Instructional Leadership in Elementary School Science

How can I be an instructional leader in a content area, like science, where I have little to no background experience or knowledge?

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ABSTRACT: Instructional leadership is internationally recognized as being a key role for school administrators to advance in their relationships with teachers. But what happens when a principal lacks content knowledge or specific pedagogical knowledge about certain curriculum areas? How do administrators support instructional practices of teachers who teach subjects in which the administrators have little to no experience? In this paper, these questions are considered in relation to the teaching of upper elementary school science. Twenty-five principals of elementary schools were interviewed about the ways they provide instructional leadership in upper elementary science, an area where many elementary teachers are challenged with regard to their understanding of science content and to their knowledge of specific pedagogical approaches. Many principals describe their own challenges in providing appropriate instructional leadership for these teachers.

Instructional leadership is internationally recognized as being a key role for school administrators to advance in their relationships with teachers. Theoretically, effective instructional leadership from school administrators can contribute indirectly to improved student outcomes (Leithwood & Prestine, 2002). Credible research (Blase & Blase, 2004) exists that encourages principals to analyze the way they encourage teachers to think critically about their teaching and assessment approaches with students. But what happens when a principal does not have the content knowledge or specific pedagogical knowledge about certain curriculum areas? How do administrators support instructional practices of teachers who teach subjects in which the administrators have little to no experience? Is it necessary to have experience in all curriculum areas in order to provide effective instructional leadership? In this paper, these questions are considered in relation to the teaching of upper elementary school science.

Background

Prior to the current study, we researched the preparedness of teachers for elementary science by interviewing B.Ed. Elementary pre-service teachers about challenges of teaching science (in one study) and interviewing grade four and five teachers (in another study). Thirty-five pre-service teachers were surveyed and interviewed both before their first teaching practicum and following their two-year B.Ed. program. The teachers provided a description of their experiences of feeling underprepared and afraid to teach science at the upper elementary level (MacDonald & Sherman, 2007). We also interviewed, and then worked with, grade four and five elementary science teachers to increase their pedagogical content knowledge (MacDonald & Sherman, 2006). One result from this teaching initiative was the creation of kits for grade four, five, and six teachers with corresponding professional development activities.

The interviews with both pre-service and in-service elementary teachers highlighted the challenges they faced. One of the challenges identified was linked to the fact that the teachers had little previous experience with hands-on science in their own schooling. Teachers commented there seemed to be few requirements in teacher education programs to have science content knowledge and, while they had the requirements needed by the university and the government's teacher licensing agency, they felt they were not adequately prepared to teach the level of science required by the curriculum of grades four, five, and six.

Many of those interviewed claimed to have only met the minimal requirement for science when they entered their teacher education program. As a result, in their interviews, teachers indicated that science is the subject area they least enjoy teaching. Almost all of the teachers claimed they have little confidence in their own level of science content knowledge and they are afraid classroom experiments will yield results they do not understand and cannot explain to their students. The teachers also said they felt challenged to acquire resources needed to create the kind of science learning environments they considered to be most appropriate. When teachers were able to find the resources, they said they were challenged to set up the equipment in a way that was accessible to the students. Many were exasperated and their comments echoed other teachers' views about teaching science and resulted in claims that they "Don't even know where to start" (MacDonald & Sherman, 2006).

Given that many elementary teachers feel unprepared for science teaching, at upper elementary levels in particular, we were curious about the supports their principals provide them. If a high degree of support is needed to enable effective science teaching, principals, as instructional leaders in schools, may find themselves challenged if they also feel they have insufficient pedagogical science content knowledge. As many principals are selected from within the ranks of elementary teachers, it seems logical that these principals may have faced similar challenges in their own science teaching. Our research questions focused on how principals can find ways to support their teachers in the area of upper elementary science.

OECD data from consecutive TIMSS (The Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) studies provide compelling evidence about the need for students to have access to world class science education. Higher credentialing of young people in the field of science adds to the life and work choices available to them. One of the key factors involved in improving student achievement is the quality of teaching (Darling-Hammond & Barnett, 2006). Principals play a crucial role in supporting teaching and as such, examining the way they live that role can provide others with important information.

The Methodology

This paper discusses key results from the study conducted with principals of elementary schools who were interviewed about their instructional leadership with a particular focus on how they support science in upper elementary classrooms. Twenty-five principals participated in informal conversation-like interviews lasting approximately one hour each with one of the authors of this paper.

Seven school boards in one province provided access to their elementary principals. All boards are publicly funded boards and located outside of large urban centres. None of the boards have specific central office consultants who provide support for science. In most cases, the schools averaged in size between 250 children and 459 children. All schools included grades kindergarten to six. Principals were invited to participate based on information from their school boards about the length of time in the role and gender considerations. The participants did not represent an accurate depiction of the boards' hiring based on gender and experience. Rather, our selection of these individuals was meant to help us look at views on instructional leadership across a balanced sample of men and women, who represent a broad range of experience in relation to the number of years they have been a principal.

In this study, all but four of the principals were elementary teachers prior to becoming elementary school administrators. Two of the others came to their principalship from the central office of the school board and two came to the elementary schools from middle or junior high schools. Of those interviewed, only one has a science degree. That principal's science degree was earned prior to completing a Bachelor of Education. Four of the interviewed principals taught science in upper elementary classrooms during their career and one principal taught junior high science for a couple of years. Eighteen of the interviewed principals claimed to have taught little to no science during their teaching career. In addition, almost all of the principals taught less than ten years before becoming an administrator and a number of them taught fewer than five years prior to taking on an administrative role. Given Berliner's (2005) work on the transition from novice to expert levels of teaching, one might question whether the teaching experience level of these principals was sufficient to ensure that they were expert teachers prior to leaving the classroom.
Principals were asked about their role as instructional leader, how their staff came to see them as an instructional leader, their concerns over the teaching of science, what they look for in an effective science lesson, and what supports they give a teacher who is struggling with the teaching of science.

Instructional Leadership Literature

Instructional Leadership is a process whereby principals are expected to promote professional growth amongst their teaching staff. A good instructional leader will also encourage critical study of pedagogy and curriculum as well as encourage teachers to be self reflective. Good instructional leaders are visible in the school to teachers, students and parents. As well, these instructional leaders may visit classrooms, wander around the school (with a keen eye for what is going on), and yet not disrupt student learning when they visit classrooms. Good instructional leaders praise effective teaching and encourage change when needed, rather than criticizing practices without providing support. An effective instructional leader will find ways to extend autonomy to their teachers in a way that allows teachers to gain control over their professional responsibilities (Blase & Blase, 1999).

Effective instructional leaders avoid conveying restrictive and intimidating approaches to teachers, as well as approaches that elicit "dog and pony shows" based on narrow definitions of teaching. Administrative control gives way to collegiality with strong instructional leaders who believe in teacher choice and discretion. Teachers are encouraged when instructional leaders

integrate collaboration, peer coaching, inquiry, collegial study groups, and reflective discussion to promote professional dialogue (Blase & Blase, 2001). Little (1993) suggests that effective instructional leaders respect teachers' knowledge and abilities, seeing the teacher as "intellectual rather than teacher as technician" (p. 129). Effective instructional leaders are committed not only to enacting school improvement and reform, but also to enhancing professional community in schools (Louis & Kruse, 1996). Instructional leadership is embedded in school culture; and as such, teachers have a right to expect it will be routinely delivered. A strong instructional leader will consider how to provide a fine balance needed between support in terms of skill development via clear expectations and challenge. In order to grow professionally, some teachers need support and others need to have their ideas and strategies challenged in a more subtle way. It is the good instructional leaders who, thus, understand the give and take of spirited discussion (Prawat, 1992. Blase and Blase (2001) found that in effective principal-teacher interaction about instruction, the result is inquiry, reflection, exploration, and experimentation. Teachers, therefore, build repertoires of flexible alternatives rather than rigid teaching procedures and methods when supported by an effective instructional leadership. In general, the literature points to the benefits of strong instructional leadership which is provided against a safe, trusting, and open organizational climate.

Professional Development in Science Teaching

Research also demonstrates the necessity of teachers having successful experiences with science before they teach science in their classrooms. For example, Bianchini, Johnston, Oram, and Cavazos (2003) describe the challenges faced by first-year science teachers as they tried to teach in contemporary and equitable ways. Overcoming pre-conceived notions of the nature of effective science teaching was, arguably, the greatest challenge. In other studies, many teachers found it difficult to describe successful and engaging science experiences they had as children in school (MacDonald & Sherman, 2007; 2006). Poor experiences with science and/or a general lack of engaging science experiences, affects the belief system each teacher has about her/his own science teaching (Bryan, 2003; Guillame, 1995. Previous science experiences are very influential in terms of teachers' capacities to be confident in the teaching of science (Cheng, 2002). This finding suggests that when typical science experiences are framed within a pedagogical context, teachers simultaneously develop understandings from the perspective of a learner, as well as a teacher of science.

Korthagen and Kessels (1999) suggest meaningful learning occurs for teachers when their learning processes start from situated knowledge. Doing so provides a route to address the challenge of teacher socialization in the sense that starting with situated knowledge helps pre-service teachers develop a deeper ownership of their own learning of science. This, in turn, helps teachers better develop connections between content and the pedagogical experiences that enable their students to engage with that content. By having teachers successfully engage in phenomena that help them gain new science understanding, they can increase their confidence and willingness to attempt novel approaches to the teaching of science (MacDonald & Sherman, 2007). Principals who have little or no science background may find it difficult to provide such experiences for their teachers. As outlined below in their interview responses, the principals' focus tends to be on general pedagogical support rather than on more content specific support. What principals are saying about their role as an instructional leader in meeting challenges in

science teaching

Principals in this study were aware of many of the challenges faced by their upper elementary teachers with regard to the teaching of science. In this section, we present principals' descriptions of the ways they believe they are viewed as instructional leaders who currently support science teaching.

A variety of themes emerged during the interviews. These included the fact that principals spoke about the need for increased resource support in science. Principals also described the general curriculum at the elementary level as being very crowded. Indeed, principals considered teachers to be overloaded with expectations in regard to programs which exist outside the core curriculum. The principals also talked about teachers' fear of teaching something when they feel unprepared to teach. Principals also talked about the need for collaborative planning and team teaching as a potential way to support teachers who lacked science content knowledge.

Principals held similar concerns as elementary teachers about the overall lack of preparation and knowledge teachers have when teaching upper elementary science. The principals believe, as instructional leaders, they provide adequate support for teachers (even though they acknowledge they also lack content knowledge related to science). Principals' comments identified that they believed their strong general pedagogical knowledge was sufficient to help their teaching colleagues. Each principal described a variety of strategies they used when teaching and reported that they made suggestions to teachers about methods that might be incorporated into science classrooms.

Typically, the principals argued that their teachers view them as instructional leaders because, as part of their role as principal, they ask questions and start conversations about teaching and learning. 'Bernice' [pseudonym] commented as follows:
I need to get them talking about their teaching so I ask lots of questions, don't I? I think that is my role as principals to get them talking. If they aren't talking about their teaching, then they are thinking enough about it. So that's my job…asking questions(Bernice, Jan. 2007). Indeed, it is conversations about teaching in general that some of the principals said is lacking in their schools. Some considered it was essential that they took the initiative to "get the conversation going" (Bernice, Jan. 2007). When asked about conversations about science teaching, only a few principals had specific examples to share. Nevertheless, some described the way they talked with teachers about how they could identify together what was most suited for a particular curriculum outcome in science.My grade four teacher came to me about his electricity lessons and he knew that I had grade four when I was teaching. We talked about some of the kinds of things I used to do and of course he asked if he could buy some resources. We went through the store room together and I found him some things he could use and we went to his classrooms and set up a few things with him. But mostly he needed someone to talk through the ways to meet the outcomes (Brad, March, 2007).

The principals also described ways they modeled teaching as an example of how they demonstrated their instructional leadership.
After all, we are teachers first. I teach half time and so many of the kids in the younger grades don't even know I am the principal. The other teachers see me at the grade group meeting and

know that I am planning for my own classroom. That's the best thing about teaching part time. I never ask the teachers to do something that I don't do in my own classroom (Charles, May, 2007).

As another example of ways they are recognized as instructional leaders, the principals argued that they give their teachers additional planning time when it is needed. Sharon describes the process below:
I try to make sure that within the timetable, the different grade groupings have the same prep time, so when one grade two class has music, I timetable the other grade two class into Phys. Ed. Sometimes, they need a little extra time so I take both classes and do an activity outside with them or play a game. I also encourage the teachers to visit each other's classrooms, so then I can go and cover one of the teachers while they visit the other teacher (Sharon, Jan., 2007).

Some principals described staff meetings as a venue to demonstrate instructional leadership by using effective instructional strategies to run their meetings. Principals gave examples of using group work, short presentations, and reading activities during their staff meetings to model strategies teachers might use in their classrooms. Karen describes her approach to staff meetings in the following way:
I avoid using meetings as simply information sessions. If I have straight information to share, it can be done through e-mail or a newsletter. Instead I try to use the meetings as a chance to open up conversation about what we are ding and where we are going. There are more important things to do at a meeting tan tell them times and places for future meetings (Karen, Jan., 2007).
Another principal talked about the impact on teachers when he is seen interacting with children. "They are reminded that I am a teacher when they see me interacting with kids." (Martin, Jan. 2007). Other principals also felt they served as good role models when interacting with students during assemblies or when they visited classrooms on a "walk-about". John commented as follows:When teachers see me visiting in their classroom, I am modeling good instructional practices. I kneel by the kids, talking to them at their level, asking children what they are engaged in, getting them to explain to me what the activity is about. Sometimes, I join in and teach with the teacher, if I know they are someone who is comfortable with that kind of thing. It helps them know that I have something to share when it comes to talking about teaching. I'm not just some guy in the office (John, March, 2007).

While the discussion and examples provided by the principals show a desire to support science and a willingness to be the best instructional leader possible, the interviews reveal a lack of awareness about the need to have a pedagogical content knowledge that is specific to science in order to best help teachers grow as science teachers. There is no doubt that these principals are strong leaders and strong teachers themselves. They have a large repertoire of teaching strategies that make up their general pedagogical knowledge. There was little to no acknowledgment that they did not possess specific science pedagogical content knowledge which could have helped them support upper elementary science teachers in more effective ways.

How do they know when they see effective science teaching?

When asked how they recognize appropriate, meaningful, or effective science teaching, the principals responded with a number of different statements that implied they knew it when they saw it. Nonetheless, most principals couldn't give a complete description as an example. Many suggested they look for hands-on teaching but couldn't fully describe what it looks like. Principals suggested it might include 'children working with materials and resources'. When asked if they were familiar with the idea of hands-on – minds-on teaching, none of the principals had heard the phrase before but several quickly identified what they thought it meant.

It must mean that children are fully engaged, not only with their hands, but with their minds. I mean, isn't that what we want to be happening all the time in school? (Gray, Feb. 2007)

Other principals suggested they looked for teachers asking lots of questions when looking for 'good' science teaching.

Science is all about answering questions and about figuring out what questions we should be asking and answering. I like to see teachers answering the kids questions by asking them more questions. Not that we shouldn't give them a direct answer sometimes, but other times it is best to answer a question with a question (Bernice, Jan. 2007).

The interviewed principals also talked about a similar idea when they described how they looked for opportunities for kids to explain science. This meant they would see children talking to each and to the teacher.

I believe that we need to be getting teachers and students to be thinking about their thinking, you know…meta-cognition, so I think we need to incorporate strategies that mean teachers aren't the only one talking in the classroom (Betsy, April, 2007).

This was also related to the principals' desire to see collaborative work integrated into the teachers' classroom activities.

There was, however, no discussion by the principals about pedagogical content knowledge specific to science. While they seemed to be well versed in general instructional strategies that promote effective learning, no one mentioned that there might be pedagogical content knowledge that is specific to the science classroom. None of the principals mentioned any science instructional strategies like POE (Predict – Observe – Explain) (White & Gunstone, 1992) the Learning Cycle (Karplus & Their, 1967; Odom & Settlage, 1996), or concept mapping that are commonly discussed in course work and texts which focus on teaching science in elementary science classrooms.

When principals don't see effective science teaching

When asked what they did when they did not see effective science teaching, or saw teaching that was inappropriate for the teaching of science, principals were quick to describe a series of pedagogical strategies used to help teachers teach in more effective ways. Most of the principals had a great number of years of teaching experience and considered themselves strong teaching teachers. They offered a number of strategies or approaches to teachers needing support.

Most of the principals said they encourage teachers to visit another classroom, sometimes within the school or sometimes at an arranged location at another school.
I had a teacher who needed help with getting his classroom organized when it came to getting more experiments happening in his classroom. I know a teacher in another school, who I used to work with, and so I arrange for my teacher to go and spend a morning with him, watching how he set up ahead of time, and how he used common materials to get the kids really interested in science activities (John, March, 2007).

The principals also shared experiences they had where they team taught with a teacher who needed in-class support.
I enjoy having the opportunity to go into a classroom and work with the students and the teacher. It gives me an opportunity to more closely analyze what the problem might be and also to demonstrate for the teacher different way to approach the topic. We usually have a chance the day or two before to plan what the activity will be and how we will share the teaching. And, I'm right there to step in if things do not go as planned. Usually the teacher is a little nervous but I do my best to make sure they are calm and give them as much praise as I can throughout the lesson privately and then after the lesson is over. If things didn't go well, I try to get them to tell me what went wrong, instead of me pointing it out (Martin, Jan. 2007).

Some principals also mentioned they sometimes asked an instructional consultant from their school board's central office to team teach with the teacher requiring support, but again, the consultant did not specifically have a great deal of content knowledge in the area of science.

Some principals identified a 'science leader' on staff who the principals occasionally went to seeking advice. Most often the science leader was asked to be the person who organized the science resources for the schools, although that was not always the case. No examples were provided of the science leaders being asked to team teach with a colleague. Although several of the schools involved held regular grade group meetings there was no strategic use of the science leader's knowledge which could have been shared during these types of meetings. Principals felt the science leaders in their schools would offer advice when asked, but there was no specific strategy in place to ensure this happened. Two principals gave examples of incidents where a new teacher came and asked them for help with science and they directed the new person to the science leader. However, the science leader was never asked to present at a staff meeting or lead a professional discussion about pedagogical content knowledge specific to science. The science leader tended to be viewed as the person who knew an activity or could describe the resources needed.

Brad: When my new grade two teacher came to me about something even I didn't understand in science, I sent her to Mark because he really is the guy on staff most interested in science. He's the guy who orders our resources and he is known in the school for his interest in environmental things. Researcher: Do you ever get Mark to lead a discussion about strategies specific to science…like a mini-workshop during a staff meeting? Brad: No, he'd be too uncomfortable to do that. He doesn't mind sharing his resources but he isn't going to want to stand up in front of his peers and talk about something that they don't know much about.

Many of the interviewed principals described their practice of ordering pre-packaged kits for their teachers to use or having their teachers create kits to meet curriculum needs. Teachers seem

to make good use of these kits and find them easy to use because all of the required materials for a unit are already in one place. However, some principals were unable to offer suggestions when asked about what happens when teachers are unwilling to use the material set out in kits. In an earlier study (MacDonald & Sherman, 2006) some teachers complained that even with kits, the set up was time consuming and classes seemed chaotic because of the mess and noise level. Principals in this current study said they encouraged teachers to utilize an approach where noise and messiness might be part of what happens, but few of the principals claimed any success when a teacher felt uncomfortable with this approach. One principal suggested that she would go in and use the kit with the teacher but acknowledged that the kit would not get used without her presence in the classroom.

For other content knowledge, many principals said they relied on local experts such as scientists working in local industries or universities to also provide some expertise when needed. Also, local agencies that promote science such as science centres were drawn on for support for teachers. Sometimes this included field trips to local institutions, however, budget restraints were mentioned as conflicting with the desire to incorporate experiences external to the classroom like field trips. Budget cutbacks were also blamed for the reduced spending in the area of science. Because literacy and mathematics are seen by the provincial Department of Education as priorities, much of the spending for resources are in these two areas.

What wasn't said

During the interviews with principals there was little to no discussion about the need to increase the professional growth of elementary teachers in science teaching. While virtually all of the principals agreed that many upper elementary teachers were underprepared to teach science, few offered suggestions about the way professional growth opportunities could be offered to these teachers.

When asked about professional development they said they are willing to send teachers to professional development days to learn more about the teaching of science, however, professional development was described solely in terms of one or two day events. None of the discussion focused on any long term or school based professional development for and with teachers. In addition, none of the principals indicated an interest in attending professional development that was related to science teaching. Professional development was only discussed in terms of being offered for teachers, and attended by teachers. When asked if they were interested in attending, they all said they simply didn't have the time given the number of other meetings they were expected to attend.

During the interviews, principals were asked if they had suggested any professional readings to teachers about science teaching. While several of the principals indicated that some reading was being done as part of a professional learning community project, none of the reading was related to science. In several of the schools, professional learning communities were mandated by the school boards, and teams of teachers had chosen books to read as part of this process. For most schools, the principals showed the interviewers books on reading in elementary school, which had been selected by their teachers for their professional reading. No discussion occurred in the interviews about suggesting professional reading or critical study about science teaching.

The principals did not indicate that teachers were necessarily interested in participating in university courses to improve their science content knowledge. Not only do universities offer courses within Faculties of Education about science teaching, other university departments often offer courses related to the science taught in schools that would be applicable to the teaching of science in grades four, five, or six. None of the principals mentioned these as appropriate solutions to improving the content knowledge level of teachers. Moreover, the principals described having very little connection with university professors as a source of professional support. When the university professors involved in this study offered to support science professional growth in their schools, only two principals considered it necessary. When principals were asked about the kind of support they had requested or received from the provincial Department of Education, none of the principals could identify any support that was asked for or received.

How can we improve instructional leadership for science teaching in elementary schools?

These interviews took place in reputable schools with principals who are identified as strong leaders. Most of them taught for a number of years and are recognized as good teachers. Some continue to teach. However, very few of them have teaching experience in science. The interviews have demonstrated the view that science is a difficult content area to teach if you lack experience with science. The principals recognized a need to support acquisition of resources and that new teachers need opportunities to work with more expert teachers as they begin to develop and grow in their teaching. What continues to be missing is the recognition of the role played by pedagogical content knowledge specific to science.

We must continue to examine the role of principals as instructional leaders in science and strive to find ways to better support their instructional leadership when they do not have experience with science content and science pedagogical content knowledge. We are not suggesting that all principals must be science experts, however, it is important for instructional leaders to recognize that many content areas, including science, have a body of pedagogical content knowledge specific to that content area. Leadership programs, offered through universities for current and aspiring school leaders, can be developed in such a way that they facilitate this understanding. Graduate programs and summer institutes can be used as ways to help support content specific instructional leadership if they include a focus on the pedagogical content knowledge that is foundational to the teaching in that content area.

Further support can occur by developing strong relationships between school leaders and their school boards with universities. These relationships can facilitate collaborative research that would provide a basis for long term professional development on the teaching of science. Such research might take place in classrooms and be extremely relevant to both school teachers and their administrators.

Instructional leaders who are more science-aware, can help teachers make informed choices about the kind of professional development opportunities that can be selected to support effective science teaching. Science PD events are typically short term and disconnected from the subsequent classroom teaching, so having an instructional leader who can offer advice either directly, or from a source they are aware of, can help prolong the thinking that emerges from

these truncated PD sessions. These principals can also play an extended role in supporting teachers as they implement new strategies in their classrooms. Instructional leaders who have gained new knowledge about science teaching may develop a support network of their own, created by a series of individuals who can offer a variety of kinds of expertise. Well informed instructional leaders may also help improve access to resources and provide teachers help in using those resources. These science-aware administrators will be also better able to interact with their provincial departments of education with regard to the content and approaches used in science teaching.

We believe school based instructional leadership has the potential to enhance the quality and quantity of science teaching that occurs in upper elementary classrooms. It requires instructional leaders who have an awareness of the existence of a body of knowledge related to the pedagogical content knowledge of science. While our paper shows some shortcomings in this area at present with principals, these instructional leaders have demonstrated a strong general pedagogical knowledge level and an interest in improving science in their schools. Addressing these shortcomings will provide opportunities for science educators to work with those who support general leadership education and principal preparation programs specifically, to create opportunities for good instructional leaders to become science-aware.

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