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Urban Elementary Science Teacher Leaders: Responsibilities, Supports, and Needs

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Abstract

The challenge of science achievement gaps is one that scholars have struggled to solve. Teacher leadership holds great promise in closing those gaps. Therefore, the purpose of the research reported here was to explore the responsibilities and supports of formally designated science teacher leaders (STLs) in urban elementary schools that have been successful in closing science achievement gaps. Using York-Barr and Duke's (2004) review on teacher leadership as a framework, findings from this study indicate that urban elementary STLs emphasize certain dimensions of practice (e.g., building partnerships) while deemphasizing or even omitting others (e.g., working with preservice teachers). Findings also indicate that a positive culture that supports STEM education, a principal that works with the STL yet encourages autonomy, control over scheduling, and training for the STLs seem to best support STLs. Finally, it appears that STLs would benefit from more targeted training and evaluation measures, and an STL network. Given that this study took place in schools that have been successful in closing science achievement gaps, these findings have implications for schools that wish to employ STLs to promote more equitable science achievement.

Introduction

The achievement gap can be defined as "the observed disparity in a number of educational measures in academic performance between different groups of students, especially groups defined by race/ethnicity, gender, and socioeconomic status" (Clark, 2014a, p. 3). However, this work refers to multiple achievement gaps rather than a singular gap, as it is noted in this definition that there are multiple disparities that exist in academic achievement amongst different groups in the United States. Although progress has been made concerning overall academic performance in science for students in the United States, large disparities remain between the science achievement of African American and Latino children when compared to that of their White and Asian classmates as well as between the science achievement of high- and low-income children (Darling-Hammond, 2014). As a result, the groups on the lower end of the gaps are severely underrepresented in the STEM workforce (Clark, 2014b). Given that, in the United States, minority children are the fastest growing school population (Clark, 2014b) and that 44% of children under 18 are from low-income families (Jiang, Ekono & Skinner, 2015), it becomes imperative to determine how to increase levels of science achievement for these students.

The challenge of science achievement gaps is one that scholars have struggled to solve. Recent efforts to address this vexing problem are exemplified by conceptual shifts in the Next Generation Science Standards (NGSS; NGSS Lead States, 2013) as well as the section in the NGSS entitled "All Standards, All Students" that details successful teaching strategies for non-dominant student groups. But by framing achievement gaps as solely a human capital problem in which teacher quality and pedagogy are the main concerns (e.g., Johnson, 2009; Lee, Deaktor, & Enders, 2008), only negligible progress has been made towards closing elementary school science achievement gaps. Perhaps this is because teachers and classrooms do not function as islands, particularly when it comes to school improvement and reforms. For example, Johnson (2013) has suggested that various system-wide policies can derail even the best-designed professional development (PD) while Finnigan and Daly (2012) have found that a school's climate and social networks can make reform difficult.

It could be argued, then, that rather than focusing exclusively on the classroom, scholars should also attend to schoolwide factors, such as school leadership (Little & Bartlett, 2010). Muijs and Harris (2003) have stated, "While the quality of teaching most strongly influences levels of pupil motivation and achievement, it has been demonstrated that the quality of leadership matters in determining the motivation of teachers and the quality of teaching in the classroom" (p. 437). Teacher leadership in particular holds great promise for schools wishing to close the achievement gaps, as it has been contended that teacher leaders have the capacity to lead the school via increasing teacher collaboration, spreading best practices, offering assistance with differentiation, and focusing on content-specific issues (Curtis, 2013; Muijs & Harris, 2006).

However, *science* teacher leadership must be considered unique. Science sits apart from other content areas due to teacher attitudes, materials, and safety. In terms of standards, the three-dimensional instruction/learning (science and engineering practices, crosscutting concepts and disciplinary core ideas) as described by the NGSS (Lead States, 2013) is certainly distinctive and requires a sophisticated understanding of real world science. As science expertise applies to

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leadership, Stein and Nelson (2003) state that, “Without knowledge that connects subject matter, learning, and teaching to acts of leadership, leadership floats disconnected from the very processes it is designed to govern” (p. 446). Indeed, as Turner (2003) found, the content area dictates how leaders perceive and enact their work. Further, Manno and Firestone (2008) found that ‘content experts’ were better able to lead their colleagues by recognizing and correcting gaps/misconceptions in content knowledge, and were thus better able to build trust with and provide PD to their colleagues.

Therefore, to close science achievement gaps suggests the need for a science teacher leader (STL) rather than a ‘generic’ teacher leader. Consistent with Peacock’s (2014) historically-based findings that science department chairs (a particular type of STLs) have the capacity to lead school change, this study viewed school-based STLs as capable of leading an entire K-8 school in science, beyond the realm of a specific initiative/reform. As such, it would behoove stakeholders to know more about how to create and support STLs. Unfortunately, scholars who discuss STLs in the literature often do so within the confines of a specific curriculum/program (e.g., Hanuscin, Rebello & Sinha, 2012; Lord, Cress & Miller, 2008; Howe & Stubbs, 2003). Consequently, the purpose of the research reported here was to explore the responsibilities and supports of formally designated STLs in urban schools that have been successful in closing achievement gaps in science.

Theoretical Framework

This study looked to York-Barr and Duke (2004) and their seminal literature review on teacher leadership to frame perspectives concerning science teacher leadership. In particular, this study sought to uncover what STLs do, what conditions influence STLs, and what might be done to increase the effectiveness of STLs.

York-Barr and Duke outlined seven dimensions of practice for teacher leaders ranging from coordination and management to educating preservice teachers (see Table 1 for more detail). It was hypothesized that practices of urban elementary STLs would deviate slightly from this list due to the particular needs of their student population. For example, perhaps these STLs focus more on parent and community involvement because encouraging family involvement and forging partnerships with external agencies has been shown to be beneficial in supporting student learning (Epstein & Sanders, 2006; Fullan, 2000). Additionally, urban elementary STLs may have more pressing concerns due to the unique complexities found in urban schools and find themselves unable to perform duties that contribute to the profession or educate preservice teachers.

Given these complexities, we not only need to better understand urban elementary STLs’ job responsibilities but also the organizational and leadership structures within which they work. Again, using York-Barr and Duke’s (2004) review as a framework, this study concentrated on factors within three categories: school culture and context, roles and relationships, and structures. While York-Barr and Duke listed both facilitators and challenges in each of these categories, this study focused solely on factors that facilitate STLs’ work (see Table 2 for more detail). Again, it was hypothesized that these categories may not be equally represented in this study, as STLs in urban schools may benefit more from particular supports and structures than STLs in other settings. For example, Mangin’s (2007) research in high-needs districts indicated that items related to roles and relationships in particular played a significant part in supporting teacher leaders.

Finally, York-Barr and Duke (2004) noted that there is still a great deal of research to be done in the area of teacher leadership, and suggested possible avenues for those investigations. One such question they posed was, “How can the work of teacher leaders be structured to maximize positive effects on teaching and learning…?” (p. 292). In that vein, urban elementary STLs may need additional supports specific to their content area or particular position. Consequently, while York-Barr and Duke’s review of the literature was not specific to science, their work provides a firm foundation to better understand the responsibilities, affordances, and needs of urban STLs.

Table 1. Teacher leader dimensions of practice

Dimension	Examples
Coordination and management	*Scheduling *Administrative meetings/tasks *Monitoring improvement
School and district curriculum work	*Defining standards *Selecting/developing curricula
Professional development (PD) of colleagues	*Mentoring *Leading workshops *Peer coaching *Modeling
Participation in school change/improvement	*Participating in school-wide decision-making *Working in committees for school change *Facilitating organization-wide learning *(Action) research, challenging status quo
Parent/community involvement	*Encouraging parent participation *Creating partnerships with community organizations
Contributions to the profession	*Participating in professional organizations *Political involvement
Preservice teacher education	*Partnering with universities to prepare preservice teachers

Adapted from York-Barr & Duke (2004), p. 266

Table 2. Facilitating factors for teacher leadership

Category	Description
School culture and context	Norms and expectations that promote teacher learning, inquiry, professionalism, shared leadership. Teacher leader position is valued.
Roles and relationships	Positive and trusting relationships between the teacher leader and peers as well as the principal. Teacher leader has well-defined job responsibilities that are clearly aligned with teaching/learning.
Structures	School has structures/processes in place that support teacher learning and shared decision-making.

Adapted from York-Barr & Duke (2004), p. 271

Research Methods

The following questions guided this research:

1. How do STLs in urban elementary schools describe their tasks and activities?
2. What organizational and leadership structures support urban elementary STLs in their work?
3. What do urban elementary STLs recognize as items that would improve their work?

To identify participants for this study, a multilevel model was created in which student demographics predicted their science scores on the 5th grade state standardized test in a state in New England (see Settlage, Butler, Wenner, Smetana & McCoach [2015] for details). Schools that outperformed expectations were identified; these schools are termed "positive outliers." From this list of schools, five STLs who had formally designated positions were contacted. While informal STLs at positive outlier schools most certainly exist, only those who held an official position were interviewed (e.g., Science Coach), as it was believed that they would have greater insight into what it meant to be a science teacher leader specifically (rather than a generic teacher leader). Details about the participants can be found in Table 3.

Data were collected via one-hour semi-structured interviews (Roulston, 2010) with the STLs to talk specifically about their work. Once transcribed, the interviews were read line by line to find examples from either the seven dimensions of practice or the three categories of facilitating conditions from York-Barr and Duke's (2004) review. Quotations that exemplified these codes were copied into a spreadsheet. Each transcript was read in this manner multiple times in order to answer the first two research questions. Examples that seemed consistent with either the dimensions of practice or facilitating conditions but were not explicitly described by the literature reviewed by York-Barr and Duke were marked to see if there were patterns that might be considered unique to STLs.

To analyze data for the third research question, each transcript was read several times in order to find occasions in which the STLs discussed what they felt would make them more successful in their work. These passages were copied

Table 3. Study Participants

Science Teacher Leader	School Name	Position Title	Years of Teaching Experience (Total)	Years in Position	Content Background	School Population*	% African American*	% Hispanic*	% FRPL*	2014 School Residual
Kelly	Brooks	STEM Coach	10	1	Public health/ engineering	87 (4)**	18%	49%	51%	0.38
Sara	Williams	STEM Coach	20	1	Meteorology/ Agronomy/Early Childhood Ed.	528 (PK-5)	29%	34%	78%	1.00
Jackie	Wonder	Science Resource Specialist	19	3	Biology/ Elementary Ed.	457(PK-7)	30%	32%	99%	1.07
Lisa	Jones	STEM Specialist	26	3	Elementary Ed./ Curriculum specialist	364 (PK-5)	9%	38%	45%	2.46
Wendy	Adams	Science/Magnet Specialist	20	7	History/ Elementary Ed.	579 (K-5)	20%	53%	64%	3.68

* All demographic information was found via the National Center for Educational Statistics and reflect 2012-2013 school year data

** Brooks is a new school that is building to a grades 4-8 school; demographic data are based on solely grade 4. At the time of the interview the school was grades 4-5.

and then became the basis for axial coding (Strauss & Corbin, 1998), in which the quotations/items were clustered and categorized. From these categories, themes were constructed. After the themes were constructed, the transcripts were read a final time to discern whether or not these themes were appropriate in light of the whole conversations with the STLs.

Findings

Tasks and Activities

The findings indicate that the five STLs have responsibilities in six of the seven main areas as identified by York-Barr and Duke (2004): coordination and management, school curriculum work, PD of colleagues, participation in school change/improvement, contributions to the profession, and parent and community involvement. The only area that was not represented was work with preservice teacher education.

In terms of coordination and management, each of the STLs' main responsibility was to handle the ordering and distribution of age-appropriate science materials. Variations of this ranged from Lisa creating the materials budget for the entire STEM program at Jones School to Jackie assisting teachers in not only procuring the materials, but also setting them up for lab activities. Other coordination and management responsibilities included supervising after-school programs, running science fairs, investigating and organizing field trips, and even directing the application process for the magnet program within the school.

Another large part of the STLs' jobs was to interpret the curriculum for their peers and create lesson plans and curricular maps. Jackie explained this work by saying, "I help them [the teachers] decipher what the standards mean and how we can connect the standards to the Next Generation Science Standards. I try to be one step ahead of the teachers, so that I can help them in any way." This responsibility involved a great deal of behind-the-scenes work and preparation on the parts of the STLs. Sara, for example, worked very closely with the district's chief academic officer to create a four-year plan to roll out the NGSS. Kelly collaborated with a local science center to align field trips and activities to the state science standards. Wendy collected resources so lessons could be specifically revamped to meet the needs of students at her school. All STLs described some sort of curricular map and accompanying process similar to that of Jackie's:

> I have a spreadsheet that has kindergarten all the way up to eighth grade and it's broken up by marking period…Within that spreadsheet, then I take…their four marking periods [and] what the units are that they do in those marking periods, and I try to use resources that we already have…I bold them [the resources] and put down different foci that they need to focus on. From there, I will meet with the teachers before that marking period… I'm looking at the standards that the state gives us, a lot of the teachers look at it and they shut down. So I try to take this and break it down into the expectations that the kids need.

Given the increased emphasis on accountability and testing – even though science is only tested in fifth grade and eighth grade in this state – the STLs devoted a great deal of time to ensuring that teachers in their schools were teaching all the science standards correctly and appropriately.

STLs also helped teachers by guiding PD at their schools via modeling lessons, serving as a resource for ideas and content, and determining what PD topics were needed by the teachers. Sara used a multi-prong approach to assisting teachers in getting acclimated to a new science program:

> Whether it's just how do you navigate through the teacher materials or how do you set up your classroom to support science or math workshops or how do you begin or how do you use data to instruct your kids, I do that. Sometimes it's short-term and sometimes it's a long-term basis…So I do everything from the one-to-one coaching to providing workshops.

Like Sara, the other STLs served as resources for their colleagues in a variety of ways, from as-needed assistance to weekly team meetings/PD, but the most common modes of support were planning lessons with teachers and modeling lessons in teachers' classrooms. Additionally, some STLs like Kelly observed teachers as they taught the co-planned lessons so they could provide feedback later; Kelly wanted to "see the whole process" to be better able to support her colleagues. Finally, Wendy pointed out that while she may not provide a great deal of "big group" PD, if teachers ask for PD, she will find it for them so they may enrich their practice.

Only two of the five STLs participated in school change/improvement as described by York-Barr and Duke (2004), and they did so by helping create a vision for the school or being a part of school governance/leadership groups. Lisa was tasked by the principal to "develop [their] narrative as a STEM school." She joked that the principal had told her that, "I want a STEM specialist whose job it is to think about STEM 24/7." Consequently, Lisa stated that a large part of her job was creating a vision regarding STEM and communicating that to parents, teachers, and students. Kelly, on the other hand, affected school change by being involved in her school's governance council, with a particular focus on using student data to make informed decisions. She often worked in her capacity as a STEM coach to review student data with teachers with the ultimate goal of improving instruction and student outcomes. The other three STLs did not mention any items related to school/improvement change.

STLs' contributions to the profession took the form of being a part of STEM-related committees and organizations. Three of the five STLs mentioned participation in these types of groups. Sara kept her involvement to the district level and facilitated district-wide STEM and math committees while Lisa and Kelly participated in organizations both in their district and beyond. In addition to district-level STEM committees, Lisa was part of the state's Common Core Coaching Network and Kelly was a part of the state's NGSS committee, a statewide charter school science council, and the National Science Teachers Association (NSTA). The other two STLs did not mention being a part of any leadership/professional organizations related to their work as STLs.

Finally, all of the STLs were heavily engaged in developing community partnerships and promoting parental involvement. In terms of community partnerships, they each had forged fruitful partnerships with a variety of entities, including hospitals, museums, aquariums, science supply companies, and several local corporations. Kelly shared that when working with these partners, her typical conversation consists of, "This is what our kids need, this is what our teachers need. What can you provide and what can we do to work together?" In addition to creating partnerships with community members, all of the STLs sought to encourage parents and families to be partners in their students' science education. To those ends, the STLs created and coordinated several science-related events for families. At Jones School, there are morning playgroups for local families two mornings a week and Lisa has attended these playgroups a few times so families could better understand her role in the building and provide feedback on the STEM program. Similarly, Kelly often attends PTO and holds recruitment events so she can get to know current and future students' families better. Jackie created a *Take-Apart* family night in which she "brought all kinds of old broken things [like] CD players, VCRs, mother boards, whatever it was, and…this engineer and the kids and their parents, they worked together to take these things apart and learn about what is inside of them." Each of the STLs described their partnering efforts with great enthusiasm and seemed to truly enjoy this part of their job.

Supports for STLs

The STLs were supported by items from all three of the categories outlined by York-Barr and Duke (2004): school culture/context, roles/relationship, and structures. First, the overall school culture had a large impact on how well the STLs could lead the school in science. Each of the STLs described school cultures in which STEM education was valued, there was a shared vision amongst the staff members that included STEM education, colleagues working well together, and the improvement of teaching practice as the norm. For example, Sara noted,

> I think one of the reasons the change [to a STEM-focused school] happened so well at Williams school is teacher leadership. The STEM committee has representation from each grade level and it builds up the capacity of the people sitting around the table. They're a great group because…they want to know everything there is to know about STEM for all the grade levels. And so I think what they've done is they've infiltrated each of their individual grade levels with some best practices.

Lisa also appreciated the culture of her school, stating,

> I would not have wanted to be a STEM specialist if it wasn't for the environment here. Just hearing that vision in terms of how kids learn and the school environment that I wanted my whole career…I don't think this job would be as rewarding if it wasn't for the teamwork between the curriculum specialist, myself, and the principal. And the teachers. There are great teachers who are going the extra mile.

Having this sort of collegial, learning-centered culture clearly enabled the STLs to fulfill their job responsibilities as described above, such as provide PD and coordinate STEM-related programs.

In terms of roles/relationships, the relationship with the principal seemed to be key to the work that the STLs were able to accomplish. Every one of the STLs described keeping in constant communication with their principals concerning materials, schoolwide goals, and instructional issues. However, that is not to say that the principals micromanaged the STLs. On the contrary, each of the STLs described the freedom and trust given to them by the principals. For example, Lisa said of her principal, "He's the visionary. He says it and I'm the implementer. And we're a great complement because the details are beyond him…I've been given a lot of responsibility and trust to do my role." Jackie discussed her relationship with her principal by saying, "[I have] so much freedom – I'm telling you – having the support of the administrative staff…she's just full-blown, Yes! Whatever you need!" In turn, these positive relationships with the principals resulted in positive relationships with the teachers, which then facilitated better quality STEM instruction. As Kelly was eager to say about STEM education at Brooks School, "It's a community. It's not just me."

Finally, concerning structures that supported the STLs' work, opportunities to attend PD and having control of their own schedules also played important roles in their success. All of the STLs referred to the importance of continuing education in order to fulfill their job responsibilities. In most cases, their principals provided time and/or paid for the STLs to attend these trainings/conferences. These opportunities focused on increasing STEM content knowledge and processes and ranged from training to be a trainer for a new engineering curriculum to learning more about inquiry at a local museum to attending NSTA conferences. A second structure that supported STLs was that by and large, the STLs had control over their own schedules. As an example, when Jackie was asked how much time she was given to fulfill her role as an STL, she replied,

> All the time my little heart desires! The whole success of this role is because I have the administration staff that believes in me and supports whatever I do. They don't have to

> pull me for classes – I'm not a substitute – if we turn out to be short handed, they just leave me alone and let me do my stuff.

The other STLs replied in a similar fashion to this question, noting that they are often "left alone" to schedule teacher observations, PD, and planning as they see fit.

Items to Improve STLs' Work

Lastly, the data revealed some ideas for changes that would better support the STLs in terms of PD, evaluations, and networks. Regarding PD, while all of the STLs did attend numerous trainings on STEM content and processes, most of the STLs still felt this was not enough. The STLs revealed specific PD needs associated with their STL work like even more content, specialized pedagogical skills, and organizational skills. Sara argued that, "I think in a STEM [leadership] position, people need to know what are the 'big truths' as we know them now in science." Wendy also saw the need for a broad, comprehensive content knowledge base in her position because, "In elementary you're teaching all the disciplines so it's not like you're just teaching biology and you can focus on that. You're doing it all." However, content was not the only need in terms of PD. Lisa pointed out that in her training to be a teacher, "You don't get taught in how to teach adults." Several of the STLs stated that teaching adults was difficult and that it required special skills that they lacked and they had to learn as they went. Finally, Jackie indicated a need for more education on how to organize the different aspects of her work so that all of her tasks could receive equal attention and priority.

A second need observed was that STLs may benefit from an evaluation system that is designed specifically for their positions. All of the STLs were evaluated using the standard teacher evaluations from the state, which could be difficult to align with their unique job responsibilities. As Wendy described it, "I get evaluated just like everybody else. It's not so much as a leader but it's just as a teacher." But evaluating the STLs using the same instrument as is used with other teachers did not credit these STLs for all the work they did. For example, Lisa's evaluation in the previous year was based on a co-taught lesson, but did not take into account all of the work she had done working with parents in STEM events. Similarly, Jackie described how she would be observed in the coming year as she modeled a lesson for a teacher, but that:

> [The principal is] probably looking at it in different ways…But I don't know if she would see how I connect with the teacher that's there or how I integrate all of that together. I think when I get evaluated they just kind-of look at different things.

This ambiguity of what principals were looking for in terms of evaluating the STLs' work was consistent across all of the participants, and points to the need to create an evaluation system that accounts for the full scope of STLs' work.

A third item that STLs identified as being potentially beneficial to their work was a support network that would enable them to communicate with other STLs. Lisa and Wendy stated that they were the only STLs in their districts, while Jackie said there was one other STL in her district but, "I don't even know what the other lady is doing." Kelly suggested an STL network, but did acknowledge that this still not might be as helpful as hoped due to the idiosyncratic nature of formalized STEM teacher leader positions:

> It would be really cool if the state had a STEM program where the STEM coaches could all meet and collaborate…and seek out people who are doing the job to see what they do and to see if that's something you would like to do. But it all depends on your leadership in your school and what your job really is. Our principal wants us to be in the classroom but not necessarily teaching the class. Other STEM coaches are teaching a class.

In fact, Jackie had reached out to STLs in neighboring districts, but found herself discouraged, stating, "I took a couple of their ideas, but neither one worked for the school…So I'm just trying to make it work. Everything is different [at different schools], which is very frustrating."

Discussion

This research sought to better understand the responsibilities, supports, and needs of STLs in urban elementary schools. Reflecting on the seven dimensions of practice, the STLs in this study did perform tasks in six of the seven categories; they did not work with preservice teacher education. This confirms the hypothesis that urban STLs emphasize some dimensions of practice and deemphasize others in order to best serve their school. These findings are similar to another study of STLs conducted by Hanuscin et al. (2012) in that STLs participated in different activities to varying degrees. However, in the Hanuscin et al. study, their participants were involved in preservice teacher education and school improvement activities at a much higher rate than the participants in this study, and involved in providing PD to their colleagues at a lower rate than the participants in this study. This finding of urban STLs tailoring teacher leadership responsibilities is important to consider, given that these STLs are in positive outlier schools. Their schools may have found success in closing the science achievement gaps because the STLs have chosen to focus on items that are more relevant to urban school contexts.

Moreover, it should be pointed out that there was one task that all of the STLs cited as a large part of their job, but was not explicitly a part of York-Barr and Duke's seven dimensions of practice for teacher leaders--managing materials. This may have been absent from York-Barr and Duke's list simply due to the special nature of science as a subject that requires a great deal of supplies for students to be able to manipulate and observe scientific processes and phenomena. However, the findings from this study indicate that the expert management of the purchase and allocation of science materials is central to STLs' work. In their study, McGuigan and Hoy (2006) describe the work of leaders who enable academic success for all students and state that, "Whenever a school makes time or resources available to improve teachers' instructional methods, it is increasing the opportunities for successful teaching, and thus for mastery experiences" (p. 213). Similarly, Horng and Loeb (2010) indicate that strong organizational managers who effectively manage resources can contribute to increased student achievement. Finally, Manno and Firestone (2008) assert that strategic management of materials can promote school change and reform. Given that this was such a large part of the STLs' jobs, it is not surprising they were in science-successful schools.

In terms of supports for the STLs, they were supported by items from all three of the categories outlined by York-Barr and Duke (2004): school culture/context, roles/relationship, and structures. This is consistent with Lewthwaite's (2006) contention that both personal and environmental factors impact the success of teacher leaders. In particular, a positive culture that supports STEM education, a principal that works with the STL yet encourages autonomy, control over scheduling, and PD for the STLs seem to be the most common supports. Interestingly, while the STLs pointed to PD as being incredibly helpful to their work, this was not an item explicitly mentioned by York-Barr and Duke (2004) as being a support to teacher leaders. Besides obtaining training in content, research has demonstrated that PD can be vital for teacher leaders due to the support networks and partnerships that are formed (Durias, 2010; Edge & Mylopoulos, 2008). For example, Brosky (2011) noted that teacher leaders who were enrolled in a PD program "pointed to their colleagues in the program as means of support in terms of resources and contacts for input" (p. 6).

However, while the STLs described a number of supports for their work, they did share their frustrations about their positions. Namely, they felt that both PD and evaluations targeted for STLs as well as STL networks would greatly improve their work. Wenner and Campbell (2016) found in their review of teacher leadership literature from 2004 to 2013 that seemingly effective teacher leadership preparation programs should not only include instruction related to content, but also pedagogy and leadership skills. Hofstein, Carmeli, and Shore (2004) asserted that in the past, leadership skills were often neglected in PD presented to those who were expected to lead their schools, leaving teacher leaders at a great disadvantage. Loucks-Horsley, Stiles, Mundry, Love, and Hewson (2009) acknowledged that teacher leaders must develop expertise in adult learning if they are to provide PD to others. Dedicated PD for STLs, then, seems necessary if STLs are to be successful in their roles.

Regarding professional evaluations of the STLs, it is disappointing to think that these STLs are not being evaluated on their full scope of work. While teaching in a classroom (typically as a model teacher) can be a large part of the STLs' work, STLs do much more than teach. Peacock (2014) provides a conceptual model for science instructional leadership that is composed of four areas: increasing science leadership content knowledge, advocating for science and science education, building a collegial environment, and negotiating context and solving problems. This conceptual model specific to science teacher leadership, in addition to the Teacher Leader Model Standards (www.teacherleaderstandards.org), might be good starting points to begin building an evaluation appropriate for STLs.

Finally, Hatch, White, and Faigenbaum (2005), argued that networks in which teacher leaders can "see and hear what teachers in other schools and districts are doing can begin to create the common language, sophisticated representations, and connections that foster the development and sharing of new ideas and improvements in practice" (p. 1029). As previously noted, PD can help create some of these networks, as can the statewide committees in which the STLs participate. However, even with these few networking opportunities, the current lack of coordination amongst STLs scattered across the state appears to be preventing STLs from improving their practice.

Conclusion

Teacher leadership has become an increasingly popular topic amongst educational policymakers and influential educational organizations as an important component of school reform. Specific to science education, NSTA drafted a position statement on leadership in science well over a decade ago. In short, it states that a leadership team consisting of administration, teacher leaders, and community members must work together to bring about science education reform so that *all* students may achieve scientific literacy. While STLs are a key piece of this equation, we still have much to learn about how to best support STLs in this important work in a variety of settings. Without strong STLs, we cannot expect science instruction/learning as advocated in the NGSS to move forward in a productive manner for all students.

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