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"I want to enable teachers in their change": Exploring the Role of a Superintendent on Science Curriculum Delivery

Brian Lewthwaite
Centre for Youth, Science Teaching and Learning (CRYSTAL)
University of Manitoba

Abstract

This research inquiry explored the factors influencing successful science program delivery among early- and middle-years schools within a rural school division in central Canada. The study is framed by the author's personal inquiry into how psycho-social factors at the classroom, school and school division level influence science program delivery. In line with case study methodology, the inquiry uses a variety of qualitative and quantitative methods and data sources to identify the contributors at the classroom, school and divisional level to science delivery. A validated science program delivery evaluation tool, the Science Curriculum Implementation Questionnaire (SCIQ), is used as the foundation for the quantitative data collection and ensuing teacher, administration and science education community discussions. Bronfenbrenner's bio-ecological model and Rutter's views on resiliency are used as a framework for interpreting the data collected and understanding the factors supporting successful science delivery. Participants identify a variety of personal attribute and environmental factors and the interplay between these factors as supportive factors contributing to effective science delivery at the classroom, school and divisional level. Implications of this inquiry are discussed, especially within the context of the role of the superintendent in influencing curriculum delivery.

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Introduction

Although significant improvement in the delivery of science programs at the early- and middle-years school levels (Grades 1 to 6, Grades 1 to 4 and 5 to 8 respectively) is recognized in some nations over the past two decades (Harlen, 1997; Frost, 1997), there is continued acknowledgement of the complex amalgam of factors impeding effective science delivery at these levels in many educational jurisdictions (Mulholland & Wallace, 1996). Teacher personal attributes or intrinsic factors such as science teaching self-efficacy, professional science knowledge and science teaching interest and motivation are critical dimensions and often cited barriers in the delivery of science programs (Abell & Roth, 1992; Goodrum, Rennie, & Hackling, 2002; Harlen, 1977, 1988; Lewthwaite, 2000). As well, extrinsic or environmental factors are identified equally as critical elements to the effective delivery of science programs in elementary schools (Lewthwaite, 2001). This commonly cited list of environmental factors includes more salient features such as time constraints and resource inadequacy associated with limited equipment, space and facilities.

Of particular importance, and less commonly acknowledged, is the role of the school administration, in particular the principal and school division superintendent, in influencing science curriculum delivery. The role of the principal in influencing science program delivery is an explored area of study (for example Lewthwaite, 2004a). Edmonds (1979) and Lewthwaite (2004a) identify the instructional leadership provided by a principal as a major factor influencing the effective delivery of the science curriculum at the early- and middle-years level. Fullan (1992) asserts that school change and improvement in any area bear the mark of the principal as central for leading and supporting change and improvement. Principals are central agents in sustaining innovations and achieving turnarounds (Fullan, 2002). It is they that carry the message as to whether some curriculum innovation is to be taken seriously (Hall & Hord, 1987; Hopkins, Ainscow, & West, 1994).

The role of the superintendent in influencing science curriculum delivery is largely unexplored. The role of the superintendent, as Cuban (1988) suggests, is portrayed by three dominant images: instructional supervisor, administrative chief and negotiator-statesman. All three images are primarily managerial in nature. Cuban asserts that most superintendents adopt, and in fact, are pressured into these managerial orientations where 'doing the thing right' is seen to take priority over 'doing the right thing' (Cuban, 1988, p. 190). On the other hand, organizational leaders are focused more on 'doing the right thing' and modifying rather than maintaining existing structures to achieve first order educational priorities (Ibid, p. 190). Leaders that achieve educational priorities are primarily characterized as people who influence the motivations and actions of others to achieve certain goals (Ibid, p. 193). Given the low priority that is typically placed on science in the early- and middle-years levels, both the divisional superintendent and individual school principals are likely to play a significant role as organizational leaders in influencing positively motivations and actions towards successful science delivery.

So, what factors contribute to successful science delivery at the classroom, school, and, ultimately, divisional level in a division historically characterized as ambivalent to science education delivery? At the centre of any successful implementation effort is the teacher. It is they that are charged with the mandate to deliver curricula. Thus, one would expect that any improvement delivery would ultimately rest in responsibility with individual teachers. But, for successful delivery across a school division one would expect the environment in which a teacher works (both at the school and divisional level) would also be of influence; in particular in enabling teachers to carry out their roles as teachers of science. How can this interplay between a teacher's own capabilities and the multiple systems of the classroom, school and divisional environment that influence science delivery improvement be best understood?

Understanding how teacher personal attribute factors and multi-system environmental factors influence successful delivery over time is likely to be best understood by considering cultural-contextual theories of development. One such theory appropriate for the context of this inquiry is posited by the work of Urie Bronfenbrenner. Bronfenbrenner's (1979) bioecological theory of development posits that development is a joint function of the person and all levels of their environment. The former includes personal attribute factors that are both biological and psychological (e.g., genetic heritage and personality) (Moen, 1995, p.1). As suggested by other studies (for example, Lewthwaite, Stableford & Fisher, 2001), teacher personal attribute factors such as professional science knowledge, science teaching efficacy and interest and motivation are likely to be important determinants in influencing science delivery. The latter encompasses the physical, social, and cultural features of immediate settings in which human beings live (e.g., family, school, and neighborhood) (Ibid, p.1). Bronfenbrenner sees the ecological environment as a system of five nested structures. The first structure represents the individual. The remaining four structures range from the immediate face-to-face setting to the more remote setting of the larger culture (Hoffman, Paris & Hall, 1994, p. 47). The innermost structure consisting of a teacher's friends, family and colleagues, the microsytem, is the immediate proximal setting the person directly interacts with that invite, permit or inhibit activity (Bronfenbrenner, 2005). In the context of this study, colleagues that a teacher works with closely are a part of the microsystem. The developmental processes that occur within a microsystem are in good part defined and limited by the beliefs and practices of the individual's immediate setting, the mesosystem, society's blueprint for a particular culture or subculture (Hoffman, Paris & Hall, 1994, p. 47). Thus, the school's belief systems and values may strongly influence the expectations endorsed by members of a microsytem. As an example, within the school context the belief systems held by senior teachers, the principal and school administration concerning the importance of a curriculum area are known to strongly influence the school's ethos for a curriculum area (Lewthwaite, 2004a). The third structure, the exosystem system, refers to environmental influences that do not involve directly the developing person but still influence the setting in an indirect manner. As an example, the community's or school division's aspirations for science as a curriculum are likely to impinge on school-based policy decision making and implementation (Lewthwaite, Stableford & Fisher, 2001). Finally, the most removed structure, the macrosystem, refers to societal and cultural ideologies and laws that impinge on the individual. In the context of this inquiry, provincial curriculum agendas and teacher education protocols are likely to influence the school's response to science as a curriculum area.

Of importance to this inquiry is the acknowledgement that, as Bronfenbrenner suggests, supporting processes within these overlapping environments are 'engines' for development. As well, Bronfenbrenner (1997) further suggests that these engines are context-, time- and process-dependent. This implies that the factors that influence a teacher's ability to successfully deliver a science program cannot be generalized but, instead, are multi-system in nature and unique to each individual taking into account their personal attributes; the context in which their development takes place; the time at which the development process is occurring; and the processes each person experiences in fostering successful science curriculum delivery. Simply put, things can 'come together' just at the right time for an individual, but, potentially, not for all.

These suggestions are endorsed by research in other areas of development. For example, Rutter's research in resiliency extends this understanding of how bio-ecological attributes can influence development. He suggests that both 'risk' and 'protective' factors contribute to an individual's development and resiliency (Rutter, 1987). Risk factors are personal attribute factors or processes in the individual's environment (e.g., low science-teaching interest and efficacy) that contribute to negative trajectories in development. Aligning his work with Bronfenbrenner's, Rutter suggests that protective factors are the 'engine' processes possessed by an individual (e.g., positive self-concept) or in an individual's environment (e.g., a committed principal) that contribute to positive outcomes and consequence in personal development. Risk and protective factors, again, are suggested to be person, context and time dependent. As might be expected, development is likely to occur where risk factors are minimized and protective factors are maximized. Yet, again, maximizing protective factors does not necessarily foster positive developments in all.

The ideas posited by Bronfenbrenner and Rutter would suggest that understanding science delivery is best investigated within a research inquiry where one is able to examine the personal attribute and environmental processes at the classroom, school and divisional level and the interplay among the processes that influence teachers in the delivery of science. Such is the focus of this research inquiry.

Methodology

This study is situated in a rural school division (pseudonym: Central School Division (CSD) in central Canada. CSD is culturally diverse (primarily including Icelandic and European Canadians and Aboriginal Canadians including First Nations and Metis); geographically broad

(2400 square kilometers); and composed of approximately 1700 students in eight schools located in four communities. Two of the communities (pseudonyms Rural and River) have a combined early- and middle-years school and a separate high school. One community (Centre), in which the CSD administrative office and superintendent are situated, has separate early- and middle-years and high schools. Finally, one community (Lake) has an elementary school (Kindergarten to Grade 7). Each school has a principal; one of which is a teaching principal. The school division has a curriculum consultant that provides instructional support to teachers in all curriculum areas. She is not a science-mathematics subject specialist. Her role, in science specifically, is primarily to sustain the current science developments. All teachers from Kindergarten through Grade 8 teach science. The only exception to this is Centre Middle-Years School that has a specialist science teacher that teaches all Grade 8s science. The superintendent for the division has been in his role as a first-time superintendent for three years, prior to this he served as the curriculum and technology consultant for the division for two years, and as a science and technology consultant for the provincial government for ten years. He is a science specialist. The school division is managed by the Board of Trustees who is responsible for development of priorities and strategic direction for the division in consultation with divisional stakeholders. A Leadership Team, composed of the superintendent, other divisional senior administration and school principals, works in association with the Board as the vehicle for site-based implementation of divisional policy. This team also works reciprocally in conveying areas of concern to the Board and assisting in informing Board decisions.

This study was prompted by the author presenting a research paper based in a northern Canadian school on science delivery evaluation at an educational forum for educators at an urban centre in Canada (Lewthwaite, 2005a). The principal at Rural Early-Middle Years School (REMYS) in attendance requested the author to conduct an analysis of science delivery in the early-years section (REYS) of his school. A comprehensive, validated on-line instrument, the *Science Curriculum Implementation Questionnaire* (SCIQ) (Lewthwaite, 2001), was used in the evaluation of factors influencing science program delivery at this school. The instrument has been applied in over 300 schools in New Zealand, Canada and Australia and has been the foundation for data collection in numerous research publications (for example Lewthwaite 2004 a,b, 2005 a,b). The SCIQ is a 7-scale, forty-nine-item questionnaire that provides accurate information concerning the factors influencing science program delivery at the classroom and school level in schools where the teaching of science is a regular part of a teacher's teaching duties. The scales have been developed with the intent of gauging teacher's perceptions on a 1 (Strongly Disagree) to 5 (Strongly Agree) scale in areas that are identified as major impediments to science program delivery (Lewthwaite, 2000). Four of the scales pertain to the school environment. These environmental or extrinsic scales include Resource Adequacy; Time; School Ethos; and Professional Support. The remaining three scales relate to teacher personal attributes. These intrinsic factors include Professional Science Knowledge; Professional Adequacy; and Professional Interest and Motivation. Examples of items from the School Ethos scale include:

> Item 5: *The school administration recognises the importance of science as a subject in the overall school curriculum.*

and

> Item 12: *The school's ethos positively influences the teaching of science.*

The SCIQ exists in two forms, Actual and Preferred, which were both completed by all seven teachers with responsibility for teaching science at REYS. The Actual form indicated the way things are at the school and the Preferred indicated how teachers would prefer things to be. By completing the Actual and Preferred forms discrepancies between the actual and preferred environment were evident. Mean (average) calculations were performed to identify general trends in perceptions for each of the scale and each item and standard deviations were calculated to determine the degree of consistency amongst respondents for each scale and again each item.

Mean and standard deviation results for each of the scales and descriptive profiles for each scale were presented to a meeting of all of the science teaching staff two weeks after they had completed the SCIQ. The author presented and facilitated the one hour discussion first determining the accuracy of the data and descriptive comments through teaching staff feedback. Second, this information became the foundation from which discussion, reflection and deliberate focused change could begin (Stewart & Prebble, 1993). The staff discussion ensuing from the data presentation, facilitated by the author, were audio taped, transcribed and authenticated as a literal transcription by the principal and science teaching staff.

The outcomes of the evaluation of science delivery at Rural Early-Years School prompted the author to determine if the positive results of the SCIQ analysis and follow-up discussion of science delivery were consistent with the other elementary and early- and middle-years schools within the division. Further SCIQ analyses including staff discussions were conducted in these schools. As well, one-one-one discussions were held with representative senior and junior teachers (in terms of gender, years in teaching, years teaching in the division); principals; divisional curriculum consultant and the school division superintendent in order to ascertain the personal attribute and multi-system environmental factors and interplay among these factors supporting science delivery. Again, all discussions ensuing were audio taped, transcribed and authenticated as a literal transcription by the respondents.

The methodology used in this research inquiry is the case study. Using multiple sources of qualitative and quantitative data the study endeavours to understand and explain a phenomenon; the processes influencing effective science delivery from Kindergarten to Grade 8 at the classroom, school and divisional level. The study strives towards a holistic understanding of cultural systems of action within a social system, the school division (Sjoberg, Williams, Vaughan, & Sjoberg, 1991). The unit of analysis in this case study is the dominant players in science program delivery across the division; the superintendent, principals, teachers and Board. Drawing upon multiple sources of information, the case study includes a multi-perspective analysis drawing themes from the relevant players and the interaction among them. The themes generated are, in turn, compared to those commonly cited in educational leadership literature (Cuban, 1988; Fullan, 1992, 1993).The study endeavors to understand, only, the factors influencing science delivery and, thus, does not include students' perceptions of the quality of the science experience they are receiving. This aspect has been recommended by the author as the next evaluative phase for the school division in evaluating the effectiveness of its efforts in improving science delivery.

Results and Discussion

SCIQ Application Results

The data obtained from the SCIQ initial Central School Division application at Rural Early-Years School (REYS) are presented in Table 1. As well, a descriptive profile for the School Ethos scale as it was presented to staff is presented in Figure 1. The author noted in his data analysis that in the approximately 300 previous applications of the SCIQ <u>no</u> school profile had scored such positive results. It was particularly notable that the mean scores for the personal attribute scales (teacher professional science adequacy, professional science knowledge and professional science interest and motivation) were quite positive and consistent among teachers across grade levels (Table 2: 3.76, 3.65 & 3.76 respectively). The one hour follow-up discussion with the teaching staff affirmed the accuracy of the personal attribute and most of the environmental scales.

Table 1: Rural Early-Years School SCIQ Application Data

Scale	***Actual Mean Score***	***Actual Standard Deviation***	***Preferred Mean Score***	***Preferred Standard Deviation***
Resource Adequacy	2.75	0.72	4.12	0.18
Time	3.06	0.66	4.06	0.23
School Ethos	3.56	0.66	4.30	0.21
Professional Support	3.55	0.76	4.13	0.17
Professional Adequacy	3.76	0.41	4.11	0.19
Professional Knowledge	3.65	0.44	4.29	0.20
Professional Attitudes	3.76	0.52	4.17	0.14

Figure 1: Rural Early-Years (REYS) School Ethos Scale

A relatively high mean score of 3.56 and standard deviation of 0.66 on the Actual SCIQ show that the staff of REYS are quite consistent in their positive view of the status paid to science in the school. This suggests that teachers at REYS perceive that the administration and school, in general, place a high priority on science as a curriculum. It is significant too that these high scores were consistent over the different grade levels of the responding teachers, indicating that science has a high perceived priority in the school across each year. The mean score of 4.30 on the Preferred SCIQ and standard deviation of 0.21 suggest that teachers consistently perceive that the priority placed on science is only somewhat lower than what they would prefer it to be.

Teachers suggested the Resource Adequacy Actual mean score (Table 1: 2.75) was inaccurate as recent actions at the divisional level had responded promptly and recently to the school's concern with the adequacy of resources. REYS was the site for the first SCIQ application and the author did not pursue an understanding of the factors that had contributed to the positive perceptions teachers held to factors influencing science delivery. Further school analyses prompted this inquiry focus.

Table 2: Science Curriculum Implementation Actual Profiles for CMYS

Scale	***Actual Mean Score***	***Actual Standard Deviation***	***Preferred Mean Score***	***Preferred Standard Deviation***
Resource Adequacy	4.32	0.65	4.30	0.15
Time	3.36	0.43	4.10	0.41
School Ethos	3.96	0.16	4.10	0.16
Professional Support	3.91	0.24	4.04	0.14
Professional Adequacy	3.60	0.63	4.12	0.34
Professional Knowledge	3.55	0.39	4.13	0.37
Professional Attitudes	3.78	0.36	4.09	0.23

Further analyses identified similar, if not even more positive, results. As an example the SCIQ results from Central Middle Years School (CMYS) are listed in Table 2. As well, a description of the School Ethos scale as presented to staff is illustrated in Figure 2.

Figure 2: Central Middle-Years School- School Ethos Scale

A high mean score of 3.96 and very low standard deviation of 0.16 on the Actual SCIQ show that the staff of CMYS are quite consistent in their positive view of the status paid to science in the school overall. Simply put, this suggests that teachers at CMYS perceive that the administration and school, in general, place a high priority on science as a curriculum. It is significant too that these high scores were consistent over the different grade levels of the responding teachers, indicating that science has a high perceived priority in the school across each year. The mean score of 4.10 on the Preferred SCIQ and standard deviation of 0.16 suggest that teachers consistently perceive that the priority placed on science is very close to where they would prefer it to be.

Again discussion with staff endorsed the accuracy of the data and very positive perceptions towards the delivery of science across each scale within the school. Knowing that these data again indicated very positive staff perceptions unrivalled in previous SCIQ applications both nationally and internationally the author pursued understanding what factors had contributed to this. The discussion that unfolded included comments such as:

Teacher A: It (science) *was a subject I never really taught. The new* (provincial) *curriculum* (released in 1998) *was packaged into clusters* (of four topics per grade level) *and I just saw it as more do-able. We received some professional development for it and I liked the way it was packaged.*

Teacher B: The initial professional development got us going. It was very positive and we responded to the opportunity. The division focused on science improvement thereafter and there was support at all levels. The support extended across the division and has remained a divisional focus.

Teacher C: The new curriculum placed more emphasis on doing hands-on activities. The curriculum gave teachers ideas of what they could do and this gave them incentive. But, it was more than that. The administration also gave it a push.

Teachers at CMYS were quickly able to identify environmental factors at Bronfenbrener's macrosystem level that had influenced science delivery improvement since the release of a new provincial curriculum. The curriculum release and ensuing voluntary one-day professional development workshops provided by the provincial government had created a climate of readiness for science improvement. Although in Bronfenbrenner's model the macrosystem is the most removed structure (referring to societal and cultural ideologies and laws that impinge on the individual), the provincial curriculum agenda had influenced many of the division's teachers' response to science as a curriculum area. As suggested by Peers, Diezmann and Watters (2003) a climate of readiness was likely generated by the initial curriculum introduction and the initial professional development. This provided the impetus for change. Teachers acknowledged the need for change and were personally committed to change.

Teacher B: It was easy to ignore (the teaching of science). *The new curriculum was pleasing and you knew you had to respond.*

But, change was not going to occur simply because of the release of a new curriculum and a day of professional development. The teachers acknowledged that other environmental factors had, since then, contributed more significantly to science program delivery improvement.

Further Discussions

The science curriculum release and accompanying professional development was followed shortly thereafter by the appointment of a science-mathematics- ICT curriculum consultant (who is now the superintendent) at the divisional level. This appointment was prompted by the introduction of the new curriculum and a division-wide perception that science was largely being ignored as a curriculum area. The author's discussions with the superintendent, principals, teachers and the divisional consultant gave clear evidence that the influence of this individual, both as a curriculum consultant and superintendent, had contributed significantly to the improvement in science delivery at the classroom level. Several themes identified as supportive factors influencing science delivery positively were evident from the discussion. These themes will be discussed in the remainder of this paper.

Theme One: Possessing and Articulating a Vision:

As suggested by Cuban (1988) an organizational leader influences organizational direction and outcomes. The impetus for organizational change commences with an articulated vision of what change will look like (Ibid, p. 193). The vision for science delivery manifested in the science curriculum was the superintendent's (at that time the curriculum consultant's) desired outcome in the division's classrooms.

Superintendent: It was about putting an emphasis on classroom-based experiences t0 enhance student learning with an emphasis on an inquiry-based, hands-on approach to develop scientific literacy in students. I wanted to see students doing science not just learning about science and enabling teachers to be able to help students learn science in an engaged manner is what I wanted to see happen. That was the goal. The effort after that was deliberate to that end.

Both teachers and principals were aware of the image conveyed concerning the intent of the science professional development and goal of the development.

Principal A: It wasn't just about seeing science taught it was about seeing science being taught with students being engaged. Before as a science teacher (in the local secondary school) *I saw the result of a science program at the early- and middle-years level that gave little attention to students actually* ***doing*** *science. I always vowed that if I got to work in this school* (referring to the REMYS school) *I would work to give students experiences in science. This was the focus of the division's efforts – it was very practical and hands-on.*

Teacher D: I thought that the way the science professional development was presented made me think that this was what our students would like. For me science was really quite sterile and this was something students would enjoy. They would be doing science and learning from these experiences.

Theme Two: Establishing a Shared Vision Among Leadership Reflecting Stakeholder Needs and Concerns

The emphasis that the superintendent placed on improved learning through purposeful and engaging teaching as a consultant was a characteristic and 'common' or 'shared vision' (Cuban, 1988) of the division's current Leadership Team. In his transition to superintendent he was motivated to diagnose divisional educational needs, especially in the area of curriculum; recommend strategies for improvement and enable individuals to attain these goals. His perceived role was very similar to that cited by Johnson (1996). She suggests that the 'new-superintendency' is charged with the task of diagnosing divisional needs and identifying strategies for addressing needs.

His articulated goal was currently being articulated in four curriculum areas, one being science (Centre School Division, 2006). Gaining support of the Board and principals was imperative to this orchestrated endeavor. The following statements summarize his leadership orientation.

Superintendent: I am a pedagogue and that is my focus as a leader. Although administration is a large and important part of my work, my leadership abilities in the area of teaching and learning are what, in my opinion, are most important to the division. I think this orientation was important to the Board and was significant in my appointment. I want to enable teachers in their change and initiate supports and change in the classroom that make things happen for the student. That is my focus in my role. Other things can distract from that goal but essentially that's our mantra around here – it's about student learning. You set your expectations around what teaching and learning should be about and then enable people to make those changes. (As a leadership team) *we can differ in our priorities at times but when it comes to educational priorities for our students sometimes we have to look beyond our own priorities for the common goal. That is our focus* (teaching and learning).

When appointed as curriculum consultant for the division, he gathered the support of the superintendent at that time in working towards this goal in the context of science.

Superintendent: The (previous) *superintendent wanted to use my skills and knew I had the skill-set to work towards these goals. The support was there. It would take time to see it realized but if we invested in enabling people and providing the necessary resources we were confident it would be realized.*

This ambition for science similarly became his goal for other curriculum areas as well. The transition to superintendent enabled him to encourage and foster similar curriculum goals for the division's principals, knowing they were critically important in sustaining innovations and achieving turnarounds (Fullan, 2002). Principals similarly perceived their roles as leaders, especially in curriculum, carrying a responsibility for development for those within their schools. The division's model for development focuses on fostering divisional goals through site-based management where every principal's role also was that of an educational leader, especially in the area of curriculum. Typical of most divisional jurisdictions, the principal was seen to be the overall curriculum leader for the school. Under the systems of decentralization, or site-based management, the responsibility of the principal with regard to curriculum policy at the school is increased but as McNeil (1996) suggests this role is pimarily managerial in nature. Principals within this division held a strong sense of accountability towards their site-based roles as curriculum leaders.

Principal B: It all focuses on people and their development - Teachers, students. The other managerial aspects are important and they consume your time but they are secondary to investing in people's development. I have to keep this as a priority. You can be driven by things lower down on the list (referring to administrative tasks). *You can lose control over your time-things that lead to my fulfillment as a principal are, in my eyes, really important are sometimes compromised. It may not seem important for some* (to compromise) *but not for me. It's about investing in people and that's what the science has been about.*

Principal B: That always takes priority and it can be squeezed (referring to what goes on in the classroom between teacher and student). *As I get more of a hold on my role as a principal you have the opportunity to somewhat define what you do. What you see as important will always be challenged by just the everyday things. I have to make it a priority to ensure that you are investing in teacher's development and assisting them to be as good as they can. A lot of it's ensuring that they are supported through the programming decisions and ensure things fit with their capabilities and experience.*

Both the superintendent and principals were aware of the forces that oppose such aspirations. As Cuban suggests (p. 130) the fundamental nature of the post of both the superintendent and principal is shaped by competing and conflicting expectations. The DNA of superintending is embedded in expectations around being an efficient technocrat rather than creating new organizational mechanisms for fostering instructional goals (Ibid, p.130). Clearly, the Leadership Team was aware of this influence and working as a team to ensure leadership priorities were not subsumed by administrative roles.

Theme Three: Identification of Strategies to Accomplish the Vision

Achieving development goals in science education was largely enabled by a coherent planning strategy based on the superintendent's awareness of factors influencing curriculum change. He had previously been involved in curriculum implementation projects and was aware of some of the challenges associated with fostering change. His role as an organizational leader was not only to influence organizational direction by influencing the motivations and actions of others to achieve certain goals but also to ensure the mechanisms developed would support teachers in realizing their aspirations. Within the division, the establishment of a Strategic Planning Cycle (Central School Division, 2005) allowed the Board and Leadership Team to work systematically to establish mechanisms that fostered the achievement of educational priorities.

Superintendent: Over the past two years, we've implemented an annual planning cycle and this has helped immensely. We establish priorities (based on consultation) *and follow through with these priorities. I think that in most cases the priorities in curriculum need to be focused, limited in number, resourced and remain in place for a five-year period. Then, like we've seen in science, as the goals become realized we can begin to shift our priorities. It doesn't mean we forget about it, but, instead, just refocus some of the effort.*

Factors identified as potential risk factors for achieving science delivery success were identified and supportive factors put in place to assist in achieving developmental goals. Focused professional development, resource allocation and management of these resources, and providing support through the divisional consultant were given priority as supportive mechanisms for influencing change positively.

Superintendent: Teachers were very open to that approach (what was advocated in the curriculum) *and they needed to be enabled to take that approach to teaching science. We initiated a variety of things to enable that goal. We held grade-group workshops for all of our Kindergarten to Grade 8 teachers over two years that focused on the clusters of the curriculum. Teachers were able to work with a variety of activities and were supported in doing these activities with classroom materials. They left each of the sessions with clear ideas of how the key ideas in the clusters of the curriculum could be approached and realized.*

Teachers were able to identify that the professional development provided at the divisional level was regular, deliberately focused and clearly articulated in terms of what the science priority was.

Teacher E: What was being conveyed about the new curriculum was not only of interest to me it was also attainable. It was just gradual steps supported at each level over a longer period of time. It had to do with the knowledge of the areas I was required to teach and also how to teach it. Managing the students wasn't an issue.

Teacher F: As an experienced teacher it wasn't about how to go about it; it was more about what was the focus. The curriculum was quite daunting but we were told to focus on the Essential Questions and to ensure these aspects were targeted. It was like an 'intelligent approach' to teaching science was being required of me. It just wasn't about doing everything - it was about doing things with thought.

Teacher G: I had a clearer picture of what the science would be like for my students. The cluster workshops (PD) *was well-organized and supported.*

Similarly, teachers identified that the division was supporting them through not only the professional development opportunities but also the adequacy of resources.

Principal B: The kits were critically important. You can just introduce a new curriculum and expect teachers to do all the preparatory work at the classroom level, especially when it is resource intensive like it is in science. The science resourcing was adequate and purposeful.

Other resourcing decisions were also seen to support the science development process at the classroom level. Instructional 'kits' were prepared for the divisional teachers by the science consultant that provided the necessary equipment for hands-on-based lessons with accompanying instructional lesson support material for teachers. Duplicate sets of these kits were made available on a loan basis. These kits were then transported among schools by a transport provider on the basis of an early school year program scheduling.

Teachers also identified that success was facilitated by allowing schools some autonomy in how they structured the delivery of science within their programs according to the characteristics of their school. As an example, one school (CMYS) allocated all the Grade 8 science teaching to a science specialist. Similarly, REYS teachers recognized flexibility in delivery was important.

Teacher D: The division has supported the initiative but we haven't felt boxed in. We've organized some of the teaching around our strengths and weaknesses and our interests.

A further supportive mechanism identified was the availability of collegial professional support both within the school and division. Teachers recognized that within their schools a contact-person or science teacher-leader was available as professional support as necessary. As well, the divisional consultant is available to provide support and initiate actions as requested and identified.

Superintendent: You need teacher-leaders in each of the schools that can take the ball and run with it. These don't need to be the principals but there has to be someone there to foster things at the school level. We have been fortunate that in each of our schools someone has been able to assist in this process. They've really helped in these efforts.

Teacher C: You know support is always available. Once you get beyond your own personal reservations about teaching science, it's fine.

Principal B: It seems there always has to be a critical mass for change to occur. In the case of science the divisions' support along with the original and on-going professional development and resourcing has continued to keep the momentum going.

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Theme Four: Ongoing Evaluation and Improvement through Informal and Informal Feedback

A common theme among the respondents was the responsiveness of the division to their concerns. Requests or suggestions for improvement in areas such as resourcing, facilities, and professional development were acknowledged and responded to. As an example, the REYS SCIQ analysis had identified school resource concerns. In response to this the division had moved to the production of additional resource kits that would be available to each grade level in early- and middle-years to address the resource requirements of delivering the provincial curriculum. The division had also negotiated a management system and means by which the kits could be transported upon request from school to school. By the time the author had conducted a further SCIQ application at CEYS and another early-years school, the situation had been resolved.

Teachers identified that principals were sensitive to the school-based needs and concerns. Teachers perceived that this responsiveness came from the fact that the principals knew that, in turn, the division's administration was responsive to concerns.

Teacher B: We're very well supported. Concerns get through. If the division sets priorities they follow through in supporting these priorities, especially our personal development as teachers. I don't feel left to my own ends when it comes to requirements (referring to curriculum requirements legislated by the Curriculum Division of the provincial government).

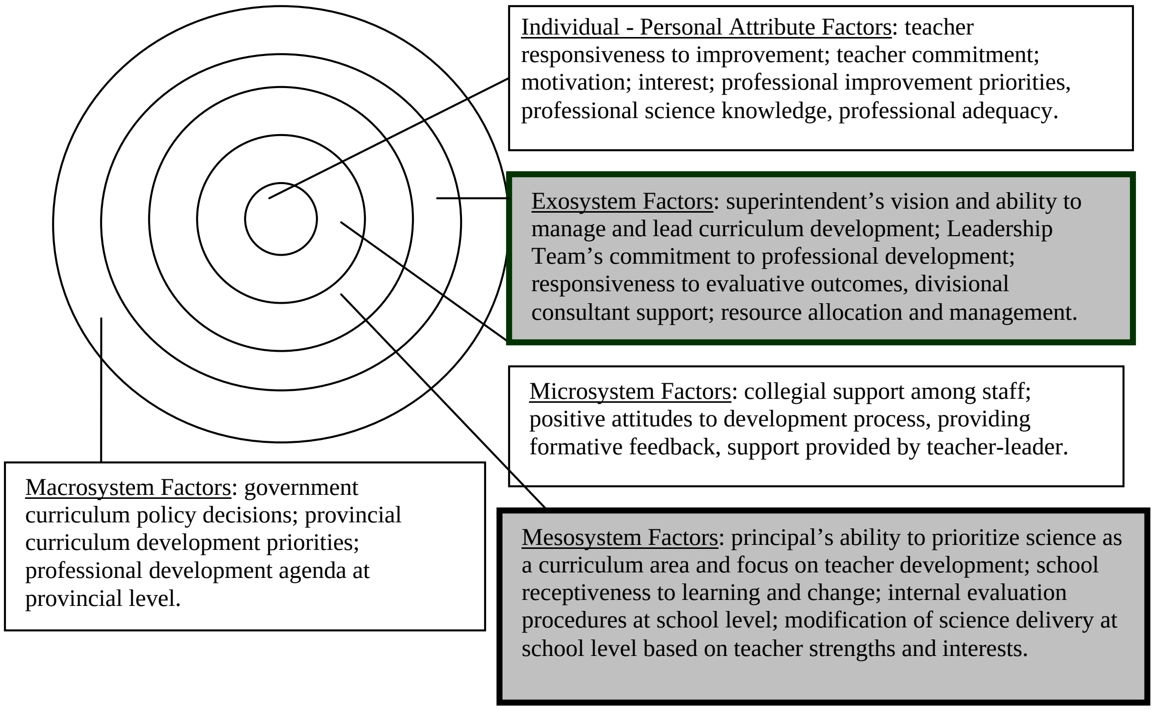
In its Strategic Plan the division places emphasis on ongoing formative evaluation in terms of making sure the curriculum actions are reaching the goals planned and to finding impediments to success (Central School Division, 2005). Principals, in particular, seemed to be watchful of indicators of science delivery success. Principal B's invitation to the author to conduct an evaluation of science delivery at REYS, independent of any involvement from the division, is an indicator of the openess of the principals to ongoing evaluation as a foundation for improvement.

These four themes evidenced through particpant responses are not dissimilar from what are typically cited as the behaviors and actions associated with educational leaders that foster educational change effectively (Cuban, 1998, p. 194). Although these characteristics were clearly evidenced in the superintendent's intentions in science education, participant responses would suggest that these themes were as much characteristic of the division's Leadership Team in its efforts in achieving educational goals.

Summary

This paper has been prompted by the author's inquiry into the factors supporting science delivery across a school division. It is evident from this study that the factors influencing science program development are specific to: (1) the teachers involved in the delivery process i.e. personal attribute factors; (2) the environment in which the implementation process is to occur i.e. environmental factors; and (3) the interplay amongst these factors.

Figure 3: Factors influencing science program delivery in Central School Division



This study shows that change requires a climate of readiness. There must be something that precipitates a desire for change. In this case, the desire for change in science delivery occurred at the individual teacher level as a result of a provincial curriculum introduction. In itself, the introduction of the curriculum and brief associated professional development did not create change. Quite deliberately, the division, as an exosystem, was able to respond to this climate of readiness.

Figure 3 illustrates the multi-system factors perceived to have contributed to science program delivery highlighting the role of the superintendent and, subsequently, principals in affecting change. Although the factors are listed as isolated spheres it is obvious from this study that there is an interplay among these spheres, especially in terms of how environmental factors have contributed to the development of the personal attribute factors often regarded as the major impediments to early- and middle-years science delivery. Clearly, the current divisional superintendent as a prominent member of the exosystem played a significant role as both a curriculum consultant and, later, superintendent in pervasively influencing the motivations and actions of principals and teachers to achieve educational goals at the teacher-student level. As suggested by Cuban (1988) leadership at one level affects what occurs at other levels bringing about a more consequential result. Bronfenbrenner (2005) suggests, similarly, that the joint operation of influences at each level produced a synergistic developmental impact. Not only did he lead to influence educational priorities at the meso-, macro-, micro-system and individual teacher level, he was also critical in influencing the establishment of physical elements that supported science delivery. He played a critical role as an agent of change in seeing the enactment of a curriculum at the classroom level through the establishment of long-term, focused and well-resourced supportive mechanisms. His role was enabled by the development of a congruency of aspiration by the Board and, in particular, the principals of the Leadership Team.

As detailed in this study, an effective superintendent as a curriculum leader needs to be able to identify or develop and articulate achievable goals; motivate a leadership team, especially principals, to work towards a common goal; change and enhance existing structures to foster the achievement of goals; invest in human and physical resources and monitor through evaluation the success of the interventions. In Bronfenbrenner's bio-ecological model the microsystem is identified as the proximal process typically regarded as the primary engine for enabling individuals in their developmental trajectories. In this study it is apparent that the superintendent of this division, although removed as a member of the exosystem (from the perspective of the individual teacher), had a significant role in assisting in the development of an environment that enabled individual teachers of science through supportive mechanisms.

Within the context of science education both nationally and internationally the spotlight for the improvement of early- and middle-years science delivery has traditionally fallen on the individual teacher usually with an emphasis on his or her shortcomings. This study enlarges that focus to the exosystem and macrosystem level illuminating and providing a model of how supportive structures established because of the leadership of a superintendent can be established to contribute to individual teacher success at the classroom level. Clearly, divisional superintendents and principals can influence classrooms through the establishment of mechanisms that can make improved science teaching and learning aspirations a reality. Improvement in science delivery at the early- and middle-years level internationally must be seen within the larger social context of the school, division and province or state in which teachers and their classrooms are located. Focusing on the limitations and inadequacies of early- and middle-years teachers only restricts the potential impact of strategies enacted to foster continued improvement in science education.

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