COMPARING THE ORGANIZATIONAL INFRASTRUCTURE FOR INSTRUCTIONAL LEADERSHIP IN NATURAL SCIENCES TEACHING AMONG FORMERLY SEGREGATED SCHOOLS IN GAUTENG

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Article Info	Abstract
	School organizational conditions influence teaching and learning. Instructional leadership is context-based, and the practices of the leader are contingent upon the school's organizational context. In this paper, we examine how different schools create the organizational infrastructure for teaching and learning natural sciences (NS) and the adequacy thereof in providing a supportive environment for the teachers and students in the subject. Using a mixed methods approach, we compare the extent to which the organizational infrastructures in schools enable and/or constrain NS instruction and its leadership. We use survey data on NS teachers and their heads of department on school conditions and infrastructures, management and administrative processes, and subject leadership practices. A total of 77 schools and 15 participants responded to the questionnaire and participated in the interview/observation respectively, from 4 districts in the Gauteng province of South Africa. The data obtained were analyzed using descriptive statistics and content analysis. The findings showed that schools sharing similar socio-economic contexts have similar organizational infrastructures and arrangements around which the core work of teaching and learning was organized. The study concludes that school organizational infrastructures (shaped by contexts) may either promote or constrain effective instructional leadership for NS. We recommend that schools need to review their organizational arrangements and infrastructures to support instructional leadership and enhance their capacity to strengthen NS instruction more effectively.

INTRODUCTION

Junior secondary science in South Africa is a conglomerate subject comprising five science disciplines and it lays the foundation for at least two senior secondary subjects. It is often taught by teachers who are typically generalists and do not have well-defined subject matter specializations (Spillane & Hopkins, 2013). These teachers tend to teach natural science (NS) only when time allows (Spillane et al., 2001) and only those components they feel they are competent to teach. The NS curriculum is open to interpretation by the teachers, who decide what to teach in order to achieve the outcomes. NS teachers therefore do not use any systematic way of making decisions about what to teach and when to teach it (Brodie et al., 2008). An evaluation done by Umalusi (2008) suggests that NS teachers lack: 1) resources to prepare for practical work; 2) subject expertise; and 3) knowledge and skills to teach NS.

Research shows that school leaders play a very important role towards achieving successes in their schools, with most of the previous studies having dwelt on school principals as instructional leaders (Ismail et al., 2018a; Ismail et al., 2018b; Vogel, 2018; Winn, 2016). Even though Hendricks and Steen (2012) opine that school principals have little influence towards improving students' academic achievement, they agree that school principals enhance classroom instruction. This finding agrees with Lachlan-Hache (2017), who found that school principals have strong influence on teachers' instructional decision-making and that their role has changed over the years to what is now referred to as instructional leader. Unfortunately, many of these principals do not have the capacity to provide appropriate instructional leadership because teacher supervision and coaching are the primary focus of their instructional leadership (Vogel, 2018). Teachers now look out for other possible ways to get instructional leadership because of the scarce leadership provided by school principals. This informs why instructional leadership is being shifted to the heads of department (HoDs) as subject/curriculum leaders.

The HoDs have to play a key role in supporting teachers with the implementation of the new curriculum. However, the ability of the HoDs to effectively provide this kind of support is sometimes constrained by organizational factors inside the school. In addition to NS teachers being generalists, school leaders allocate teachers who are poorly qualified in science or who do not have any science specialization to teach the subject. Malinga and Jita (2015) tell the story of a language teacher who was allocated to teach NS when the language that teacher had taught was phased out as a subject in the school. At another school, a life orientation teacher volunteered and was allowed to teach NS. There is also evidence that the capacity of the school to provide and support learning differs based on how the school is broadly resourced (Jita & Mokhele, 2008).

Organizational infrastructure is the collection of business procedures and policies of a company based on defined responsibilities and duties of its employees (Reference, 2020). In the field of education, organizational infrastructure refers to those educational processes and goals of the school that are clearly outlined in relation to the duties of the

stakeholders to ensure the realization of teaching and learning objectives. Organizational infrastructure includes methods, apparatus, arrangement, conventions, agreements, operations, formations, and proceedings that give shape and design to teaching in secondary schools. Organizational infrastructure also involves identifying positions and showing how these positions connect with one another to obtain necessary feedback during and/or after classroom teaching. Organizational infrastructure can therefore be referred to as a framework that defines the responsibility of leaders and who will be responsible for making decisions about processes, projects, tasks, and development of the school.

Instructional leadership is a collaborative process between school leaders, such as principals, teachers, and other stakeholders, who serve to define the mission of the school, ensure a serene school learning climate, and administer the instructional program. This suggests that apart from the principal, other school leaders have prominent roles to play to ensure adequate instruction in schools. De-Lima (2008) defines instructional leadership as the ability to involve colleagues collaboratively in mutual learning and development, with the main purpose of improving teaching and learning. The goal of instructional leadership is to design the school environment to be completely in line with instruction, especially in the three dimensions of defining the school mission, managing the instructional program, and promoting a positive school climate. Lachlan-Hache (2017) supports this view by asserting that instructional leadership concerns the management of teaching and learning in schools through transformational, organizational, political, and human resource engagements.

Before 1994, there were separate education departments in South Africa. Schools for black children belonged to the Department of Education and Training (DET), the House of Representatives (HOR) controlled schools for colored children, the House of Delegates controlled schools for Indian children, and schools for white children were known as Model C schools (Branson & Lam, 2010). This explains the differences in the funding and the resources available in these schools due to the apartheid that was currently in place then. The legacies of apartheid organization appears to remain because of the great disparity that currently exist in the distribution of physical and intellectual resources and infrastructure. This dilemma led us to investigate how formerly segregated schools in South Africa organize science departments to meet the organizational resource capital challenge, and its impact on instructional leadership to ensure quality NS instruction.

Conceptual Framework

The conceptual framework used in this study shows how the instructional leader's attributes and knowledge of the context and its problems can be integrated to provide leadership through effective interactions with the department members, and influence the teaching choices (Robinson, 2010). Six major components of the framework for leading instruction have been identified in the literature and are briefly discussed (Fig. 1). The first component of the framework is the leader's attributes, such as subject proficiency, professional credibility (Angelle & DeHart, 2011), and agency in resourcing the department. The second component is the leadership practices, such as vision setting,

building collegiality, developing teachers, and the manner in which leadership is distributed among the department members (Koh et al., 2011).
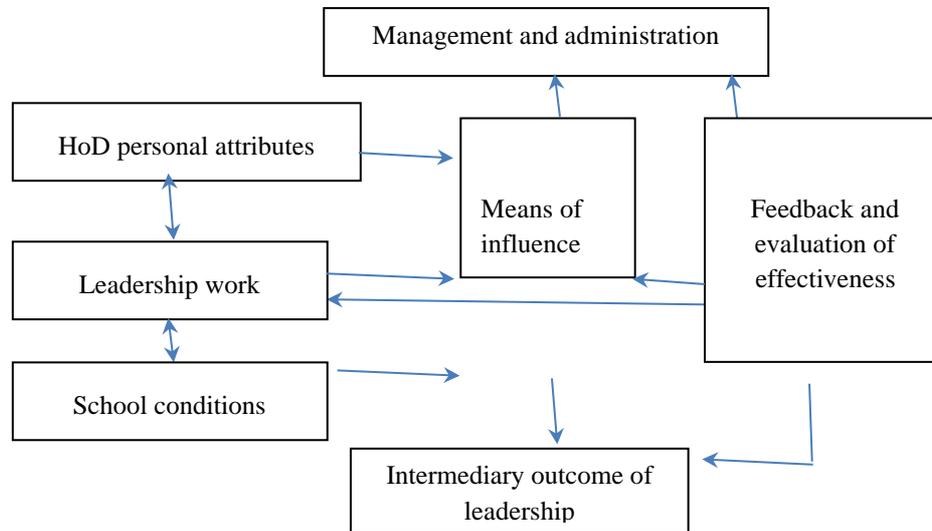
Figure 1: Abridged version of the conceptual framework for leading instruction (adapted from York-Barr & Duke, 2004)

The third component of the framework for leading instruction includes how the HoD negotiates their influence through the social, political, economic, cultural, and other contextual problems of the school (Robinson, 2010). The fourth component explores how the HoD influences teaching choices through setting instructional objectives, planning instruction, and developing reflective practice using classroom observational feedback sessions (Wanzare, 2013) and action research (York-Barr & Duke, 2004). The fifth component is where administration and management overarch the role of managing people and resources (Fig. 1). This is where routines and different systems and processes for managing the curriculum are located (Spillane et al., 2011). The sixth component introduces the feedback loop and evaluation of the effectiveness of leadership. This paper focused on the integration of these six components by different schools to improve NS instruction. Using the conceptual framework developed, we then ask the key question of our study: How do instructional leadership practices of science HoDs from different types of schools compare with regard to NS?

METHODS

This study was a mixed methods exploration of the instructional leadership practices of HoDs from different school contexts, and integrated numerical and qualitative information gathered in several ways (Creswell, 2014). The mixed methods approach combined elements of quantitative (numerical) and qualitative (narrative) approaches in a single project and integrated the findings (Creswell & Plano-Clark, 2011), thereby achieving a deeper and broader understanding and corroboration of the research problem. The decision to use a mixed methods approach was based solely on the research purpose,

the type of data we wanted to collect, answering questions from a number of perspectives, and complementarity.

Sampling

The overall sequential mixed methods sampling strategy was used where information from the quantitative sample in phase 1 informed the qualitative sample in phase 2 (Teddlie & Yu, 2007). The data reported in this paper were only from those schools where both the HoD and the NS teacher responded to the questionnaire. From these schools, seven were selected for in-depth interviews with their NS HoDs and teachers, participant observation of their subject/departmental meetings, and document analysis.

Description of Instruments

Two questionnaires were used to collect data for this study, the HoD questionnaire and NS multi-rater questionnaire for the NS teachers. The HoD questionnaire explored, among other items, HoDs' teaching experience, the instructional activities of the science department, and the profiles of the department members. It also focused on the ways in which the HoDs attempted to influence the teaching of members of their departments in order to improve it. A similar questionnaire in the form of a multi-rater assessment instrument measuring HoDs' instructional leadership practices was administered to NS teachers. The qualitative data were collected from a purposeful sample of schools using semi-structured interviews, meeting observations, and documentary analysis (Creswell, 2014). The interview schedule focused on the HoD's role in influencing the practices of NS teachers, and it explored both general and specific issues regarding HoDs' attempts to influence teaching.

Procedure for Data Collection

We used a mixed methods study in schools from four Gauteng school districts to examine how formerly segregated schools organize their subject departments for NS instruction. We specifically examined how different types of schools (independent, former Model C, and township and/or informal settlement schools) arranged their formal organizational routines and formal positions. These are two organizational infrastructural aspects that can enable or constrain leadership practice (Spillane & Coldren, 2015). For the study, organizational routines included departmental meetings, SMT meetings, lesson plan and assessment data reviews, checking of learners' books, and teacher files. Data were collected using self-reporting techniques (questionnaire and interview), observational methods (participant observation), and secondary-data analysis from artefacts and school documents (Teddlie & Tashakkori, 2012). The quantitative study used full-group data for all 243 secondary and combined schools (all schools with grades 8 and 9) in 4 out of the 15 districts in Gauteng. The questionnaire targeted science HoDs and NS teachers. Completed questionnaires were collected from 77 schools, although only 30 HoDs returned the questionnaire. We followed up the HoDs and NS teachers from seven schools with in-depth semi-structured face-to-face interviews. We observed three departmental

meetings chaired by the HoDs at the schools and took field notes from the schools seven schools for in-depth analyses.

Analysis

The data obtained from 112 teachers and 30 HoDs were analyzed using descriptive statistics. Some descriptive statistical analyses were done on the quantitative data and these results could not be generalized outside this study setting. The semi-structured interviews were audio-recorded and transcribed, while field notes of the meeting discussions were taken. We analyzed departmental and educator files, learners' activity and test books, and minutes of departmental meetings. Several patterns were identified in phase 1 (quantitative strand), which became the basis for the data collection of phase 2 (qualitative strand). In phase 2, interview transcripts were coded for HoDs and teachers' perspectives on leading and managing NS instruction across different schools using an open coding strategy (Creswell, 2014). Five coding categories were used, namely biography, arrangement, and composition of departments; compliance to administrative routines; professional development; other instructional leadership practices; and support provided by principal. We then analyzed the coded data, identified patterns, and checked their prevalence across schools. We coded the field notes of meetings according to five categories: compliance activities, frequency and duration of meetings, discussion points of meetings, learning material, and professional development. Our analysis focused on understanding whether and how formal structures and HoDs' leadership practice connected with the type and context of school. Tables 1 and 2 show the demographic details of the schools that responded to the questionnaires and were followed up with semi-structured interviews.

Table 1. Spread of schools across the districts

District	Number of HoDs who responded	Number of schools whose teachers responded
B	13	16
E	8	16
J	5	8
W	4	37
Total	**30**	**77**

Table 2. School demographics

Type of school	Race	Number of schools	Number of teacher responses	Number of HoD responses	Number of teachers from schools where both HoD and teachers responded
Township and informal settlement	Black	42	64	17	23
Former Model C	Mixed	30	44	10	21
Independent	Mixed	5	4	3	3
Total		**77**	**112**	**30**	**47**

FINDINGS

Biographic Data

School A

Sheba Secondary School is a 60-year-old township school with relatively good infrastructure, and an enrolment of approximately 1600 learners, with 48 teachers. It is a no-fee-paying school. There were three NS teachers at this school. We interviewed the HoD (Mr Chester) and two NS teachers (SF and SM) at this school.

School B

Promise Secondary School is a big township school in the east of Johannesburg that was formerly a technical training center too. It had an enrolment of approximately 1500 learners, with 39 teachers, and it is a no-fee-paying school. The school lacks adequate infrastructure required for a secondary school. Nonetheless, the school has properly built classrooms and other prefabricated structures that are used as SMT offices which were sponsored by a local bank. The premises of the school are shared with an adult education and training center (AETC). There were three NS teachers at this school, including the HoD, Themba.

School C

Knowledge Secondary School is a relatively new township school located west of Johannesburg with an enrolment of approximately 1200 learners, with 36 teachers. This school is located in an industrial area and is a no-fee-paying school. It is fairly new with good infrastructure and is located in a township that has developed from an informal settlement that housed the labor force from the nearby industries. The laboratory storeroom was converted into the science HoD's office. There were three NS teachers

and the subject department is fairly new as it had just been split from a bigger department comprising mathematics and NS.

School D

Fhutura Secondary School is a 12-year-old, big school in a new area on the eastern side of Johannesburg. It is located at the border of a new township and an informal settlement. This is a no-fee-paying school and at the time of our visit, the school had no electricity. We interviewed two teachers (FF and FM) and the HoD, Mr Silumko, at this school. The third teacher did not consent to being interviewed.

School E

Alpha Secondary School is a no-fee-paying, medium-sized school located close to an informal settlement, with approximately 900 learners. The school is over 20 years old but uses prefabricated structures as classrooms and lacks electricity. A large proportion of the learners from this school are 'migrants' in the province who live in informal settlement houses.

School F

Harriotside School is a small, low-fee, independent school, one of the few township-based independent schools. The school is about six years old, and many classrooms were made of prefabricated structures. The enrolment of the school was approximately 450 learners, with 17 teachers. Harriotside is a combined school that houses learners from grades R to 12. We only interviewed the HoD at this school, Mr Bertus, in his office. He was the only one who taught NS in the school.

School G

Mooredale is a big, former Model C school situated in an industrial area on the outskirts of a small East Rand town of Johannesburg that boasts of good and well-kept facilities. This mixed race school had an enrolment of approximately 1500 learners, with 63 teachers. This school utilized the services of a senior teacher for PS to focus on the PS strands of NS. There were four NS teachers at this school. We interviewed the HoD, Mrs Winfreda, and two NS teachers (MW and MF). The interviews were conducted in the HoD's office. During the time of data collection, a new HoD, Mr Mthende, who is a life sciences (LS) specialist, was appointed. This HoD chaired the subject departmental meeting that we observed.

Table 3 shows the age ranges of teachers and HoDs from the schools where both (teachers and HoDs) had responded to the questionnaires. Most of the HoDs and NS teachers in this study were in their middle ages (40 years and above) from all different contexts. This age range suggests that they may have experienced many changes in the curriculum and

may have professionally qualified when the subject (NS) was still general science and comprised only two science disciplines.

Table 3. Age ranges of teachers and heads of department

Type of school	Age range (in years)								
	Teachers only		30–39		40–49		50–59		HoDs only
	< 25	25–29	Ts	HoDs	Ts	HoDs	Ts	HoDs	> 60
Township/informal settlement	1	2	6	3	12	5	2	9	0
Former Model C	3	1	3	1	8	6	4	3	2
Independent	0	1	1	1	1	1	0	1	0
Total	**4**	**4**	**10**	**5**	**21**	**12**	**6**	**13**	**2**

Institution of Professional Qualification

After analyzing the biographic data, we explored the institutions where these teachers and HoDs had qualified. These results are presented in Table 4. While teachers' colleges offer a three-year diploma qualification, universities offer a four-year degree. A degree qualification is considered a higher qualification and hence offering better preparation to teach than a diploma qualification.

Table 4. Institutions where participants professionally qualified

Type of school	Rank	University	Teachers college
Township/informal settlement	HoDs	4	13
	Teachers	6	17
Former Model C	HoDs	5	6
	Teachers	18	3
Independent	HoDs	1	2
	Teachers	2	2

Table 4 shows that the majority of the teachers (17) from township and informal settlement schools qualified from teachers' colleges, while the majority of the former Model C school teachers (18) qualified from universities. A similar pattern was observed with the HoDs from the township schools, where more HoDs had qualified from teachers' colleges (13), whereas the number of university and teachers' college qualifications for the former Model C school HoDs were more or less equal (5 and 6, respectively). This correlated with the age range of the HoDs as well because most of the HoDs and teachers from township schools were older than 40 years.

Specialization of Heads of Department Regarding Natural Sciences

Because of the interdisciplinary nature of NS, the HoDs were expected to have the ability, knowledge, and expertise to support the teachers who might not have expertise in some science disciplines. Various subjects that HoDs specialized in were grouped into categories according to the school science disciplines. Table 5 shows the spread of subject specialization by HoDs in the different schools with regard to the key strands of NS, LS and PS.

Table 5. Head of department specialization according to school type

Subject	Former Model C n = 10*	Township/informal settlement n = 17*	Independent n = 3*
LS only	1(10%)	7(41%)	2
NS	5(50%)	5(29%)	0
PS only	3(30%)	4(24%)	1
Maths	3(30%)	3(18%)	3

The HODs specialized in more than one subject; therefore, the total number of specializations do not tally with the number of HODs per school type

The earth sciences strand was not the focus of this study. The HoDs, as specialists themselves, could only specialize in certain science disciplines and not all the disciplines of NS. The majority of the township school HoDs (41%) had specialized in LS, while an equal number (30%) of the HoDs from former Model C schools had specialized in either PS or mathematics. This was because some schools had mathematics as part of the science department. An equal number of HoDs (5) from both township and former Model C schools had specialized in NS. Half of the former Model C school HoDs and 29% of the township and informal settlement school HoDs had a qualification that allowed them to teach any science discipline. The rest of the HoDs were qualified to teach either of the science disciplines.

Department Size

Most schools had science departments with less than ten teachers irrespective of the school type (Table 6). The minimum number of teachers per department was 3 in an independent school and the maximum number was 12 in a former Model C school. A few schools (10.7%) had less than ten teachers in the department.

Table 6. Number of teachers in the science department

	Township/informal settlement	Former Model C	Independent
< 10	8	12	3
11 to 20	1	2	0
> 20	1	1	0

Table 7. Subjects comprising the science departments according to school type

	Former Model C	**Township/informal settlement**	**Independent**
NS	11 (32.4%)	15 (28.9%)	3 (33.3%)
PS	10 (29.5%)	13 (25.0%)	2 (22.3%)
LS	7 (20.6%)	12 (23.1%)	3 (33.3%)
ES	1 (2.9%)	1 (1.9%)	0
Maths	3 (8.8%)	4 (7.7%)	1 (11.1%)
ML	1 (2.9%)	2 (3.8%)	0
AS	0	2 (3.8%)	0
Tech	1 (2.9%)	3 (5.8%)	0

NS – natural sciences, PS – physical sciences, LS – life sciences, ES – environmental sciences, ML – mathematical literacy, AS – agricultural sciences, Tech – technology

Most of the former Model C schools' science departments comprised NS, LS, and PS, but 11.7% of the school had mathematics and mathematical literacy as part of the department. Only 11.5% and 8.9% of township/informal settlement and former Model C schools respectively had mathematical literacy, earth sciences, and technology education as part of the science department. The former Model C and independent schools did not have agricultural sciences as part of the science department, while two township schools included it. Just over a quarter of the schools, from all contexts, also had mathematics as part of the science department.

Departmental or Subject Meetings

The PAM document prescribes subject meetings and therefore all school-based HoDs are expected to have these meetings. We looked at the different patterns and styles in which the HoDs conducted these meetings.

Schedule and Duration of Meetings

Almost all the schools that we followed up with semi-structured interviews, whether public or independent, township or former Model C, held their meetings during the lunch hour. The meetings were very short as teachers took time to gather from the respective classrooms.

> *We try to meet about twice a term. The meetings are during lunchtime or after school.* (HoD, Sheba)

However, one township school indicated that they held their departmental meeting during the sports period instead of during the lunch hour.

> *The meetings are usually on Wednesday during the sports period.* (Teacher 1, Alpha)

The HoD from Fhutura also indicated that lunchtime was usually too short to discuss any detail and they sometimes used time after school to complete the meetings.

> *Nowadays, we normally hold meetings during lunchtime ... If maybe you find that during lunchtime we couldn't exhaust the agenda, we normally adjourn to half past two, after school ... Lunchtime is not enough actually.* (HoD, Fhutura)

Frequency of Meetings

Almost all the township schools held their departmental meetings once a term, although they tried to have them more frequently.

> *We try to meet about twice a term.* (HoD, Sheba)

> *My plan is to have a departmental meeting at least once a term and then at least one subject meeting per subject, which means it's going to be three subject meetings.* (HoD, Promise)

The HoD from another school confirmed the above:

> *Mandatory we must have a meeting every term.* (HoD, Sheba)

The HoD from Knowledge mentioned that meetings were flexible.

> *Subject meetings we do as often as possible; maybe if Mr Lato comes with some issues that need to be discussed, then we do diagnostic analysis of the question paper, just to see.*

In the former Model C school that we followed up with, Mooredale, subject meetings were held at least once every two weeks and departmental meetings once a quarter. The Mooredale HoD clearly distinguished between subject and departmental meetings.

> *We normally have a department meeting once a term, the whole lot together. I just found that it is sometimes, if you are only working with the NS, then it is a bit much to sit through everybody else's issues ... Alright, so basically what we do is have a meeting once every two weeks just to check that everybody is in the right place.*

Sometimes Mooredale schools did not even meet at all due to other pressing issues. The HoD from Alpha also emphasized the flexibility of the year plan as far as departmental meetings were concerned, saying: "*There is a year plan, but things just occur, but they are flexible. The plan is changed for emergency issues.*" The HoD from Promise reported that other priorities competed with the subject meetings.

> *No, this term we haven't had the meeting yet. We were busy doing all the submission and other stuff, so that was the biggest problem; I don't have a meeting this term yet.*

This was the view from the new HoD, who had only been at the school for two months upon data collection.

Content of the Discussions at Meetings

Except for one township school, Knowledge, all the township schools had departmental meetings where every department member attended. The subject meeting at the former Model C school was only for NS teachers and only topics pertaining to the teaching and learning of NS were discussed at this meeting. Table 8 shows the mean responses of the teachers on the frequency with which topics were discussed in departmental meetings.

Table 8. Topics discussed at departmental meetings – teachers' responses

| | Mean | | |
Topic	Township/informal settlement n = 17	Independent n = 3	Model C n = 10
Policies	4.25	1.50	3.00
Department direction	4.25	1.00	2.75
Material reviews	5.00	3.00	2.75
Improvement plan	4.50	1.50	2.20
Evaluation	3.40	1.00	2.75
Professional development	3.40	1.50	3.67
Learner outcomes	3.40	1.00	2.75
Assessment	5.00	1.00	5.00
Exam papers	3.40	1.00	3.67
Assessment scores	3.40	1.50	3.67
Start-end term issues	3.40	1.50	2.75
Budget	3.40	1.50	2.20
Lesson plans	3.40	2.00	3.67
Content coverage	3.40	1.00	3.67
Distribution of leadership	3.40	1.50	2.75
Remedial and enrichment	3.40	1.50	3.67

In the township schools, meetings were held quarterly and the topics that were frequently discussed pertained to subject assessments, material reviews, and improvement plans. The rest of the items were fairly equally discussed. The HoD from Sheba confirmed this:

> *We also discuss circulars from the district; remind each other there is a circular that 1-2-3, and whether we are in line with that circular.*

The teachers of the township and informal settlement schools indicated that the budget was among the least discussed item during subject meetings; instead, the direction of the department and policies were discussed more frequently. The Model C schools discussed most items equally frequently, but at the top of their list were material review, professional development, assessment issues, lesson plans and differentiated teaching (remedial and enrichment), among other topics. The improvement plan and the budget were some of the least discussed topics in their meetings.

Meeting Place

All schools that we followed up with, except the former Model C school, Mooredale, held their meetings in the HoD's office. This was observed during the interviews at the schools. These were not proper offices but usually storerooms behind the laboratories that were full of chemicals, broken equipment, stationery, textbooks and learners' books. Mooredale held their departmental meeting in one of the classrooms.

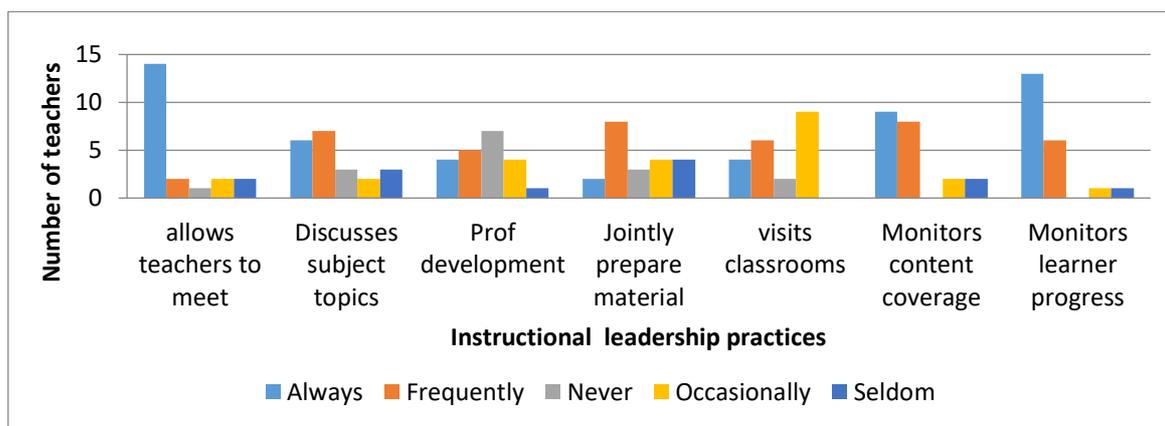**Instructional Leadership Practices of Heads of Department**

We analyzed the instructional practices that heads of departments engage in. Table 9 shows HoDs instructional leadership practices.

Table 9. Head of department instructional leadership practices (self-reported)

|	MEAN	
	Township/informal settlement	Model C
Calls meetings	3.44	3.33
Allows staff to discuss issues	3.73	2.75
Develops staff professionally	3.73	3.33
Discusses topics with staff	3.69	2.50
Prepares material together	3.69	2.00
Performs class visits	3.83	2.50
Knows what is going on	3.82	2.75

The township and informal settlement school HoDs responded that they always performed class visits (mean of 3.83) and knew what was going on in NS classrooms (mean of 3.82) and provided professional development (mean of 3.73). The former Model C school HoDs reported frequently providing professional development to the teachers and calling meetings (both with a mean of 3.33), while over a quarter (28.6%) of the former Model C school HoDs responded that they never called meetings. Over a quarter of the township school HoDs also reported that they frequently discussed subject topics with staff and prepared lesson material jointly (both with a mean of 3.69). It was later established during the follow-up face-to-face semi-structured interviews that these class visits were only performed to adhere to compliancy measures for the Integrated Quality Measurement System (IQMS). The former Model C school HoDs reported that they occasionally discussed topics with staff, allowed teachers to discuss issues, or knew what was going on in NS classrooms. These HoDs seldom prepared material or jointly prepared instructional material. Below we explore the perspectives of the teachers on these instructional leadership practices of the HoDs.

Teachers' Views on the Instructional Leadership Practices of Heads of Department

**Figure 2**: Former Model C school teachers' views on head of department instructional leadership practices

Figure 2 shows that NS teachers from the former Model C schools responded that their HoDs always allowed teachers to meet with them and monitored learners' progress and content coverage. The teachers concurred with the HoDs that they occasionally performed classroom visits and rarely developed teachers professionally. The teachers responded that their HODs frequently discussed subject topics with teachers and jointly prepared instructional material.
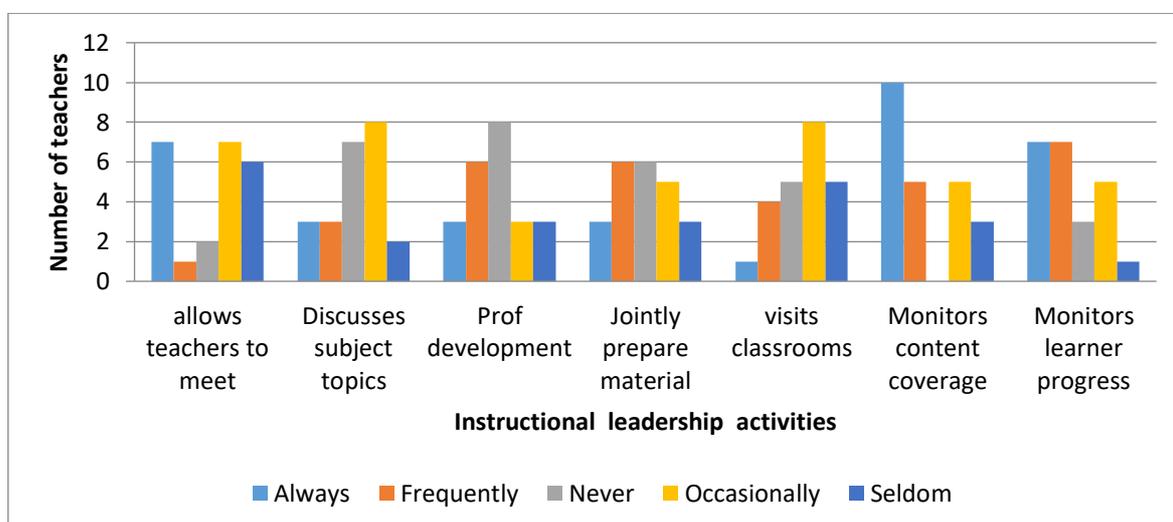
Figure 3: Township and informal settlement school teachers' views on head of department instructional leadership practices

Figure 3 reveals that the teachers from the township and informal settlement schools responded that their HoDs never developed them professionally and that they occasionally discussed subject topics with teachers or visited classrooms. Some of these teachers responded that their HoDs always monitored content coverage and learners' progress and allowed department teachers to meet. The data show that teachers from all

the schools concurred that HoDs always allowed teachers to meet and monitored the content coverage and learners' progress. The classroom visits and professional development of teachers were the least performed duties by the HoDs.
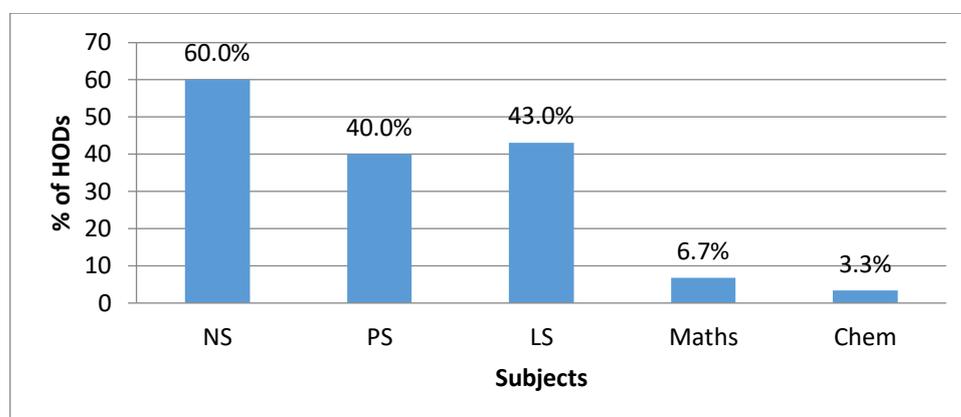

Figure 4: Subjects taught by heads of department

Figure 4 shows that 60% of the HoDs taught NS. These HoDs would understand the subject challenges, prove to have the needed subject expertise, and be in a position to work with the teachers in the subject instead of working for them. The HoDs did not teach only NS, they also taught either PS, LS, or mathematics. The number of HoDs who taught PS (40%) was almost equal to the number of those who taught LS (43%).

Table 10. Subjects taught by heads of department according to school type

Subject grade	Township/informal settlement n = 17	Former Model C n = 10	Independent n = 3
NS 7	4 (10.0%)	1 (5.6%)	0
NS 8	11 (27.5%)	8 (44.4%)	3 (37.5%)
NS 9	12 (30.0%	7 (38.8%)	3 (37.5%)
PS 10	8 (20.0%)	1 (5.6%)	1 (12.5%)
PS 11	3 (7.5%)	1 (5.6%)	1 (12.5%)
PS 12	2 (5.0%)	0	0

Table 10 shows the subject taught by HoDs according to school type. Some of the HoDs taught NS in grades 8 and 9 and PS in grades 10 and/or 11 and/or 12. The table only reports data on NS and PS teaching. More than half of the NS syllabus lays the foundation for PS in senior secondary science. Comparing the teaching of NS and PS across schools assisted us to form an understanding of the level of expertise of the HoDs to support this big part of the NS curriculum. HoDs who teach PS would be in a position to understand the topic progression and areas that need to be emphasized in NS before PS topics are introduced. The data revealed that not all the HoDs taught NS in their schools irrespective of the school context.
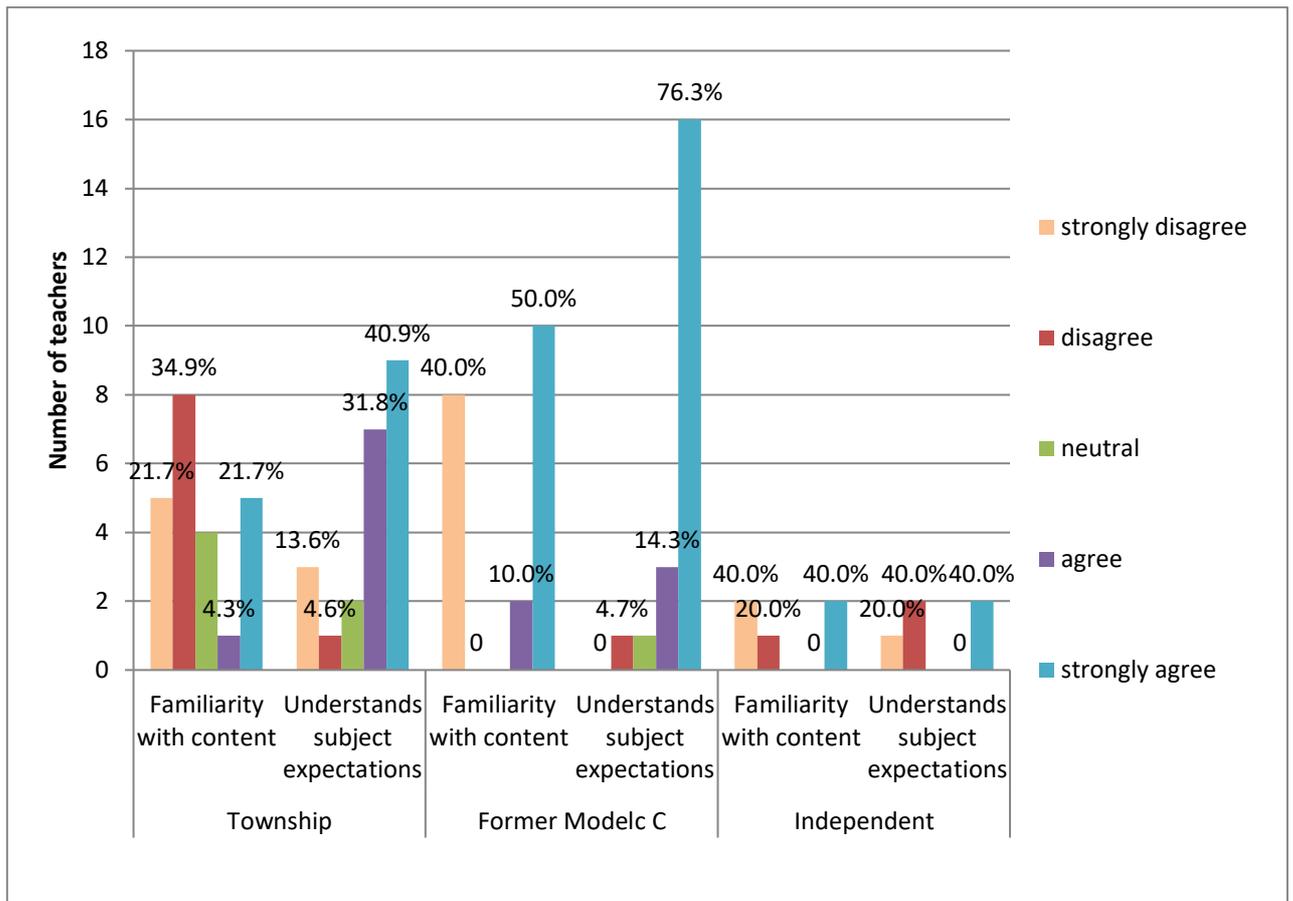
Figure 5: Heads of department's familiarity with the subject – teachers' views

Figure 5 shows the expertise of HoDs according to teachers The responses from all teachers, irrespective of the type of school, indicated that they did not agree that the HoDs were familiar with the content or understood subject expectations at different grades because some teachers still disagreed or strongly disagreed with the assertion (Fig. 5). Of the teachers from the former Model C schools, 76.3% strongly agreed that their HoDs understood the subject expectations, but only 50.0% strongly agreed to their HoDs being familiar with the content while 40.0% of the teachers strongly disagreed with this. Also, 34.9% of the township and informal settlement school teachers disagreed that their HoDs were familiar with the content, and only 40.9% strongly agreed that their HoDs understood the subject expectations. The comparison depicts that the former Model C school teachers were quite outright with their responses, either agreeing or disagreeing, while the township and informal settlement school teachers, however, were modest with their rating.

Table 11. Most helpful person in the school

	Township/informal settlement		Former Model C	
	Senior teacher	**HoD**	**Senior teacher**	**HoD**
Did not need help	1 (4.3%)	2 (8.7)	0	3(14.3%)
Least helpful	0	2 (8.7)	0	0
Less helpful	1 (4.3%)	1 (4.3)	0	2 (9.5%)
Neutral	1 (4.3%)	6 (26.1)	0	1 (4.8)
Most Helpful	0	2 (8.7)	9 (45.0%)	3(14.3%)
Helpful	10 (43.5)	9 (39.2)	11 (55.0%)	12(57.1%)
No response	10 (43.5)	1 (4.3)	0	0
Total	23	23	20	21

Table 11 shows those who provided the help that teachers need. Although the township school teachers did not explicitly indicate having senior teachers, they found them to be helpful (43.5%) and an equal number of the teachers (43.5%) chose not to respond to this question. Nine of the former Model C school teachers (45.0%) found the senior teacher most helpful, compared to three who found the HOD most helpful. Only one teacher (4.3%) indicated that they did not need the senior teacher's help.

Principal's Support

Table 12 shows the support received from the principal. The support was categorized into specific areas, such as provision of space, time, and resources for departmental activities involving doing instructional work, buffering the school from outside influences, and different forms of encouragement.

Table 12. Extent of principal's support to the head of department

|	Township/informal settlement	Former Model C
Least helpful	1 (6.3)	1 (9.1)
Less helpful	3 (18.8)	0
Neutral	2 (12.5)	0
Helpful	5 (31.2)	4 (36.4)
Most helpful	5 (31.2)	6 (54.5)
Mean	3.2	2.2

31.25% of the HoDs from the township/informal settlement and 36.4% from the former Model C schools rated their principals as helpful. Furthermore, 31.2% of the HoDs from the township/informal settlement and 54.5% from the former Model C schools rated their principals most helpful. However, some HoDs from the township/informal settlement schools found their principals to be either least helpful (6.3%) or were neutral (12.5%) about the kind of support that they received from the principal.

Table 13 shows the specific areas HoDs found their principals to be supportive or otherwise. The township school HoDs strongly agreed that their principals encouraged lesson observations (66.7%) and asked about instructional practices (60.0%), but they were neutral about the principal attending departmental meetings (75.0%). The former Model C school HoDs strongly disagreed that the principal attended their departmental/subject meetings (50.0%), but strongly agreed that the principal buffered the school from outside influence (80.0%), encouraged lesson observation (50.0%) and new ideas (42.8%) and asked about instructional practice (42.8%).

Table 13. Principal support on instructional issues

| | Township/informal settlement | | | | Former Model C | | | |
	Strongly disagree	Neutral	Strongly agree	Mean	Strongly disagree	Neutral	Strongly agree	Mean
Asks about instructional practice	3 (30.0%)	1 (10.0%)	6 60.0%)	3.33	2 (28.6)	2 (28.6%)	3 (42.8%)	2.33
Encourages new ideas	3 (33.3%)	4 (44.4%)	2 (22.2%)	3.00	2 (28.6%)	2 (28.6%)	3 (42.8%)	2.33
Encourages lesson observant-ion	2 (22.2)	1 (11.1%)	6 (66.7%)	3.00	1 (16.7%)	2 (33.3%)	3 (50.0)	2.00
Attends subject meetings	1 (12.5)	6 (75.0%)	1 (12.5%)	2.67	5 (50.0%)	3 (30.0%)	2 (20.0%)	3.33
Buffers outside pressures	4 (44.4%)	1 (11.1%)	4 (44.4%)	3.00	1 (20.0%)	0	4 (80.0%)	1.67

Figure 6 reveals how principals supported the HoDs in terms of providing materials, space, and time. The HoDs from the township/informal settlement schools strongly disagreed that they received support from principals in terms of space (100.0%) and time provided (100.0%). Only few of the former Model C school HoDs responded to the questions regarding principal support with respect to space and time.
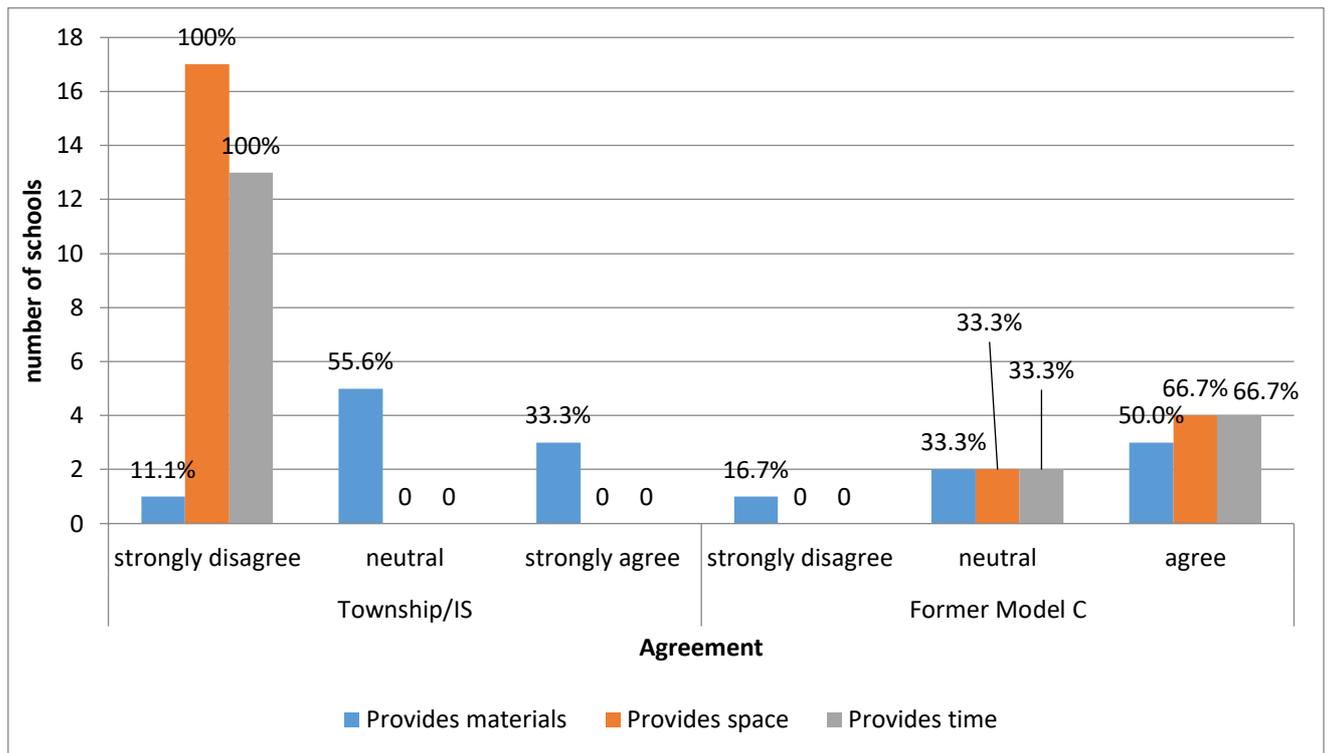
Figure 6: Principal support regarding physical conditions

DISCUSSION

Based on the findings from this study, the HoDs of township schools rated their principals as helpful, although there were a few HoDs who were either neutral about the kind of help they receive, or they found the principal to be less helpful. The township school HoDs indicated, however, that their principals did not support them in terms of providing space and time for them to do their instructional leadership work. In the township schools that we followed up with, we witnessed a shortage of space for HoDs in terms of meeting, professional development, storage, and filing. We conducted interviews in very crammed spaces that were originally laboratory storerooms. These rooms were packed with textbooks, some laboratory equipment, some learner books, teacher files etc. In other schools, we conducted interviews in the deputy principal's office because the HoDs did not have any space other than their classroom.

Also, the HoDs used the only space available to them (cramped laboratory storerooms) to hold meetings. They could not use the classrooms as was the case with the former Model C schools because they were used as serving points for the school feeding scheme, which former Model C schools did not have. A number of other organizational infrastructural reasons made it impossible for the HoDs to use their classrooms during the lunchbreak, but those fall outside the scope of this study.

On the other hand, the former Model C school HoDs were mostly silent about this kind of infrastructural support. It could be argued that the HoDs from the former Model C schools received more help from the principal than those from the township or informal settlement schools. It could be possible the that the former Model C schools did not have space challenges because their schools were well-resourced. In the former Model C school that we followed up with, we conducted interviews in the HoD's office, which had enough space and furniture, and we observed subject department meetings in classrooms. Although this difference in organization could be based on how the school leadership has allocated space to its management team, it is an undisputable fact that former Model C schools have better facilities than township and informal settlement schools. The organization of school infrastructure does not provide township HoDs with the space that is conducive to do their instructional leadership work.

Release time is one of the HoD role challenges that face some HoDs across different contexts and in some countries (Collier et al., 2002; Glickman et al., 2011). Only two of the HoDs whom we followed up with interviews mentioned that they had some release time to do their HoD work, but most did not. These HoDs indicated that they have fewer teaching periods and hence have some release time. The allocation of release time is a prerogative of the school leadership as they are the ones who could design staff timetables for each school year, such that these HODs received some release time from their teaching duties to do their HoD duties. Only one former Model C school HoD responded that they were overworked but did not specifically relate this to release time. Findings have revealed that release time is still a challenge to HoD instructional leadership in all countries despite the shift to the distributed approach to leadership (Koh et al., 2011). Those to whom leadership has been 'stretched over', such as science HoDs, do not receive the accompanying release time.

Attributes of Heads of Science Department

Having compared the allocation of space and release time of the HoDs by different school types and arrangements, we looked at how these organizational infrastructure arrangements translated into the running of the subject departments. First, in this section, we discuss how the instructional leader's qualifications influenced NS teaching in the different schools. Second, we discuss one of the means of influencing instruction and the subject/departmental meetings.

Qualifications of Heads of Department

The HoD's role and position, although formal, has not been clearly outlined in the DoE policy documents in South Africa (SA. DoE, 1999). The PAM document only mentions that an HoD will be responsible for the effective functioning of the department and organize relevant/related extracurricular activities so as to ensure that the subject, learning area or phase, and the education of the learners are promoted in a proper manner (SA. DoE, 1999). This role ambiguity (Zepeda & Kruskamp, 2007) lends itself to various interpretations by different individuals in different schools (Stephenson, 2010). The context in the different schools also shapes how the role is enacted by HoDs and perceived

by school leaders and teachers. For a federal subject such as NS, it is important that the appointed HoD is able to support teachers in all the science disciplines of the subject. If not, the school should have an organized structure and system of how all the disciplines would be supported. Each school in the study had at least one HoD responsible for NS. The qualifications of the HoDs differed from school to school. The HoDs also had other subjects, especially FET subjects, that they were responsible for other than NS.

Institution of Professional Qualification

While there was no significant difference in the type of institution where the former Model C school HoDs had professionally qualified, there was, however, a significant difference with the teachers. A majority of the former Model C school teachers had qualified at universities, whereas the opposite was true in the township and informal settlement schools, where a majority of the teachers and HoDs had qualified in teachers' colleges. This difference could be a result of the former segregation of schools in that former Model C schools were for white children and their teachers were predominantly white as well. The teachers in these schools had therefore mostly qualified at universities or colleges that were linked to universities, unlike the African teachers, where teachers' colleges were not linked to universities. Until recently, a majority of the teachers in the country had had a three-year qualification, which is also a minimum requirement when applying for teaching jobs (Centre for Development and Enterprise [CDE], 2015). This minimum qualification with a status lower than the four-year qualification may have contributed to the type of instructional practices of teachers and HoDs and level of preparation for beginning teachers. This is one very clear example of where the former segregation of schools resulted in learners from townships flooding former Model C schools for 'better education'.

Heads of Department Teaching Natural Sciences

Not all the HoDs in the study taught NS or knew what was going on in the NS classrooms. During their allocation of teacher workloads, each school decided whether the HoD would teach the subject or not. Those HoDs who did not teach NS were largely also teachers of senior secondary subjects such as PS, LS, and mathematics. They would therefore dedicate most of their time to these subjects and they would know what is going on in those subjects. The NS teachers raised a concern, however, that their HoDs were not familiar with the NS subject content. From all school types, some of the teachers disagreed that their HoDs were familiar with NS content because their HoDs did not teach NS. The HoDs were seen as lacking expertise in terms of all types of content knowledge necessary to support the teachers, and what is expected of the instructional leader. Literature suggests that an HoD leads instruction by example, providing demo lessons and coaching the teachers (Ghamrawi, 2010). HoDs are expected to be excellent and experienced teachers in their subject who are respected by their colleagues. This was not the case in the schools that participated in the study.

Distributing Leadership to Senior Teachers

A few schools in the study had a senior, master, or lead teacher system where a particular teacher is assigned the responsibility of supporting other teachers in a particular subject. These positions are either formalized or informal. This system is anecdotally more effective in former Model C schools because they remunerate the senior teachers (from the SGB funds) for the additional hours that they put in supporting other teachers in the subject. In township schools, however, teachers do this voluntarily, either because of their agency (Lai & Cheung, 2013) or because the schools have no additional funds other than the salary paid to the formally appointed HoD. Guthrie and Schuermann (2010) affirm that distributed instructional leadership works well with skilled, capable, and competent teachers.

It was found that compared to the HoDs, senior teachers were most helpful in all schools, although the township school participants did not respond to this question. A possible explanation could be that they did not have senior teachers in their schools. The role of the senior teacher is very important, especially in schools where the HoD does not teach NS, or where they do, do not have expertise in certain strands of the subject, for example the PS strand. Appointing a senior teacher encourages distributed leadership, especially in departments comprising a group of subjects. Timperley (2005) argues that leadership is distributed as a result of situation and task at hand. The situation in the schools in the study was that 1) HoDs had not specialized in science or had no release time because they were also teachers, albeit of FET subjects; and 2) NS teachers themselves had not specialized in some strands and needed help. Distributed leadership is a solution that could address this challenge amicably. This, however, was not the case in the sampled township schools. These schools were not formalized by senior school leadership and there was no reference to these teachers during our interaction with the HoDs and teachers, except that some teachers indicated that they were senior teachers.

Staff Composition of Science Departments

The current reality in the South African education system is that most teachers in the system, especially mathematics and science teachers, are older than 40. In 2013, there were four times more teachers in their late 40s than in their early 30s (CDE, 2015). Only the former Model C schools had a few teachers younger than 25 and older than 60. This could be explained by the fact that former Model C schools are able to keep their good, retired teachers in the schools for longer by employing them in SGB paid positions because these are fee-paying schools. Because former Model C schools supposedly produce good results and have better resources and working conditions than township and informal settlement schools, they are able to attract younger teachers as well. The policies and staff establishment of the DoE does not specify what the composition of the science department should be; it only allocates the HoD position to the school. The school must appoint the HoD to their department and allocate subjects that will form part of it. Two schools in this study (Knowledge and Mooredale) were confronted with this situation. NS was separated from other subjects to be a department on its own. The biggest challenge with the arrangement of the science department with subjects from junior and senior

secondary phases is that the subjects tend to be treated unequally. The senior secondary school subjects are used in the systemic exit examination to measure the quality of education nationally and they therefore receive more attention than the junior secondary school subjects. This was confirmed during the departmental meeting observations as well, where the largest amount of the subject meeting time was dedicated to senior secondary school subjects such as PS and LS. We discuss this observation in detail below.

Subject/Departmental Meetings

The differences in the arrangement of the departments in the schools used in this study led to the varying quality of the discussions during subject meetings. In two schools (Knowledge and Mooredale) because the meetings were subject meetings and not departmental meetings, issues pertinent to the teaching and learning of the subject were addressed. These meetings were spent on NS and not on other subjects. Teachers were able to voice their concerns about the subjects and the learner receptiveness. The meetings ended with concrete suggestions of the next steps to improve the teaching and learning of NS. What was common in all the other schools was the content of departmental meetings, which focused on compliance issues and preparation for common tests or examinations. Because there were both junior and senior secondary subject teachers in the departmental meetings, they rushed through the discussions on the junior secondary subject (NS) and spent the rest of the time on the senior secondary school subjects and all the deadlines that had to be met. The frequency of the meetings for all the township schools was most commonly once a term. This is contrary to the findings revealed by literature, that subject meetings are used for staff development and preparing instructional materials (Burch & Spillane, 2003).

Mooredale (former Model C school) was an exception in the frequency of meetings held, with subject meetings held more frequently (every month). The frequency of the meetings resulted in more subject instructional and pedagogical approaches being discussed in this school than in the rest of the schools. Burch and Spillane (2003) affirm that the frequency and content of teacher interactions with one another are what make a difference. This becomes a fundamental part of the professional life of teachers, instead of scattered workshops here and there. The township schools that met only once a term tended to focus on assessment and other deadlines, considering the short duration of the meeting as well, which we discuss below. In some instances, the deadlines and urgent issues resulted in the cancellation of subject or departmental meetings.

The departmental meetings happened during lunchtime and, irrespective of school type, the meetings were very short. There could be two reasons for the short duration of time and lower frequency of meetings. First, the school leadership did not prioritize these meetings and did not attach much importance to it. This shows that the meetings are not formalized and prioritized by the school leadership to the extent of being allocated time. They are considered less important than extramural activities, which were at least allocated time. Teachers had to sacrifice their own lunchtime to attend these meetings. This was also evident in the number of times that these meetings were postponed in some schools during the data collection cycle. The principals of these schools did not prove

very supportive of HoDs in terms of scheduling and securing time for these meetings, contrary to findings from other countries (Klar, 2012). Second, the school leadership preferred that HoDs provided grade leadership (meaning all subjects in the grade) and/or led phases (e.g. grades 8 and 9, grades 10–12) instead of being loyal to their teams and subject disciplines (Bennett et al., 2003). Although this preference by principals was not explicit, it was noticeable in the allocation of school committees led by science HoDs and in other administrative duties allocated to them.

The fact that the school leadership did not provide time or prioritize these meetings is also seen in the way that subjects are allocated in different departments. The allocations show very little appreciation of the role that the HoD plays in supporting the teachers in their department. The overall analysis suggests that there are more interactions in the meetings regarding the teaching of senior secondary subjects than NS teaching. The HoDs resorted to curriculum management as a refuge for avoiding instructional leadership, an observation also made by Barnett and Aagaard (2007). At the township schools, we witnessed more discussion about assessment and compliance demands rather than the content and actual teaching of NS than at the former Model C school.

CONCLUSION

The success of the science HoD in supporting instruction depends on how the school has arranged its systems and infrastructure to support instruction. The school leadership plays a major role in designing these organizational infrastructures. The instructional leadership practices of HoDs are shaped by these organizational structures and systems and are contingent on what the school context is. Although the segregation of schools happened over 20 years ago, the playing field has not been levelled yet and the schools are no closer to desegregation. Former Model C schools are better organized by way of human resources and infrastructure to support NS instruction. The findings of this study have offered evidence that the differences in instructional practices are related to differences in organizational infrastructure linked to the segregation of schools. The findings showed that a department comprising of a single subject is better managed than one with a group of subjects. A science HoD for NS alone supports instruction better than the one leading many subjects in their department, as was the case in Knowledge and Mooredale. The findings also revealed that the principals of township schools are not as supportive to the instructional leadership role of the HoDs as former Model C school principals. The principals have not put systems in place to support the functioning of subject departments, especially regarding NS.

The findings and analysis suggest that the DoE should reconsider the arrangement of departments in schools and make recommendations to schools to rearrange the subjects such that junior secondary subjects are not grouped with senior secondary subjects. The rearrangement of departments will not have any financial or human resource risks but may enhance the instructional leadership practices of science HoDs with regard to NS. This will need to be coupled with a plan to manage the transition and progression from the junior secondary to the senior secondary phase. This will enable the NS HoD to

provide enough attention to the subject, while the PS and LS HoD will be able to focus on preparing learners for matric examinations. In this way, the NS teachers would not feel neglected. We therefore argue, firstly, for the separate arrangement of HoDs into GET and FET HODs. Secondly, we argue that HoDs be allowed to be subject leaders for subjects that they have specialized in and not grade or phase leaders, as is currently the case in some schools. There is a need to specify the arrangement and composition of subject departments, especially federal ones such as science, in policy to facilitate the effective leadership of departments and hence improve instruction.

Limitations

Our research is limited in that we did not do on-the-job HoD observation on a day-to-day basis. Nonetheless, subject meeting minutes suggested some activities that the HoDs engaged in on a daily basis. Future research may systematically do case studies of the different school types to examine instructional leadership differences. The limitations existing due to the small sample size means that the results could not be generalized but only interpreted for the findings of this study.

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