In or Out of the Classroom? Differentiating Science Teacher Leaders and District Science Coordinators: A Literature Review

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Due to the lack of research, District Science Coordinators (DSCs) are frequently misidentified as Science Teacher Leaders (STLs). It is important to establish a clear distinction between the roles to differentiate professional learning, understand responsibilities, and clearly define the network of influence each of these leaders holds. This literature review explores the salient similarities and differences between STLs and DSCs while attending to their individual roles, responsibilities, and professional support. The literature demonstrates that STLs and DSCs are essential in facilitating professional development, collaboration with colleagues across schools and supporting teacher and student learning. Differences between the two include classroom teaching assignments and official titles, and this is a large distinction in the literature. This research holds promise to properly support each type of leader with relevant professional learning encompassing pertinent issues to each group.

Keywords: District science coordinator, science teacher leader, leadership

Introduction

There are different types of leadership in public school systems. Teacher leaders (TLs) may have formal titles such as department chair, grade level coordinator, or middle leaders, and carry specific responsibilities and work between teachers and school administrators. Other teachers may engage in leadership roles without a title. The definition of a TL varies within contexts, and researchers are still exploring the roles and responsibilities of TLs. In the most current review of science teacher leader (STL) literature, Whitworth and colleagues (2022) define an STL as "a teacher of science who influences others while developing their leadership identity, and who uses their social, cultural, and symbolic capital to advocate for science and promote student learning" (p. 251).

In addition to TLs (or STLs), school districts sometimes have content coordinators overseeing curriculum implementation, facilitating teacher professional development, and standards alignment for a specific subject area. Content coordinators or supervisors are a relatively under-researched area in education research (Whitworth & Chiu, 2015; Whitworth et al., 2017b). These positions are a different type of leadership outside the classroom and should be considered separately from teacher leadership, yet content coordinators are sometimes called TLs because research has yet to distinguish between the two roles. Content coordinators, more specifically district science coordinators (DSCs), are "involved in the administration and execution of leadership activities associated with curriculum and instruction" in science

(Whitworth & Chiu, 2015, p. 130). These titles, STLs and DSCs, are sometimes used interchangeably, but research finds they are distinctly different positions (Whitworth et al., 2022).

Differentiating STLs and DSCs may lead to focused professional learning pertinent to each role, establishing coherence and allowing the individual to immediately implement new learnings. This review explores the literature on an STL and a DSC, intending to provide specific differentiation between these two types of science educational leaders. The findings from this review could inform district organizational structure and start to refine the roles and responsibilities of each leader.

Methods

This literature review aims to synthesize the literature about DSCs and STLs. It seeks to differentiate between individuals titled "teacher leaders" and those who serve in content administrative roles (i.e., those no longer teaching in the classroom). The following research questions guided the review of the literature:

1. How are DSCs and STLs defined in the literature?
2. What are the similarities and differences in the professional roles and responsibilities of DSCs and STLs?
3. What types of programs support the development of DSCs and STLs?

Systematic Review Design and Search Process

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method (Moher et al., 2010) was followed for this manuscript. The EBSCO and ERIC databases were used to identify potential peer-reviewed studies. Search keywords specific to teacher leadership, subject coordinator, district coordinator, specialist, professional development facilitator, and science were used and combined using the operator "AND" (Table 1). The search included articles published between 2013 and 2023, as the Next Generation Science Standards (NGSS; NGSS Lead States, 2013) were released in 2013, and a literature review discussing the DSC position was also written (Whitworth & Chiu, 2015). Teacher leadership is an expanding field in all content areas, and to better understand this role, articles from other content areas were also included. The search process resulted in 1,860 citation records.

Table 1
Keyword Search

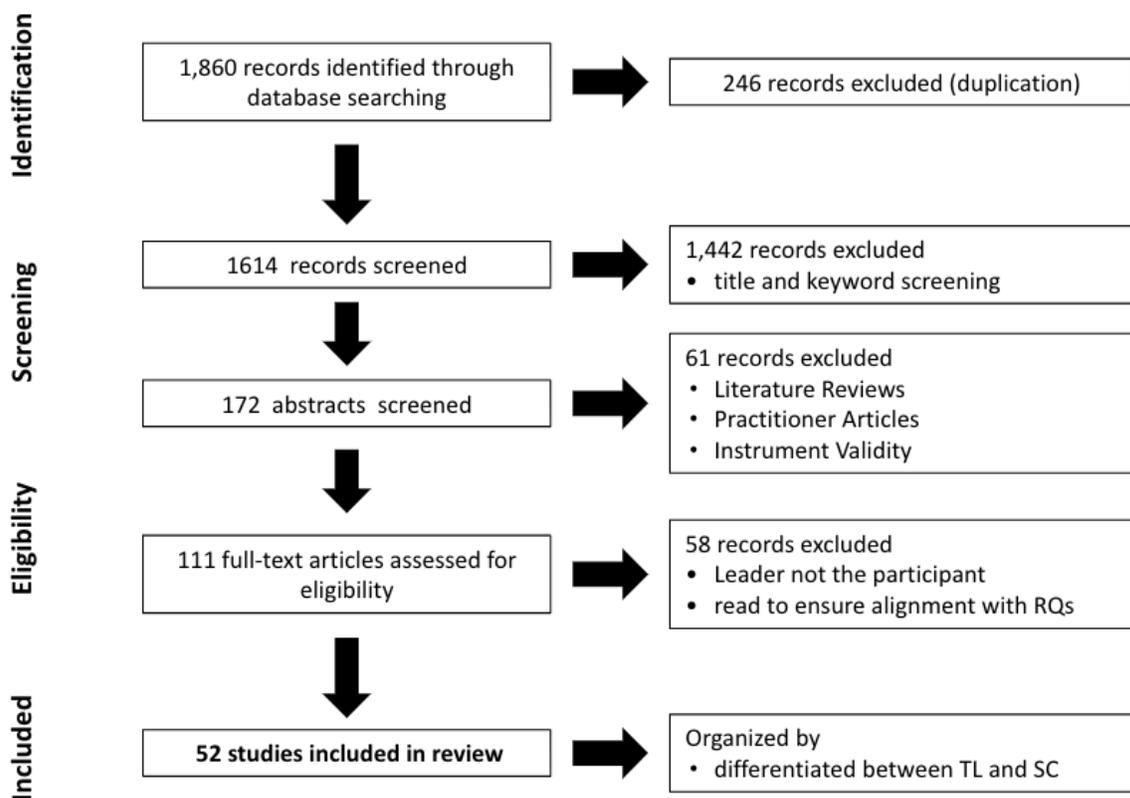| Database keywords search			
Keywords searched alone	**Keyword search with "AND" operator**		
"science teacher leaders" "district science coordinator" "science specialist" "science coordinator" "science teacher leadership"	"science"	"AND"	"teacher leadership", "subject coordinator", "teacher leader", "professional development facilitator", "specialist", "coordinator"

Screening Process and Inclusion

A decision tree was created to identify studies based on the following inclusion criteria:

- The paper was written in English,
- The paper was an empirical peer-reviewed article from an academic journal,
- The paper was not a literature review, practitioner article, test of instrument or theory, dissertation, or book chapter, and
- The research of the paper centered on TLs or subject coordinators.

Figure 1 provides a visual for the inclusion and exclusion process, as described above and below. During the first round of screenings, 246 records were excluded due to being duplicates. From here, 1,614 records were screened and excluded based on title and keyword alignment. Then, 172 record abstracts were screened to include only empirical articles. This left 111 full-text articles to be assessed for eligibility in the review. Articles not centered on the TL or content coordinator were excluded as they needed to be aligned with the research questions. This resulted in 52 articles to be included in the review. These 52 articles were organized by participant(s) in the research, with 45 about TLs and seven articles about content coordinators/facilitators.

Figure 1

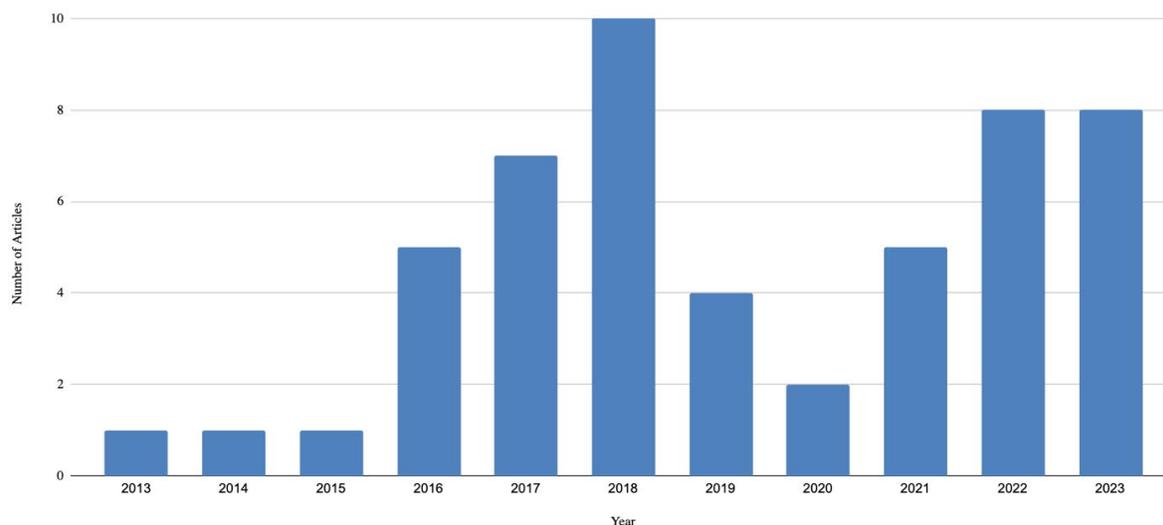*PRISMA flow diagram, based on Moher et al. (2009)*

Data Collection and Analysis

  The 52 articles were downloaded and saved by type of participant (TL, DSC) into Zotero, a reference management system. A Google Sheet system was devised to track the article's author, title, year of publication, and journal title. Furthermore, columns were created to allow notation of the country, subject area of the research, if a preparation or professional development program was described and for each of the three research questions addressed in this review. Notes summarizing each column were added while reading. From these notes, an inductive analysis was completed to analyze the article information. Articles were coded based upon each research question using codes such as influence, classroom responsibilities, advocate, and modeling. These codes allowed quick organization of articles with the same code, leading to themes emerging from the literature to answer the research questions.

  Basic count data was visualized from the analysis (see Figure 2) to understand the evolution of the research over time and content area (see Table 2).

Figure 2

Number of Articles Published by Year

Table 2

Content Area and Number of Articles

Content Area	Number
Not Specified	13
Various	9
Math	5
Science	16
Sci/Math	8
ELA	1

Results

This review aimed to distinguish between the role of a DSC and STL to further characterize each correctly in future literature. This section will present results specific to the overall characteristics of the articles reviewed. Then, each research question will be answered by summarizing what was found in the literature.

Literature Characteristics

The final 52 studies included in the review were published across 30 peer-reviewed journals (see Table 3 below). Many articles surround teacher leadership (45), while only seven pertain to DSCs or professional development facilitators.[1] Fifty percent of the articles reviewed were found in the *International Journal of Leadership in Education, Professional Development*

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[1] The term 'professional development facilitators' appears in the international literature pertaining to individuals with similar job descriptions as district science coordinators.

in Education, and the *Journal of Research on Leadership Education*. Search parameters between 2013 and 2023 saw an increase in articles by 2018, the median year investigated, followed by a decrease in 2019-2020 and a steady increase to the present (see Figure 2 above). More than 75% of the research from these articles occurred in the United States, with one article spanning both the U.S. and Jamaica.

Table 3
Number of Journals by Title

Journal Title	Number of Articles
Cambridge Journal of Education	1
Education and Urban Society	1
Educational Management, Administration & Leadership	1
International Journal of Educational Management	1
International Journal of Leadership in Education	6
International Journal of Science and Mathematics Education	3
International Journal of STEM Education	1
International Journal of Teacher Leadership	1
Journal of Education for Teaching	1
Journal of Educational Change	1
Journal of Professional Capital and Community	1
Journal of Research in Science Teaching	1
Journal of Research on Leadership Education	4
Journal of Science Education and Technology	1
Journal of Science Teacher Education	3
Leadership and Policy in Schools	1
McGill Journal of Education	1
Professional Development in Education	5
School Leadership & Management	2
School Science and Mathematics	1
Science Education	2
Science Educator	3
Teacher Development	1
Teacher Education Quarterly	1
Teaching and Teacher Education	2
Teaching Education	1
The Journal of Mathematical Behavior	3
The Journal of the Learning Sciences	1
The Professional Educator	1

Other articles were from Australia, Canada, China, Israel, Sweden, and the United Kingdom (see Table 4). Over half of the articles defined a specific content area (28), while others engaged participants from various disciplines (24).

Table 4
Number of Articles by Country

Country	Number of Articles
USA	41
Australia	2
China	2
Canada	2
UK	2
Sweden	1
Israel	1
Combination	1

Research Question 1: How are DSCs and STLs defined in the literature?

Research surrounding DSCs is meager, and all contain a similar definition. STL descriptions vary slightly in the literature, with several similar characteristics.

District Science Coordinators

Whitworth and colleagues (2017a) describe District Science Coordinators (DSCs) as educational leaders who hold a science or education undergraduate degree, are former classroom teachers, and oversee the science curriculum in a district. A DSC may manage all levels of K-12 science content or a portion of science content, such as K-5, K-8, or 9-12 Sometimes, DSCs manage more than just science and have added curricular responsibilities in STEM, engineering, or other subjects. In the same research, over 90% of DSCs surveyed reported their top three responsibilities as aligning curriculum with state standards (93%), distributing information to teachers in their district (92%), and working with administrators (92%). DSCs collaborate with school principals and seek to advocate for science instruction through this partnership. DSCs have an administrative role and could influence teachers' practice (Lee, 2014), but they rarely have evaluative responsibilities (Whitworth et al., 2017a).

Science Teacher Leaders

In support of the recent STL definition by Whitworth and colleagues (2022) provided in the introduction, we find similar themes echoed in the literature. Overall, TLs in and outside science still maintain a presence in the classroom while taking on other leadership roles inside and outside the classroom (Barth et al., 2023; Criswell et al., 2018; Friesen & Brown, 2022; Grimm, 2023; Gul et al., 2019; Polizzi et al., 2019; Wenner, 2017; Wenner & Campbell, 2018; Yow & Lotter, 2016; Yow et al., 2021a). STLs and TLs also often collaborate with other teachers in professional learning to influence a change in teaching practice (Barth et al., 2023; Carver, 2016; Cassata & Allensworth, 2021; Gul et al., 2022; Knapp, 2017; Scornavacco et al., 2022; Sinha & Hanuscin, 2017; Smith et al., 2017; Velasco et al., 2022; Yow et al., 2016). They are experienced teachers who "exert influence based on credibility and trustworthiness" (Carver,

2016, p. 164) to improve their schools and districts (Knapp, 2017; Luft et al., 2016; Roofe & Blair, 2023; Velasco et al., 2022; Weiner & Woulfin, 2018; Yow & Lotter, 2016).

Of the 47 TL articles, only 16 clearly define STLs or TLs. Several authors use an already established definition of TLs, making it applicable to their subject, such as Wenner and Campbell's (2017) "teachers who maintain K-12 classroom-based teaching responsibilities, while also taking on leadership responsibilities outside of the classroom" (p. 840) (e.g., Yow et al., 2021b), or York-Barr and Duke's (2004), "… the process by which teachers, individually or collectively; influence their colleagues, principals, and other members of school communities to improve teaching and learning practices with the aim of increased student learning and achievement" (p. 357) (e.g., Sinha & Hanuscin, 2017). Others crafted their own definitions, as evidenced here:

- Teachers who use their expertise and influence to improve the learning of teachers and students, along with the school community (Barth et al., 2023);
- A teacher who supports others to develop a vision for improving teaching and learning and "empower others to promote change" (Criswell, 2018);
- Teachers who have a leadership role in supporting the instruction of others while remaining in the classroom (Friesen & Brown, 2022);
- Leaders who influence others' practices, have strong teaching skills, and enable improvements across school boundaries (Gul et al., 2022);
- Teachers who "lead from the classroom" (Polizzi et al., 2019);
- "Good teachers" who recognize their ability to lead and influence others (Yow & Lotter, 2016);
- A teacher who leads by example to affect change in colleagues (Vaughn et al., 2023).

These definitions show a common theme: STLs or TLs are classroom-based leaders who may or may not have a formal leadership role within the school and influence others' teaching practices.

Research Question 2: What are the salient similarities and differences in the professional roles and responsibilities of DSCs and STLs?

The work of both a DSC and STL is dependent upon the context where they work (Barth et al., 2023; Whitworth et al., 2017b). Many of the roles and responsibilities of both positions have varied overlap in the literature. Both roles facilitate professional development for teachers within their school or district, work with the curriculum through either writing or implementation and collaborate with other teachers and administrators. Salient differences are discussed in the following section.

District Science Coordinators

DSCs are tasked with creating and facilitating professional development for teachers in their district (Lee et al., 2014; Whitworth et al., 2017b). Whitworth and colleagues (2017b) surveyed over 100 DSCs and found that 90% reported distributing information to teachers as one of their duties. Lee and colleagues (2014) said that DSCs described providing professional development for teachers as one of their top five responsibilities. However, the level of interaction DSCs have with teachers depends on the district context. Due to their significant administrative responsibilities, some DSCs lack time to interact with teachers as much as they wish (Whitworth et al., 2017b).

DSCs are responsible for curating and aligning science curricula with standards and providing professional learning opportunities to teachers in their district around those curricula (Whitworth et al., 2017b). They are content and pedagogical specialists who effectively communicate changes in policy and procedures specific to their content area to teachers in the district (Lee et al., 2014; Perry & Booth, 2021; Whitworth et al., 2017b). Because of state testing requirements in virtually all U.S. public schools, DSCs also write common assessments (Whitworth et al., 2017b). They must keep abreast of state and district testing requirements and analyze student data (Lee et al., 2014; Whitworth et al., 2017b). Science tends to be a material and resource heavy subject, and DSCs can be responsible for advocating for budgeting to cover materials and ordering and distributing materials to schools and teachers (Whitworth et al., 2017b).

There may also be other roles a DSC undertakes that are specific to their district's context (Whitworth et al., 2017b). For example, in smaller, more rural districts, the DSC may be tasked with supporting more than one content area due to the smaller infrastructure of the district (Whitworth et al., 2017b). DSCs may also write grants to secure funding for science-specific materials, be pulled to the classroom to teach, work with student groups outside of classroom settings, and develop relationships with external stakeholders (Whitworth et al., 2017b). In a cross-case comparison of three DSCs, Whitworth and colleagues (2018) found that all three DSCs observed teachers giving feedback to improve practice, creating and distributing resources and materials, and contacting teachers regularly through email or newsletters. However, there may be differences in the perceptions of support that DSCs provide between DSCs and teachers. Teachers may perceive a different level of support than the DSC believes is happening (Whitworth et al., 2018). DSCs with the responsibility to supervise science are seen as more supportive by teachers than those managing a large district or multiple content areas (Whitworth et al., 2018). Because of their varying responsibilities, DSCs may have less availability for individualized support than a teacher needs (Whitworth et al., 2018).

Science Teacher Leaders

STLs are experienced teachers with pedagogical and content expertise within their building (Criswell et al., 2018; Green & Kent, 2016; Gul et al., 2022; Lotter et al., 2020; Velasco et al., 2022; Wenner, 2017; Whitworth et al., 2021; Yow et al., 2021a; Yow & Lotter, 2016). Nineteen of the reviewed studies found STLs are strong collaborators with others inside and outside their schools to advise, influence, and support their colleagues to use best practices in their subject (e.g. Barth et al., 2023; Gul et al., 2022).

They are often department chairs, lead teachers, instructional coaches, or professional learning community (PLC) facilitators (Heredia et al., 2023). STLs may also work with school administrators to bring about change and improvement in their schools (Cassata & Allensworth, 2021; Klein et al., 2018; Luft et al., 2016). Like a DSC, their position may also be contextualized to their school and district.

Opportunities for STLs to learn professional development facilitation strategies are noted in the literature (Luft et al., 2016). For example, Cassata and Allensworth (2021) investigated the district implementation of standards using a teacher leader model in an urban public school system. In this research, science and mathematics TLs attended "Teacher Leader Institutes" (p.4) to engage in professional development surrounding best practices in instruction and facilitating this learning to their peers. From this, STLs created and initiated professional development for teachers around the new standards at their schools. STLs engaged in different methods of

influence to support their colleagues in the teacher leader model, which increased student engagement with the latest standards. They also described their responsibility and influence on peers as: "advocating for change; providing individual support; inspiring others; sharing with colleagues; and working in collaboration" (p. 10).

STLs implement curriculum through classroom instructional practices (Luft et al., 2016). A theme throughout the literature reflects STL's engagement with the curriculum through their teaching practice and bolstering the instructional practices of teachers around them (Low et al., 2020). STLs have the foresight and understanding of content and curriculum to influence change in others through using the resources available (Criswell et al., 2018). STLs are often agents of change within their school or district and use curriculum resources as the basis for change (Gul et al., 2022; Wenner, 2017). STLs characteristically have a deep knowledge of their content and the pedagogical skills necessary to facilitate their students' learning (Criswell et al., 2018; Yow & Lotter, 2016). They use influential relationships with other teachers to mentor and support them to engage students with the curriculum meaningfully (Cassata & Allensworth, 2021; Velasco et al., 2022).

Influence in the domain of teacher leadership is not the same as power (Reid et al., 2022). Within a school's hierarchical system, power usually sits with a principal, and STLs do not always have a formal title (Reid et al., 2022). A principal as a leader can differ from the support and mentorship an STL provides to influence their colleagues to change their practice (Cassata & Allensworth, 2021). Sometimes, this influence reaches beyond teachers, and STLs impact change across schools or districts (Velasco et al., 2022). In a study by Velasco and colleagues (2022), they sought to intentionally engage and inform STEM TLs about policy and advocacy strategies to create more significant systems change within their district and state. The intentional collaboration of STLs or TLs within hierarchical school systems supports distributed leadership and allows them to engage in the influential processes noted in the literature (Klein et al., 2018; Reid et al., 2022). However, administrative boundaries can impede STL's influence and support if their role is not acknowledged (Klein et al., 2018).

Context can influence an STL or DSC's professional role within their district. Rural districts with fewer resources may not fund a DSC as a full-time position or at all (Whitworth et al., 2017b). Likewise, STLs in a rural district with no DSC may have more responsibilities across the district rather than within their school (Lotter et al., 2020). Both roles work toward increasing student learning and achievement and supporting teachers' practice. Teacher leaders often advocate for support to learn new standards or pedagogical methods (Cassata & Allensworth, 2021) but may face challenges with administrative leaders who have different visions for instruction (Cooper et al., 2016). Furthermore, STLs and DSCs often advocate for more teaching time in science, especially in elementary school grades (Heredia et al., 2023).

Differences

Differences in professional roles and responsibilities of an STL and DSC include the individual's practice inside or outside the classroom and leadership skills learned or designated. To better understand the science education leader's role, Heredia and colleagues (2023) examined how leaders reported on their roles in seven possible areas. These areas include Activist, Ambassador, Collaborator, Innovator, Networker, Organizer, and Translator. This study classified a DSC as a type of STL. DSCs said enacting all seven areas was part of their work as district administrators. Each DSC's primary role differed based on the context of their district; however, all DSCs engaged in each identified role. Of the STLs in the study, they identified four

to six of the seven voluntary areas that were not necessarily related to their position as a science teacher. All but one STL in this study did not identify with the translator role, which is seen as an intermediary between administrators and teachers. Other roles these STLs did not identify with include activist, who intentionally engages in equitable science practices, and organizers, who engage with other teachers to disseminate resources and support other's practices. These three roles are pertinent to DSCs' immediate work and the support they offer to science teachers in their district. These STLs worked inside their school and classrooms to support science learning for students and professional learning for teachers. The DSCs in this study had no classroom responsibilities. This research shows full-time presence in the classroom as a point of differentiation between DSCs' and STLs' self-described professional roles.

In addition to self-described roles, a DSC and STL exhibit leadership skills (Whitworth et al., 2017b), yet the interpretation of these skills varies. DSCs are referred to as leaders based on their titles. However, their leadership skills have not been investigated (Whitworth et al., 2017b). DSC leadership skills are not specifically mentioned in the literature and are often assumed based on the job title. Many definitions of an STL reference leadership and the enrichment of those skills are noted through professional development programs (Criswell et al., 2018; Fairman & Mackenzie, 2015). Criswell and colleagues (2018) intentionally developed leadership skills with teachers enrolled in professional development. STLs enrolled in this program gained an endorsement in teacher leadership, showing the importance of these skills (Criswell et al., 2018). As outside observers, Fairman and Mackenzie (2015) investigated how cross content TLs understand and develop their leadership. Based on their analysis, these TLs conceptualized their leadership through collaborative efforts with colleagues. They did not perceive themselves as leaders as individuals but only through a collective effort with others.

Research Question 3: What types of programs support the development of these leaders?

The literature described professional development programs that support DSCs and STLs. Programs range from university-based, where the teachers interact with university faculty and staff (e.g., Barth et al., 2023), to a university and district partnership in which a district asks a university to step in and facilitate specific professional development across schools (e.g., Cooper et al., 2016). This section will review and describe the programs available to each role.

District Science Coordinators

Few professional development programs designed specifically for DSCs exist; however, more professional development is needed for these often-isolated positions (Whitworth et al., 2017a). Only one professional development program reported in the literature offered five days of in-person, full-day instruction divided between the fall and spring semesters (Whitworth et al., 2017a). Of the outcomes, one tangible product from this professional development program was a strategic plan written by the DSCs to take back to their district and enact over the next several years. Writing the strategic plan and continued support for DSCs from the facilitators of the professional development program occurred throughout the academic year (Whitworth et al., 2017a). This specific professional development program was created for DSCs who had less than five years of experience in their role; however, in a study by Whitworth and colleagues (2017b), they noted that DSCs were interested in and wanted more professional development regardless of the years of experience as a DSC. There is evidence that planning professional development for these leaders using the same effective professional development strategies as science teachers is successful if the content material is related to their current position (Whitworth et al., 2017b).

Another professional development program enacted over five months asked participants to record themselves facilitating professional development to teachers and then share the recording with peers to gain feedback and self-reflection (Perry & Boylan, 2018). Participants engaged in specific prompts to analyze and discuss the recorded session. The video feedback proved to be an effective professional development model for participants. The two areas participants identified as needed were understanding professional development and improving skills and knowledge surrounding professional development facilitation. This contrasts with TL professional development, which typically focuses on pedagogical and content knowledge (Barth et al., 2023; Lotter et al., 2020; Scornavacco et al., 2022).

Science Teacher Leaders

Effective professional development programs in the literature for STLs vary in duration from 1-7 years, and all studies describing professional development (19 articles) engage STLs for at least one academic year. Differences in specific professional development outcomes vary; however, leadership skills are always a skill addressed across STL professional development programs. Some participants are already defined as STLs when they enter the program, while others are labeled "emerging" STLs during and after their program is over (e.g. Yow et al., 2021a; Yow & Lotter, 2016). Specific programs center around pedagogical strategies such as Project or Place-Based Learning (Barth et al., 2023; Lotter et al., 2020), while others train the teacher in STEM education policy to advocate their local and state levels (Velasco et al., 2022), or train the teacher as a mentor to work with colleagues and support their practice (Criswell et al., 2018; Gul et al., 2019; Hutchinson et al., 2023). Growing an STL's leadership occurs through training to lead PLCs at their home school (Cooper et al., 2016; Friesen & Brown, 2022; Grimm, 2023; Turner et al., 2018), learning skills to advocate for their teachers and content area (Velasco et al., 2022; Yow & Lotter, 2016), rehearsal scenarios to practice leader engagement with others (Vaughn et al., 2023), and creating a vision or plan of leadership for the teacher's school (Klein et al., 2018; Sinha & Hanuscin, 2017; Whitworth et al., 2021). These programs support and enhance the social, cultural, and symbolic capital of an STL, as defined earlier.

Many programs created to support teacher leadership allow teachers to earn graduate-level credit (Barth et al., 2023; Criswell et al., 2018; Gul et al., 2019; Gul et al., 2022; Lotter et al., 2020; Polizzi et al., 2019; Reid et al., 2022; Yow et al., 2021b). Criswell and colleagues (2018) engaged STLs in approximately 24 full days of professional learning over two academic years. During this time, the authors partnered with the state board of education to offer the participants a STL endorsement upon completion of the program (Criswell et al., 2018; Gul et al., 2019; Gul et al., 2022; Polizzi et al., 2019). In a study by Barth and colleagues (2023), STLs engaged in a seven-year leadership development program that included five graduate courses. One course explicitly designed around Project-Based Learning (PBL) included STLs implementing this strategy in their classrooms and then blending the PBL units in place-based education (Barth et al., 2023; Lotter et al., 2020). Yow, and colleagues (2021b) reported a teacher leadership course designed for science and mathematics TLs, which was the first course of twelve the enrolled TLs participated in to earn a master's degree. Reid and colleagues (2022) also engaged STEM TLs in a professional development program where they participated in completing STEM education courses. Only one program (Yow et al., 2021b) supported STLs through a master's degree program; all other programs required participants to have earned a master's before participation.

STLs also gained professional development facilitation skills through many programs described in the literature (Cooper et al., 2016; Green & Kent, 2016; Turner et al., 2018). Turner and colleagues (2018) trained high school TLs across content areas to lead PLCs within their buildings over two years. The science TLs specifically engaged their PLC in effective instructional practices to support students' quarterly tests. Similarly, elementary teachers in a large city learned to lead PLCs within their school to influence pedagogical changes in colleague's practice (Cooper et al., 2016). Science and math TLs in a program with Green and Kent (2016) learned to lead through mentoring from a specialist and then, through gradual release, began coaching relationships with teachers in their subject area.

STLs gained other skills by participating in professional development surrounding their learning and growth. Science and math TLs used rehearsals and modeling to practice facilitating and working with teachers in their home schools (Vaughn et al., 2023). They used this strategy over five years to learn and practice techniques to constructively engage and lead colleagues (Vaughn et al., 2023). STLs were involved in creating a leadership plan to be implemented at their school with Whitworth and colleagues (2021). Velasco and colleagues (2022) trained presidential award-winning teachers in science and mathematics to communicate pressing STEM educational policy with stakeholders. STLs engaged with researchers to create leadership action plans to support their new knowledge of leadership and enhance their TL identity (Sinha & Hanuscin, 2017).

Most of the literature reviewed showed an overwhelming theme of interest in growing STLs by supporting their content and pedagogical knowledge, followed by increasing leadership skills. After leaving professional development, the STL's enactment of their learning and leadership may vary based on support from building and district administration. Programs to support DSCs include creating a strategic vision for science education within their district and focusing on strategies to facilitate professional development effectively.

Discussion

This review aimed to distinguish similarities and differences between the preparation, roles, and responsibilities of a DSC and STL based on recent literature. The review revealed commonalities between the two groups in facilitating professional development for teachers, curriculum work, and collaboration with colleagues. Moving forward, salient details to distinguish the groups in future research should include the physical location of leaders' practice, formal or informal professional title, and relationship approach with teachers. Possible implications for labeling a DSC or STL incorrectly can yield unproductive professional learning for either leader, resulting in frustration or confusion. DSC may need support for interacting with district or state level administration who hold a different power in education than an STL interacting with their building principal. DSCs need to be up to date on education policy and abreast of the state of science education as discussed in the current research literature. These supports may be useful to STLs, yet not applicable to their day-to-day interactions with other teachers in their school.
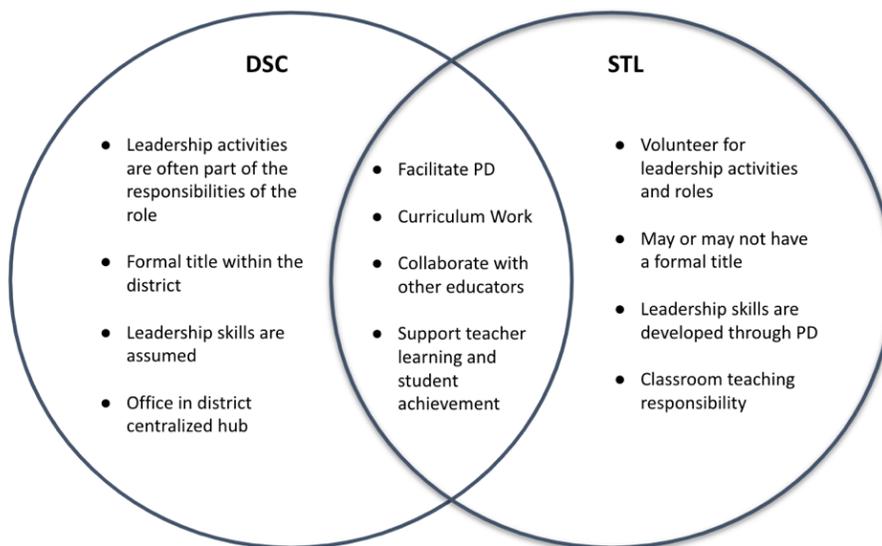
Considering the current operational definitions for either an STL or DSC, along with the findings of this review, implications for future research involve researchers definitively differentiating between the two positions. STLs are current classroom teachers who apply or volunteer to lead inside and outside the classroom, advocate for science instruction and influence colleagues' teaching practice. DSCs support science instruction through their leadership role

from outside the classroom and whose formal title situates them in an administrative capacity. DSCs advocate for and support science teacher learning and student achievement, like STLs.

An STL's presence in the classroom limits the amount of time they can allocate toward supporting other science teachers. Despite this, STLs can bring teachers into their classrooms for lesson modeling, something DSCs may only accomplish with help from a cooperating teacher. DSCs are not practicing classroom teachers and, ideally, have more opportunities to connect and support science teachers. However, they also have many more administrative duties that pull their focus (Whitworth et al., 2017b). Although DSCs may have a larger reach to distribute information to many teachers within the district, this increase in the network does not necessitate a teacher's change in practice. STLs may have a smaller contact circle but working closely with a few teachers allows them to make lasting influence and change in a colleague's practice. Regardless, it is imperative to distinguish between the two, as the role one holds impacts the ability to influence, communicate, and advocate for science education. The title of DSC may be noticed as more influential based on their immediate network of superintendents towards policy and state level issues, where STLs are one of many in a district and are often overlooked. Figure 3 visually displays the similarities and differences.

Figure 3
Venn Diagram: Similarities and Differences between STLs and DSCs

A DSC has a formal professional title afforded to them based upon their hiring. Accompanying the title are specific duties outside the range of a practicing classroom teacher (Whitworth et al., 2017b). STLs may hold formal titles (i.e., department chair), and some may function as informal leaders without a designated title. The absence of a title could imply that STLs often volunteer for leadership positions beyond their professional obligations. STL and DSC literature does not indicate that leaders engage in leadership responsibilities to seek recognition. DSC leadership skills are implied in the research and assumed upon appointment. Further investigation of current DSC leadership skills would help inform future professional development to build upon or learn additional skills relevant to the position. Other questions

arise surrounding how a teacher is chosen by a principal or administrator for leadership, as well as teacher motivation for seeking out leadership voluntarily. Investigations into motivation to pursue these roles could uncover professional initiative and identify novice teachers suited for leadership.

An individual's title may also influence relationship building. STL studies continuously mention influence in practice with colleagues (e.g. Barth et al., 2023). Influence is gained through building relationships. A DSC title assumes a more knowledgeable educator, which may be intimidating to some teachers. The impact of DSCs may be more limited than an STL, stemming from the number of teachers they can cultivate trusting relationships with and support directly. Considering STLs' existing relationships with teachers, the transition of STL to DSC may be seamless within the same district.

There are limitations to this study. One limitation is the very low number of articles available on district science coordinators (DSCs) in general, with even less information addressing their professional development. Because of this limitation, the information surrounding a DSC may seem skewed. Research on DSC leadership skills, position expectations, and career trajectory are all areas for further research. Additionally, most existing studies are based in the United States, with only three studies from other countries raising questions about how science education is organized internationally and whether different approaches used elsewhere might be more effective. Finally, there is a lack of research on the interaction between DSCs and STLs, leaving a gap in understanding how these roles collaborate within districts. Further research in these areas is warranted.

Conclusion

As evidenced in this review, research surrounding the roles of STLs, and DSCs has been increasing in recent years. Yet, there are still many gaps to explore, including the intersection of the two roles. Advancing research and professional development for each group should include specific support and preparation based on the definition of the role. Additionally, clarifying roles and responsibilities for each position would give novice teachers insight to strengthen their skills, should they want either role within their career trajectory.

For DSCs, the research gaps include acquiring leadership skills, rationale for leaving the classroom, skills for building relationships with teachers and administrators, and mapping career trajectories. While more robust, STL literature shows room for growth in understanding traits teachers exhibit that make them better suited for an STL role, differences in STL practices by grade band, and types of informal STL roles. Longitudinal studies after STL experience professional development could inform transformational practices STLs permanently incorporated. Furthermore, the relationship between STLs and DSCs warrants examination. From this review, many avenues exist moving forward in STL and DSC research, simultaneously acknowledging and accurately representing their similarities and differences. It is important to delineate these roles in research and practice to properly support each type of leader with relevant professional learning encompassing pertinent issues to each group.

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