“Are you saying it’s my fault?”-
Exploring the Influence of a Principal on Elementary Science Delivery

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Abstract

This research exercise, employing an action research model for curriculum improvement, explored the factors influencing science program delivery at an elementary school in New Zealand. Using a validated science program delivery evaluation tool, the Science Curriculum Implementation Questionnaire (SCIQ), as a foundation for data collection, staff discussion and collaborative decision-making, a school embarked on a self-review process and, first of all, identified factors influencing science program delivery and, secondly, identified strategies for improvement of science delivery. After a school-wide cycle of focused science delivery improvement, the evaluation was repeated and further emerging trends and strategies for improvement were collaboratively discussed and implemented. Implications of this self-review process on science program delivery improvement are discussed, especially within the context of the role of the principal in influencing curriculum delivery.

Key Words

elementary science curriculum delivery
principal instructional leadership

Introduction

Although significant improvement in the delivery of science programs at the elementary school level 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 elementary science delivery 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, 2001; Harlen, 1978, 1988, 1997; 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, Stableford & Fisher, 2001). Of particular importance, and less commonly acknowledged, is the role of the school administration, in particular the principal, in influencing science curriculum delivery. Edmonds (1979) identifies poor instructional leadership as a major factor influencing the effective delivery of the science
curriculum at the primary level. Hall and Hord (1987) state that the degree of implementation of any innovation varies in different schools because of the actions and concerns of senior management, in particular, the principal. Fullan (1992) asserts that school change and improvement in any area, including the area of curriculum, 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 principal and central administration in influencing instructional improvement becomes of particular interest to educational jurisdictions where, because of policy changes endorsing greater school self-management, the role of the principal has required more involvement in administrative matters as opposed to curriculum and instructional leadership. Within the New Zealand context the role of the principal and school’s central administration has undergone considerable change since the inception of *Tomorrow’s Schools* (1989) that has seen the establishment of school boards to manage school affairs. As stated by Harold (1999), New Zealand’s recent experience in educational reform has had a significant effect on the role of the principal. In her case study of several New Zealand schools working towards a system of self-management, Harold asserts that principals identify self-management as a critical and detrimental element in contributing to their shift from their role as a professional leader, especially in the area of curriculum matters, to that of a manager. Harold further states that most of her case study participants were quite ambivalent about the degree of impact self-management had had on improvement on teaching and learning. This is quite paradoxical when one considers that improvements to learning were claimed as a predictable key outcome of self-management. Although Wylie (1997) states teachers’ views of the impact of reform on teaching content and style and quality of student learning have improved since the inception of *Tomorrow’s Schools*, this has been accompanied by increased managerial accountability and administrative demand, to the detriment of the role of the principal as an instructional leader. For educational jurisdictions attempting to remedy the problems associated with science curriculum delivery, the remediation efforts are likely
to be more complicated where the instructional leadership role of the principal is potentially changing because of policy changes towards greater school self-management. This research exercise is carried out in such an environment.

**Intent and Context of the Study**

The initial purpose of this research exercise was to use a curriculum delivery evaluation tool as a vehicle for focused and collaborative science delivery improvement at an urban elementary school in New Zealand. Particular attention would focus, as a result of the initial data collection stage, on the role of the school administration, in particular the principal, as contributor to curriculum delivery improvement. The study endeavours to, first of all, understand a phenomenon (i.e. the factors influencing science program delivery) and is thus interpretivist in nature. It further explores strategies for curriculum delivery improvement, through collaborative discussion and decision-making, and, after implementation, reflects on the overall effectiveness of the strategies and thus subscribes to an action research model of school improvement.

East School (pseudonym) is a Year 1-6 school in an urban community in New Zealand. The school has a full-time teaching staff of eighteen with a very low staff turnover rate and a student enrolment of 432. All teachers, aside from two subject specialist teachers in technology and Te Reo Maori, are expected to teach science as a part of their regular classroom program. Although no specific allocation regulates the amount of time devoted to the teaching of science, the school policy document states that students will be provided with a balanced and comprehensive education that addresses the requirements of the National Curriculum Framework (East School, 2001). The policy document further identifies that within each school year, students will receive instruction in each of the four Contextual Strands of *Science in the New Zealand Curriculum* (i.e., Living World, Physical World, Material World, Planet Earth and Beyond). Units of study have been developed collaboratively by teams representing the Junior (Years 1-3) and Senior (Years 4-6) section of the school. East School has a senior teacher designated as the science curriculum leader. Her leadership role is limited to liaising with the Junior and
Senior team leaders during the year to ensure that the resource materials required for science delivery are purchased and organized for classroom use. When requested by the principal, she is also required to conduct a curriculum review and report her findings to staff. Because of administrative changes within the school over the past four years, this self-review process had not been completed. As part of the school’s recent decision to implement an annual curriculum self-review process in selected areas, the science curriculum leader invited the author, to assist in this self-review process. During the initial consultation between the author and science curriculum leader it was decided that a cycle of self-review and development, as suggested by Stewart and Prebble (1985), would focus on (1) ascertaining the factors influencing science program delivery at East School; (2) identifying and implementing focused strategies for improvement (with outside professional development support if necessary) based on collaborative staff decisions; (3) re-evaluating the effectiveness of the focused strategies after a cycle of focused improvement; and, finally, (4) further identifying and implementing strategies for improvement on the basis of the re-evaluation.

**Methodology**

A comprehensive, statistically validated instrument, the *Science Curriculum Implementation Questionnaire* (SCIQ) (Lewthwaite, 2001) was used in the evaluation of factors influencing science program delivery at East School. The SCIQ is a 7-scale, forty-nine-item questionnaire that provides information concerning the factors influencing science program delivery at the classroom and school level (Appendix). The 7, 7-item scales have been developed with the intent of gauging staff perceptions on a 1 (Strongly Disagree) to 5 (Strongly Agree) Likert scale in areas that are identified as major impediments to science program delivery both nationally and internationally (Lewthwaite, 2000). Four of the scales pertain to the school environment. These environmental scales include Resource Adequacy; Time; School Ethos; and Professional Support. The remaining three scales relate to teacher personal attributes. These include Professional Science Knowledge; Professional Adequacy; and Professional Interest and Motivation.
The procedures used in the development and statistical validation of the SCIQ are outlined in a further manuscript (Lewthwaite, 2001). Details of the statistical validation process are outlined in Table 1 below.

Table 1: *Statistical details pertaining to the SCIQ validation*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Scale Item Number</th>
<th>Alpha Reliability Coefficient</th>
<th>Factor Loadings</th>
<th>Interscale Correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource Adequacy</td>
<td>3, 10, 17, 24,</td>
<td>0.83</td>
<td>0.66 – 0.81</td>
<td>0.22 – 0.46</td>
</tr>
<tr>
<td></td>
<td>31, 38, 45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>6, 13, 20, 27,</td>
<td>0.90</td>
<td>0.69 – 0.82</td>
<td>0.22 – 0.35</td>
</tr>
<tr>
<td></td>
<td>34, 41, 48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Support</td>
<td>7, 14, 21, 28,</td>
<td>0.90</td>
<td>0.51 – 0.77</td>
<td>0.33 – 0.67</td>
</tr>
<tr>
<td></td>
<td>35, 42, 49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School Ethos</td>
<td>5, 12, 19, 26,</td>
<td>0.90</td>
<td>0.36 – 0.75</td>
<td>0.29 – 0.45</td>
</tr>
<tr>
<td></td>
<td>33, 40, 47</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Personal Attribute</td>
<td></td>
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</tr>
<tr>
<td>Factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Science Knowledge</td>
<td>1, 8, 15, 22,</td>
<td>0.77</td>
<td>0.68 – 0.85</td>
<td>0.33 – 0.87</td>
</tr>
<tr>
<td></td>
<td>29, 36, 43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional Interest and Motivation</td>
<td>2, 9, 16, 23,</td>
<td>0.88</td>
<td>0.53 – 0.73</td>
<td>0.33 – 0.87</td>
</tr>
<tr>
<td></td>
<td>30, 37, 44</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Professional Adequacy</td>
<td>4, 11, 18, 25,</td>
<td>0.92</td>
<td>0.60 – 0.79</td>
<td>0.29 – 0.78</td>
</tr>
<tr>
<td></td>
<td>32, 39, 45</td>
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</table>

In the development and validation of the SCIQ, the alpha reliability of the scales ranged from 0.74 to 0.93 indicating strong internal consistency within each scale (Lewthwaite, 2001). Although elimination of some items would have increased scale internal consistency, these items were retained to ensure that the scales addressed several aspects of the same dimension. Further scales could potentially have been created in the development of the instrument to accommodate these aspects but for economy of use, a seven scale SCIQ was retained. As an example, the Professional Science Knowledge scale measures teacher perceptions of multiple dimensions of the complex knowledge base teachers require to teach effectively e.g. subject matter, pedagogical content and pedagogical knowledge. In the development and validation of the SCIQ, the pedagogical content knowledge item (Item 15) could have been omitted to increase the internal consistency of the scale but was retained because of the importance of this professional
science knowledge dimension in promoting effective science delivery at the classroom level (Baker, 1994). Examples of items from the Professional Science Knowledge scale are:

*Item 15: Teachers have a sound understanding of alternative ways of teaching scientific ideas to foster student learning.*

and

*Item 29: Teachers at this school possess the necessary science subject knowledge to be a good primary science educator.*

Further SCIQ items from the School Ethos scale are:

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

and

*Item 19: The school places a strong emphasis on science as a curriculum area.*

All eighteen teachers, aside from the technology and Te Reo Maori teachers, completed the questionnaire. Mean and standard deviation results for each of the 7-item scales were calculated and served as a foundation for staff discussion and collaborative decision-making regarding action for strategic curriculum development. After an eight-month period whereby the strategies for improvement had been implemented, the SCIQ was applied again and used as a foundation for further staff discussion and decision-making. Since only general trends in the changes associated with the strategies for improvement were of interest, t-tests on these data were not performed. Both staff discussions ensuing from the data presentation were audio taped, transcribed and authenticated as a literal transcription by the principal, science curriculum leader and science teaching staff.
Results and Discussion

Following a model of school development endorsed by Stewart and Prebble (1985) whereby data collection and presentation become the foundation for discussion and collaborative decision-making, the intent of the SCIQ and meanings of the scales and collected data were explained by the author to the staff. The results section (Table 2 and Figure 1) and discussion that follow present the foundation data collected from this initial SCIQ application.

Table 2: Science Curriculum Implementation Profile for East School Before Remediation (n=16)

<table>
<thead>
<tr>
<th>Scale</th>
<th>Scale Mean Before Remediation</th>
<th>Scale Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource Adequacy</td>
<td>4.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Time</td>
<td>3.8</td>
<td>0.7</td>
</tr>
<tr>
<td>School Ethos</td>
<td>2.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Professional Support</td>
<td>3.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Professional Adequacy</td>
<td>3.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Professional Science Knowledge</td>
<td>3.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Professional Attitudes</td>
<td>3.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Teachers at East School perceive that the school is adequately resourced (mean score 4.2) for the teaching of science. Not only is the school well resourced, the school’s facilities and system of managing these resources positively influences the teaching of science. The standard deviation score of 0.3 indicates that this positive perception is consistent amongst staff.

Teachers at East School perceive that the school does not place a high priority on science as a curriculum area (mean score 2.0). The school ethos is not seen to be contributing positively to the teaching of science. The standard deviation score of 0.3 indicates that this negative perception is quite consistent amongst staff.

Teachers at East School have reasonably positive perceptions of their ability to teach science (mean score 3.7). Teachers see themselves to be adequately prepared to teach science and are reasonably confident science teachers. They have positive perceptions of themselves as regards their ability to teach science. The standard deviation of 0.4 indicates that this perception is consistent amongst staff.
The staff were asked to comment on the accuracy of each scale and the general trends evidenced from these data. Although the discussion prompted many comments, primarily in the confirmation of the positive aspects identified by the SCIQ, considerable attention focused on the School Ethos score.

Staff A: *So the low number* (for the School Ethos scale) *indicates the degree to which we acknowledge science important as a curriculum area.....if that’s the case it’s very accurate.*

Facilitator: *Why do you say that?*

Staff A: *It certainly doesn’t have a high profile .....we never hear mention of science as a curriculum area.*

Staff B: *That’s a fair comment...it happens but there isn’t any real encouragement to lift the profile.*

Facilitator: *Any comments?*

Staff B: *.... odd when you think of it because it wasn’t always this way......it seems to just be in the background now.*

Staff C: *Yah, I’d agree. We used to spend a lot of time on science related activities...especially in the senior school...*

Staff D: *I think it had a reasonably strong focus across the school. School-wide science themes ran every year......that was good ... especially for the children.*

Several staff affirmed these comments.

Facilitator: *And what would you attribute the change too?*

Staff C: *Just being busy and curriculum squeeze!*  

Staff E: *Yes... but... that’s true... but the school emphasis has changed too over the years...and science just isn’t given the emphasis as it has been......there was always a clear message that science.......all learning areas need to be addressed...but I think we now compromise on that and let some things go.*

Staff F: *We’re pretty clear around here about what to emphasize and science isn’t one of them.*

Principal: *I hear what you’re saying......you’re meaning that the curriculum emphasis has changed....Are you saying I’m to blame?*
Staff B: *Not to blame...we’ve had a shift in the time you’ve been here ... you’ve been really busy with other matters...but I think you’re in the position to do something about it.*

Staff G: *The shift is evident...we’re less focused on curriculum matters and more concerned about the general running of the school.*

Principal: *I guess I’ve probably put my effort there (non-curriculum). Certainly more of my time is spent on those matters. Not that I thought that would influence the teaching of any subject. I just expected everyone to just get on with their teaching.*

Staff B: *I think we look to you as principal for curriculum leadership ...not just you but a principal in general...that’s the way it has been.*

Staff discussion continued to identify the complexities of influences on curriculum delivery, especially the role of the principal in leading and influencing staff in instructional matters, specifically in the area of science program delivery. The staff clearly perceived the principal’s role to be multidimensional and within this amalgam of roles was the requirement to lead, or at least catalyze, improvement in curriculum delivery and student learning. This perception of the principal as the driving force for improvement is a typical expectation held by the educational community (Fullan, 1988). Nias, Southworth, and Yeomans (1989) refer to the role of the principal as integral to fostering a commitment to a shared institutional value. In East School’s case, the lack of instructional leadership by the principal had been identified as the major hindrance to the development of a shared institutional value towards instructional improvement, specifically within the area of science.

Thereafter, staff discussion, primarily lead by the principal, focused on strategies for improvement. Decisions made during this phase of the discussion included (1) the principal personally redefining his role not only as a school manager, but also as a leader and catalyst for curriculum improvement; (2) an explicit statement by senior administration to ensure that science is taught as regular part of the school program; (3) a teacher decision to ensure science, as well as social studies, was regularly taught as part of the school program; (4) re-establishing a science focus in annual outdoor education programs, especially a Senior school waterways project to link with a national waterways
program; (5) re-designation of the role of the science curriculum leader to serve as a science teacher leader with allocated release time for professional support and ensuring resource adequacy; and (6) increased expenditure on science program delivery.

Throughout the year following the staff discussion, the author held several informal meetings with the principal and science teacher leader to monitor ongoing developments in science and encouraging, in particular, the principal’s curriculum leadership capabilities. Both the principal and science teacher leader acknowledged that the science profile had lifted significantly, both at the classroom and school-wide level. They also communicated to the author that they recognized that they were critical agents in establishing this higher profile. The principal, in particular, recognized that he needed to consistently give a message to staff that the improved delivery of science and instruction in general curriculum were to be taken seriously (Hall & Hord, 1987; Hopkins, Ainscow, & West, 1994). The science teacher leader, as well, made repeated comment about the call for support and resources that had come from her colleagues. She also identified the need for her own self-development through professional development opportunities and was encouraged to pursue such support during the year. Near the end of the school year, a follow-up SCI Q application was implemented. The results of the application exercise (Table 3 & Figure 1) were presented to staff and a further discussion, based on these data, ensued.

Table 3:

<table>
<thead>
<tr>
<th>Scale</th>
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<th>Scale Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource Adequacy</td>
<td>4.7</td>
<td>0.2</td>
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<td>3.8</td>
<td>0.5</td>
</tr>
<tr>
<td>School Ethos</td>
<td>3.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Professional Support</td>
<td>4.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Professional Adequacy</td>
<td>2.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Professional Science Knowledge</td>
<td>2.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Professional Attitudes</td>
<td>3.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>
As presented in the initial staff discussion, the intent of the SCIQ and meanings of the scales and the meaning of the collected data were explained by the author to the staff. Some of the general trends identified from these data were presented to staff included:

Teachers at East School perceive that the school does place a reasonably high priority on science as a curriculum area (mean score 3.5). The overall school ethos is seen to be contributing to the teaching of science. The standard deviation score of 0.5 indicates that this quite positive perception is quite consistent amongst staff.

Teachers at East School have reasonably low perceptions of their ability to teach science (mean score 2.7). Teachers see themselves to not be adequately prepared to teach science and are not overly confident science teachers. They do not have positive perceptions of themselves as regards their ability to teach science. The standard deviation of 0.3 indicates that teacher perceptions of their science teaching professional adequacy is consistent amongst staff.

Teachers have reasonably low perceptions of their professional science knowledge (mean score 2.7). Teachers perceive that they are not secure in their knowledge of science concepts pertinent to the primary science curriculum. As well, they do not see that they possess a sound understanding of alternative ways of teaching scientific ideas to foster student understanding. The standard deviation of 0.3 indicates that teacher
perceptions of their professional science knowledge is consistent amongst staff.

Again, the staff were asked to comment on the accuracy of each scale and the general trends evidenced from these data. Although the discussion prompted comments, primarily in the confirmation of the positive aspects identified by the SCIQ, especially the improvement in the School Ethos dimension, considerable attention focused on the teacher personal attribute scales of Professional Adequacy and Professional Knowledge.

Staff D: *For myself, I can see that the overall profile fits where I think the school is at and where I am at now.*

Facilitator: *What do you mean?*

Staff D: *Many things…but we have consciously tried to improve the level of science in the school. That’s largely because (the principal) and Staff G (the science teacher leader) have encouraged … and even insisted that we give attention to our instruction…not just in science.*

Staff B: *I can see that there has been a collective effort to improve on the science experience we provide for our children…. the time I spend teaching science…the time I spend preparing for science….but I also have become more aware of my own need to improve in my science teaching.*

Staff H: *I agree, I’ve taught more science units than I have before in the time I’ve been here and it’s required a lot more of me. It’s shown up my own weaknesses.*

Facilitator: *So you’re saying you’ve felt less adequate in your level of preparation?*

Staff H: *Before, I think I taught from my experience and knowledge base and as we’ve moved to increase the presence of science I’ve had to become more secure in my own knowledge of science content and understandings and how best to deliver it.*

Staff discussion clearly identified the development of an improved shared institutional value towards science as a curriculum area fostered primarily by the principal (Nias, Southworth, and Yeomans, 1989). This was manifested through a variety of characteristics such as (1) an emphasis on increasing the instructional time devoted to science in classrooms and in outdoor educational programs; (2) an increase in staff
discussion, both formally and informally, about science and the teaching of science; (3) increased expenditure on resources for staff instruction; (4) collaborative science planning sessions with the science teacher leader, and (5) a more prominent leadership role for the science teacher leader. Several staff members affirmed this trend and acknowledged the need they had for support from each other, in particular, the science teacher leader. Thereafter, staff discussion, primarily lead by the principal and science teacher leader, focused on further strategies for improvement. Decisions made during this phase of the discussion included (1) the principal reasserting his role as not only a school manager, but also as a leader and catalyst for curriculum improvement; (2) the staff to identify, through a questionnaire developed by the facilitator and science teacher leader, content areas of the science curriculum that were regarded as difficult to teach; (3) the need for science professional development sessions with the facilitator and science teacher leader that would foster a development in subject matter and pedagogical content knowledge and appropriate teaching strategies in areas identified as being difficult to teach.

This staff discussion marked the end of a complete cycle of school self-review based on data collection and discussion and collective decision-making in the area of science program delivery (Stewart & Prebble, 1985, 1993). The initial evaluative phase had identified that teachers perceived that various extrinsic factors associated with the school environment, in particular those relating to the role of the principal as an instructional leader, were compounding the complexity of the problems influencing the science delivery process. With an increased emphasis on the teaching of science, intrinsic factors such as teacher professional knowledge and self-efficacy were now being identified as the major influences on effective science program delivery as a result of an increased emphasis on the teaching of science. The staff recognized that the principal’s role, as Fullan asserts (1992) was pivotal in catalyzing a shared institutional value to improvement in science delivery. The principal also recognized that his role change from that of not only school manager but also instructional leader had occurred within an environment of consensus from below and pressure from above to create a two-way relationship with top-down and bottom-up influence (Fullan, 1993). As Fullan suggests
(1993) a sustained two-way relationship of pressure, support, and continuous negotiation amongst the teaching staff, principal, science teacher leader and author fostered the commitment to progress towards identified targets. Critical to the identification of these targets was the gathering of good-quality data by using the SCIQ to serve as a foundation to inform collective understanding of the factors influencing science program delivery and decision-making.

Summary

Although intrinsic factors such as teacher knowledge, beliefs and attitudes are major influences on effective science program delivery, this study affirms that various extrinsic factors associated with the school environment, in particular those relating to the role of the principal as an instructional leader, also compound the complexity of the delivery process. Thus, in order for the science education community to continue to address the maladies in primary science delivery, a coherent strategy for improvement must be developed that not only gives attention to developing the professional science knowledge, adequacy and attitude of individual teachers but also to understanding the influence of the educational environment on curriculum delivery. Of particular concern is the role of the principal as an instructional leader in fostering improvement in curriculum delivery. It is they that carry the message as to whether some curriculum intervention or innovation is to be taken seriously (Hopkins, Ainscow, & West, 1994). Consequently, for New Zealand and potentially many other countries facing the challenge of improving the primary science experience for its children, improving science delivery is as likely to be about putting the spotlight on the role of the principal as an instructional leader and the existing school culture as it is about focusing on the professional science knowledge, adequacy and attitudes of individual school teachers.
References


