33 physics, as well as the males. So at Cabrillo, the Hispanic males taking first
 34 year physics were 38 at 20.8% versus Serra High at 100 at 38.0%.
 35 Brent: So they did better in both groups, but ironically, the females by almost 10
 36 points are doing better. Which is not traditionally Hispanic—it's the males
 37 who [are] supposed to be the dominant and it's not in academics. Again, we
 38 may want to concentrate more on Latino males The data doesn't show
 39 that. It shows that [it is] the males that are having the problem—a higher
 40 JR: And for first year physics, the White males at Cabrillo, there was 72
 [students] at 27.6%.
 41 Brent: Which was less than the Hispanic females [in those courses]. The Hispanic
 42 females are going [into this course] at a higher rate than White females.
 // //
 46 Shawn: What are the socioeconomics between the two [schools]? What are they
 47 like? Cabrillo, I don't know.
 48 JR: That's a very good question.

Throughout this conversation, as suggested in the brief excerpt above, teacher participants recognized students as members of diverse groups and attempted to better understand which groups experienced successes and challenges in enrolling in college preparatory science and mathematics courses both in a given school and across schools. Trisha (lines 1–6) explained that her small group began its examination of district data by determining student course-taking patterns by gender and by ethnicity. They then moved to consider student groups found at the intersection of these categories, for example, Hispanic females. Socioeconomic considerations also entered into their conversation, for example, when JR (lines 11–12) noted that African American students in the county tended to be of high socioeconomic status and when Shawn (lines 46–47) suggested socioeconomic status might help explain differences in course-taking patterns by groups of students attending two different schools.

Teacher participants also emphasized that they had learned something unexpected by looking at these student data. For example, Brent (lines 35–39) stated that society traditionally expects males to do better than females in science, but the data they examined did not support this idea. Near the end of this small group presentation (not included in the transcript excerpt above), Trisha termed the differences in course-taking patterns between two high schools in her district as “amazing” and “front page news” because one school did so much better than the other in preparing Latinas/os for college entrance. Furthermore, later in this same conversation, Suzie expressed surprise as she presented male students' course-taking patterns in her district: “So again, we [my small group] were very shocked [by what we found in the data about the course-taking patterns of male students]. But again, you guys [Brent, Trisha, and JR] had mentioned how the boys are not doing as well.” In short, this examination of school/state/national data activity appeared both to facilitate teachers' careful examination of the needs of different groups of students and to help challenge ideas they held about which student groups participated in college preparatory science and mathematics courses.

Teacher Research: Somewhat Generative Conversations. We found that teacher research conversations were somewhat generative for learning about equity. We identified three reasons this was the case. One generative theme that emerged in teachers' conversations was their description of research as a powerful tool to think about equity. However, as a second theme, we found that teachers vacillated between blaming students and considering how teachers and administrators could effect change in classrooms and schools. Across activities, some participants explained inequities by pointing to teachers' instructional decisions and/or to contextual factors, such as school structure and policies, while others blamed their students for failing to learn. Furthermore, as a third theme, teachers remained unchanged in their views of diversity in the classroom. Across all five activities, teachers described diversity in problematic ways—as an obstacle that inhibited their ability to teach effectively rather than as a resource to facilitate learning.

In comparing teachers' shared conversations to their individual reflections, we found that teachers expanded on or clarified the first two of these three conversation themes. For Theme 1, eight participants articulated more clearly and more elaborately than in their conversations the benefits of using research to investigate equity. For Theme 2, rather than vacillating between blaming students and pointing to teacher actions, in their reflections seven teachers focused on ways they themselves could promote equity. Finally, with regard to Theme 3, we found no evidence in teachers' reflections that they perceived diversity as a struggle.

We provide a detailed analysis of teachers' shared talk in relation to Theme 2, teachers' vacillation between blaming students and considering the impact classroom instruction and school structure had on them (see again Supplemental Materials 3 in the Supporting Information for additional examples). We clarify that although the process of learning to design and conduct research helped move teacher participants to more thoughtfully consider equity issues in their classrooms, they struggled to sustain these new perspectives during teacher research conversations. Some parts of these conversations were generative; a few participants considered ways that school structure and/or classroom instruction impacted all students' opportunities to learn science or mathematics. However, in other parts of these conversations, teachers focused on blaming students, a focus that persisted across all five teacher research activities and that was expressed during several final research project presentations as well.

As an early example, during Activity 7, BB and NO prompted participants to separate into small groups and to generate ideas for possible research questions that bridged equity and their own classrooms. In the following excerpt, Marcella, Diane, Walter, and Suzie discussed why they thought some female students did not excel in mathematics.

- 1 Marcella: You know another thing that I've often wondered about is, "How do we
- 2 dispel the notion that women can't do math?" I've had a student tell me,
- 3 "My mom said it's okay that I'm failing because she knows girls can't do math."
- 4 Diane: Yeah, that's a big one for me.
- 5 Marcella: I'm like, "I'm a girl. [I have a] math career [as a] math teacher."
- 6 Suzie: Look around at all the math teachers at our school.
- 7 Marcella: Even some kids will say, "I can't do math." They've just decided that
- 8 they can't do it. So how do we break them of that? They've heard it so
- 9 often that they've accepted it. I don't know if they've accepted it to
- 10 have an excuse or if they've accepted it truly believing that they can't
- 11 do math. Somebody told them somewhere along the line, "Just do as well as you can, you're just not the kind of person that can do math." I get a lot of that

- 12 Walter: It doesn't have to be that someone told them explicitly. It could be the
13 classes they're placed in, that kind of thing. Because all my kids know
that [they] are in the lower class.
- 14 Marcella: That they're in the lower class, yes.
- 15 Walter: They look at what my other classes are doing and they [say], "Are we
16 ever going to do that?" [I say,] "We'll get there."
- 17 Diane: It was worst in my lower classes, especially bad [at my school] last
18 year. They would pull out the students who were performing very well,
19 they'd pull them out mid-year and then put them in an advanced class.
20 And the kids who were still left in the lower performing class would be
like, "Oh we're not good enough to go." . . .
- 21 Walter: (overlapping) "We're left behind."
- 22 Diane: "She's good. We're just"
- 23 Marcella: (overlapping) And they've accepted that and they don't work. I don't
24 see them working to go beyond that. That's another big one, "How do
25 you dispel all those myths? That girls can't do math. That girls can't be
engineers. That girls." And a lot of girls believe that.

Above, Marcella (lines 1–3, 5–11) blamed her female students for not pursuing mathematics and for using the stereotype that “girls can’t do math” as an excuse to underperform. However, Walter and Diane countered that this underperformance lies, in part, with how schools are structured. Walter (lines 12–13, 15–16, 21) reminded Marcella that many students in lower tracked classes understand that they are not assigned the same level of work as those in the upper tracked classes. Diane (lines 17–20) added that when high-achieving students are pulled out of one class and placed in a more advanced class, the remaining students consider themselves “not good enough.” Although Marcella (line 14) acknowledged these contextual factors, she moved the conversation again to the idea that students themselves are not working hard enough (lines 23–25), continuing to blame girls for their failure to excel in mathematics for the remainder of the conversation.

Reform-Based Instructional Practices: Somewhat Generative Conversations. As with the teacher research strategy, the reform-based instructional practices strategy yielded somewhat generative conversations about equity. We identified two themes across these conversations that spoke to their somewhat generative nature. One, teachers expressed a deeper understanding of and empathy for their students who struggled to learn science or mathematics. Two, they shared curricular and instructional strategies effective in supporting *all* students in learning disciplinary content; however, they rarely moved beyond recommending existing strategies grounded in their own practice to exploring new ways to transform their curriculum and instruction.

In our analysis of teachers’ individual reflections of reform-based instructional practices, we found additional evidence for Theme 1 and evidence both supporting and contradicting Theme 2. More specifically, for Theme 2, two teachers explained that the instructional strategies highlighted in these activities were similar to those they had learned about in other professional development contexts and had already implemented in their own classrooms. However, unlike in their shared conversations where teachers consistently drew from their existing practice to recommend effective instruction, in their individual reflections, seven teachers discussed new strategies they had tried to enrich and diversify their teaching.

We provide a detailed analysis of teachers' shared talk in relation to Theme 2 (see again Supplemental Materials 3 in the Supporting Information for additional examples). In conversations that emerged during instructional practices activities, teachers underscored the need to implement reform-based curricular and instructional strategies so that all students can learn science and mathematics concepts and practices. However, they tended to limit their conversations to instructional strategies they themselves already implemented.

For example, in Activity 96 on geometric visualizations, teachers first worked alone to create a two-dimensional drawing of a cube and then moved to small groups to use algebraic, numeric, and graphical tools to connect geometric figures to their algebraic expressions. After publically presenting their groups' solutions, teachers collectively discussed the importance of using multiple instructional strategies to help all students, including students labeled low achieving and second language learners, learn science and mathematics.

- 1 John: The closest thing to a guarantee of having equity in the classroom is if you
2 do these [kinds of hands-on activities].
- 3 Suzie: Yeah, I was going to say
- 4 JB: (overlapping, to John) That you would—that?
- 5 John: That it comes the closest to guaranteeing that there is going to be some
6 sort of equity in the classroom.
- 7 Suzie: I don't know if we use the word equity very much, but just strategies to meet
8 all your learners. That's I guess more of what's at our school. And so, you
9 know, good teaching is good teaching, it's all the same. If it gets more
students involved, then you're doing a better job.
- 10 Shawn: One thing I like in terms of equity I think is that the two—we had three
11 different, slightly different ways of getting the answer [to the geometric
12 visualization task]. And that's something I always try to emphasize, even if I
13 understand how they [students] got the answer or not. There are different
14 ways to get the answer. There's not just one size that fits all. And I think
15 because a lot of times students really do figure out a problem their way.
Then the teacher says, "No, no, no." Because the teacher doesn't
understand how they got it. And instead
- 16 Suzie: (overlapping) Right, what the textbook says.
- 17 Shawn: By about my second or third year, if I didn't understand it [a student's
18 answer], I'd say, "Can you show me what you just did?" And that's a whole
19 lot different than saying, "No, no, no, no, no. You didn't get it. Can you show
me what you did?" And that makes it equitable
- // //
- 39 John: (talking over several others) Having the teachers use different types of
40 instructional strategies. It's real[ly] stressful mostly because you know most
teachers are not
- 41 Suzie: (overlapping) Familiar, or lack of familiarity
- 42 John: Familiar or they don't feel comfortable, whatever.
- 43 Brent: (overlapping) You went through college in the lecture mode. You learned in
the lecture mode.
- 44 Suzie: Or allowing kids to do things differently. I think that's the level of frustration
45 of different teachers.
- 46 Shawn: But you also hear teachers say, "Well if I had a class that could do it that
47 way." It means if they had higher functioning kids, they'll do it.
- 48 Brent: Right. They'll try it.
- 49 Shawn: But if they had the kids that function a little lower, "Then I'm going to tell
50 them what to do." And that's where, that's where you've got to discipline
51 yourself, John, I think. And that's, that's hard.

- 52 John: Well, I think it's expectation. This [a hands-on activity like the geometric
53 visualization task] can be done in any classroom.
- 54 Shawn: Yeah, you're right.
- 55 Trisha: You might have to huddle [provide guidance to groups] more in one class
than another.
- // //
- 65 Suzie: That's why we, I mean in my math classroom, they would write their answers
66 on their own papers but they'd have to write everyone down depending
67 upon how much time I'd give them. But then I'd give them an overhead and
68 so now the recorder now has to copy that onto the overhead or to the
poster. So they are writing it both ways. They sort of—they can't opt out . . .

More specifically, as part of this conversation, John (lines 1–2, 5–6, 39–40, 52–53) argued that teachers should regularly implement hands-on activities to promote the learning of all students in their classrooms (John both implemented and served as a longtime teacher trainer of the activity-based College Preparatory Mathematics curriculum). Many teachers avoid doing so, he continued, because they find implementing unfamiliar strategies stressful. Shawn (lines 46–47, 49–51) added that teachers routinely blame their low-achieving students for their failure to implement reform-based strategies and insist that they would implement hands-on experiences if they had higher achieving students. Shawn and Suzie also shared strategies they themselves used to help all their students learn. Shawn (lines 10–15, 17–19) attempted to promote equity in his classroom by regularly asking those students who solved a mathematics problem in a different way to share out what they did. Suzie (lines 65–68) recommended her approach of requiring small groups to complete individual as well as collective written responses as a way to ensure that all learned. However, before the close of this conversation, the teachers never moved to considering if or how they might integrate additional equity-focused approaches into their instruction, strategies that they did not currently implement. As such, we viewed this theme as speaking to the somewhat generative nature of instructional practices conversations.

Personal Experiences: Few Generative Conversations. We found that the personal experiences strategy produced few generative conversations among teacher participants; unlike the other three professional learning strategies examined, teachers' shared talk did not orient their attention toward a deeper understanding of equity. We identified three reasons for this lack of generativity. One, in personal experiences conversations, teachers tended to present problems—to complain about individual students, their classrooms, or their students' parents—without then exploring larger contextual factors or suggesting changes they had or could make to their curriculum and instruction. Two, teacher participants tended to ignore invitations or to redirect conversations away from equity issues. Three European American teachers were less likely than teachers of color to share personal experiences with in/equities and privilege. We remind readers that the topics of race/ethnicity and privilege were more often introduced during personal experiences activities than the other three, although teachers were willing and able to move away from initial prompts to examine other equity and diversity topics as well.

In our examination of teachers' individual reflections on the personal experiences strategy, we found that teachers contradicted Themes 1 and 3 identified in their shared conversations, and provided additional insight into Theme 2. For Theme 1, in their conversations, teachers often blamed their students for issues faced in their classrooms. However, in their

reflections, seven teachers disrupted this theme by focusing on ways they could change their own instruction to address classroom inequities. For Theme 2, in their conversations, teachers tended to ignore or redirect equity prompts. In their reflections, six teachers explained they thought such conversations sensitive and challenging because they were asked to examine their own views and experiences with different forms of prejudice and bias. For Theme 3, in their conversations, we found that European American teachers were less likely than teachers of color to share their own experiences tied to in/equity. However, in their reflections, nine participants, regardless of their racial/ethnic background, cited benefits and recommended use of this strategy.

We provide a detailed analysis of teachers' shared talk in relation to Theme 1 (see again Supplemental Materials 3 in the Supporting Information for additional examples). The personal experiences strategy was designed to encourage teachers to interrogate their own experiences with different forms of privilege and inequities, and to use those new insights generated to transform their educational practices. Teacher participants, however, tended to blame students or parents for the curricular and instructional challenges they faced, a tendency that persisted across time.

During Activity 117, for example, LC, a member of the professional development staff, prompted teacher participants to think about equity issues they continued to face in their schools after participating in TEMSE for over 2 years. In response, teachers cited problems in their classrooms and pointed to the lack of adequate parenting as the cause; they mitigated their role as teachers in equity-related classroom issues. More specifically, Shawn (lines 1–6) began by discussing the lack of adequate parenting among his students, which he labeled as an inequity at his school. He compared his experiences as an African American from an impoverished area in Southern California to those of his students, emphasizing that he “grew up in a similar neighborhood but *parents were there* [emphasis added].” Suzie (lines 10–11, 14–17) added that her students often went to bed at 1 am, which she too attributed to a lack of adequate parenting. Trisha (lines 20–28) then described a parent–teacher conference where the parent did not follow through with a child who was failing science.

- 1 Shawn: I just would like adequate, good parenting from students. I think that's an
 2 inequity at our school. We have so many kids that have single parents,
 3 raised by mothers Even the mothers that are there are not there on the
 4 weekends I grew up in a similar neighborhood but parents were there.
 5 I think it's a real inequity, I really do. There isn't adequate parenting. . . .
 6 And I know that that's an age-old problem, but it's still a major problem. But
 it doesn't seem to be getting much better to me.
- 7 Suzie: To just piggy back on that, I always ask my kids—every week I've been
 8 talking about something of value, or something information[a] like drinking
 9 water, or dehydration, or sleep. The first one I do is on sleep. And since it's
 10 a math class, I have them calculate when they go to bed and when they
 11 wake up There are kids . . . who are up until 1 o'clock at night
- 12 Trisha: (overlapping) Same at junior high.
- 13 Shawn: (overlapping) Same at junior high.
- 14 Suzie on the phone, watching TV, on the internet. And if that isn't affecting our test
 15 scores, you know, and our learning, [then] I don't know. And obviously the
 16 lack of parenting—I don't know what the parents are thinking. . . . Over half
 17 my kids are getting 6 or less hours of sleep. And my daughter read an
 article, teenagers are supposed to have 9.25 [hours]
- 18 Brent: (overlapping) At [a] minimum.
- 19 Suzie: 9.25 [hours] And they're not getting that . . .

20 Trisha: (interrupting) I had a parent at a parent–teacher conference tell me. I said,
 21 “Well, have you checked your agenda book that you’ve asked me to sign? I
 22 write in her homework every night for her and you want me to sign it.” She
 23 goes, “Well that’s her private thing. I don’t go into her private things.” And
 24 I’m thinking, “Ok, so I’m expected to hand write in every single day what her
 25 homework assignment is and you don’t even read it?” . . . “Well, do you
 26 knock on the door to check that she’s doing her homework?” [The parent
 27 says,] “Well, no, that’s her private space, I can’t go into her space.” [I say],
 28 “Well, she’s failing . . . Maybe you need to open the agenda and open the
 door a few more times and figure out what she is doing [in her room
 be]cause it’s not science.”

As this conversation about inadequate parenting continued, the group suggested mandat-
 ing parenting classes for parents of failing students. AC (line 1), a TEMSE staff member,
 challenged the existence of a uniform approach to parenting. Trisha (lines 2–5, 7–13, 15)
 overlooked the intent of AC’s question—to explore the values asserted in a mandatory
 parenting class—and instead focused on possible content, such as hygiene and nutrition.

1 AC: But whose standards of parenting are you going to be teaching [in this
 parenting class]?

2 Trisha: Well, at the homeless shelter where I volunteer, they have parenting
 3 classes and they are mandatory because you are living at the shelter, you
 4 must go through parenting classes. And it is basic things, like basic
 5 hygiene of your child. I mean it sounds like we would all know that. No, we
 don’t all know that.

6 Suzie: (overlapping) Health, hygiene, nutrition.

7 Trisha: [Such as] nutrition. So I mean, it’s not saying, “Oh, ok. You’re going to
 8 grow up with this method of discipline.” It’s just basic, “Ok, how do you
 9 dispose of that diaper? . . . What are you supposed to do with
 10 bottle-feeding? What are you supposed to do with homework?” You might
 11 not know how to answer the questions, but are you just even asking, “Do
 12 they have any [homework]?” . . . I’ve sat in on a couple of those parenting
 13 classes and they’re by no means biased saying, “Well this is the American
 way of doing it.” It just seems like it’s more from the vantage point of

14 Michelle: (overlapping) Common sense.

15 Trisha: This is what you should be doing.

Rather than exploring AC’s prompt that standards in parenting might be tied to individual,
 cultural, and/or class differences, Trisha, as well as Suzie (line 6) and Michelle (line 14),
 ignored the opportunity to reintroduce equity into the conversation.

DISCUSSION

As stated in our introduction, this study contributes to the research base on effective
 equity professional development by investigating four different strategies used to facilitate
 teachers’ shared talk and by teasing apart the strengths and limitations of each strategy. We
 examined a large and longitudinal corpus of data, systematically analyzed teachers’ equity
 talk, and compared themes that emerged from their collective conversations to ideas they
 expressed individually in reflections. We found that the four professional learning strate-
 gies implemented did indeed generate similar opportunities for teachers to discuss equity

issues. However, these strategies differed in the length of equity conversations prompted, the extent to which such conversations could be considered generative for learning about equity, and the degree to which ideas discussed in shared conversations aligned with those expressed individually. Below, we provide possible reasons some of these professional learning strategies were better than others at facilitating lengthy and generative conversations about equity.

We placed the four strategies we investigated along a continuum from most strengths to most limitations in facilitating teachers' equity talk. The examination of school/state/national data strategy emerged as having the most strengths. It prompted the highest percentage of equity talk and two generative themes during equity conversations, as well as having the closest alignment between collective and individual themes expressed. We provide two possible reasons why this was the case. One, because the data examined during activities were concrete and limited (e.g., tables of numbers printed on pieces of paper), teachers might have spent less time trying to identify and frame equity issues and more time trying to thoughtfully make sense of them. As teacher participants themselves noted, they were able to find clear trends in the data that challenged their beliefs about diverse student groups' course-taking preferences and academic achievement. For example, they were able to see that Latina/o students in a given district experienced greater success in some schools than in others. Two, because most of the data examined were at the school, state, and/or national levels, teachers might have found participating in these activities less personally and professionally challenging than other types of professional learning strategies. In other words, because most data were not at the level of teachers' individual classrooms, they might have experienced greater ease and comfort in deciding when and what kinds of connections to make to their own experiences and classroom practices. For example, Trisha and Brent (with JR) decided on their own to narrow their investigation of district course-taking patterns to focus exclusively on the two high schools their students typically attended after graduating from De La Vina.

On the other end of the continuum, the personal experiences strategy had the most limitations; it provided the fewest opportunities for lengthy and generative conversations about equity. Although this strategy had the second highest percentage of equity talk, its equity conversations were the least generative and its alignment between collective and individual themes was the least obvious. Again, we identified two reasons this might be the case. One reason this strategy emerged as limited might reside with its implementation: It was difficult to engage all teacher participants in interrogating equity issues during personal experiences conversations. More specifically, it was the only strategy of the four where we found teachers tended to ignore or redirect equity prompts. Given that personal experiences conversations often began with explorations of race/ethnicity and/or privilege, this reluctance was not unexpected (see Nieto & McDonough, 2011, for similar findings at the preservice level), but it might have been better addressed. It was also the only strategy where we found differences in participation among subgroups of teachers. Again, it was not unexpected that teachers of color would share their own experiences tied to inequities more often than their European American colleagues (see Grant & Gibson, 2011, for similar findings at the preservice level); however, this unevenness in participation might have been identified early on and made more level. A second and related reason might be that teachers found it particularly challenging to participate in this strategy's conversations. In their individual reflections, teacher participants emphasized that personal experiences conversations required members of a learning community both to build a collective sense of trust and to overcome their individual reluctance to sharing personal, sometimes painful, experiences.

We found that the teacher research strategy yielded the second highest number of strengths. Teacher research activities facilitated the third highest percentage of equity talk, conversations that were somewhat generative for learning about equity, and alignment between two of the three themes expressed collectively versus individually. We offer three reasons why this might be the case. One, as with examination of school/state/national data, teacher research activities focused on the collection, analysis, and presentation of data. Because the data themselves and the strategies suggested to collect and analyze such data were bounded and concrete, teachers might have had more time to thoughtfully make connections between equity issues and their methods or findings. Indeed, during teacher research conversations, teachers themselves emphasized that they found research to be a powerful tool in understanding equity issues. Two, again as with examination of school/state/national data, at times, discussions about research methods and collected data challenged teachers' existing beliefs and practices, facilitating their reflection on inequities at the classroom, school, and community levels. We add, however, that teacher research activities at times supported what teachers already believed, and in some cases, reinforced negative stereotypes of students. Marcella's complaints about the girls at her school and their intentional underperformance in mathematics serve as a case in point. Three, because the focus of most teacher research activities was at the classroom level, these activities were more personally and professionally challenging than examination of school/state/national data activities and thus more difficult for teachers and professional developers to guide in generative ways. In their study of middle school mathematics teachers, Males, Otten, and Herbel-Eisenmann (2010) found that teacher participants experienced greater difficulty critiquing their own practices than the ideas of those outside their learning community (e.g., the authors of articles read). Similarly, in our study, because teachers regularly shared their own classroom practices, they might have been reluctant to consider ways to then critique them.

Finally, instructional practices was placed between teacher research and personal experiences on our continuum of strengths to limitations. This strategy had a clear limitation: It yielded the lowest percentage of equity talk. However, it did engender equity conversations that were somewhat generative and its collective themes did align with those identified in individual reflections. We offer two reasons for instructional practices' position on our continuum of facilitating lengthy and generative equity talk. One reason is tied to the perceived novelty of the instructional strategies examined. Because some teachers saw themselves as deeply knowledgeable about reform-based instruction and had attended many other professional development opportunities, certain activities seemed simply to reiterate what they already knew. Thus, we argue that instructional practices activities were somewhat less generative than examination of school/state/national data and teacher research activities because they were less novel. Two, as with teacher research activities, teachers often talked about what they did in their own classrooms. For example, John shared his experiences using hands-on group activities to teach mathematics; Shawn, his practice of asking students to share novel solutions to problems; and Suzie, her requirement that small group activities include both individual and group accountability. Again, because teachers recommended strategies they already implemented and found effective, they might have been reluctant to engage in the critical examination of their own and each other's practices (see, again, Males et al., 2010).

IMPLICATIONS

We return to our conceptual framework to discuss the implications of our study—to craft recommendations for other professional developers and researchers intent on better supporting science and mathematics teachers' movement toward the goal of equity in

education. One implication of our study is that any of the four professional learning strategies investigated can be used to explore various layers and dimensions of equity. We remind readers that, in our conceptual frame, we defined educational equity as spanning teachers and their teaching (e.g., Cochran-Smith & Lytle, 2009), students and their learning (e.g., Rosebery et al., 2010), and school and community contexts (e.g., Mallya et al., 2012). For each of our professional learning strategies, we found that (a) invitations to discuss equity included a range of topics and (b) that teachers and professional developers often moved beyond these invitations to consider additional dimensions of equity. In short, professional developers need not assume that the type of professional learning strategy implemented constrains the dimensions of equity discussed.

As a second implication, our study suggests to professional developers and researchers that it is important to encourage and examine teacher talk across different contexts. In our study, we examined in-the-moment public discourse (professional development seminar conversations) and private individual discourse (interviews between one researcher and one teacher participant). We identified both overlaps and inconsistencies in the themes generated from our analysis of collective conversations versus individual reflections. We are not attempting to argue that one type of discourse is more trustworthy (Brenner, 2006) than the other. Rather, we see such differences as another reminder to those who organize and research professional development opportunities that teachers think and speak differently in different kinds of contexts (Gee & Green, 1998).

Our third implication lies at the intersection of the two parts of our conceptual frame. Though each of the professional learning strategies in this study could be used to explore equity, as we stated above, professional developers and researchers must thoughtfully consider how the structure and substance of a given professional development project—the number of professional learning strategies implemented and the kinds of opportunities they afford teachers for learning—differentially shapes teachers' engagement in and/or resistance to exploring equity issues. Horn and Little (2010) found differences in conversational routines between two groups of teachers; we found differences within the same teacher group among four types of strategies. More specifically, we found that the same teacher participants talked more or less frequently and more or less generatively about equity depending on the professional learning strategy implemented (see Males et al., 2010, for a related set of findings). In other words, we found that some strategies for professional learning were more effective than others in fostering lengthy and generative conversations about equity. As such, we encourage professional developers and researchers to move away from blaming teacher participants for their reluctance to engage in explorations of equity issues and carefully consider the opportunities and constraints afforded these teachers by the professional development context itself.

CONCLUSIONS

We close by considering possible next steps in improving equity professional development for science and mathematics teachers. We note that the study presented here was limited in a number of ways. One limitation was that we did not include investigation of the synergistic relationships among our four professional learning strategies. We did not determine the strategies' collective impact on our teacher participants' equity talk, and as such, cannot speak to how their sum might be greater than their individual parts. A second limitation is that we did not draw connections between teachers' equity talk and teachers' outcome data. Because we conducted a fine-grained analysis of teacher talk, we did not have adequate room in this paper to identify mis/connections between talk and outcomes as

well. A final limitation is that we did not follow teachers after the professional development experience had ended to determine what they retained from TEMSE months or years later.

Viewing our findings in light of these limitations, we suggest possible directions for future equity professional development and research efforts. We encourage others to continue to investigate the strengths and limitations of professional learning strategies, so as to provide more specific and concrete guidance to professional developers on ways to structure and sequence their professional development in support of lengthy and generative talk about equity. Examination of the deliberate pairing of two or more strategies would provide new insights into which combinations, if any, might be more effective. Examination of teachers' talk during the professional development process itself and their views and practices months or years later would help deepen understanding of the connections across talk, learning, and action. Ultimately, improving the professional development opportunities afforded practicing teachers is an important and necessary step in helping all students receive an excellent and equitable science and mathematics education.

The authors would like to thank Dr. Gregory Kelly for his helpful comments.

REFERENCES

- Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, 36(3), 269–288.
- Banks, J. A., Cookson, P., Gay, G., Hawley, W. D., Jordan Irvine, J., Nieto, S., et al. (2001). Diversity within unity: Essential principles for teaching and learning in a multicultural society. *The Phi Delta Kappan*, 83(3), 196–198, 200–203.
- Bianchini, J. A., Cavazos, L. M., & Helms, J. V. (2000). From professional lives to inclusive practice: Science teachers and scientists' views of gender and ethnicity in science education. *Journal of Research in Science Teaching*, 37(6), 511–547.
- Brenner, M. E. (2006). Interviewing in education research. In J. Green, G. Camilli, & P. Elmore (Eds.), *Handbook of complementary methods in education research* (pp. 357–370). Mahwah, NJ: Erlbaum.
- Brenner, M. E., Bianchini, J. A., & Dwyer, H. A. (in progress). Working toward equity through teacher research: Changes in mathematics and science teachers' views and practices.
- Brenner, M. E., Bianchini, J. A., Goto, K. F., Cavazos, L. M., & Kelly, G. J. (2006). Working toward equity through professional development: Changes in science and mathematics teachers' conceptions and self-reported practices. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.
- Brickhouse, N. W., Lowery, P., & Schultz, K. (2001). What kind of girl does science? The construction of school science identities. *Journal of Research in Science Teaching*, 37(5), 441–458.
- Brown, B. A., & Spang, E. (2008). Double talk: Synthesizing everyday and science language in the classroom. *Science Education*, 94(4), 708–732.
- Bunch, G. C. (2013). Pedagogical language knowledge: Preparing mainstream teachers for English learners in the new standards era. *Review of Research in Education*, 37(1), 298–341.
- Calabrese Barton, A., Tan, E., & Rivet, A. (2008). Creating hybrid spaces for engaging school science among urban middle school girls. *American Educational Research Journal*, 45(1), 68–103.
- Capobianco, B. M. (2007). Science teachers' attempts at integrating feminist pedagogy through collaborative action research. *Journal of Research in Science Teaching*, 44(1), 1–32.
- Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge- and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching*, 48(5), 459–485.
- Chinn, P. W. U. (2007). Decolonizing methodologies and indigenous knowledge: The role of culture, place and personal experience in professional development. *Journal of Research in Science Teaching*, 44(9), 1247–1268.
- Cochran-Smith, M. (2003). The multiple meanings of multicultural teacher education: A conceptual framework. *Teacher Education Quarterly*, 30(2), 7–26.
- Cochran-Smith, M., & Lytle, S. L. (1999). Relationship of knowledge and practice: Teacher learning in communities. *Review of Research in Education*, 24, 249–305.

- Cochran-Smith, M., & Lytle, S. L. (2009). *Inquiry as stance: Practitioner research for the next generation*. New York: Teachers College Press.
- Confrey, J., Makar, K., & Kazak, S. (2004). Undertaking data analysis of student outcomes as professional development for teachers. *Zentralblatt für Didaktik der Mathematik [International Reviews on Mathematical Education]*, 36(1), 32–40.
- Cortazzi, M. (1993). *Narrative analysis*. London: Falmer Press.
- Delpit, L. D. (1988). The silenced dialogue: Power and pedagogy in educating other people's children. *Harvard Educational Review*, 58(3), 280–298.
- Delpit, L. (2003). Educators as “seed people” growing a new future. *Educational Researcher*, 32(7), 14–21.
- Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, 38(3), 181–199.
- Dixon, C. N., Frank, C. R., & Green, J. L. (1999). Classrooms as cultures: Understanding the constructed nature of life in classrooms. *Primary Voices K-6*, 7(3), 4–8.
- Gee, J. P., & Green, J. L. (1998). Discourse analysis, learning, and social practice: A methodological study. *Review of Research in Education*, 23(1), 119–169.
- Grant, C. & Gibson, M. (2011). Diversity and teacher education: A historical perspective on research and policy. In A. F. Ball & C. A. Tyson (Eds.), *Studying diversity in teacher education* (pp. 19–61). New York: Rowman & Littlefield.
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record*, 103(6), 942–1012.
- Guest, C., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. Thousand Oaks, CA: Sage.
- Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education*, 34(1), 37–73.
- Hammond, L. (2001). Notes from California: An anthropological approach to urban science education for language minority families. *Journal of Research in Science Teaching*, 38(9), 983–999.
- 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.
- Hubbard, R. S., & Power, B. M. (1993). *The art of classroom inquiry: A handbook for teacher-researchers*. New York: Heinemann.
- Kelly, G., Crawford, T., & Green, J. (2001). Common task and uncommon knowledge: Dissenting voices in the discursive construction of physics across small laboratory groups. *Linguistics and Education*, 12(2), 135–174.
- Khisty, L. L. (1995). Making inequality: Issues of language and meanings in mathematics teaching with Hispanic students. In W. G. Secada, E. Fennema, & L. B. Adajian (Eds.), *New directions for equity in mathematics education* (pp. 279–297). New York: Cambridge University Press.
- Kisker, E. E., Lipka, J., Adams, B. L., Rickard, A., Andrew-Ihrke, D., Yanez, E. E., et al. (2012). The potential of a culturally based supplemental mathematics curriculum to improve the mathematics performance of Alaska Native and other students. *Journal for Research in Mathematics Education*, 43(1), 75–113.
- Kohl, H. (1994). I won't learn from you! Confronting student resistance. In B. Bigelow, L. Christensen, S. Karp, B. Miner, & B. Peterson (Eds.), *Rethinking our classrooms* (Vol. 1, pp. 134–135). Milwaukee, WI: Rethinking Schools.
- Kumashiro, K. K. (2001). “Posts” perspectives on anti-oppressive education in social studies, English, mathematics, and science classrooms. *Educational Researcher*, 30(3), 3–12.
- Lee, O., & Buxton, C. A. (2010). *Diversity and equity in science education: Research, policy, and practice*. New York: Teachers College Press.
- Lee, O., Quinn, H., & Valdes, G. (2013). Science and language for English language learners in relation to next generation science standards and with implications for common core state standards for English language arts and mathematics. *Educational Researcher*, 42(4), 223–233.
- Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Westport, CT: Ablex.
- Lippincott, A. C. (1999). *Reflective thinking among and between beginning professional educators*. Unpublished dissertation, University of California, Santa Barbara.
- Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics* (3rd ed.). Thousand Oaks, CA: Sage.
- Love, N., Stiles, K. E., Mundry, S., & DiRanna, K. (2008). *The data coach's guide to improving learning for all students: Unleashing the power of collaborative inquiry*. Thousand Oaks, CA: Corwin Press.
- Makar, K., & Confrey, J. (2007). Moving the context of modeling to the forefront: Preservice teachers' investigations of equity in testing. In W. Blum, P. L. Galbraith, H-W. Henn, & M. Niss (Eds.), *Modelling and applications in mathematics education* (pp. 485–490). New York: Springer.

- Males, L. M., Otten, S., & Herbel-Eisenmann, B. A. (2010). Challenges of critical collegueship: Examining and reflection on mathematics teacher study group interactions. *Journal of Mathematics Teacher Education*, 13(6), 459–471.
- Mallya, A., Mensah, F. M., Contento, I. R., Koch, P. A., & Calabrese Barton, A. (2012). Extending science beyond the classroom door: Learning from students' experiences with the choice, control and change (C3) curriculum. *Journal of Research in Science Teaching*, 49(2), 244–269.
- McAllister, G., & Irvine, J. J. (2002). The role of empathy in teaching culturally diverse students: A qualitative study of teachers' beliefs. *Journal of Teacher Education*, 53(5), 433–443.
- McIntosh, P. (1995). White privilege and male privilege: A personal account of coming to see correspondences through work in women's studies. In M. L. Andersen & P. H. Collins (Eds.), *Race, class, and gender: An anthology* (pp. 76–87). Belmont, CA: Wadsworth.
- Moje, E., Collazo, T., Carrillo, R., & Marx, R. W. (2001). "Maestro, what is quality?": Examining competing discourses in project-based science. *Journal of Research in Science Teaching*, 38(4), 469–495.
- Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice*, 31(2), 132–141. Retrieved April 19, 2008, from <http://www.jstor.org/stable/1476399>.
- Morgan, D. L. (1997). *Focus groups as qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards for mathematics*. Retrieved January 25, 2014, from http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf.
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.
- NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Retrieved from <http://www.nextgenscience.org/next-generation-science-standards>.
- Nieto, S. (1999). *The light in their eyes: Creating multicultural learning communities*. New York: Teachers College Press.
- Nieto, S., & McDonough, K. (2011). "Placing equity front and center" revisited. In A. F. Ball & C. A. Tyson (Eds.), *Studying diversity in teacher education* (pp. 363–384). New York: Rowman & Littlefield.
- Noftke, S. E. (1997). Professional, personal, and political dimensions of action research. *Review of Research in Education*, 22, 305–343.
- Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.
- Planas, N., & Civil, M. (2009). Working with mathematics teachers and immigrant students: An empowerment perspective. *Journal of Mathematics Teacher Education*, 12(6), 391–409.
- Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teaching learning? *Educational Researcher*, 29(1), 4–15.
- Rivera Maulucci, M. S. (2013). Emotions and positional identity in becoming a social justice science teacher: Nicole's story. *Journal of Research in Science Teaching*, 50(4), 453–478.
- Rodriguez, A. J., & Beryman, C. (2002). Using sociotransformative constructivism to teach for understanding in diverse classrooms: A beginning teacher's journey. *American Educational Research Journal*, 39(4), 1017–1045.
- Rosebery, A. S., Ogonowski, M., DiSchino, M., & Warren, B. (2010). "The coat traps all your body heat": Heterogeneity as fundamental to learning. *Journal of the Learning Sciences*, 19(3), 322–357.
- Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Thousand Oaks, CA: Sage.
- Santa Barbara Classroom Discourse Group. (1992). Do you see what we see? The referential and intertextual nature of classroom life. *Journal of Classroom Interaction*, 27(2), 29–36.
- Secada, W. (1994). Equity and mathematics reform. *NCRMSE Research Review: The Teaching and Learning of Mathematics*, 3(3), 1–5.
- Stanley, W. B., & Brickhouse, N. W. (1994). Multiculturalism, universalism, and science education. *Science Education*, 78(4), 387–398.
- Stanley, W. B., & Brickhouse, N. W. (2001). Teaching sciences: The multicultural question revisited. *Science Education*, 85(1), 35–49.
- Strutchens, M., Bay-Williams, J., Civil, M., Chval, K., Malloy, C. E., White, D. Y., et al. (2012). Foregrounding equity in mathematics teacher education. *Journal of Mathematics Teacher Education*, 15(1), 1–7.
- Taylor, E. V. (2012). Supporting children's mathematics understanding: Professional development focused on out-of-school practices. *Journal of Mathematics Teacher Education*, 15(4), 271–291.
- van Zee, E., Lay, D., & Roberts, D. (2003). Fostering collaborative inquiries by prospective and practicing elementary and middle school teachers. *Science Education*, 87(4), 588–612.

- Warren, B., Ballenger, C., Ogonowski, M., Rosebery, A. S., & Hudicourt-Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sense-making. *Journal of Research in Science Teaching*, 38(5), 529–552.
- Weissglass, J. (2000). No compromise on equity in mathematics education: Developing an infrastructure. In W. G. Secada (Ed.), *Perspectives on multiculturalism and gender equity* (pp. 5–24). Reston, VA: National Council of Teachers of Mathematics.
- Wilson, S. M., & Berne, J. (1999). Teacher learning and the acquisition of professional knowledge: An examination of research on contemporary professional development. *Review of Research in Education*, 24, 173–209.
- Yerrick, R., Schiller, J., & Reisfeld, J. (2011). “Who are you callin’ expert?”: Using student narratives to redefine expertise and advocacy [in] lower track science. *Journal of Research in Science Teaching*, 48(1), 13–36.