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Exploring School Improvement Opportunities through Distributed Leadership Practices for Science and Mathematics in South African Schools

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ABSTRACT

School leadership practices are significant in addressing learner-attainment gaps in school subjects such as science and mathematics. This paper uses an exploratory qualitative case-study approach with four purposely selected high schools to explore how distributed leadership (DL) improves opportunities for teaching and learning in science and mathematics. The four schools constituted two suburban and two township schools prioritizing science and mathematics on school improvement agendas. Principals, deputy principals, heads of department, and teachers of science and mathematics participated in semi-structured interviews. Thematic content analysis in which the emerging themes were compared to the DL tenets was used to make sense of the gathered data. The findings indicate that DL practices influenced the teaching and learning of science and mathematics, irrespective of a school's socioeconomic status. The participating schools developed useful mechanisms for school improvement through science and mathematics that were compatible with the DL setups existing in their schools. The study recommends that DL should be promoted in schools by being one of the topics for professional development made available to science and mathematics teachers.

KEYWORDS
Distributed leadership practices; school improvement; science and mathematics; South African schools.

INTRODUCTION

As schools become increasingly accountable and responsive towards school improvement, science and mathematics teaching and learning have become improvement foci. School leadership is recognized as significantly influential in improving learner attainments in addition to classroom practices, considering its ability to mobilize resources, empower teachers, and put together achievable agendas (Bullock & Moyer-Packenham, 2020). Leithwood et al. (2020) claimed that leadership is second only to classroom practices in influencing learner attainments. Hallinger (2018) observed that there are persuasive findings linking school leadership to school performance based on the assumption that leadership practices are adapted to meet the needs of the people and overcome contextual constraints.

Traditionally, positional leaders in schools, such as subject heads, heads of department (HODs), deputy principals, and principals, are the main actors who execute leadership roles. However, reformed perspectives of leadership show that leadership has greater influence on schools and learners when it is widely distributed (Leithwood et al., 2020). Similarly, Tonich (2021) posited that while principals may influence school improvement, the organizational culture also has a significant bearing on practices and performance. There is a growing recognition that instruction improvement is about taking up leadership roles to improve classroom practice. It enhances teachers' motivation and introduces a climate of collaboration among teachers, thereby influencing classroom practice (Camburn & Han, 2009; Carvalho et al., 2022; Hall, 2013). Collaboration is very critical in school improvement efforts (Datnow & Park, 2018). Notably, teacher leadership thrives in supportive school environments that allow the spread of leadership over several individuals. Diamond and Spillane (2016) posited that leadership is stretched over people instead of being centered on a few positional leaders. The stretching of leadership over people allows people other than those in formal positions in- and outside of the school to perform leadership functions (Diamond & Spillane, 2016), including teachers. The stretching of leadership over people where leadership is uncoupled with leadership positions but is determined by expertise is called distributed leadership (DL) (Bush & Ng, 2021). Harris (2003a) posited that there is an overlap between DL and teacher leadership. The implication is that DL enables teachers to take up leadership positions. Tian et al. (2016) bemoaned the absence of a universal definition for the concept of DL, while Diamond and Spillane (2016) view DL as a conceptual framework to study the leadership practices in an organization. Tian et al. (2016) posited that DL is a pragmatic approach to leadership, whereby leadership is an organizational resource and an agency for individuals. In summary, DL contributes to the creation of conditions that promote teacher effectiveness and school improvement through improved learner attainments.

The teaching of science and mathematics in secondary schools is used as a strategy to prepare citizens who will pursue studies that develop skills in science, technology, engineering, and mathematics (STEM) fields. This study explored school improvement opportunities for science and mathematics through a DL lens using four South African secondary schools. In this study, school improvement opportunities for science and mathematics refer to the possibilities of increased learner attainment. Science and mathematics are on the school improvement agenda in South Africa against the backdrop of poor learner outcomes and uptake. Spillane (2005) recommended that descriptive theory building should be conducted before determining the causal links between DL, instructional improvement, and learners' outcomes. Consequently, the main question in this study is: How are DL practices implemented to support school improvement opportunities through science and mathematics? The findings of this study contribute towards building knowledge on how DL practices from the perspective of a developing African country influence efforts to improve learners' attainments in science and mathematics. Hallinger (2019) noted that research on educational management and leadership in South Africa is still growing and requires attention.

Research Aim and Objectives

The aim of this study is to explore how DL practices are implemented to support school improvement opportunities through science and mathematics. To achieve the aim of the study, we formulated two research objectives:

- Examine the DL setups for school improvement through science and mathematics in the participating schools.
- Explore how the schools implement DL for school improvement through science and mathematics.

LITERATURE REVIEW

DL is considered a catalyst for school improvement (Day et al., 2011; Harris, 2004, 2008). School improvement results from improved practices in the school, which include leadership and classroom practice (Budiharso & Tarman, 2020). Improved practices positively correlate with professional learning and networking (Mohd Tahir & Mohd Salleh, 2018). Azorín et al. (2020) argued that teacher continual learning happens through collaboration in professional networks which are sustained by shared leadership. Mohd Tahir and Mohd Salleh (2018) also showed how the coaching of school leaders by school improvement partners helps them to achieve outstanding performances. Seemingly, effective DL improves teachers' morale, potentially influencing classroom practices and performance (Harris, 2003b). Similarly, a study by Liu et al. (2021) showed that DL influences teacher job satisfaction and self-efficacy. However, Robinson (2008) argued that although a relationship exists between DL and academic performance in schools, more empirical research is required to ascertain this supposed link. Harris (2013) emphasized the need to focus on DL as a practice and not only as a way of thinking. However, Spillane (2005) threw caution in the discourse by saying that DL is a "conceptual or diagnostic tool for thinking about school leadership … not a blueprint for effective leadership, nor a prescription for how school leadership should be practiced" (p. 149).

For Harris (2013), the actualization of DL has potential positive outcomes in an organization. Actualization of DL may lead to noticeable school improvement and reform. The wide distribution of leadership in schools is one of the strategies to achieve the desired change outcomes in schools (Leithwood et al., 2020). This is because leadership is allowed to extend over several people since the focus will be on harnessing the expertise in an organization to achieve specific objectives (Harris, 2004). One of the essential objectives to be achieved for school improvement, which includes improving learner attainments in science and mathematics, is the engagement in instructional leadership by various stakeholders, including teachers. This is based on Spillane's (2005) statement that DL is about leadership practices. Spillane (2005) explained that "[d]istributed leadership is first and foremost about leadership practice rather than leaders or their roles, functions, routines, and structures" (p. 146). In support, Harris (2004) argued for portraying effective DL beyond formal positions or roles. Consequently, leadership is a collective task in which role players, including teachers, can develop and share their expertise by working together as a team while being guided and directed to ensure efficiency (Harris, 2004). In support of the portrayal of DL as a collective task, Torres (2019) asserted that there is reciprocal mediation between DL and professional collaboration. Munje et al. (2020), in their study, showed that HODs function by collaborating with teachers and other stakeholders to support the improvement of science and mathematics in schools. Bush and Ng (2019) explained that by practicing DL in schools, the principals and HODs move away from their traditional roles by adopting collaborative roles and sharing leadership roles with teachers.

Presumably, effective DL requires those at the helm to play monitoring and directive roles, hold the pieces together, and communicate what needs to be done (Harris, 2003b). Thus, Harris (2003b) argued that practicing DL is challenging despite its advantages, as those in formal leadership positions need to relinquish some of their powers and control to others to ensure effective implementation. For Harris et al. (2013), a school leader who truly wants to implement reform should select which initiatives they become involved in, provide support to others for their implementation efforts, and guide others when they engage in new initiatives and adapt to them as such. This support creates space for other employees to use their skills and expertise to contribute to the organization's well-being. The described DL conditions enable teachers to develop their expertise, considered by Harris (2003b) as collating expertise under one roof. Therefore, effective DL enables leaders and teachers to interact with the genuine intention of influencing instructional practices (Spillane et al., 2004).

The Distributed Leadership Framework

From the literature reviewed, a precise definition of DL may be elusive; however, some inherent tenets can be highlighted. DL is viewed as a fairly new and evolving theory in a field in which new theories frequently emerge (Harris, 2004). As a perspective, DL can be used to elicit insights on how management and leadership are conducted in schools (Spillane et al., 2004). The notion of DL is grounded in the argument that school improvement cannot be attributed to the actions of a single leader such as the school principal (Spillane, 2005). The continuous school improvement attributed to DL is based on the notion that there is an expansion and more levels of leadership in schools (Hallinger & Heck, 2009). There is a view that DL is associated with structural reforms that aspire to transform instructional practices and outcomes in schools (Hall, 2013). The expansion of the leadership and aspired instructional practices reforms is achieved by placing leadership roles on the shoulders of teachers (Camburn & Han, 2009). Allocating leadership roles to more individuals in the school, including teachers, is an organizational culture and, according to Tonich (2021), organizational cultures assist principals in the achievement of school improvement. The inclusion of the teachers in leadership has been observed to remedy the resistance to change that characterizes instructional practice (Tonich, 2021). In a study by Heck and Hallinger (2009), it was observed that DL supported improved learner outcomes in math.

The study used DL as framed by Spillane (2005, 2006), highlighting three aspects: the leader plus factor, the leadership practice, and the situation. Therefore, in DL, there are multiple leaders in formal and informal positions. The more leadership is spread across individuals in the school, the more influential it is on school improvement efforts (Leithwood et al., 2020). The leadership practice is not attributed to individuals, but is a product of the interactions among leaders, followers, and their situation. Finally, the situation consists of the task at hand, which for this study is improving the teaching of science and mathematics through leadership practices. Based on the discussion above, the DL tenets considered in this paper for school science and mathematics improvement are: (1) the sharing of leadership responsibilities, enabling teachers to lead using their expertise, (2) focus on improving learner performance, (3) continuous teacher learning and professional development, and (4) collaboration among the stakeholders for the improvement of science and mathematics.

METHODOLOGY

Study Context

This explorative qualitative case study (Yin, 2018) involved four schools: two suburban schools (schools A and B) from high socioeconomic status (SES) backgrounds, and two township schools (schools C and D) from low SES backgrounds in the city of Pretoria, South Africa. The case study was based on the phenomenon of the use of DL practices for science and mathematics for school improvement. The identified phenomenon, together with its context, was the unit of study that defined the case study (Flyvbjerg, 2011). The interpretivist paradigm was used for meaning-making, because as Ponelis (2015) asserted, knowledge is socially constructed by human actors. Therefore, the findings of this study on the use of DL practices in science and mathematics for school improvement are based on the views of the participants. Table 1 summarizes the features of the four schools in terms of location, learner/teacher population, medium of instruction, status, grades offered, number of teachers, and learner enrolment.

Table 1.
School Contextual Settings

School	Location	Learner/ teacher population	Medium of instruction	Status	Available grades	Number of teachers	Learner enrolment and learner–teacher ratio
A	Suburban	Predominantly white	Afrikaans	Former Model C school	8–12	105	1800 (17.14:1)
B	Suburban	Predominantly white	Afrikaans	Former Model C school	10–12	115	1800 (15.65:1)
C	Township	African (race)	English	Low SES	10–12	45	1089 (24.2:1)
D	Township	African (race)	English	Low SES	8–12	43	1000 (23.26:1)

The schools had maintained a consistent record of being top performers in science and mathematics in their districts for five years. The learner–teacher ratios were lower in the suburban schools and higher in the township schools. The bounded system for the case study was defined by a phenomenon (Creswell, 2007) – which was an exploration of school improvement opportunities through DL in science and mathematics.

Data Collection Instruments and Procedures

Semi-structured interviews were used to generate data between September 2015 and October 2015. During this time, the South African curriculum and assessment policy statement (CAPS) was in the fourth year of implementation, with many schools grappling with implementation. The DL tenets as summarized in the discussion of the framework guided the questions in the semi-structured interview protocol focusing on leadership plus, leadership practice, and the situation (Spillane, 2006). First, the interview questions sought to determine the DL setup for school improvement through science and mathematics by identifying individuals who engaged in leadership activities and processes that defined the type of leadership. The DL setup was premised on the assumption that leadership would be spread over several individuals, including others who are not positional leaders (Spillane, 2005). Second, the interview questions were used to elicit how DL was used for school improvement through science and mathematics. The questions asked sought information on the DL-setup activities engaged in to improve school outcomes through science and mathematics. The tracking of the activities was premised on the assumption that DL is reform-oriented and aims to transform instructional practices for improved school outcomes (Hall, 2013). These activities include collaborative and participative leadership in which science and mathematics teachers take part. Harris (2003b) posited that teachers can lead through classroom practice that promotes school improvement goals, owning change processes by being part of participative leadership processes, acting as experts and sources of information, and participating in teacher learning processes.

Study Participants

The schools were selected through purposive sampling techniques, and 14 participants were conveniently selected and agreed to participate voluntarily. Participants had to be science and mathematics HODs and teachers, principals, and deputy principals. As shown in Table 1, the schools are referred to as School A, B, C, and D. The participants are identified by the school and position they held. For example, the mathematics teacher in School D is named School D mathematics teacher. The distribution of the participants per school is shown in Table 2.

Table 2.

Distribution of Participants per School

School	Participant	Gender	Age/years	Experience in position
A	1. Deputy principal	F	50–55	12
	2. Science HOD	F	40–45	15
	3. Mathematics HOD	M	46–50	4
	4. Mathematics teacher	F	30–35	8
B	1. Principal	M	50–55	10
	2. Deputy principal	F	56–60	15
	3. Science HOD	F	45–50	12
	4. Mathematics teacher	M	30–35	7
C	1. Deputy principal	M	56–60	5
	2. Science and mathematics HOD	M	36–40	4
	3. Mathematics teacher	F	36–40	12
D	1. Deputy principal	M	50–55	6
	2. Science and mathematics HOD	M	40–45	8
	3. Physical science teacher	F	30–35	10

Trustworthiness and Ethical Considerations

The credibility of the data was ensured by using the DL conceptual framework and the assumptions mentioned in the previous section to guide the questions in the semi-structured interview schedule. The open-ended questions ensured that the participants provided rich data and narratives guided by the tenets of DL. The use of four schools from two different contexts enabled the triangulation of the data in the building of the case study. We also used verbatim extracts in the discussion of the findings to enhance the credibility of the data. The study was ethically cleared by the relevant committee of the university to make sure it abides by the human research protocols. Accordingly, the identity of the participants was kept confidential. Participation was voluntary and we sought permission to conduct research from the Gauteng Department of Basic Education of South Africa.

Data Analysis

The audio-recorded interviews were transcribed and subjected to thematic analysis as guided by the two subsidiary questions. Following the thematic analysis steps outlined by Nowell et al. (2017), we read the interview transcripts until we were familiar with the data. The data were manually coded with the research questions in mind and the codes were clustered into categories, which were further clustered into themes. An excerpt from the codebook is shown in Table 3 to illustrate how the themes were built.

Table 3.

Excerpt from the Interview Transcripts Codebook

Research question	Example of interview excerpt	Theme
What is the DL setup for school improvement through science and mathematics in the schools?	"Potential is reflected by the qualifications of the teachers; we ensure that the foundation is strong. We make sure that the educator that is very strong holds the position of laying the foundation." **Code: Strategic task allocation**	Teachers as an organizational resource for DL
	"I am in the position of showing them what to do and how to do it, because teachers in my department are quite young." **Code: School-based mentoring**	Professional development as school resource for DL
How do the schools implement DL for school improvement through science and mathematics?	"Before you mark … you sit down and look at the memo. If there are any mistakes, we correct them together." **Coding: Expertise sharing**	Leading through collaboration and expertise sharing
	"We try to conduct extra lessons in the morning and the afternoons – preferably in the afternoon." **Coding: Extra classes**	Leading through a focus on instruction

FINDINGS

Thematic content analysis yielded four main themes. These were: (1) teachers as an organizational human resource for DL, (2) professional development as a tool to facilitate DL practice, (3) collaboration and expertise sharing, and (4) leading through a focus on instruction. The themes were used to describe how DL was used in school improvement through science and mathematics.

Theme 1: Teachers as an Organizational Human Resource for Distributed Leadership

One of the ways in which teachers led was through classroom practice and therefore grade and class allocation was given a lot of consideration. For example, schools A, B, and C considered grade allocation fundamental in influencing how teachers teach and how learners learn. Collective distribution of leadership was evident, since the principals, deputy principals, and

HODs were responsible for class allocation, while the teachers engaged in classroom practice. School A's science HOD aligned grade allocation with teacher welfare by saying:

I ask them … a sort of wish list and then … whether they will be able to cope because there is a lot of tension and stress from grades 11 to 12, more especially in Grade 12 …. We can put them in the timetable for what they wish … but we only have so many classes … so that's not always possible.

This shows signs of instructional leadership with potential positive implications. The thinking behind this approach is to ensure teacher job satisfaction and maximize output. This explains why teachers get a chance to make their wishes, as explained by School A's deputy principal when she said:

During subject meetings, they gave me the wish lists; they say what they would like to teach and what they are comfortable with, what new challenges they think they can handle and then we also go back and check the results for the grade they taught.

School A's mathematics HOD also confirmed that teachers were consulted as classroom leaders on the classes that they were comfortable teaching. He said:

I gave them a form where they indicate what they want to do … so we have teachers who want to stay at the junior phases – grades 8 and 9 … after a few years, they will change; obviously, the junior teachers will start with the junior grades. However, when a teacher after a few years tells me, "I want to move," I let them.

This method helps to reduce the negative effect excessive workload may have on teacher performance, especially with a curtailment of time to deal with distinct learner challenges.

Unlike at School A, School D emphasized teacher qualifications, with a preference for more qualified teachers at the junior-classes level to lay a solid foundation. The deputy principal elucidated: "Potential is reflected by the qualifications of the teachers; we ensure that the foundation is strong. We make sure that the educator that is very strong holds the position of laying the foundation." The need to lay a foundation before Grade 12 was re-echoed by School C's mathematics teacher: "when you are in Grade 12 and learners are not performing, they [stakeholders] forget that they [learners] need a strong foundation. Focus is in Grade 12 … in Grade 10 they [teachers] think they are not important." The approach of laying a solid foundation by allocating qualified teachers to the junior classes in schools C and D contributed to improving opportunities for science and mathematics.

Schools B and C used a similar approach of allocating classes to teachers. The approach differed slightly from the one used by schools A and D. In School B, the deputy principal, HODs, and principal collaboratively guided the process of grade allocation, considering teachers' individual needs and experience. School B's principal said:

That's more a discussion between me, HOD, and the deputy principal, who are responsible for the timetable … because they know them [teachers] the best in their grades …. We go to their workload and then we will ask them to motivate certain areas …. Then we discuss it; as a group we decide. We need good teachers in Grade 8 and 9, and matric as well.

Collaboration between the principal and HODs, specifically allowing HODs to take the lead, demonstrates how the leadership was determined by the task to be completed as a way of distributing leadership. The HODs came to the discussion table with information acquired through careful monitoring and supervision of teachers.

Likewise, School C used workload distribution as a deliberate attempt by the HOD, deputy principal, and principal to match teacher qualifications and experiences with classroom needs to improve science and mathematics teaching and learning. The HOD explained as follows:

It's the principal and me. We consult with the deputies and the principal when we do allocation at the end of the year for the next year. … We have to agree. But, you just give your reasons why you want them in those grades.

In all the schools, careful consideration was made when allocating classes to teachers because they were recognized as the ones who would be responsible for leading school improvement through classroom practice. The teachers were also consulted when allocating the classes, although the HODs made the final decisions in collaboration with other positional leaders.

Theme 2: Professional Development as a Tool to Facilitate Distributed Leadership Practice

Data indicate that existing professional development opportunities for teachers and HODs in and out of the schools were aimed at improving science and mathematics teaching and learning. Aspects of professional development varied in nature and magnitude between schools, with varied ramifications. To begin with, School D's physical science teacher considered professional development with a content focus to be very useful. Similarly, School A's deputy principal associated the teachers' improved classroom practice with the professional development opportunities, which contributed to the smooth adaptation and implementation of the new CAPS curriculum at the time. She said:

In our school, we have well-trained teachers who are prepared to do extra. With the coming of CAPS, certain subject content changed, and the assessment changed, but all our teachers were sent to be trained on how to adapt.

Apart from improving decision-making, HODs organized teacher professional development activities to enhance teachers' pedagogical knowledge, with positive implications for curriculum implementation. Professional development was identified at two levels – that of school and district.

Theme 2.1: School-Level Professional Development

The data indicate that school-based professional development was used as a mechanism to empower teachers, improve classroom practice, and ensure quality teaching and learning. For example, workshops conducted at the schools kept teachers up to date with curriculum-delivery strategies and expectations and, in some instances, made up for the deficiencies of district-facilitated workshops. School B's science HOD validated the relevance of peer mentorship enhanced by saying: "I am in the position of showing them what to do and how to do it because teachers in my department are quite young.” School D’s physical science teacher also indicated that the HOD in the school provided teachers with classroom practice support: “In terms of teacher development, he supports us well, because sometimes we discuss the topics before we even go to class.”

In School C, the HOD gave an overview of how they organized internal professional development efforts with a blend of peer coaching and observation to improve the teaching and learning of science and mathematics. The HOD said:

We are trying to have some workshops – our workshops – especially if we start a new topic; we come together … find out if there are some challenges. We do peer teaching or group teaching, where you find that a teacher who is versatile … [and] good in that section, he or she will assist. Maybe I can take one teacher to go with me to class to observe. Alternatively, I can go there, teach, observe, and see how that topic is tackled.

School A’s deputy principal explained how the school used subject meetings as training sessions to empower teachers with content knowledge and technology use by saying:

We have regular subject meetings, like the Maths Department, once a week. I get them together, discuss what they have taught, and discuss the different ways … to explain and set up an internal technology system where the teachers can access lots of information to compile the lessons.

Similar approaches were adopted to induct HODs, as further explained by School A’s deputy principal: “We have meetings with them before they get the whole documents of what is expected from an HOD of the school and we have regular meetings; they come to my office.” The meetings were meant to empower HODs with skills that will enable them to perform their duties effectively. Professional development was used as a strategy to influence science and mathematics teaching and learning for school improvement. Both positional leaders and teachers were involved in leading some of the professional development through peer mentoring and coaching.

Theme 2.2: District-Level Professional Development

Schools expected district offices to be actively involved in teacher professional development to facilitate curriculum implementation. In this regard, School C’s deputy principal agreed that district-facilitated workshops were instrumental in empowering the teachers and promoting strategies that influence classroom practice, thus explaining why the school played a pivotal role by encouraging its teachers to attend. Remarkably, teachers at School B recounted benefiting more from workshops facilitated by teachers than those by the district unions (teacher unions also facilitated some workshops for the members).

Furthermore, School C’s deputy principal acknowledged benefiting from district-facilitated workshops that responded to the curriculum changes by saying: “lots of changes came along in the last 20 years … the department and the unions had some courses … we sent out teachers to those development sessions to get used to the new system and the new syllabus.” School A’s mathematics HOD echoed similar sentiments: “Most of the teachers went for training … given by Gauteng Education Department." Likewise, School D's physical science teacher commented on district instructional support as follows: "we do have some support because we have some content trainings, like having some training for math teachers for FET (Further Education and Training) content." Similarly, when asked about participation in development workshops, School A's mathematics teacher said: "I do attend some even during the holidays. … We attend three times during last holiday … and there was training of HeyMath (mathematics software) … every Thursday from January to the last holidays when schools close."

In addition, School D's deputy principal indicated that HODs attended some district-facilitated workshops:

When we give them marks, the district office will see and come here and then … identify areas of need … and organize workshops with HODs … so that they can take the information to school.

Apart from training workshops and meetings, subject advisers (from the district office) influenced teaching and learning in science and mathematics wherever possible through other means such as WhatsApp (a social media platform). School A's mathematics HOD noted that subject advisers do more during face-to-face sessions, making it the preferred meeting mode. The HOD for School A attested that during face-to-face meetings, they look at files, marks on the system, and learners' portfolios and conduct class visits to acquire first-hand experience of what teachers do in class and the existing challenges. These sessions gave room for the identification of existent challenges and possible engagements to find a way forward. Professional development activities demonstrated the different layers of DL for school improvement through science and mathematics from teachers, the HODs, the deputy principals, the district, and the teacher unions.

Theme 3: Collaboration and Expertise Sharing

The data show evidence of principal–HOD, HOD–teacher, teacher–teacher, and school–district collaboration, with irrefutable variations across schools in terms of improving opportunities for science and mathematics. School A's mathematics HOD explained what propelled collaboration in her department:

I am very lucky I have many colleagues in my department. We work very close together. We have meetings for the whole group of teachers, and we have separate meetings just for the grade, and all the teachers in that grade must be at those meetings.

The excerpt from School A's mathematics HOD indicates that when teachers work together voluntarily, they are likely to create an environment conducive to teaching and learning. School A's mathematics HOD noted that effective collaboration depended on trust and confidence that propel cordial working relationships in corroboration. Trust and confidence are why teachers in School A approached the HODs whenever they encountered challenges, thus facilitating the school's vision of working together as a team towards achieving a common goal. The mathematics teacher for School A supposed that despite the influence of trust and confidence, consultation with the HOD is mandatory: "Before you mark … you sit down and look at the memo. If there are any mistakes, we correct them together." Within the DL structure, the HOD as a positional leader is a point of call for all teachers in the school improvement journey. In essence, collaboration at various levels enabled teachers to share knowledge among themselves and with the HOD, with positive implications on classroom practices. This is evident from the assertion of School D's physical science teacher, who elaborated on how collaboration among teachers promoted instruction: "teachers teaching Grade 10, they sometimes exchange classes, brainstorming on what is expected in the topic … we sit down and plan it together."

Correspondingly, School C's HOD said that informal meetings by mathematics and science teachers resulted in sharing useful ideas on what to teach learners daily and the nature of assessments to be administered. School D's physical science teacher expressed a similar sentiment by saying: "Usually, we do it in the afternoons, … [if] teachers who teach Grade 11 are free; we discuss the topics that we were doing; we share the ideas and the information; sometimes we do plan." School B's mathematics teacher corroborated as follows:

It's very easy here because we are 13 in the Math Department; we work together very well. We stand outside the classes. All our math classes are in one building, so during breaks, where the children come to class in between lessons, we stand outside, and we ask questions.

The DL setup seemed to allow for interactions that made it is easier for HODs to create environments favorable for collaboration among teachers, impacting school effectiveness. Within the same context, School A's mathematics HOD reinforced the notion of collaboration through knowledge sharing to ensure standardization in the teaching and learning of science and mathematics. Here is what he said:

We also do photocopies for all the Grade 12 teachers; we do the same, and if a colleague gives me something, I give my learners. … You must always give the same work for every class, because we are about six teachers in Grade 12 – those six must work together. If I decide to do something in my class, all the teachers must know about it.

Similarly, School C's deputy principal indicated how collaboration opens spaces for alternative strategies that improve teaching and learning:

HODs do quarterly or monthly checking, and they provide reports. … Then I also compile my own report. If there are any challenges, then I'll take the matter up, maybe invite the subject specialist, or even talk to the principal about the challenges. Moreover, we look into issues like how best we can support these educators, if they need retraining.

Such involvement signifies the existence of a strong instructional leadership foregrounded by effective DL. For HODs to perform their duties effectively, there needs to be good relationships that inspire educators to collaborate. The mathematics and science HOD for School C elucidated by saying:

The educators won't be the same – some are willing to cooperate, but some don't cooperate. So, we have different types of people. Overall, they are good people to work with. ... I think 90% cooperate. … That is what makes us to achieve, because everyone is willing to work.

Similarly, School D's HOD further illuminated how communication and collaboration among teachers improved teaching and learning:

We always check one another in the morning briefings … we always check what is supposed to be done … every Monday, we check what is supposed to be done for the whole week. We say, "[t]his is the work to be covered for the whole week …" – even if it's informal, we check one another – "How far are you?"

School D's HOD further commented on collaboration with the deputy principal and principal:

We usually have morning briefings every day as a school management team. Where there are challenges, we can always communicate that with the principal or the deputy; the relationship is good there – we don't have a problem. We always do our duty in controlling the learners' books; the deputy will also go through my work and check the learners' books which I checked.

School D's deputy principal highlighted the importance of school–district collaborative efforts by saying:

We interact with subject advisers at the district. We show them the bright side of the school curriculum, and we also try to show them how it's linked to child career … the learner to be strong and to pursue their dreams, we try and put on the table the career and show one another and discuss the effectiveness of the kind of content.

In School D, collaboration was intertwined with classroom visits from the principal and teachers to improve teaching and learning. The deputy principal explained: "I communicate with the HOD and at the same time visit the teachers when they are in the classrooms. Whatever preparation they do, I will know … their challenges as well."

Similarly, School C's science and mathematics HOD portrayed class visits as instrumental in forging collaborative and problem-solving opportunities among teachers: "During our interaction, especially during the class visits, you can sense where the teacher is having a problem, and we usually discuss that." This shows how collaboration influences classroom practice, because of the opportunity it gives to both the teachers and HODs to discuss impending challenges and alternative strategies after the visits. Furthermore, the district promoted the improvement of instruction by supervising the assessment of learners. School B's deputy principal pointed out this practice when he said: "The district is involved in normal meetings that usually correspond with the moderation process … some moderation activities are usually a part of the meeting that is on instruction."

Collaboration and cooperation in decision-making, planning, and teaching supported the distribution of leadership by making the process participatory. The collaborative efforts in their distinctive ways contributed to improving opportunities for science and mathematics in the selected schools.

Theme 4: Intensified Instruction as a Tool to Enable Distributed Leadership

The extra classes (lessons given to learners outside of the regular school timetable) supporting teaching and learning in science and mathematics varied across the four schools. School C's HOD indicated that assisting learners who had learning needs through extra classes ameliorated challenges brought from primary school and fulfilled the school's vision to promote mathematics and science learning:

The jump from primary school to secondary school is very big for them, but we will get it right eventually. We give them a lot of tasks … by the time they get to Grade 10, they are good. Grades 8 and 9, we have many extra classes for them; for example, by June, both Grade 8 and 9, we had 17 learners that failed, and there's lot of extra classes for them.

Learners who faced difficulties in mathematics in Grade 10, despite the assistance provided, voluntarily switched to mathematics literacy. The participants highlighted the usefulness of extra classes in reducing the ever-widening gap between low- and high-performing learners.

School A's deputy principal placed more emphasis on efforts made to promote mathematics learning among learners:

In Grade 10, the learners mostly choose maths, but if they [are] not coping, they will then go to mathematical literacy. The majority of them, they got maths as a subject in Grade 12. We have eight maths … [and] five maths literacy classes, and we don't want many learners in the classes.

Similarly, School D paid more attention to pure mathematics than technical mathematics, arguing that pure mathematics increases learners' chances of coping at university. The school's physical science teacher explained by saying:

Some technical subjects would need a learner to be more [competent] in pure mathematics, and we found that when they complete their matric it's a challenge for them to cope … especially when they go to university; the kind of mathematics there won't be the one that they are exposed to when they are doing technical maths.

Furthermore, School A's principal elaborated on the usefulness of extra classes, aligning it with the school's philosophy of promoting science and mathematics teaching and learning. He said:

We got lot of extra classes for maths, and we got lots of assistance from teachers even in the afternoon … we got the love for maths and science ... The maths and physical science teachers are not involved in extramural activities; their extramural activities are their extra classes in the weekends and afternoons.

The excerpt from School A's principal demonstrates efforts to improve mathematics and science opportunities for learners through extra classes.

The seriousness of extra classes at School A was demonstrated by supervision conducted by the principal to ensure its effectiveness. The School A mathematics teacher explained that the principal supervised to "[f]ind out about the work programme; if they (learners) are attending extra classes, he will ask for a list of those (learners) who are not attending ... [so] that we can inform their parents.” Attempts to bring in the parents when learners fail to attend extra classes demonstrate how serious the school considered extra classes in their journey to improve opportunities for science and mathematics learning among the learners.

It is worth mentioning that School C provided minimal extra classes amid socioeconomic challenges, as explained by the HOD:

We try to conduct extra lessons in the morning and the afternoons – preferably in the afternoon. In the morning, there are some challenges because of late-coming, but afternoon lessons are already here. It’s four and a half hours that we can have (on the regular timetable).

The preceding evidence from School C demonstrates that schools experiencing socioeconomic challenges could put in place effective leadership practices that are context friendly for school improvement purposes, thus guaranteeing an improvement in learner performance.

Contrarily, extra classes in School B were voluntary, with learners deciding if they needed extra assistance or not, unlike in School A, where parents were engaged when learners failed to attend. The physical science teacher for School B illuminated by saying:

In my class, I tell them: “these are the days I am available after school for an hour and if you have a question or if something is unclear … those are my times; my door is always open, and you can come and ask. Therefore, it is not an extra lesson, it is more help if you need it.” And for those kids who really need it, we ask by name to attend this class so that I can explain … more in detail. So, it’s their option whether they want to come or not.

In School B, there was an assumption that many learners were performing well, and therefore not all of them needed extra classes. The norm at the school was to encourage extra classes, primarily for Grade 12 learners since they were in an examination class. The deputy principal explained that the school devoted its afternoon hours to extramural activities; as such, extra classes were at the teachers’ discretion: “Teachers manage own groups for extra classes every week, especially Grade 12.” School A’s principal considered extra classes as a contingency measure to ensure the completion of the CAPS syllabus to avoid superficial content coverage. School D’s physical science teacher bemoaned time constraints in completing the syllabus, warranting extra classes. She said:

You got the choice … to get through the syllabus, but if you can do that, the learners at the end of the year will not know the foundation, so you can’t just rush through the curriculum, so we offer extra lessons.

Interestingly, School C used a different approach to create learning opportunities for learners in mathematics, considering their capacities. The HOD indicated that all learners were given a fair chance from the beginning to do mathematics. However, those who could not cope were allowed to voluntarily switch to mathematics literacy. To champion school improvement through science and mathematics, the teachers focused on leading by providing extra tuition to the learners.

DISCUSSION

This paper explored school improvement opportunities in school science and mathematics through DL practices. In line with Spillane (2006), the paper focused on the neglected "how" of the DL practices in addition to the "what". Consequently, the school DL setups were explored as well as how the setups worked. The study contributes case-based DL insights aimed at school improvement through science and mathematics. Four main findings were made. The first finding speaks to how DL was used as an organizational resource through strategic workload allocation to improve science and mathematics outcomes. Tian et al. (2016) referred to the notion that DL is used pragmatically as an organizational resource. Towards the cause of tapping into DL as an organizational resource in this study, science and mathematics teachers were allocated grades strategically in a way that would allow them to produce the best results. Class allocation was conducted by the HODs and other positional leaders in the management team with some input from the teachers in some schools. In some schools, the allocation was solely based on the teachers' preferences considering their capacity. Both ways of managing the DL human resource for science and mathematics teaching align with the notion that DL practices are pragmatic (Tian et al., 2016) because the goal is to reform instructional practice (Hall, 2013).

The second finding speaks to how DL was used as an organizational resource through professional development activities. It is noted from the literature that DL setups create an environment for teacher growth through the sharing of expertise, peer learning, and coaching (Harris, 2003a, 2004; Harris et al., 2013). In this study, professional development activities aimed at teacher growth and ultimately improving classroom practice were conducted at different levels. These levels of professional development included teacher–teacher, teacher–HOD, and HOD–deputy principal interactions in the schools. The professional development activities also occurred at the district level by involving district officials and other schools. Furthermore, the teacher unions provided opportunities for teacher growth, intending to improve classroom practice expertise in science and mathematics. The teacher development activities showed how leadership was expanded over several individuals, starting with the teachers and extending to bodies outside the schools. Literature has confirmed that instructional reform is achieved when leadership responsibilities are expanded to include several individuals at different levels (Bush & Ng, 2019; Camburn & Han, 2009; Leithwood et al., 2020).

The third finding speaks to how DL for school improvement through science and mathematics was implemented in the schools, and the evidence indicates collaboration as one of the strategies. As the different individuals in the DL setups played varied roles towards improving science and mathematics, they did not do that in silo, but there was collaboration and cooperation. For example, teachers met formally and informally to discuss classroom challenges and content-related matters and initiate alternative solutions with positive classroom practice and school improvement implications. Datnow and Park (2018) and Spillane et al. (2004) emphasized the crucial role played by collaborative activities in school improvement. School improvement results from reformed practices that include DL practices.

The fourth finding shows how teacher leadership was highlighted by focusing on classroom practice to improve science and mathematics outcomes. To improve the learning outcomes, the teachers arranged extra tuition for the learners outside of the regular school timetable. The spread of leadership over several individuals acknowledges that teacher leadership and teachers can lead through classroom practice to promote school improvement goals (Harris, 2003b).

CONCLUSION

The schools in this study developed some mechanisms of how to stretch leadership over several individuals to ensure school improvement through science and mathematics. The strategic allocation of tasks to improve science and mathematics classroom practice shaped DL practices in the schools. The spread and expansion of leadership were also enabled by implementing professional development activities that included teacher–teacher interactions, school-organized expertise-sharing activities, district-facilitated workshops, and professional development provided by teacher unions. The use of collaboration and cooperation when engaging in activities concerned with the teaching and learning of science and mathematics enabled all stakeholders to stay focused on the same goal of school improvement. Teachers also led through intensified classroom practice by offering extra classes to learners to improve school outcomes. DL was used by participating schools as an organizational resource, regardless of context, because the schools pragmatically developed helpful mechanisms. The study was limited because the focus was on a case study of opportunities for school improvement through DL practices for science and mathematics and did not compare the influence of school–context factors. Therefore, the study recommends more studies to understand how school contexts shape and influence DL practices and, by consequence, contribute to improving opportunities for science and mathematics.

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