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Inside and Outside: Teacher-Researcher Collaboration

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In this paper, we discuss our approach to teacher-researcher collaboration and how it is similar and different from other models of teacher collaboration. Our approach to collaboration employed design experimentation (Brown, 1992; Design Based Research Collective, 2003) as a central method since it yields important findings for teachers' pedagogical practices and contributes to the research literature on teaching and learning. We use three key moments in our collaborative practice to highlight how our work impacted student thinking and learning and involved our own shifting identities as teachers and researchers. Key themes that were central to our joint work are discussed to demonstrate how we brought research and practice into regular dialogue. We argue that although this model is not necessarily supported by current institutional organization, it holds promise for ongoing professional development for teachers and researchers that can support building a culture of research-based practices in schools.

In this paper, we discuss studying teaching practices in order to build robust, ecologically valid models of teaching and learning. Our title plays off of an important

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distinction that has surfaced in the literature between "insider" points-of-view or teachers' perspectives on their own teaching and "outsider" or researcher perspectives on teaching (Ball, 2000; Cochran-Smith & Lytle, 1993). In this paper, we suggest that the roles of teachers and researchers collaborating together often involve moving across the chasm of inside-outside in ways that have the potential to positively impact both communities (Cochran-Smith & Lytle, 1999). Although this kind of in-depth collaboration is rare, it is an important way that the field can address ongoing concerns about the theory-practice divide (Duckworth, 2005). Our approach to collaboration employed design experimentation (Brown, 1992; Design Based Research Collective, 2003) as our central method. Design experimentation provides a framework for teachers and researchers to design and conduct iterative research in classrooms (Cobb, 2000; Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999).

What we share here is a vision of a unique collaboration that has lasted for over a decade. Our design experiment together has provided important short and long-term findings for our own pedagogical practices. It has also contributed to the research literature on teaching and learning. Our work is included in key national panel summaries of science learning (National Research Council, 2007) and was featured as one of twelve case examples in the recent volume on applying science research to practice (Michaels, Shouse, & Schweingruber, 2008). Through an analysis of our collaborative activity in a design experiment tradition, we will argue that teacher-researcher collaboration offers significant benefits to research and researchers, teaching and teachers, and students and their learning.

ADULT COLLABORATION IN SCHOOL SETTINGS

In the United States, it is uncommon for teachers to find intellectual communities in their school settings (Horn, 2005) and even more rare that they involve both PK-12 and university colleagues working together. When these communities do form, they often seem to do so around the teaching of math and science, perhaps due to funding patterns in education. In one such model, teachers of mathematics or science come together with university partners to explore concepts as learners themselves (Carpenter, Fennema, & Franke, 1996; Schifter, 1996; McDermott, 1990; McDermott & DeWater, 2000). Most of these groups are formed through grant monies or projects initiated at the university level and involve a subject matter expert planning, organizing, and leading group meetings. Teachers choose to participate in these optional activities, often putting in time well beyond that which is required by their district.

Grossman, Wineburg, and Woolworth (2000) present a different model of teacher researcher community in the humanities based on their work together with urban high school teachers. In their model, most teachers in the English and History departments in an urban high school participated in discussions modeled after book clubs. They also planned to work together to build interdisciplinary curricula and explore other issues related to teaching and student learning. Teachers volunteered to participate and were provided release time from school days to engage in discussions and activities. Although the work Grossman, Wineburg, and Woolworth describes focuses upon teacher learning and collaboration, this model also sought to include teaching, curriculum development, and student learning. Through their work in this context, they suggest that it is more likely that teachers develop a kind of pseudocommunity, or the surface appearance of community, without fully engaging in meaningful intellectual and personal dilemmas around teaching and learning. This sets their model apart from others that do not generally evaluate the quality of community and collaboration that is created among participants.

Coaching is another possible form of teacher-researcher collaboration. This is becoming a popular model of ongoing professional development for in-service teachers (Costa & Garmston, 1994; Neufeld & Roper, 2003; West & Staub, 2003). Although coaching takes different forms, one form involves coaching as a follow-up strategy to a workshop that helps teachers try out new curricula and pedagogical practices in the context of their own classroom. In some cases, it is a researcher (Becker & Pence, 2003) who acts in the role of coach during visits to participating teachers' classrooms. Teachers identify goals for developing their practice and for understanding and documenting student learning. The coach makes observations and provides feedback to support the teacher to achieve her goals. In cases where research is also a focus, data are collected to help understand the process of improving teaching practices.

Other models of teacher community that involve research, such as teacher research communities (Cochran-Smith & Lytle, 1993, 1999), are formed by teachers who are interested in pursuing their own collective conversation and research about teaching in a particular domain. These groups often create and share individual action research projects directed at improving student learning opportunities within each teacher's classroom.

A final model is that of a "researcher-teacher," or a person who acts in both the roles of teacher and researcher simultaneously (Ball, 2000; Duckworth, 1987; Lampert, 2001; Paley, 1981, 1992). In these approaches, scholars with teaching and research experience choose to use their own teaching as a site for asking questions that are of larger importance within the field (Ball, 2000). Typically these researcher-teachers have a primary appointment in a university context and use their university teaching (Duckworth, 1987) or seek out experiences teaching in PK-12 schools (Lampert, 2001) to use as primary data for their work.

TEACHER-RESEARCHER COLLABORATION SUPPORTED BY A DESIGN EXPERIMENT METHODOLOGY

Our own model differs from the ones we describe above. However, there are some similarities to the models above including our focus on one domain, science, and our desire to understand and support student learning in the context of science instruction at the elementary level. We were working in the design experiment tradition to thoughtfully create a unit of study and then examine what happened when we used the unit within classroom contexts (Brown, 1992). The approach of co-learning, as described by Edwards and Jones (2003), involves the design of a piece of collaborative research involving a teacher and researcher in all aspects of the process both for the improvement of practice and scholarly knowledge. Although our research differed in focus and approach from Edwards and Jones, the co-design and execution of their work closely resembled our own.

Our work focused on the creation and use of a science unit on density for Keiko's gifted 3rd/4th grade classroom and Lezlie's regular education 5th grade classroom. The final version of the unit was divided into 3 sets of 3 activities with some benchmark lessons at critical points that would allow us to introduce or refine important concepts or skills (see Appendix A for an overview of the unit). We used a set of roles around theory building and evaluation to guide all hands-on activities and reporting out, so students created predictions and theories, summaries of results, and discussed the relationship between predictions, theories, and results for each experiment they conducted. Every time a group reported, their theory or theories were included on a chart that allowed us to track the collective thinking of the classes over time. Through this process, students developed sophisticated ways to coordinate claims and evidence, create scientific models that were testable, and question one another about their ideas (Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999; Kawasaki, Herrenkohl, & Yeary, 2004).

We came to the collaboration with different motivations. Keiko had just completed her second year of teaching. She described herself as young, inexperienced, idealistic, and a little scared. Although a bit hesitant to jump on board, she also expressed excitement about what might be accomplished through a collaboration that spanned a school year. Lezlie was a veteran teacher who described herself as tired and uncomfortable with the idea that she had become "settled." Lezlie agreed to work on the project because she was hoping to identify some way to make her twentieth year more intellectually engaging and professionally satisfying. Leslie was a new Ph.D. relocating to the Northwest to begin a postdoctoral project. She was seeking teacher collaborators in her new location after working in teacher-researcher collaborations in other places (Reddy, Jacobs, McCrohon, & Herrenkohl, 1998). She could not imagine working in classrooms without using a collaborative teacher-researcher model.

Initially, we perceived ourselves in distributed and complementary roles in the way that Bateson (1990) eloquently describes in her work together with women to understand how she and they "compose lives." Lezlie and Keiko were going to be the teachers and Leslie was going to be the researcher for the project. These complementary roles would divide important and laborious tasks while propelling our joint work further than any of us could manage on our own. As we moved from planning to implementation, reflection, and writing, we shifted roles in unexpected ways. Leslie became more of a teacher, speaking and stepping out from behind her video camera at Keiko's and Lezlie's invitations. Leslie helped lead instructional conversations and supported students to engage important questions and theories. The students came to view her as a valued teacher. One day, late in our work with students, Leslie was unable to join Keiko's class and the students told Keiko, "We can't do science. Leslie's not here." Keiko and Lezlie also became researchers throughout the project, thinking carefully about applying what we learned about student thinking to help shape decisions about further data collection as well as instruction. Lezlie and Keiko also participated in reporting our findings at professional meetings and worked toward advanced degrees while co-authoring research articles. What we discovered throughout our collaborative teaching and research process is that the kind of community we set out to design and engineer for our students we found as a by-product for ourselves. Years after the end of our intensive data collection, our work is fresh in our minds as we teach and plan new research endeavors. And, we still present and write together, sharing our findings with research and teaching communities as much as possible.

Our purpose in writing this paper is to make important aspects of our own collaboration transparent as an example of a more dialogic, distributed, and collaborative approach to teaching and conducting research. This approach tethers the building of theories and practices together through combining knowledge of research with the wisdom of practicing teachers for the benefit of all participants in our educational endeavor. It also highlights the need to value and support ways of being as well as ways of knowing not only for the children but also for the adults involved within a learning community (Herrenkohl & Mertl, 2007). It embraces education as a human science (Flyvbjerg, 2001)

HOW WE BECAME A TEAM: OUR APPROACH TO DISCUSSING OUR COLLABORATION

In describing the pivotal activities of our collaboration below, we build on the work of Hall and Stevens (1995) and Engestrom and Middleton (1998) as exemplars of examining practices, including design and problem-solving, within contexts in which they occur. Although much of the work in describing practices within professions has looked outside of the context of formal schooling (for exceptions

see Gallucci, 2003; Horn 2005), we will apply this idea of examining practices to look at our own work as designers of educational environments. We will use Engestrom and Middleton's (1998) approach to try to describe and account for the "mindfulness" (p. 3) of our own actions.

For the purposes of this paper we will describe in detail three episodes (out of many we could have identified) that illustrate our collaboration. We draw on several data sources to support our discussion of these pivotal activities including notes from planning meetings, videotapes, Leslie's fieldnotes taken during data collection with the students, and transcripts from classroom lessons.

PIVOTAL ACTIVITIES IN OUR COLLABORATION

We selected these episodes because they bring together the design of the curriculum, teaching practices associated with enacting the design, and adjustments made together "on-line" to address unexpected challenges. These episodes highlight the importance of many different kinds of knowledge (Shulman, 1987) needed to support powerful student learning. They also illustrate some of the roles we adopted throughout our work together. Each episode will be told from the point of view of one person.

The Big Flop—As Told from Keiko's Perspective

The day we introduced the small group materials in my class was a disaster. I was completely unprepared for the problems that ensued. To this point, the students had been engaged and on track during the introduction to the unit. We had given instructions about the progression of the activities and the handling of the materials. However, since this activity was unlike any other we had done so far this year, the students did not really understand our expectations for their behavior in small groups. In addition, I had agreed to take a student from another class because he was having difficulty with his behavior in his regular class that day. I spent the entire lesson running around putting out fires. Students argued which led to giant messes, wandering around, and very little work. Leslie's notes from the day capture it well:

> The visiting boy began throwing things in one small group. This escalated in the group and the students began throwing things at each other. Keiko stopped the entire class and pointed out that this group was not a good example of how to use materials and cooperate. After this point, many groups, instead of cooperating more effectively, seemed to have more difficulties. Toward the end of the activities, Keiko decided to stop everything and debrief with the students instead of proceeding to reporting. She asked me to turn off the

> videocamera. During this time she tells students that she thought that they were ready for working on experiments in groups. She asks them to think about what worked, what didn't, and how they could make it better. They talked together as a class for about 20 minutes and then they had time to reflect independently in their science lab notebooks about what they could do in their group to cooperate better next time.

As the lesson, and thankfully the day, came to an end, I was distraught. I was sure that I had lost Leslie's confidence and that we would be unable to continue with the project. Not only did I feel inept at managing a complicated procedure with my students, we were now behind in our tight schedule. Leslie and I cleaned up and she took me to a nearby café to debrief.

It was at this meeting that I came to learn the value of the relationship we were developing. Leslie was not only supportive and reassuring, but she had fabulous insight and was already working out a solution. She suggested that we work with the students using some cooperative games to prepare them for the small group work (Cohen, 1994). Her perspective allowed me to see the problems for what they were, to see that they were surmountable and not to get mired in negative feelings about what had happened. I returned to the classroom the next day with a plan and materials to support my students to learn how to collaborate in small groups. I used a new cooperative game but included some familiar group process evaluation forms that I had used in the past to help the students focus on how to improve their cooperative skills. This made an enormous difference. By the end of the day, I felt much more confident as I listened to the students honestly report about their successes and challenges in small groups. At one point during reporting a student stopped and said, "I'm going to start over again. I'm going to wait until everyone's quiet. I'm not kidding." The students themselves began to express expectations that would allow our classroom to become a well-functioning intellectual community. These cooperative groupwork activities did not derail the general flow of the unit or slow us down as I had worried. Instead, it strengthened students' collaborative capacities as individuals, small groups, and a whole class and made the rest of the unit much more successful.

This early episode changed the way I worked with Leslie. At that time, I did all the classroom-based talk with the students and she was in a researcher's role on the side. After this, I never hesitated to invite her to join in right on the spot. Later in the unit, Leslie, Lezlie, and I reflected during a check-in meeting on the students' struggle to evaluate what counts as a reason "why" something happens. Many students were confusing prior experience of seeing wood float with an explanation for wood floating. We were working on strategies to help the students confront this issue directly. When it came up during a classroom discussion, I began to facilitate but then realized I was struggling to help the students, so right there on the spot I turned to Leslie and said, "Can you do it? Go ahead," inviting her to join in.

We worked as a team to support the students and having this extra set of ears, eyes, hands, and ideas in the classroom was enormously helpful to me.

Changing the Roles to Include Procedural Tasks—As Told from Leslie's Perspective

On the first day that students completed small group activities in Lezlie's class, she knew something was not right. In the debriefing session that followed, one group of students mentioned that they did not understand the roles that they had been asked to use. In designing these roles, I felt strongly that students needed intellectual guidance and not just procedural directions. Roles like materials manager and recorder highlight tasks that can often be removed from the substantial intellectual work that is needed to complete a small group investigation. Many cooperative learning programs do not attend to the intellectual aspects of tasks, so I was convinced we should use what I had done in earlier work (which focused on intellectual and not procedural roles, although procedural roles were already in place in the school science curriculum) to inform the pedagogical methods we employed. I suggested that we use only two procedural roles, scribe (person who prepares written materials to present small group work to class) and reporter (person who prepares to orally present small group work to the class using materials designed by scribes), which were directed toward the important activity of reporting out to the whole class. In most cases this meant that there were two reporters and two scribes (sometime three if there were five students in a group). The students were not used to these kinds of roles. In addition, it became clear that they were not used to making decisions about who would get the materials, who would read the activity card, who would clean up, etc. The chaos that erupted in Keiko's class on the first day may have been related to the fact that the students did not receive any direction about who was responsible for certain mundane but necessary steps in getting their work accomplished. As a seasoned teacher, Lezlie responded to her students' confusion by suggesting that we amend the role assignments to include these procedural details. It was one of many times that I would be reminded that elementary students need multiple kinds of guidance. And, that experienced teachers are so amazingly capable of working on the fly to figure out how to give this support to their students. Combining the procedural direction with the intellectual guidance did prove to be a much better solution, even though it required the students to juggle several sets of roles at once. When I walked into Keiko's classroom the next day and told her what Lezlie came up with she said that she "felt the anxiety leaving her body" as we worked on making the new role chart together. Lezlie's quick ability to revise her teaching strategies to respond to students' needs was evident and we all appreciated her willingness to help us move on to better cooperative group work as a result.

Trying on the Roles—As Told from Lezlie's Perspective

It was the 6th day of our science program in my classroom. The previous day the students had developed questions that would assist them in assuming their audience roles. Three sets of questions, one set for each audience role, would be used to make certain that during the investigations each group had given careful attention to the following: (1) they made predictions based on a clearly articulated theory, (2) they accurately recorded the results of their investigations, and (3) they reviewed the theory and predictions in light of the results for consistency with the outcomes of the investigation. While the students were still wrestling with the meaning of the words *prediction* and *theory*, I struggled to get them to suggest possible questions. With Leslie's guidance and support, the students finally managed to list several for each category. Now it was time to put them to the test. The chart listed each student's name under the appropriate category of question. This meant that for this reporting day the student would ask questions in their assigned category. As the first pair of reporters came forward to share their experiences, the students in the audience seemed to be in high spirits. As questions began, I noticed that the questioners were simply going down the list one after another, scarcely giving the reporters time to respond before throwing out the next query. They would giggle as they took turns with the roles. At first, the reporters patiently responded to the barrage of inquiries, apparently unaware of the fact that on several occasions they were responding to a question they had already answered. Later, as it became a game for the audience members, other groups came forward and interactions like the snippet provided below ensued.

Veena: Did everyone on your team have the same results?
Karita: That question was already asked.
Aaron: Yes, we had the same results. Yeah, we did. Karita.
Karita: Do you think your results make sense?
Aaron: Somebody already asked that. I said yes.
Karita: You did? Oh. What were the main things that happened in your results? [laughter from the audience as Karita is obviously reading questions off the chart. Her reading is deliberate. Her tone and delivery make the students laugh. They're also laughing because all the questions that Karita asks have been asked already.]
Aaron: Somebody already asked that.
Karita: Does the team agree with the results? [laughter from the audience] They didn't ask that one.
Students: Yeah, they did!
Teacher: Remember the rule? If you're called on, you talk.
Karita: What were the results you found?
Aaron: We said that at the beginning [laughing and clapping from the audience]

Here Karita waited until the appropriate time to engage in her role, and then plunged headlong into it. The obvious pleasure many of the students derived from the new task did not wane as group after group took their turn in front. By the time the period ended, I was exasperated with my students. As the students cleared the room to head to lunch, I confided to Leslie that I was not only embarrassed by the behavior of the class, but also disappointed that they had not taken their assignments more seriously. Leslie smiled reassuringly, immediately indicating to me that the situation was not as dreadful as I had presumed. She had viewed the children through a different lens, and explained to me that what she saw was very natural. The students had neither intended to be naughty, nor irresponsible. They were simply being children trying on new hats and reveling in the way it made them feel. This was something new for the 5th graders. It gave them a taste of power they had not experienced in lessons before. It *was* a game to some extent, but that was okay. Leslie managed to ease my concerns. Her expertise offered me both comfort and insight.

Leslie and I agreed to channel the students' exuberance by giving several types of feedback. We asked students to think about why they were asking questions. We pointed out that students should ask questions for which they wanted answers. We also suggested that they work hard to listen to reporters' responses and ask questions based on those responses. The following exchange on day 8 demonstrates how the students began to take up these ideas.

Toneisha: Shamone
Shamone: Okay, did everybody agree with the results and your object predictions and theory?
Lynn: With our predictions, no, everyone had pretty much different predictions.
Shamone: Okay
Lynn: I don't know about results. I think, I don't know what happened to results. And everyone agreed on our theory.
Toneisha: Dineta
Dineta: Some people keep on asking why do everybody agree on the results. They should agree on the results, they was there watching! So how could everybody be [interrupts herself] why do you ask that?
Teacher: Yeah, I think that's a very good point. That there isn't a question about results—you see what happens—there shouldn't be [disagreement about results]. I agree with what Dineta's saying, that everyone should agree on results because everyone's there to see what happened. So perhaps that's a question we should strike from our list [questions chart] up there. So you might want to think about whether the question you're asking makes sense. Good point.

In this exchange, Dineta questions why some students are asking questions about agreeing on results—a question that appears prominently on their chart under the

"summarizing results" section. After several days of working together on the activities, she argued that if everyone was watching when the objects are placed in the water, they should all agree on whether an object sank or floated. I agreed that maybe we should strike that question from the "questions chart." I was interested in supporting the students to view the chart itself as something that could and should undergo revision as we continued our discussions together. I wanted our class to identify questions that we initially thought would be helpful but in the end turned out not to make much sense. These are visions Leslie, Keiko, and I had from the beginning—to help students use tools like roles and charts flexibly. Our collaboration made it possible to help students develop these important habits of mind. As students grew into these new roles, we saw enormous shifts in their ownership of the questions they posed. It would have been easy to get discouraged if I were on my own. I may have given up prior to seeing just how productive these new roles could be for the students.

PRESENTING AND WRITING ABOUT OUR WORK

Lezlie and Keiko, who had been participating in a series of summer institutes on science education, decided to share our work in this forum. They decided to present our study because they were excited to talk with the other teachers, scientists, and educators to receive feedback on our approach. Although all three of constructed the presentation together, Lezlie and Keiko presented the work orally to this group. This marked yet another shift in typical roles. Lezlie and Keiko were acting in the typical role of researchers, assuming full responsibility for reporting findings and answering questions from colleagues and other academics, including scientists, who were part of the summer institute.

By the time Lezlie and Keiko presented to the audience at their summer institute gathering, Keiko had been accepted to the M.Ed. program in Human Development and Cognition (Leslie's department) at the University of Washington. She decided to take a leave of absence from her district in order to pursue her Master's degree. At the same time, Lezlie had agreed to leave her position as a K-5 science resource teacher to work with the Physics Education Group, also at the University of Washington. She would serve as a liaison between the university and the K-5 science program in her former school district. This also allowed Lezlie to finish her M.Ed. degree that she had started years earlier. Lezlie and Keiko's affiliation with the University helped further solidify our resolve to work on writing projects together. Having all of us on campus provided opportunities to meet more regularly and begin preparing for our first presentation all together at the 1998 American Educational Research Association meeting.

For our presentation we decided to focus on how students defined, created, and revised theories over time in each class. This was a complex process with similarities and differences across classes. We thought that the contrasting ways

that students defined and began using the tools would be interesting to trace across the classes. It was a new chapter in our work together which culminated in a paper that was published in the Journal of the Learning Sciences in 1999 (Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999). In this way, our collaboration began to impact not only our own classroom practice but also the academic scholarship related to learning and teaching science at the elementary level. Keiko went on to write an M.Ed. thesis on her classroom data as well which culminated in a publication in the International Journal of Science Education (Kawasaki, Herrenkohl, & Yeary, 2004). Lezlie and Leslie were invited to present at the National Science Teacher's Association in 2005 to showcase this work. Lezlie has since played many roles in education, elementary classroom teacher, mentor teacher and liason for elementary science teachers, and now preservice teacher educator. Keiko has worked as an elementary classroom teacher and mentor for early career teachers. Working to find ways to continually combine powerful pedagogy with research about student learning is an ongoing challenge—with little institutional support to shift the more traditional roles of either teacher *or* researcher.

Key Themes from Our Pivotal Activities

> In a professional community of teachers, a core responsibility is to the learning of other teachers. This responsibility might entail contributing to group discussions, pressing others to clarify their thoughts, engaging in intellectual midwifery for the ideas of others, and providing resources for others' learning. If a feature of pseudocommunity is withdrawal from the public space when conflict erupts, then a feature of a mature community is the willingness to engage in critique in order to further collective understanding. (Grossman, Wineburg, & Woolworth, 2001, p. 39)

This quote, although addressing teacher community and not teacher-researcher community, captures some of the very reasons why we feel we flourished as a real rather than a "pseudocommunity." This is remarkable given that Grossman et al. make a convincing argument that building teacher intellectual community looks different depending on the school context, grade level, and discipline. We believe that their framework may have more traction and broad applicability than they were comfortable assuming. It definitely provides a way to understand our elementary teacher-researcher collaboration, in a small group, and in science (all different features from what they examined in their work.)

In what follows we identify four themes that resulted from our analysis of pivotal activities. Although variations will exist across school and disciplinary context, we believe that these themes will be relevant to collaborations across and among academics and PK-12 school professionals. These themes include (1) shared

understanding and vision with both complementary and overlapping roles and perspectives, (2) place, status, power, position, and control, (3) social and emotional support and acceptance, (4) intellectual rigor and debate among ourselves and with the larger field for the sake of students.

Shared Understanding and Vision with Both Complementary and Overlapping Roles and Perspectives

One of the most significant factors in our work together was our compatible philosophies about learning, teaching, and what elementary students are able to accomplish in general and in science in particular. Early evidence that we shared basic beliefs, work habits, and practices impacted our ability to build our own value system to guide our joint work with each other and with students. Although we shared an overarching vision, we also had complementary perspectives as a result of our different backgrounds and experiences. Reflecting back, it seemed the right mix of unity and diversity to propel our work forward. Too much unity might mean little challenge and learning and ultimately the disintegration of the community. Too much difference might make it hard to agree on a starting point and trajectory for shared work. We were also flexible, adapting together to the ever-changing demands of teaching complex material. Over time we have come even more to appreciate the truly special nature of our relationship as each of us has continued on in other settings with other collaborators. It is hard to get the right balance and chemistry, but when it happens, it has enormous potential for personal and professional impact. We believe that supporting more successful collaborative efforts such as ours could be enormously productive for coordinating educational theory, research, and practice.

Place, Status, Power, Position, and Control

This is perhaps the most important of all of our themes, if only because it is so easy for those with power to unintentionally or inadvertently forget it. We established early patterns of respectful interaction, listening to ideas carefully and weighing them thoroughly before deciding how to proceed. Everyone's ideas were treated in this same manner. Productive debate was encouraged and embraced. Our interpersonal communication patterns suggested shared responsibility and control over our collaborative activities in preparing and in executing our work together. We also enacted the belief that one person did not have all the answers. Each one of us offered something of real value to the group. This is evident in the pivotal activities we discussed above. One lesson learned, however, is the need to explicitly address institutional inequities. We did not do this often enough during our early work. Misunderstandings and "pseudocommunity" are potential threats to this

powerful form of collaboration and may have their roots in historical, cultural, and institutional inequities as well as the interpersonal interaction within a group. Guarding against this outcome requires conscious awareness and discussion, something that we eventually achieved together, but from our experience the earlier this issue is raised, the easier it can be to navigate challenging terrain.

Social and Emotional Support and Acceptance

We learned early and often that our collaboration was greater than the sum of us, especially when it came to giving and receiving emotional support and acceptance. John-Steiner's (2000) work suggests that productive collaborations vary on this factor – some being tumultuous and others being steady and supportive. We believe that in a partnership of this type, only those that remain supportive and encouraging will endure over time. This factor made our partnership both intellectually challenging and nurturing at the same time. None of us had to be right all of the time. We found that our own vulnerability was treated with the care that it deserved. At those moments when each of us thought the others might decide this work together was not possible, we received confirmation that we were in it together and we would find a way to navigate the challenges that we faced. Our perceived disasters and mistakes were joint learning opportunities. In our classrooms, research and writing, we were not alone. This has had a profound and lasting personal impact on all of us.

The byproducts of this kind of support was amazing energy to boost morale and confidence. Each of us experienced this. It is easy to get tired and discouraged when working hard to try new things. In this case, doing it together meant that when one of us was down, the others were there to support and encourage. It prevented all of us from becoming comfortable with mediocrity and accepting things as they were. We had the courage to face our own failures and trust that our partners were there with our best interests at heart to help us make it through.

Intellectual Rigor and Debate among Ourselves and with the Larger Field

In addition to social and emotional support, our collaboration met and continues to meet our need for intellectual stimulation to counteract a culture of isolation that permeates teaching, both in PK-12 and university contexts. We all craved this, but Lezlie, as the most experienced teacher among us, articulated it most explicitly throughout our early work together. What she expressed then continues to drive our work today – something real and meaningful that encourages deep engagement with a critical reflective eye. We encouraged debate among ourselves and we critiqued our previous thoughts and ideas. After all, this is exactly what we wanted to cultivate with our students—an intellectually rigorous yet socially supportive culture.

We experienced successes and failures and we analyzed them to further our own learning and to contribute to developing knowledge available in published literature. The work and the collaboration was invigorating as a result, especially demonstrating to Keiko and Lezlie how important their work was both inside and outside the classroom.

A key factor for our successful collaboration was our focus on student thinking and development and how to use our own knowledge of research and professional hunches to create the best possible learning experience for the students. This was the motivating force for our work together. Focusing on what students learn or fail to learn, or how their approaches differed from what we expected became the common portal for research and for teaching. This made our collaboration vital to all members because it addressed daily teaching practices to improve instruction and student learning opportunities while also contributing to the research literature.

We have enjoyed the opportunity to write and present together about our work. It is unusual that teachers participate in writing for publication but this was something that we were able to do as Keiko and Lezlie shifted roles from their classroom work to a university context. We are not sure what would have happened had this shift not taken place given that PK-12 schools are not set up to support teachers' engagement in these kinds of professional writing activities. However, we would not want to give up this aspect of our joint enterprise. Lezlie and Keiko have since returned to their elementary teaching work, over the years serving elementary students in the role of classroom teacher, and working with preservice, early career, and in-service teachers as instructors and mentors. However, there is little institutional support and incentive for the hybrid roles we describe, especially for Lezlie and Keiko who have little time to focus on research and writing. One of the upshots of this work, and the challenge in finally writing about the collaboration itself, is the need for more institutional support for work that spans the theory-practice divide and includes time for teacher writing. It simply does not exist. We continue to write and present together on Lezlie's and Keiko's "donated" time.

CONCLUSION

> "The concept of teacher as researcher can interrupt traditional views about the relationships of knowledge and practice and the roles of teachers in educational change, blurring the boundaries between teachers and researchers, knowers and doers, and experts and novices." (Cochran-Smith & Lytle, 1999, p. 22)

Our model of collaboration created opportunities to traverse inside and outside, to blur the boundaries that Cochran- Smith and Lytle eloquently describe with respect to teachers as researchers. Thus, although our model was different, we share some

important outcomes with the teacher as researcher movement. Our work allowed us to bring research and practice into regular dialogue and for each of us to be at one and the same time both teachers and researchers together. It has profoundly impacted our wisdom of practice for teaching elementary science. All of us now use our collective insights regularly in our teaching of in-service and preservice teachers as well. Over time we've also seen how our work on student learning in science contributed to the research literature, rendering it meaningful not just to us but to a larger audience. At a time when collaborating across established boundaries is becoming a regular expectation for work of all kinds, it's important to discuss our example of working across the boundaries of PK-12 schooling and the academy. We need new and innovative institutional structures and sources of funding to be dedicated to this kind of intensive work that holds promise for developing a culture of research-based practice. Combined with other forms of productive teacher collaboration, teacher-researcher collaborations could effect change at a larger scale (Lewis, Perry, & Murata, 2006) and contribute to ongoing professional development, the research literature, and general career satisfaction.

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APPENDIX A: OVERALL PLAN FOR THE UNIT

FIRST PART OF UNIT – Experimenting with volume, weight, and other factors relating to sinking and floating

Days 1 & 2—Whole class baseline and introduction including explanation of Mickey Mouse Submarine

Days 3 & 4—Introduction to first set of activities - complete first round in this set

Days 5 & 6—Second round in first set of activities

Days 7 & 8—Last round in first set of activities

Day 9 – Benchmark—Whole class review of their theory chart before moving on to the next set of activities

Key elements of understanding:

(1) Whether something sinks or floats is a property of "material kind," not relative volume or weight
(2) Begin to use the three strategic steps in science and take on group and audience roles

SECOND PART OF UNIT—Focusing on notion of crowdedness as a "model" of what the students observed in the first part of the unit
Day 10 – Benchmark—"Walking in a crowd" whole class activity and introduction of the concept of modeling. Demonstrate use of computer program with crowdedness lab (tutorial)
Days 11–13—Complete three rounds related to second set of activities. Discuss the use of scientific explanations. Build in discussion across days to help students understand the characteristics of explanations in science when compared to other genres.
Day 14 – Benchmark – Colombo Murder Mystery—Whole class reporting session & review of ideas developed by students during the second part of the unit

Key elements of understanding:

(1) "Crowdedness" as a "material kind" model and explanation for sinking and floating
(2) Continue to practice using strategic steps and group and audience roles.
(3) Build understanding of models and explanations as tools for understanding and explaining in science
(4) Develop the mathematical model (ie. formula and conceptual relationships) for density

THIRD PART OF UNIT—Applying the "crowdedness" theory to sinking and floating activities

Days 15–17—Complete three rounds related to third set of activities

Key elements of understanding:

(1) Make full distinction between weight, volume, and density and apply new knowledge to the last set of activities.
(2) Construct multiple models to demonstrate the "crowdedness" theory.
(3) Continue becoming expert at taking on audience roles and using three steps to guide inquiry
(4) Continue practice writing explanations and making models
FOURTH PART OF UNIT—Getting back to Mickey Mouse and student feedback and review
Day 18—Students have another chance to write an explanation about the Mickey Mouse submarine
Day 19—Videotape review and student reflection and feedback.