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Collaborating with Teacher Researchers

to Study What Young Children Know and Can Do in Science

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The purpose of this article is to address the role 24 preschool teachers played as teacher researchers in a National Science Foundation funded research project. The primary goal of this project has been to collect data on young children's knowledge and skills in science. The processes and outcomes of the collaborative work of a university-based research team with teacher researchers provide new understanding as to "what works" in STEM (Science, Technology, Engineering, and Mathematics) education design.

In the fall of 2008, five researchers (the university based team) at the University of Texas at Austin's Center for STEM Education received a grant from the National Science Foundation (NSF) to study what children know about science by the time they enter kindergarten. The grant, *Building Base Line Objectives for Children's Knowledge & Skills for Science (BLOCKS),* is a project that includes extensive classroom observation by the collaborative research team of children's ability to learn science processes and content; intensive professional development and mentoring support for teachers to learn science; and multiple qualitative, as well as quantitative assessment strategies (The National Research Council 2007). Currently in its final year, the project involves 24 prekindergarten teachers from multiple backgrounds and in a variety of settings in the Austin, TX area, with an emphasis on including classrooms where children are culturally and economically diverse. Since the project's inception these teachers have been regarded as teacher researchers who collaborate with us to collect data, make meaning

of the data, and contribute their expertise regarding the world of four-year-old children. As the authors of *BLOCKS* we believe that by formalizing the process of involving classroom teachers in collecting and reporting data on what young children know and can do, we can contribute significantly to a baseline of knowledge about young children's abilities and skills upon entering kindergarten. The prekindergarten teachers are an essential part of our research team.

Throughout the study we have been providing ongoing professional development and mentoring support to the teacher researchers via summer professional development and monthly focus group sessions. Experts in physical, life, and earth sciences make up the rest of our support team to make sure that all researchers have deep and accurate science content knowledge. The professional development became collaborative in nature as we all discussed what we had seen four-year-olds do and what science experiences we speculated they might find interesting, engaging, and capable of truly understanding.

While science specialists contributedtheir expertise on the content the teacher researchers contributed their rich understand of how four-year-olds learn and what they can do.

We addressed the following research questions:

- What should children know and be able to do in science when they enter kindergarten?
- What core STEM ideas should be stressed in prekindergarten/kindergarten science learning activities?
- What professional development practices best support the teaching of complex STEM concepts and processes to young learners?

This article is about what happened to the teacher researchers and university-based team members as we engaged in our collaborative work. The intent was that *BLOCKS* would incorporate the most current ideas on how children learn and on how to best teach science concepts. We would observe children engaged in science activities specifically designed to provide opportunities to record what children would say and do. While science specialists contributed their expertise on the content of physical science, life science, and earth science, teacher researchers contributed their rich understanding of four-year-old children—how they learn, what they can do—and together we developed strategies for working with young children and assessing what they could and could not understand. Within this structure, teacher researchers adapted approaches in response to their children's actions, comments, questions, and behaviors. Using a narrative inquiry approach, we periodically stopped to reflect on our experiences, sometimes casually in conversation, but other times formally, capturing the stories of teacher researchers and mentors learning, adapting, and growing (Henderson et al. 2012; Pushor & Clandinin 2009). That is the story we share.

Developing science understanding

During the initial Summer Institute we spent two weeks exploring physical science concepts and how to teach and assess them. The teachers traveled into

The first challenge we faced was finding ways to communicate to children what we wanted them to do . . . the teacher researchers found the right words for the task.

their classrooms to evaluate the children's knowledge before they delivered any instruction. When Thelma taught the content to her children via hands on activities the group had developed together, she remembered what the content experts had said, and in a teaching context the science concepts made sense.

The first assessment, which a small group of teacher researchers designed, was on properties of matter. The teacher researchers decided that the children would identify items that were familiar, tell what they knew about them, and then sort them into groups and name the groups. The first challenge we all faced was finding ways to communicate to children what it was we wanted them to do. The teacher researchers were experts in this area and found the right words for the task. For example, they discovered that our initial idea to say, "Which things go together" resulted in creative assembly of several items from the collection, rather than the sorting and classifying we had expected.

Kelli comments:

"Giving kids real objects to sort allows them to be more creative in their categories and properties observed. Children's abilities to observe properties of matter grow with each experience they have to make observations. The more they are asked to share their observations, the better they get at it."

And someone writes anonymously on a reflection card:

"I was surprised at how my children came up with different ways to classify. I think that the hands on experiences we have had in our classrooms have impacted their language and observant eyes."

We decided that the teacher researchers should video tape several children completing the assessment task and then select one to represent each of three videos—one of a child whose sorting was typical of what the teacher researcher saw in the class, one of a child who struggled, and one of a child who was very proficient in sorting, i.e., formed interesting and/or multiple groups. The university based team watched the videos and were somewhat perplexed by the teacher researchers' labels. We finally realized that they were basing their judgments on language ability, and this became a topic of discussion at a later group meeting. "Language literacy does not equal science literacy." Even so, the teacher researchers have been very proficient at capitalizing on language connections and in using the science to enhance their language and literacy programs. This is another important outcome of the project.

During the second summer we spent three days together at a remote overnight facility.

Barbara describes the second summer of professional development well:

"At Flat Creek a group of pre-K teachers who had superficially known each other investigated several kinds of habitats, learned to use field guides to classify native plants and animals, and used the digital microscopes for a closer look at specimens. Having the mentor teachers serve as guides and facilitators, not "teachers" gave me new insights into how inquiry investigations in nature and indoors affect and empower the learner. During this time our BLOCKS group came to respect each other more thoroughly and to share enthusiasms, insights, organisms and views on the microscopes. Our group solidified through these shared experiences. Since the Flat Creek "retreat" I have tried to implement these approaches with my pre-K children. I still backslide more than I want into directed teaching, but have striven to be more child-centered and inquiry-based since then because I felt the power of this approach."

Engaging in professional development

The child assessments revised in the project by university and teacher researchers provided teachers with timely feedback about children's emergent thinking.

Teacher researchers received professional development from the mentors on science content/concepts and on modifying and adapting curriculum materials to adjust for appropriate developmental levels and needs. Professional Development focused on helping teachers construct knowledge of science content, an understanding of how children learn science, and how to implement an effective science curriculum. The sessions also included training in creating and administering assessments. The child assessments, designed and piloted by teachers, were revised in the project as a result of feedback from both university and teacher researchers and content experts. They provided the teachers with timely feedback about children's emergent thinking, and will ultimately become products of the project. Over the years the science content focused on physical science, life sciences and earth science. A content specialist was present for all professional development sessions, and emphasis was placed on "doing science" and on developing a conceptual understanding of big ideas in science.

From the beginning, professional development sessions were casual and often conducted as conversations between the mentors themselves and between mentors and teachers. Mentors and teachers alike asked questions of the experts to be sure we all had accurate understanding of physics phenomena. We respected the teachers' decisions as well as those of the school district and university-based researchers for implementing the assessment activities. We also valued the teachers' time and showed this through the awarding of generous stipends for the time they spent on the project outside school including journaling, attending meetings, providing materials for all hands on activities, and being involved in other grant related activities.

Understandings of the roles of teachers as researchers

These classroom teachers had expertise that was as valuable as the science content knowledge and formal research expertise we had as mentors.

In *Inside Outside: Teacher Research and Knowledge*, Cochran-Smith and Lytle (1993), proposed a broad working definition for teacher research described as a systematic and intentional inquiry carried out by teachers. This was the strategy we employed. While we intended that the teacher researchers be reflective and critically examine and improve their practice through professional development sessions, our focus was equally on the teachers contribution to the project. Our view was that these classroom teachers had the expertise developed from their specialized education and daily interactions with four-year-olds that was as valuable as the science content knowledge and formal research expertise we had as mentors. Cochran-Smith and Lytle (1993) warn of the danger of cooperative research framing and mediating teachers' perspectives through outside researchers' perspectives. Our salvation from becoming too prescriptive arose from our own lack of experience in conducting this particular research. (In our defense, no one had done this kind of research, and that was largely why we were funded.) We sought from the beginning to value the teachers as our research partners who contributed different experiences and skills than those brought to the project by university personnel. We anticipated that the teachers would work with autonomy and take the lead role in certain aspects of the research, particularly in the details of delivering instruction and in assessing children's understanding.

Judith captures our intent in her role as teacher researcher when she notes:

> "The most qualified individuals to collect that data would be the classroom teachers who have the training to interact with the children in such a way as to make the collection of data possible and not contrived or out of context. The teachers became researchers, and as professionals, we can keep our focus on the goal of the research."

Many aspects of the research were open ended. We were prepared to try strategies that could fail, then regroup and try again . . . over time we were transformed—all of us.

In our model the teacher researchers conducted individual projects that addressed children's science understanding. The primary objective was data collection on a large scale that will eventually describe a continuum of abilities as exhibited by children from diverse backgrounds and with varied experiences and over a variety of science topics.

The teachers engaged in various kinds of data gathering. Each of the 24 teacher researchers conducted individual case study research in their classroom. The data collection was an ongoing and formative exchange between the teachers and their mentors. Another way that teachers gathered data was through their observations of selected children. Teachers were encouraged to focus on one skill or concept throughout the program as they conducted their case studies. They then kept journals of the children' behaviors and learning as well as collected work samples or photographs of the experiences. Interviews may also have been taped or videoed. The purpose of the interview/research was twofold. One objec-

tive was to obtain data on the abilities of children to perform tasks. The other objective was for the teacher to closely observe how children learn and process learning. Both outcomes impacted what will be reported about what children should know and be able to do at the beginning of kindergarten. Teacher journal entries were one source of discussion at monthly teacher meetings. The journal entries also provided content for journal articles and other writings by both teacher researchers and mentors. The combination of data assessment via checklists and teacher and researcher joint case studies has produced a wealth of data for analysis.

We had questions we wanted to answer, but many aspects of the research were open ended. We were prepared to try strategies that could fail, regroup and try again. We learned, we reflected, and over time we were transformed—all of us.

Finding a Voice

The teachers' excitement about being chosen for the project caused them to be eager to please. So eager that they asked us to tell them exactly what it was we needed them to do. Out of that came our motto, the Albert Einstein quote, "If we knew what it was we were doing, it would not be called research, would it?" At first, the teachers seemed to doubt how we perceived their role. We found ourselves insisting for the first year that we truly needed their expertise in assessment design, delivery and reporting. We pointed out that they were our valuable resource for knowledge about how to gather information from four-year-olds. Over time the teachers grew in confidence in this role, and at the end of the project they are comfortable expressing their opinions, even as all of us still struggle at times with finding the right words to elicit a response from a four-year-old.

The teachers appreciated our [the mentors] openness and willingness to discuss our differences,our friendly disagreements as we incorporated a discourse of questioning and exploring ideas.

Simultaneous to our struggle to engage the teacher researchers as full partners in the research, we had to settle into our individual roles as mentors and professional development providers rather than traditional, university researchers. The university-based team members represented diverse communities but shared a common attribute: a dedication to working with teachers. Meanwhile we had different ideas about professional development and assessments, and that was frequently displayed in the presence of the teacher researchers. Fortunately respect for each other as knowledgeable individuals prevailed, and we were able to incorporate a discourse of questioning and exploring ideas and assumptions from our different areas of expertise during the sessions. An evaluation of the first Summer Institute revealed that the teachers had taken notice. They commented on appreciating our openness in sharing our friendly disagreements. After that first year we began using the phrase "well actually" as a transition to correct misinformation or offer another perspective. The phrase has been particularly useful during physical science sessions where misconceptions are

common among both teachers and mentors. It has helped us bridge the space between mentors and teachers as we have all used the phrase frequently and under a variety of circumstances. It always brings smiles.

Besides our two-week Summer Institutes, we also meet monthly—one month as a whole group and the alternate months in small groups of six, consisting of five teachers and a mentor. Large group meetings always begin with a sharing session so that we can celebrate any good news anyone has received (recognition, awards, workshop presentations, etc.). We have successfully tried remote mentoring via Skype modeled after the remote mentoring Elizabeth Sherwood and her five teachers-researchers have done.

In mentor group discussions from Year 3, Diana and Lisa discussed the idea of children as researchers. Lisa asked,

"How can I best honor children as researchers? I watch them in the garden and they have such interesting ideas about everything they see."

While Diana added,

"They teach me to be a better teacher."

As mentors, we have developed a more complex understanding of the work of teachers of young children.

All the teachers noted that they were becoming better at questioning, kid watching, and documenting learning. Teachers have typically found one or two of the mentors with whom they particularly bond, and that has been another source of professional support that we expect to continue beyond the duration of the grant. Meanwhile, as mentors, we have developed a more complex understanding of the work of teachers of young children and its impact on children's development and learning.

We encouraged the teacher researchers to begin presenting at conferences during their first year of work. Initially we presented with them, primarily at local meetings. We suggested they work in pairs so that they could help each other and both gain confidence. Over time they found a teacher researcher partner or partners and began to present on their own. Their presentations attracted attention and several have been asked to present for school districts and/or at other meetings, as there is an obvious shortage of science sessions at virtually all the early childhood conferences. Last fall twenty of the teachers and several mentors attended the state science conference, presenting and wearing their *BLOCKS* shirts, and beaming at the recognition the group as a whole received.

Additionally most have proposed, attended, and half have presented at national meetings such as AERA, NARST, NAEYC, NSTA among others. This was an original projected outcome of the grant. We are in agreement that this has been one of the most successful aspects of the overall program. The teachers are empowered by opportunities to share what they know about science teaching and learning. In the process they have also developed professional collegial relationships with each other, sometimes in unlikely pairings, given their back-

grounds and the circumstances of their individual teaching assignments. The teachers express pride in their association with the project, and one was reported to have announced at the state science conference, "If *BLOCKS* comes to your town, be sure you get involved."

Other comments from teacher researchers about their experiences include:

"The process of becoming a teacher researcher has been very rewarding and validating. I considered myself a teacher researcher before this, even though I had no focus and no plans, and no framework or support. Perhaps I was just a child watcher. This experience has forced me to become more aware of the resources available and the need to share my observations with others who may benefit from them."

"I am just so grateful for the camaraderie, the professional development, and the "stuff" (although the stuff is not the main thing I value)."

"The process has been eye opening. I feel that I now look at my children's work more analytically and I see great knowledge in the tiniest things they do."

"The process of becoming a teacher researcher was confusing, more work, interesting, "I really signed up for this!" and "Yes, I can do this". I saw an immediate engagement with children and myself that was deeper and richer than before."

"It's an interesting and challenging process. Interesting in that I've started to pay attention to details I might have missed in past years (children's commentary or maybe using/playing with materials in ways they were not "deemed" for) and have reflected on these observations instead of letting them go by."

The process of becoming a teacher researcher was confusing more work, interesting—Then I saw an immediate engagement with childrenthat was deeper and richer than before.

Learning about collaboration

Having spent hours discussing the outcomes of *BLOCKS* with both the teacher researchers and all personnel involved, we have identified certain aspects of the program as having been integral to its success as collaboration. Some of these were ideas we already held and specified in the proposal. Others occurred to us along the way, or at least we recognized them along the way but were perhaps values we held inside ourselves all along. Those include:

Teachers need opportunities to be adult learners. By experiencing excitement themselves over learning science content and processes, teachers internalize how children feel. Our teachers knew in general what was developmentally appropriate for four-year-olds, and we did not necessarily need to have them participate in the activities as their children would. We instead gave them adult-level, challenging versions of the activities to build

their own conceptual understanding, and they could tell us what that might look like in a pre-K classroom.

As mentors, we also (frankly unintentionally) modeled being adult learners. A passion for working with teachers was not the only attribute we had in common. The five mentors all genuinely love learning, and we were enthusiastic participants when Bob showed us an insect, Elizabeth talked about research on outdoor learning, and Brian explained the physics of a book resting on a table. We also showed our comfort level with our lack of knowledge in many areas, physics being the primary example. We all began to see lack of science content knowledge as an opportunity rather than an embarrassment.

A content expert is critical. All of us involved as mentors could be described as scientifically literate, but we all (mentors and teachers) came to respect real expertise. There was no substitute for having someone in our midst who "really got it" and who could "really explain it", that person who could legitimately say, "Well, actually . . . " As one of the teacher researchers writes, "It was reassuring to know we had experts to contact for guidance. I learned so much from all of them. It is a privilege to participate in this process."

Professional development with teachers takes time. We saw significant changes in confidence in science understanding and in ability to capture what their children were learning, in our teacher researchers by the end of Year 2. We commented to one at that time that we thought we could let them go at that point and consider the program a success. The teacher researchers disagreed and said they definitely needed that third and final year. It was during this final year that many of the teacher researchers began going far beyond the strategies shared during the Summer Institutes. Some initiated their own investigations or used the tools of technology the grant provided in unique and meaningful ways.

This is an aspect of providing professional delivery that merits consideration—What does it take for individuals to become innovators and leaders? We think that we created some of those leaders with *BLOCKS* but are wondering if there is a pattern that could be replicated. One of the teacher researchers writes, "The process of being a teacher researcher has been exciting and frustrating. I usually work best when I have clear and specific guidelines. We were told that we were 'pioneers' . . . so what we did was often very open ended. It was fun to have flexibility. At the same time, I was often unsure if I was doing it 'right'."

As authors and mentors in BLOCKS we are pleased with overall project outcomes, and working with these teacher researchers has been a pleasure. Joy started the project with only three years of classroom experience, and she experienced some struggles in Year 2, but now she says, "I truly like this project, no matter how cumbersome. It is an approach to teaching science that has been challenging, exciting, and fun."

Conclusions and implications

Kelli confessed in her application that she had always "been a little afraid of teaching science" because she did not have a lot of knowledge or experience. Now she notes:

"When you see the light bulb come on and they make an extraordinary connection because of the activities that you have set up you really begin to feel like a science teacher who is making a difference in the lives of young children."

Gail on the other hand, had significant science content knowledge when the project began. She describes the benefits of participation for her as follows:

"Even though I have always felt comfortable teaching science and offered my young children many experiences, being a part of BLOCKS "forced" me into areas of science that I might not have gone, i.e., physical science—force and motion. For me (BLOCKS) was about finding out what the children knew about science and deciding how I would thoughtfully and purposely set up science experiences/environments. Being able to collaborate with 24 other teachers and our expert mentors also helped change the way I taught science."

In the written proposal to NSF we did not suggest that a significant outcome would be increasing our individual understandings of the teaching/learning and assessment cycles. Nor did we anticipate personal transformation, but in retrospect that is the case. We assembled a group of P-16 educators whom we had reason to believe were lifelong learners, dedicated educators and team players. We discussed strategies. We listened openly to diverse opinions. We reflected individually and in small and large groups on every aspect of the work. Three years later, and regardless of past experience, expertise, or personal potential, we all perceive education differently. We are all better educators for having done this research.

This study provided us, the university researchers, with an opportunity to engage in collaborative research while simultaneously providing professional development and empowering teacher researchers. Outcomes of the *BLOCKS* model support the integration of teacher research within professional development initiatives. Teachers who see themselves as legitimate members of the

science education research community are more likely to function as empowered professionals eager to share their learning with other teachers. This study exemplifies the notion that repositioning teacher research as quality evidence-based research is both realistic and attainable in science teacher education.

References

Cochran-Smith, M., & S.L. Lytle. 1993. *Inside/outside: Teacher research and knowledge.* New York: Teachers College Press.

Henderson, B., D.R. Meier, G. Perry, & A.J. Stremmel. 2012. The nature of teacher research. *Voices of Practitioners Teacher Research in Early Childhood Education,* 6(2), 1-7.

The National Research Council, 2007. *Taking science to school.* Washington, DC: National Academies Press.

Pushor, D., & D.J. Clandinin 2009. The interconnections between narrative inquiry and action research. In *The Sage handbook of educational action research,* ed. S. Noffke & B. Somekh, 290-300. Thousand Oaks, CA: Sage.