A Shift in Scientific Identities: How Teacher-Scientist Partnerships Can Impact Middle School Teachers’ Science Teaching and Instruction

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Introduction

Following the push to improve science literacy and implement science education programs in the 1970s, organizations such as the National Science Foundation (NSF) and American Association for the Advancement of Science (AAAS) have worked fervently to develop programs aimed at reforming science education and increasing science literacy among America’s students. The emergence of teacher-scientist partnerships in K-12 classrooms has proven influential in broadening teachers’ content knowledge, understanding of scientific inquiry, and increasing teachers’ confidence in their abilities to teach science. Unfortunately, research exploring how these partnerships impact teachers’ identities, in general, and teachers’ self-efficacy, pedagogical practices, and identities as scientists, more specifically, has remained limited.

An investigation of the impact that one teacher-scientist partnership had on a select group of Students Discover middle school teachers’ various teacher identities was designed to explore how teacher-scientist partnerships: (1) impact how teachers view their ability to teach science, and (2) shape teachers’ teaching practices. Findings from the study, shared in this report, are intended to inform district leaders, school administrators, and teachers about the unique possibilities of improving science teaching effectiveness in the classroom through the use of teacher-scientist partnerships.

About the Students Discover Teacher-Scientist Partnership

The overarching goal of the Students Discover project, a National Science Foundation-funded Math Science Partnership grant (NSF Award ID# 1319293), is to improve STEM education in middle schools by developing a model for engaging students in doing real science. Project activities aim to create a context for student engagement in real, on-going scientific research by making citizen science projects accessible and tailored to the formal classroom environment. A central component of the project is a mentorship model in which teacher leaders (Kenan Fellows) engage in a 3-week summer internship with scientists at the North Carolina Museum of Natural Sciences (NCMNS). During the internship, teachers engage in rigorous scientific inquiry with the scientists and, based on this work, co-develop citizen science curriculum modules to be taught by the teacher during the following school year. As teachers implement the modules, they receive ongoing virtual support from the scientists and periodic face-to-face visits.
About the Study and the Teachers

While not an initial focus of the Students Discover project, the narrative that unfolded among teachers during a two-year timespan in the project caught the attention of this article’s author, a graduate research assistant on the project. As part of the student’s graduate coursework, a small narrative study was undertaken to delve into the impact that the teacher-scientist partnership was having on teachers’ self-efficacy and science instruction. Narrative inquiry is a qualitative research approach that uses the interpretation of peoples “stories” to better understand – in this case – program or project experiences. Four teachers were selected for inclusion in this study as a result of their diverse racial, ethnic, gender, and subject area backgrounds.

The Relationship Between Self-Efficacy and Teacher Effectiveness

It has been argued that teacher effectiveness may be directly correlated with teacher confidence. The confidence one has to perform an action successfully is a direct result of their self-efficacy, or their belief in their ability to effectively perform a task. For teachers, self-efficacy is not only aligned with teachers’ beliefs about their personal ability to teach effectively, thus, enhancing student learning, it is also aligned with how they judge their ability to achieve desired student outcomes (e.g., engagement, motivation, performance). It is not difficult to imagine, then, the impact a teacher’s self-efficacy can have on student achievement, in particular, as teachers with high efficacy in their ability to teach content engage in pedagogical practices that are beneficial to their students.
Major Findings

Analysis of the stories presented by the four Students Discover teachers revealed five major themes that embody the experiences the teachers had working alongside scientists in a teacher-scientist partnership. Additionally, the four stories told by the teachers reflect the impact the Students Discover teacher-scientist partnership has had, so far, on their teacher identities and effectiveness as teachers of science. Their stories—both unique and parallel—expose us to the experiences that have helped shape their newfound identities as teachers of science. By working alongside scientists in research labs to develop citizen science lesson plans, these four teachers’ narratives communicate the ways in which being involved in a teacher-scientist partnership affected them and their work:

- Increased confidence in ability to teach science
- Adoption of student-centered teaching practices
- Inspiration to foster student interest and confidence in science, especially among female students
- A newfound scientific identity
- Formation of non-hierarchical and mutually beneficial relationships with scientists
Increased confidence in ability to teach science

The immersive 3-week experience of working side-by-side with a scientist in a lab at the NCMNS broadened teachers’ science content knowledge, particularly in areas where they had relatively little prior knowledge, and deepened their understanding of scientific inquiry. Teachers reported that the scientists’ ability to break down complex scientific content into smaller components helped them “digest” the concepts and develop a more comprehensive understanding of how the different components fit together. This approach worked especially well for the non-science teachers. For example, the art teacher, feeling somewhat marginalized by his teaching background, noted feeling more confident in his ability to effectively engage his students in rigorous scientific inquiry. As a result of the teacher-scientist partnership and his close collaboration with science and math teachers whom he worked alongside daily, both his motivation to become an effective teacher of science and his confidence significantly increased as his science content knowledge grew. Additionally, despite holding a degree in science, the 7th grade math teacher expressed how her initial lack of confidence in teaching complex science content to her students, due to the fact that she had not worked in a lab setting in several years, significantly waned after working alongside her scientist during the internship.

Through ongoing conversations with the scientists, teachers were also able to think about how the content might best be delivered to a diverse group of students in various subject areas including science, math, and art. These conversations repeatedly brought to light the interdisciplinary nature of the content. Hence, as teachers deepened their knowledge of the scientific content, increased their awareness of the interconnected nature of science, and developed their ability to effectively communicate the science content, their confidence in their ability to teach the content to students grew. For example, the 6th grade math and science teacher found that the teacher-scientist partnership also helped her see the interrelatedness of math and science and, as a result, gave her the confidence to integrate both subject areas in an effort to help her students gain a deeper understanding of the ways in which math and science were connected, as opposed to teaching each subject in isolation as she had done in previous years. She noted:

“We’re bringing more of the science part to math so that the kids realize that math is not just something isolated. Scientists work with math as well. When you collect data, you work with math. When you talk about photosynthesis, you’re doing math as well.”
One 6th grade science teacher described how the knowledge she gained through the partnership with scientists boosted her confidence in effectively teaching “protocols and procedures” to her students.

“I learned a lot about protocols and procedures during the internship. In turn, I think I did way better in the classroom with my students than I would have done without the internship experience. We were doing Polymerase Chain Reaction and stuff like that in a 6th grade science classroom, and I could share that with them because I understood it way better. So, I had more confidence.”

Adoption of student-centered teaching practices

Throughout the summer internship, teachers “learned by doing.” The experience reawakened teachers’ own engagement and excitement about learning, sparking critical discourse and reflection. Upon returning to the classroom, all four teachers reported changing their pedagogical practices to create a more student-centered learning environment. They consciously worked to reject a traditional pedagogical approach that espouses teacher and textbook as the ultimate sources of knowledge, and began to favor a student-centered pedagogical approach that: (a) breaks down the hierarchical structure that often exists between teacher and student; (b) values the perspectives of students; (c) allows students to ask questions and attempt to find answers to those questions; and, (d) provides students with the opportunity to work to develop their own understanding of the content material through rigorous, hands-on learning.

When discussing how her teaching has improved as a result of the partnership with scientists, the 6th grade math and science teacher recalls using hands-on scientific inquiry and encouraging her students to ask questions as a method of engaging her students in learning about the process of plant germination and measuring plant growth with lentil beans. She reveals:

“I have improved as a teacher by getting my students engaged with more real life science activities. My kids are really engaged in what they’re doing because they see something meaningful, hands-on, and they can ask questions to solve a problem.”

In addition, she found that, contrary to the traditional view of teachers being omniscient beings who disseminate knowledge to their students through a teacher-centered teaching approach, her experience working in a teacher-scientist partnership helped boost her confidence and understanding
that she may not always know the answer, and that’s quite okay:

“I feel very comfortable telling my students, ‘I don’t have the answer of which variable will work better for the growth of these seeds, but we’re going to find the answer together.’”

As a result of her involvement in the teacher-scientist partnership, the 6th grade science teacher became more committed to emphasizing the importance of introducing her students to more meaningful science activities—activities that would not merely become lost in their science notebooks. She also noted how the partnership caused her to emphasize to her students that by participating in this citizen science project, they were all a part of something bigger, and their findings would be of great scientific value.

The 7th grade math teacher found that after participating in the teacher-scientist partnership, she began to expose her students to “messy data” and science content that was very different from the made-up data in their science and math texts. As a result, she was able to get her students to engage in real, hands-on science activities and see that data is not always neat:

“In math, we collect data and it’s made-up data. It looks pretty for whatever all-intensive purposes. But the data we collected when we were implementing our citizen science project wasn’t so pretty. It looked a hot mess, bluntly. And the kids thought, ‘I must be doing something wrong. This isn’t like what you taught us.’ But I told them, ‘It is. This is real science. And sometimes, real science isn’t pretty. It changes. It’s not just made-up textbook stuff.’”

**Inspiration to foster student interest and confidence in science, especially among female students**

When discussing the many ways in which the teacher-scientist partnership has impacted her effectiveness in teaching science to her students, the 7th grade math teacher states that it was her ability to expose her students to careers in science that increased all of her students’ science interest and encouraged them to consider pursuing science careers in the future. In addition to increasing student interest in science, more generally, participating in the teacher-scientist partnership inspired both the 7th grade math teacher and 6th grade science teacher to make a greater commitment to encouraging female students to consider science careers. The 7th grade math teacher shares:

“I think, for me, being a math teacher—and math and science kind of go hand-in-hand—
participating in a teacher-scientist partnership helped me to open up STEM careers to my students because they saw the female scientist I worked with over the summer. She came into my classroom at the beginning of the year to introduce herself. I also had another female scientist from Duke University who was a graduate of Wake County Public Schools who came in and talked about all the cool things she was doing at Duke. So, I think it’s opened my students up to more careers that some of them didn’t think to explore. Now I have female students that say, ‘Oh, I think I want to do that; I think I might want to be a marine biologist, or study microbiomes.’ It’s opening up other careers where they see women in science.”

Both the 6th grade science teacher and the 7th grade math teacher were inspired to make a stronger commitment to develop their female students’ interest in science, an area where many females are underrepresented.

For example, the 7th grade math teacher found that the partnership she shared with a female scientist really helped to expose her female students, in particular, to the notion of “girls doing science” while also boosting their confidence in science. She shares:

“Not just to pick on girls and females, there are not a lot of representatives—women representatives or ethnic representatives—in science. It’s usually, as our scientist used to call them, the old curmudgeons—the old guys with the white lab coats—doing science. But it’s good for female students to see that they are smart enough to be a scientist, too. They are smart enough to study something in mathematics. They can do it. And I think interacting with female scientists is building their confidence.”

In addition, the 6th grade science teacher believes that the interaction with female scientists has given many of her female students inspiration:

“The female role models are huge. I try to be really careful because I feel like the boys feel left out. But that’s not an issue. They have been in STEM and in science. They’re there. I just keep saying, ‘Keep doing what you’re doing boys.’ But the girls, I love that they’re seeing these female role models in science. They’re seeing themselves.”

As a result of this, not only have they seen a drastic increase in their female students’ science self-efficacy, they have also noticed that these girls have become extremely interested in science careers.
A newfound scientific identity

The teachers found a new scientific identity emerging by the third week of the summer internship—a scientific identity many of them had not yet experienced. As a result of the Students Discover teacher-scientist partnership, these teachers began to view themselves as scientists and educators. Just the year before, teachers found their identities to be confined within the institution of school and viewed themselves as science teacher, art teacher, math teacher, and math/science teacher, respectively. Following their participation in the Students Discover teacher-scientist partnership over the summer, these teachers all strutted around their middle schools wearing t-shirts that boasted, “This is what a scientist looks like”, with pride, embracing their newfound identities as not only math, science, and art teachers, but scientists as well. For instance, one teacher who began her professional career as a biologist in Colombia before becoming a 6th grade math and science teacher, discusses how the teacher-scientist partnership allowed her to embrace both her identity as a teacher and her identity as a scientist, by marrying the two identities. In addition, as a result of her experience, she has become motivated to teach her students to view themselves as scientists. She shares:

“I have brought back, again, the scientist part of me, and it has empowered me. I feel like I’m a scientist as well. Yes, I’m teaching these kids about being scientists as well.”

This emergent identity inspired these teachers’ middle school students who, too, began to view themselves as scientists, capable of asking questions, investigating the scientific unknown, and analyzing and reporting scientific data through various scientific inquiry methods. Moreover, this collaborative model shaped how teachers viewed their teaching ability as teachers of student scientists.

Importantly, as a result of the shift in the teachers’ identities following their teacher-scientist partnership experience, the students of these four teachers began to understand what made them scientists, too, as they became citizen scientists who: (1) participated in rigorous, authentic science activities; (2) asked questions that had not yet been answered and attempted to find their own answers to those questions through intense data collection methods; (3) began to understand that everyone is allowed to make mistakes as they transition through the scientific experimental process; (4) engaged in “non-cookbook” science that allowed them to realize science can be “messy” and requires active learning as opposed to step-by-step instructions and clean, fabricated data reflective of most in-school science labs and their accompanying science textbooks; and, (5) acknowledged the uncertainties involved in science, embracing the notion that scientists do not have all the answers, nor do their teachers.
Formation of non-hierarchical and mutually beneficial relationships with scientists

The collaborative nature of the teacher-scientist partnerships allowed teachers to feel as if they were colleagues of the scientists, alleviating a hierarchical structure between teachers and scientists and allowing teachers to feel more comfortable raising questions regarding the science content even after the internship ended. In fact, the 7th grade math teacher believes that it was her ability to ask her scientist questions throughout the school year that helped her to become a more effective teacher when implementing the citizen science lessons. For example, following an incident in her classroom in which she had her students collect dandelions and use containers to transport them to different types of soils in order to collect data for the research scientists at the museum, she noted how the death of her students’ first crop of dandelions immediately catapulted her into panic mode. However, as a result of the close relationship she shared with her scientist, which had always thrived on open communication via regular texting, Skyping, phone calls, and face-to-face meetings, she was almost instantaneously relieved of her fright upon speaking with her scientist about the potential problem with her students’ data collection efforts.

Teachers’ identities were impacted as a result of their involvement in a community of practice with their scientists. Teachers began to collectively develop a new view of themselves as colleagues of their scientists as opposed to perceiving that a hierarchical structure existed between themselves and their scientists. Further, this equal playing field allowed both teachers and scientists to view each other as experts in their respective fields. For example, the 6th grade math and science teacher recalls:

“It’s not that he’s the scientist and I’m the teacher; now it has become a collaboration where we’re two people interested in the same thing.”

Moreover, teachers believed the teacher-scientist partnership was beneficial in helping them to see that their pedagogical knowledge was as valuable to the scientists as the scientists’ content knowledge was valuable to them. Some teachers even believed that a friendship emerged as a result of the Students Discover teacher-scientist partnership. Similarly, the art teacher believes that his relationship with his scientist was further strengthened when he and his cohort of teachers were invited to Florida to work alongside their scientist during the internship. It was in Florida during a conversation about issues in education where the art teacher found that the relationship he shared with his scientist, who had recently accepted a teaching position at the university-level, was a mutually beneficial one:
“While we were in Florida we went out one night and talked about the trouble with education and how we might fix it. During the conversation, our scientist was taking notes and scrawling on the back of a napkin and told us, ‘You don’t realize the freedom of change. I’m about to begin teaching in the Fall. You guys have changed the way I’m going to teach my class.’”

Additionally, the 7th grade math teacher believes that it was her scientist’s trust in her that helped her to realize the mutuality of their shared relationship. Moreover, the communication habits she shared with her scientist were reflective of a forming friendship.

**How Scientists Nurtured the Teacher-Scientist Partnership**

The stories shared by the teachers detail the impact the Students Discover teacher-scientist partnership experience had on their collective identities as teachers, emerging identities as scientists, and pedagogical practices. While their storied experiences varied individually, their collective experiences of participating in the Students Discover teacher-scientist partnership all demonstrate an increase in both their confidence in their ability to teach science as well as their effectiveness as teachers of science. While non-science teachers, in particular, initially reported lower levels of confidence in their ability to teach science, all teachers struggled with their confidence, noting feelings of intimidation about working with scientists prior to the 3-week summer internship. However, these initial feelings dissolved over the course of the internship as scientists:

- demonstrated their passion for helping teachers disseminate citizen science content into their classrooms;
- illustrated the ability to break down complicated science content into a digestible format that teachers could both understand and make professional judgments about how to best communicate the content to their students;
- displayed patience with the teachers during the course of the internship as they grappled with new science content and engaged in developing the citizen science modules;
- demonstrated confidence in their teachers’ abilities to articulate the science content during their implementation of the citizen science modules in their classrooms;
- expressed genuine care and concern about improving their teachers’ abilities to teach the science content to their students effectively;
- encouraged teachers to view themselves as both scientists and educators; and
- admitted to teachers that they, too, had been critically impacted by the partnership as they witnessed a change in their own beliefs and professional practices as a result of working with teachers whom they learned a great deal from on both a pedagogical and professional level.
Embodying these characteristics allowed the scientists to gain a stronger rapport with the teachers throughout the summer internship and the rest of the school year, and promoted a sense of shared friendship between the teachers and scientists as teachers found greater comfort in expressing their thoughts and ideas to the scientists, asking the scientists questions for clarification during the implementation process, and regularly contacting the scientists via texting and other modes of communication.

**Making Teacher-Scientist Partnerships Work in Your District**

Teacher-scientist partnership models that bridge relationships between school districts, neighboring universities, and nearby museum research labs are instrumental in promoting teacher effectiveness and enhancing student learning outcomes in science, especially. Involvement in these partnerships allows teachers to not only extend their science content knowledge significantly, but to also gain confidence in both their ability to teach science that is authentic rather than prescriptive as well as their effectiveness in the classroom. These partnership dynamics also increase students’ access to scientists within the physical confines of their classrooms and make careers in science seem much more attainable.

In order for this unique type of partnership to work successfully in school districts, however, several elements must be in place to ensure optimal success.

**First**, scientists who are hired as or volunteer to be active participants in a teacher-scientist partnership must possess a passion and commitment toward helping teachers to enhance science instruction in the classroom. Finding these scientists can be a challenge, as teachers and administrators do not often have access to directories of local scientists. We suggest starting with local museums and nearby university science departments to seek out such partnerships or leads for potential partnerships.

**Second**, scientists involved in the teacher-scientist partnership must have the ability to break down difficult scientific concepts into a digestible format for teachers and students.

**Third**, teachers involved in the teacher-scientist partnership must be willing to adopt new teaching practices, and consider alternative ways of teaching science by engaging students in real science learning opportunities outside the confines of the traditional textbook. If you are an administrator looking to start a program similar to the one described in this research, you must identify those teachers who want to implement something different and aren’t afraid of change - and look beyond the science classroom to find them, like the art teacher mentioned in this study. Then, once you’ve
found your teachers, give them freedom and flexibility.

**Fourth**, teachers and scientists must have effective communication practices in place to ensure that both teacher and scientists’ needs are being interchangeably met through regular interaction.

**Finally**, due to the stringent nature of high-stakes testing in schools and its impact on the school curriculum, teachers and scientists must work together to brainstorm the varied ways the science content might align with the curriculum they are expected to teach during the school year, including viewing the content from an interdisciplinary perspective.

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**References**


About the Author

Oriana Johnson is a Graduate Research Assistant for the Friday Institute’s Research and Evaluation Group (FIRE) at North Carolina State University. In addition to being a full-time Ph.D. candidate at North Carolina State University’s College of Education in the Educational Psychology department, she serves as a member of the NSF-funded Students Discover scale research team.

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