Chapter 15

Growing our Own: Fostering Teacher Leadership in K-12 Science Teachers through School–University Partnerships

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Abstract

This chapter describes a teacher leadership professional development program for K-12 science teachers constructed through a partnership between a university and five school districts. The development and implementation of the program drew from the literature on teacher leadership, communities of practice, and distributed leadership. The program supports teachers through a two-year fellowship program where they examine their teaching practices, attend professional development workshops, and undertake an independent teacher leadership project in their own schools. The chapter also describes the research conducted by the university to improve the program and shares findings and future implications of this research.

Keywords: Communities of practice; reflective practice; distributed leadership; school–university partnerships; teacher fellows; teacher leadership; STEM; simultaneous renewal

> It would be cool to be the person [who can help when a teacher asks], "Oh, I'm having a hard time teaching density. Can you help me?" And being like, "Yes! I have this great

thing we can do. Let's go!" … Kind of like a super-hero.
(Definition of a Teacher Leader, Fellow, Cohort One)

This chapter describes a school–university partnership program designed to support the teacher leadership development of 60 K-12 science teachers from five local school districts. The overarching goal of the program was to nurture experienced teachers to become teacher leaders by having them reflect upon their practice, collaborate with peers, and develop and implement independent teacher leadership projects. Teachers who participated in the program (hereafter referred to as fellows) come to see themselves as teacher leaders who have the potential to work alongside school administrators and other teachers to make change within their districts, each in a distinct way. In this chapter, we describe our innovative school–university partnership program, highlight the most significant program features, and discuss the salient outcomes of the program. We end with questions that will serve as the focus for our next round of funding and development.

Overview of the Program

The Wipro Science Education Fellowship (SEF) is a teacher leadership grant program designed to support experienced K-12 science teachers as they improve their teaching practice and develop into teacher leaders within their districts. It is a five-year program funded by Wipro Limited, a global information technology and consulting company with a vested interest in public education, both in India and in the United States. The program was developed by University of Massachusetts, Boston, and is being implemented in similar ways across three universities, each working with five local school districts, with slight variations that accommodate differences in settings. Here, we describe the specific implementation and outcomes associated with the project at one of the three sites: Montclair State University (MSU).

A primary goal of the program was to promote teacher leadership and to improve teachers' instructional practice in schools, with the potential to impact student learning (Crowther, Kaagan, Ferguson, & Hann, 2009). Furthermore, we encouraged our fellows to lead within and beyond the classroom; identify with and contribute to a community of teachers, learners, and leaders; and influence others toward improved educational practice (Katzenmeyer & Moller, 2001). Our hope was that the fellows would view themselves as teachers of both students and peers and would

be driven by the desire to influence instructional practice (Danielson, 2006).

Our program at MSU is coordinated by four members of the College of Science and Mathematics and the College of Education and Human Services, a project manager, and doctoral students. Specifically, the project team includes two teacher educators with expertise in teacher leadership, a mathematics educator who works in STEM (science, technology, engineering, mathematics) education, and a science educator and director of a STEM professional development center. The project team at MSU led all monthly professional development workshops, coordinated with the other sites and school districts, and mentored the fellows – both in groups and individually – as they pursued their year one group activities and year two individual teacher leadership projects. In addition to coordinating the program, the faculty and doctoral students on the project conducted research, both to inform revisions and to contribute to the literature on teacher leadership. We relied on interviews, observations, and artifact data, which enabled us to examine the complex work and dynamic relationships of the fellows.

Teacher Leadership

Teacher leadership is not a new concept, yet the definition is elusive, varied, and emerging. The literature collectively has described teacher leaders through varied lenses: as educators who positively influence their peers by establishing and sustaining collegial relationships for the purpose of affecting and advocating for change (Jacobs & Crowell, 2016; Lieberman & Miller, 2005; York-Barr & Duke, 2004); as individuals who possess a strong sense of purpose (Donaldson, 2007; Lambert, 2003); as those willing to extend their work beyond their respective classrooms to foster collegial interactions that focus on instructional strategies (Fullan & Hargreaves, 1996); and as risk takers (Center for Comprehensive School Reform and Improvement, 2009). As lifelong learners, teacher leaders continually reflect and refine their practice (Day & Harris, 2002). Their informal leadership practice evolves over time, going through several developmental stages (Hunzicker, 2012). Finally, teacher leaders cultivate a positive school environment because they understand how political factors of the school impact their peers' needs (Donaldson, 2007: Frost & Durrant, 2003; Gronn, 2000; Harris, 2010; Muijs & Harris, 2007; Spillane, 2006).

Teacher leaders influence others' instructional practice beyond the scope of their classroom through constant collaboration with teachers,

administrators, and university faculty (Ackerman & Mackenzie, 2006; Burns, Yendel-Hoppey, & Jacobs, 2015; Chrispeels & Martin, 2002; Rogers, 2002). This involves collaborating with various stakeholders to help them shape their pedagogy, while simultaneously changing and refining their own teaching practice. As one of our fellows explained, teacher leadership does not occur in isolation: "You have to build those teams of people that will do it together or help each other out or work toward the common goal not … you know the leadership that is really one person just running the show." Thus, it is essential to support teacher leaders' work toward improved instructional practice, understanding teacher leaders' experiences when enacting and supporting leadership.

Our program has been greatly influenced by the distributed leadership framework (Gronn, 2000; Harris, 2010; Muijs & Harris, 2007; Spillane, 2006). This perspective situates a teacher leader's role at the epicenter of improving teaching and learning. In contrast to the traditional leadership roles, teacher leaders emerge spontaneously and organically from the teacher ranks. Teacher leaders are known for taking initiatives to address various areas within their school, where they work directly with peers or colleagues. They have no positional authority; their influence stems from the respect they elicit from their colleagues by means of their expertise and practice (Danielson, 2006; Katzenmeyer & Moller, 2001; Taylor, Goeke, Klein, Onore, & Geist, 2011).

Msu ipro S Model

Existing research points toward teachers' need for opportunities to examine their practices in the context of their own schools and that connect to the needs of their students (Taylor, Klein, Munakata, Trabona, & Rahman, under review). Most teacher professional development continues to be driven by district agendas and led by outside professionals who may have little understanding of the needs of individual students in specific classrooms (Cochran-Smith & Lytle, 2009; Elmore, 2004; Lieberman & Miller, 2011; Talbert, 2010). The use of videos as an effective means to promote teacher reflections has been documented (Borko, Jacobs, Eiteljorg, & Pittman, 2008). Furthermore, there has been a rise in literature on teacher leadership as a means of improving teaching practices within collaborative groups of teachers working in response to calls for education reform (Muijs & Harris, 2003; Murphy, 2005; Smylie, Conley, & Marks, 2002; Welch, 2000).

This program is built upon the Montclair State University Network for Educational Renewal (MSUNER), a school–university partnership that

is committed to the simultaneous renewal of schools and teacher education through collaboration among the university and its partner school districts. It exemplifies a teacher leadership model that builds upon a decade-long partnership and various collaborative school/university models such as professional development schools (Goodlad, 1988; Levine & Trachtman, 2009; Rutter, 2011; Teitel, 2003, 2004). Being university-based, our program existed in a space outside of the district yet within a sphere of influence. We were positioned to both influence and support teachers as we were intimately familiar with their school and district contexts. But we also offered an outside perspective that helped them seek other possibilities for how things might be done.

Fellow Selection

School districts from the MSUNER were invited to apply to participate in the Wipro SEF program. Of the eight that applied, we selected five districts based on their demonstrated commitment to the program and alignment of vision for the teachers. These five districts located across three states participated in all five years of the project. All members of the university project team had worked within these districts in other partnerships prior to this grant and thus had a context for understanding the challenges and supports each faced. We knew from literature on partnership work (Levine & Trachtman, 2009; Rutter, 2011; Teitel, 2003, 2004) that this kind of understanding was essential to support change and also required sustained engagement.

Our program involved three cohorts, each comprising 20 K-12 science teachers. Teachers were recruited based on their experience (with most teaching more than three years at the time of recruitment) and written responses to questions related to their understanding of and plans for teacher leadership and content area focus. To support their work on the fellowship, each selected fellow received $10,000 for two years of participation. Over the two years, each fellow was required to participate in 125 hours of Wipro SEF activities.

Significant Program Features

Collaborative Work in Year One: Horizontal and Vertical Learning

In the first year of the program, fellows worked in vertical teams (content-based) in the fall semester and then in horizontal teams (grade level-based)

in the spring semester. Vertical teams included members across grades from elementary to high school with the understanding that they would share ideas and experiences spanning all grade bands. For example, while an elementary school teacher might learn what is expected of students in the middle school and high school, a teacher in high school might learn about the background knowledge students bring into their classrooms. The intent of the horizontal teams was to facilitate discussion among teachers from the same grade level band to allow for deeper inquiry into the teaching practices and content specific to that grade level. For both models, each team consisted of four or five teachers. This work was premised on the theory that, while we could not prescribe a community of practice, genuine inquiry with similarly motivated teachers around issues of practice would support the growth of a strong learning community.

The purpose of the collaborative work in year one was to provide a structure for fellows to engage in reflective practice around their instruction. Fellows met regularly (about five times a semester) as they discussed each member's instruction, based on viewing of a lesson through video. The program guided the fellows as they navigated the protocol and became accustomed to a process that was unfamiliar to most. Given the sensitive nature of providing feedback on one's own and others' teaching, it became critical that a clear support system and set of norms be in place.

At the beginning of the semester, each team chose a problem of instructional practice to study and a content area upon which to focus. They also selected one research article related to their chosen practice to serve as a framework for their analysis. For example, one vertical team, whose content area was physics, chose to focus on questioning techniques and read a research paper on the role of questioning in the teaching and learning of science (Eshach, Dor-Ziderman, & Yefroimsky, 2014). The first group meeting involved discussing the research article and setting norms for providing feedback on video-recorded lessons. After this initial meeting, each member of the team video-recorded a lesson and shared it with the team. Teams met approximately five times during the semester, using a series of protocols to conduct video analysis. These protocols were developed by the University of Massachusetts, Boston (Center of Science and Mathematics in Context, n.d.), and modified for our context based on our own work with video and teacher leadership professional development. For each teacher observed, the group engaged in a pre-lesson meeting and a debrief meeting. To guide discussions during these meetings, each individual came to the meetings with completed forms that gathered their feedback. To gather feedback, fellows used simple forms to jot down "warm" (positive) and "cool" (for areas in need of improvement)

feedback as they viewed the videos. To guide reflection and the debrief meetings, fellows were asked to complete a reflection form on what they learned from the meetings as they thought about their own classroom experiences and teaching practice. The form also encouraged the fellows to connect the observed lesson to research and provide suggestions for future meetings.

Our research points to the value of the fellows' collaborative work in the first year. The vertical articulation in the fall semester benefited teachers of all levels. High school teachers expressed a newfound appreciation for the elementary teachers. As one research participant put it, "The elementary teachers were really doing science…because, sometimes, you don't know because it's not their major." Through the videos, the observing teachers saw the depth of science content in which the students were engaged. Teachers of the higher grades also came to better understand the educational backgrounds of their students: "[It] enlightened me as to what to expect when students arrived." A different teacher noted, "Another interesting thing was I was able to see what kind of curriculum misconceptions teachers and/or the students had from younger grades. This allowed me to clarify when students came to high school."

Regardless of grade level taught, the vertical groups provided insights into the K-12 curriculum as a whole, through the lens of the chosen science content area. For many, this form of professional development was completely novel and participants noted it as particularly powerful, somewhat to our surprise. We realized that few professional development programs for public school teachers are focused on vertical learning, especially between elementary, middle, and high schools. It seems that, especially for the high school teachers, knowing the significant level of conceptual work of elementary students made them re-consider what they were asking of their own students.

Monthly Professional Development Workshops: Participating in a Community of Learners

In addition to vertical (and horizontal) meetings, the entire cohort met monthly with the project team in professional development workshops that focused on such topics as Understanding by Design (Wiggins & McTighe, 2005), classroom discourse, standards-based teaching, teacher leadership, developing effective communication skills, and action research. The purpose of these workshops was to provide ongoing support to the teachers for improving their teaching practice and a space where they

could share ideas and experiences. They also laid the foundation for the teachers' independent leadership projects in year two. One session in particular focused on elements of successful professional development workshops. During this session, the fellows were encouraged to think about how they might implement a professional development workshop in year two. Underlying all of our activities were two important goals: (1) to provide teacher leaders the tools they would need to support their work and (2) to build a larger community of practice for their leadership. Fellows reported that this was indeed an important aspect of their development.

The professional development workshops, along with their experiences in the vertical and horizontal groups, provided valuable learning opportunities for the fellows. They shared what they learned at the end of each semester, and in groups presented their experiences from their vertical and horizontal teams. The teams were charged with framing their work within the context of their research article and with sharing lessons learned from the experience.

The participation in professional development workshops spanning five districts seemed to have a particular benefit. For example, one teacher noted, "They all have the same issues. Different districts show the same problems. We look at problems collectively. We don't have the same prejudices of administrators. It was nice to look at this collectively with outside opinions and without bias." Fellows also appreciated the community built around the program. When asked about the most significant learning experiences in year one, a teacher reported, "Definitely all the connections I made with teachers. We can e-mail, ask for advice…" Camaraderie and a sense of community among the teachers were significant benefits of our regular professional development workshops.

The constant work on building reflective discourse, a feature of numerous meetings, was another big take-away for the fellows:

> We spent a lot of time encouraging reflection and dialogue. I tried new things because I had district support … As far as pedagogy, the most beneficial was the focus on student driven dialogue or discourse as they call it. This became a massive role in how I run my class … Also, the reflective practices that we worked on made a difference. The introduction to SE [science education] practices is helping me teach this year.

Overall, we note the importance of building both pedagogical skills and community in supporting teacher leadership development. Too often, professional development for teacher leaders leaves out the skills teachers

need both to improve their own practice and to engage in leadership work. This program sought to fill this gap.

Pursuing Teacher Leadership Projects in Year Two

In year two, fellows designed and implemented a teacher leadership plan in their districts with support from mentors from MSU and their districts, as well as a "buddy" from a previous cohort. The fellows were encouraged to draw from their collaborative experiences and the professional development workshops from year one that were deliberately developed to prepare the teachers to undertake independent teacher leadership projects (e.g., communication, action research, and teacher leadership). The goal of the teacher leadership project was for teachers to strive to meet an individually designed objective and enact positive change in their districts. Fellows were encouraged to take lessons learned from year one activities and propose a project that could be completed between September and June. Fellows submitted project proposals, delving deeply into their inquiries and extending their spheres of influence to lead professional development in their grades, schools, and districts. Some required several iterations of revision and support from the mentors to develop their teacher leadership plans. The whole group met twice a year to share their experiences and problem-solve challenges.

Projects included conducting action research, facilitating teacher study groups, mentoring and coaching teachers, exploring interdisciplinary connections, infusing instruction with meaningful uses of technology, revising curricula, and proposing to de-track first-year science courses. Fellows were encouraged to present their work at state and national conferences and at meetings within their districts. In addition to implementing their leadership projects, fellows were required to lead and video record one professional development activity. The activities ranged from leading multi-district workshops on the implementation of the Next Generation Science Standards to coaching teachers from a single school. Fellows submitted monthly reflection logs chronicling their teacher leadership projects and their work on developing and implementing a professional development activity for their colleagues.

In our research, fellows reported that, in some cases, the most significant support of the year two teacher leadership project was the backing of a university-based program:

> Actually, it gave me the avenue to do this…When I approached them, I asked, "Well, I'm doing this for the

> Wipro program. This is the whole idea if you wanted to par-
> ticipate." If I was doing this on my own, I would have come
> across as some crazy guy. I don't know how they would have
> interpreted it, but the whole idea gave me a foundation that
> [suggested]: "Oh, this is something important, sure I'll help."

Many of our teacher leaders noted the value of the project's backing in
the collateral it gave them as they negotiated with districts, schools, and
peers. The program encouraged (and even required) them to take risks
in reaching out to those who might be able to help them realize a project
they had been considering for years.

For others, the time, support, and funding to delve deeply into an area
of teaching practice became the most significant feature of the program.
One fellow described how it helped her emerge as a leader in implement-
ing the new science standards in her building:

> Because my [teacher leadership project] focus is on Next
> Gen Standards, it allowed me to jump into that and really
> understand it. I have an understanding of what they expect
> of us in the classroom from these standards. From the very
> beginning it completely changed how I teach science, not so
> much of the content but more the activities that allow stu-
> dents to be more in control. Actually it's more a facilitator
> role than a teacher role.

The teacher leadership project in year two opened a space for the fel-
lows to engage in the kinds of activities they had previously been unable
to enact, either because the resources did not exist, or they did not feel
they had the necessary authority.

Differentiated Mentoring of Teacher Leadership

Meeting the fellows where they were in the process of becoming teacher
leaders was a unique feature of our program. Mentoring might involve
finding relevant resources or necessary professional development oppor-
tunities for the fellow. Other fellows needed help with strategies to navigate
the school districts and devise a step-by-step approach to encouraging
change. For example, one fellow needed mentoring in developing her
conversation skills when working with someone she perceived to be a
person in authority. Her university mentor modeled for her how these

conversations might sound, and with this support and guidance, by the third year, the fellow was having these conversations on her own.

In terms of facilitating fellows' growth, the program provided mentorship by taking the fellows' feedback into account, guiding them in developing their teacher leadership plans, and encouraging them to continue to seek leadership opportunities within their districts. One fellow noted how his mentor encouraged him to think more ambitiously about his goals:

> She was instrumental in getting me to realize that I could do more than what I was actually going to do for my [teacher leadership project]. On top of that, I got help from [university mentors] in getting funding for better filming equipment. Throughout every step of the way, they were instrumental in getting me to a point where I could do really solid work.

It is worth noting that in many cases, fellows needed support that went beyond ideas and resources. For example, fellows often needed help in re-shaping their notions of what counted as leadership. One fellow who was working on building a girls' STEM initiative (that would eventually incorporate both girls and boys in the entire school) worried that her goals were too modest and that she wasn't doing the "right" kind of teacher leadership. "That was something that I talked to [the faculty mentor] about…I'm just running a club after school…How am I really being a leader?" Many conversations helped this fellow re-define her notion of teacher leadership, which then pushed her to think more expansively about how to build upon the impact of her work.

Additionally, university mentors supported fellows in accessing other opportunities to engage in the profession. For example, fellows were provided funds to attend national conferences to present their work and to network with other teachers. For some, this was their first experience presenting to peers or attending a national conference, an opportunity that allowed them to share their leadership efforts with the wider research community. Many noted the power of attending and presenting at conferences with university mentors since those experiences helped them to see the broader context and impact of their work.

Besides the support provided by the university, school administrators, district coordinators (DCs), and other members of the school also played a significant role in mentoring fellows in the program. They provided tangible administrative support to the fellows as they discovered their own leadership paths and implemented their teacher leadership plans, from mentoring them in designing their leadership plans to helping them

enact those plans. The DCs enlisted qualified teachers into the program and helped with the logistics of enacting leadership (i.e., scheduling and planning professional development, providing substitute teachers when needed, and arranging schedules and meetings to facilitate teacher leadership plans). They also attended regular meetings with the fellows and extended their support by acting as a liaison between the fellows and the school administration as the fellows pursued their teacher leadership projects.

Extending Teacher Leadership beyond the Program

Our program has offered fellows multiple and various opportunities to grow as teacher leaders. In addition to the regular professional development workshops and the collaborative work that was put into place, the teacher leaders had opportunities to find a network of professionals beyond the walls of their classrooms.

After year two, fellows were encouraged to apply for a mini-grant to extend their teacher leadership project. For some fellows, mini-grants led to looking for and completing larger grant proposals to support new initiatives. For others the mini-grants allowed other teachers in their schools to become involved in new curriculum development. For example, prior to program participation, a Cohort One fellow noticed that the freshman biology classes in her high school were taught using traditional pedagogy with many students failing and having to repeat the class. Participating in the program led her to reflect on her practice and question why so many students were failing. She spent the first year of the program reading research about different teaching practices and attended a workshop about using cases to teach science.

Encouraged by the effectiveness of this pedagogy, she decided to create an individual project that focused on teaching biology using cases with a team of teachers. She and her colleagues collected data that year and found that they had far fewer failures and many more students being recommended for honors-level tenth grade geoscience. In her third year, with support from a mini-grant, she invited her tenth grade geoscience colleagues to participate in the case study method, and has now impacted the science pedagogy of two grade levels. Demonstrating that changing to a more engaging pedagogy leads to achievement, this fellow's teacher leadership project has led the de-tracking of the ninth grade biology classes. In the future, teachers hope to do the same in the tenth grade geoscience classes. The mini-grants funded more sustainable change in

the participating districts and provided fellows with more freedom to take ownership of the changes they were leading in their schools.

Engagement in the program allowed for the fellows to alter their perceptions of their own role as a science teacher. In the process of emerging as teacher leaders, they expanded that role to include more agency into their teaching practice, whether through their independent teacher leadership projects or efforts to sustain their projects (Taylor et al., under review). The program also brought fellows recognition within their districts because their work was viewed as affiliated with an outside source. This helped in giving fellows a voice within their districts and gave their projects credibility. Fellows received recognition in various ways. Some became teacher of the year, and all districts were awarded plaques for their efforts at board meetings. Recognition of the fellows' work allowed them to further their causes and recruit other teachers into their programs.

Their teacher networks naturally extended across three sites, because the implementation of the program is in three states. Each year, one of the sites hosted a conference during which teams from year one presented their work and fellows at the end of year two presented posters of their teacher leadership projects. In addition to workshops led by leaders in the field of science education and teacher leadership, fellows from the three sites had opportunities to share their respective experiences, not just about the program, but about K-12 science education in general.

More than anything, this project provided an opportunity for teachers to be treated as professionals. They attended conferences, presented, and networked with other teachers, both through our program and by meeting colleagues from across the three sites. Many noted that the opportunity to serve as professionals beyond the classroom was central to their growth as teacher leaders.

Nurturing Teacher Leaders: Our Findings

In addition to the features of the Wipro SEF noted above, this work has given us a unique opportunity to analyze the experiences of teachers as they developed into teacher leaders. We have been conducting ongoing recursive research to inform and to hone our professional development practices, and to disseminate findings at national and international conferences and through peer-reviewed publications in the field.

Four major themes emerged from careful analyses of the data.

Ownership

Fellows need to have ownership of the direction of their professional development. They are more invested in the examination of practices when their questions and potential innovative practices directly emerge from challenges they face in the classroom or school. Their motivation needs to be both authentic and organic. This was particularly evident when we examined the transcripts of the vertical team debrief meetings. The most in-depth discussions centered around issues that emerged organically from examining the teaching videos in the debrief sessions. Taking ownership of the conversation was an important step in the fellows' journey toward becoming teacher leaders. The move from providing structured responses elicited by the protocols to communicating shared concerns depicted a development of the team from a pseudo-community (Grossman, Wineburg, & Woolworth, 2001) toward a strong learning community. Moving forward, we plan to foster side conversations that develop organically as a way of gaining deeper insights into how teams take ownership of conversations. Conversations are features of authentic communities of practice that emerge as teachers discuss common goals and questions that are relevant to them (Printy, 2008).

Teachers are the Most Consistent Change Agents

In our extensive experiences of working in partnerships with schools, including prior to this project, we have understood that administrative leadership can have a significant impact on teacher leadership and sustainable school change, and also that administrators are in constant flux and such instability must be anticipated. For example, in one district the superintendent has changed three times in the last four years. The same district eliminated the math/science supervisor position last year. This lack of stability in the upper administration points to the need for classroom teachers, or Wipro SEFs, to be the stable forces that advocate for positive change and lead initiatives in their districts. This finding supports our vision of our fellows' role as teacher leaders. As we mentioned earlier, the Wipro SEF draws from the literature on distributed leadership in which teachers shoulder the responsibilities of change along with school administration to bring about change in their districts (Danielson, 2006; Katzenmeyer & Moller, 2001; Taylor et al., 2011). Teacher leaders are the consistent change agents in their buildings because their leadership work – as well as their leadership identities – emerge from working on issues within their districts.

Principals as Supports

Fellows feel pressure to address district needs, as outlined by district-level administrators, but often the principal is the most significant administrator in determining both needs and implementation. In year one of the grant, principals were not included in the teams and therefore had not been in positions to support the fellows. We would like to provide increased opportunities for principal involvement – but in a twofold capacity as both an administrator who can help to support the teacher leaders and also as a co-learner who understands the complexities of implementing innovative practices to bring about change. Our hope is that these efforts will allow principals to realize the benefits of distributed leadership (Gronn, 2000; Harris, 2010; Muijs & Harris, 2007; Spillane, 2006).

Elementary Science Teachers in Particular Need Support

The fellows in the elementary schools teach a variety of content areas, and hence are naturally interdisciplinary. Furthermore, connecting other disciplines to science is one way to give science adequate instructional time. Our intensive science-focused program allowed the elementary-level fellows further opportunities for reflection about their pedagogical practices in a science content area. The vertical articulation enhanced their understanding of science across the grade levels, enabling them to gain a deeper understanding of the content they teach (Suh & Seshaiyer, 2015).

Supporting elementary science teachers as they become teacher leaders can also encourage recruitment of colleagues to engage in interdisciplinary projects. Many feel isolated without the Wipro community and seek a community of inquiry. Our fellows also sought to build their own communities and transfer what they learned from their experience with the Wipro SEF, developing their own communities for sustained support. This is consistent with the literature, which notes the importance of communities of practice for elementary school teachers (Cook & Buck, 2014; Gellert, 2013).

Conclusion

Much of the research about teacher leadership examines the ways in which teachers enact leadership in schools and districts with little focus on the best practices for the professional development of teacher leaders. The Wipro

SEF provides a model for school–university partnerships that involves teacher leaders, university personnel, and school administrators collaborating to enhance practice and student outcomes in K-12 science education. While much of what we know about effective professional development holds true for teacher leadership development, we also recognize the unique ways in which teacher leaders need to learn and be supported in their growth. We are continually making efforts to improve our program and the findings from our research guide our efforts and provide insight into the design of other programs aimed at developing teacher leaders.

We realize that much of what we were able to offer teacher leaders in the Wipro SEF was a kind of "in between" space for teacher leaders to network, develop, and "tune" their practice with others. Additionally, university-based mentors were able to work within districts where they had long-standing partnerships to help fellows navigate the inevitable challenges of leadership work. Each fellow needed unique and differentiated support, with consideration given to the context of their school and district – support we were able to structure through the flexibility of the second year of the model.

As we conclude three cohorts of the Wipro SEF, we move into a second phase of the project: sustainability and scale. This next phase will seek to build on the significant base of science teachers in each district who have been members of the program. For the next three years, we will support teachers as they become more independent from the program structures. They will be charged with taking lessons learned from their previous experiences as they involve others in professional development practices such as vertically aligned reflective teaching groups, or as they undertake new or expanded teacher leadership projects. In addition to working within their districts, fellows will work to recruit new teachers into the Wipro SEF, challenging themselves to become spokespeople for the program. In this way, our first cohorts of science teacher leaders will continue to be instrumental as our program develops and grows.

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Author Queries

AQ1: Please provide volume number for the reference "Jacobs and Crowell (2016)".

AQ2: Please update the reference "Taylor et al. (under review)" in the list (and text citation also).