Continuous professional learning through school based strategic planning

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Abstract

There is ample evidence that in many countries school science is in difficulty, with declining student attitudes and uptake of science. This presentation argues that a key to addressing the problem lies in transforming teachers' classroom practice, and that pedagogical innovation is best supported within a school context. Evidence for effective change will draw on the School Innovation in Science (SIS) initiative in Victoria, which has developed and evaluated a model to improve science teaching and learning across a school system. The model involves a framework for describing effective teaching and learning, and a strategy that allows schools flexibility to develop their practice to suit local conditions and to maintain ownership of the change process. SIS has proved successful in improving science teaching and learning in primary and secondary schools. Experience from SIS and related projects, from a national Australian science and literacy project, and from system wide science initiatives in Europe, will be used to explore the factors that affect the success and the path of innovation in schools.

Background

There have been substantial criticisms of the quality of learning in science, mathematics and subjects more generally, coming out of research studies and major international testing programs. In science engagement with this criticism has become more urgent at policy level because of the importance placed on science as a subject feeding into whole of government technological renewal strategic directions. Relative performance on international testing regimes such as TIMSS and PISA have helped focus attention on the limitations of science curricula in many if not most countries. In science, this concern for quality learning outcomes has been supported by three decades of research into student science conceptions and the lack of success of traditional teaching approaches and curricula in engaging students and supporting meaningful learning (Lyons, in press)

At the same time, there is a long standing and growing concern with the lack of engagement of students with science and indeed schooling in general, in the middle years 5-9 in particular, and decreasing participation rates in senior school and university science and mathematics programs. This is of particular concern given the increasing importance and profile of science related innovations and social issues. Concerns have been expressed (eg. Hargreaves 1994) about the adequacy of the school system to respond to the needs of students and society in this post modern, globalised age.

These concerns have implications at different levels. Concerns relating to the relevance and adaptability of the schooling system to student needs have been approached at the level of school structural arrangements, and the professional relationship of teachers within these structures (eg. Hill & Crevola, 1999). At both a systemic and school level, attention has focused on the nature of the curriculum and, in many jurisdictions, on accountability measures built into it. The level focused on in this presentation, addressing student engagement and learning, focuses on classroom practice; the beliefs and practices of the teacher. The teacher is arguably the most important element influencing student attitudinal and conceptual outcomes (Goodrum, Hackling & Rennie, 2001). Many studies have striven to define what are the important determinants of quality classroom teaching and learning, in terms of teacher knowledge (Shulman, 1986), teacher classroom practices (Penick & Yager, 1983; Tobin & Fraser, 1988; Treagust, 1991, Hall & Hord, 2001), classroom

environment factors (Fraser & Treagust, 1986), or more general formulations that include teacher orientation and beliefs (Goodrum, Hackling & Rennie, 2001; Osborne, Simon & Collins, 2003; Tytler, Waldrip & Griffiths, 2004). There is a substantial literature on teacher development and change (Guskey & Huberman, 1995; Goldsmith & Schifter, 1997) that is associated with this focus teacher practice, addressing both the nature of teacher development, and the effectiveness of different methods that aim at improvement or transformation.

Teacher development models

In science, professional development of teachers most often occurs through the medium of workshops and conferences that focus on particular elements of practice, classroom activities and ideas, and skills and content knowledge. While this short term 'skills and knowledge' approach can be valuable and efficient in disseminating information and ideas it has been shown to be quite ineffective in challenging and supporting more fundamental aspects of teaching practice and beliefs practices (eg. Hoban 1992).

Recently, a number of system – initiated projects in Australia have approached the problem in just this way, embedding teacher professional development within a school context and paying attention to the different layers through which teachers relate to students, colleagues, school leadership and the community. In Victoria, the Hill and Crevola design elements (Hill & Crevola 1999) have been used in the Early Years Literacy Project, and the Middle Years Research and Development Project, as a way of conceptualising the different elements of schooling that interact in the change process. The New Basics / Productive Pedagogies initiative in Queensland (http://education.qld.gov.au/corporate/newbasics/html/pedagogies/pedagog.html) is also an attempt to bring together multiple elements (the teacher and the classroom, leadership, and assessment) in the change process (Luke et al., 2003). The New Essential Learnings project in Tasmania (http://www.education.tas.gov.au/ocll) similarly has a broad focus. In terms of intended student outcomes, each of these projects focuses on engagement with schooling and learning, the promotion of meaningful learning, and higher order thinking.

Many writers (eg. Hargreaves 1994, Hall & Hord 2001) have emphasised that change requires of teachers that they ground new ideas in their own personal experience. Joyce and Showers (1995), drawing on research from a large number of studies, argue strongly for the need to site professional development within the school context. They discuss professional development within a framework of cultural change, and argue the need for social support as teachers practice strategies that are new to their repertoire or implement the difficult areas of a curriculum change. Contemporary large scale reform projects in a number of countries have tended to incorporate these principles (Beeth et al., 2003).

To improve teaching and learning in schools, on a large scale basis, it is necessary to adopt a model that is sensitive to the structures within which teachers and schools work, that is grounded in a coherent view of teacher learning and teacher professionalism, and that is based on a coherent and explicit vision of teaching and learning and wider purposes of schooling.

The structures that need to be acknowledged by any model, if it is to be effective, include policy frameworks and charters, organisational frameworks, the school and community culture within which teachers and students sit, and the cultures of subjects and other professional groupings within the school. Without attention to these multiple levels at which students, teachers and the school community interact, innovation and change runs the risk of being surface deep.

School Innovation in Science

The Science in Schools Research Project is a major initiative funded by the Victorian Department of Education and Training, and managed by a team based at Deakin University. The Project over three years developed an approach to improving teaching and learning in science that is applicable to improvement in subject based teaching and learning more generally. The project worked with more than 200 schools to develop, refine and validate the approach, which is now being used more

widely as 'School Innovation in Science'. The impact of SIS in the participating schools has been extensively researched. It has led to significant changes in many if not most of these schools.

The SI Model focuses centrally on the teacher as the primary agent influencing student learning and attitudes. Of course, the teacher, particularly in a process of change, sits in a complex relation with different elements of the school including the science team culture and wider school and community processes. The model has three basic elements:

1. A core vision of teaching and learning, in a form that is generative, and sufficiently explicit to encourage and support teachers to critique their practice
2. A strategic planning process that acknowledges the way teachers learn, and relate professionally within teaching and learning teams.
3. A support surround which operates at different levels, designed to challenge and support teachers and schools in a multi layered change process

Describing quality teaching and learning in science

The SiS Research project required a framework to describe effective teaching and learning which was sufficiently robust to inform the process of change in elementary and secondary schools from Years 1 to 10, with widely varying cultures and histories of teaching science. The framework needed:

- to be cast in clear and relatively unambiguous language,
- to cover the full gamut of aspects of science provision in schools,
- to focus attention clearly on classroom teaching and learning and support serious reflection on learning issues, and
- to support monitoring (self monitoring and also measurement of change for research purposes) of teacher classroom practice.

The framework was expressed as a series of components of effective science teaching and learning, influenced by the notion of Innovation Configuration Maps (Hall & Hord, 2001). The process is described in Tytler (2003), and Tytler, Waldrip and Griffiths (2004).

The development of these components involved interviews probing the beliefs and practices of 19 primary and secondary teachers from three Australian states. Each teacher was identified as an effective practitioner by science educators or government teaching and curriculum advisors who had worked with them. The interviews were face to face and involved a broad discussion stimulated by questions which focused on building up a picture of what happened in their science classrooms, what they saw as their core purposes, their attitudes and beliefs concerning science teaching and learning, and influences on their practice.

The Components were also informed by the literature on learning and attitudes, and principles of effective teaching and learning in the middle years of schooling. Each component was framed to focus on classroom teaching and learning principles rather than skills or beliefs, and is in a form against which teachers can evaluate and monitor their own practice. The components were caste in terms of a combination of teachers' actions and students' experience of the learning situation, such that quality pedagogy is caste as a function of how the teacher shapes student experience rather than details of their performance. The Components are shown in Figure 1.

The components form the basis of a component map by which teacher classroom practice is monitored in the project.

The component mapping exercise was a powerful innovation. In this exercise SIS Coordinators interviewed each teacher to reach an agreed teaching and learning profile based on the SIS Components. Word descriptors are used to represent four different levels of exemplification of the components (some are divided into sub-components for clarity), and each teacher's profile is constructed during an interview with the SIS Coordinator who clarifies and probes. The exercise

caused teachers to think about what they had been doing in science and what they wanted to do in the future. SIS Coordinators valued the process for the direction it gave to the project:

> The teaching and learning review exercise … identified teacher strengths and areas that they would like to improve on … allowed teachers to identify and be open about their limitations and expertise … encouraged a more thoughtful approach to teaching and learning … encouraged the development of a shared vision of science. (From a review meeting of SIS Coordinators)

The Component Map was validated in the project by a number of means (Tytler, 2001) and was the basis on which changes to teacher practice were tracked over the project. Figure 2 shows the growth, over three years of the project, in teachers' mean score (out of 4) across all eight components.

In classrooms that effectively support student learning and engagement in science:

1. Students are encouraged to engage actively with ideas and evidence

Students are encouraged to express their ideas and to question evidence in investigations and in public science issues. Their input influences the course of lessons. They are encouraged and supported to take some responsibility for science investigations and for their own learning.

2. Students are challenged to develop meaningful understandings

Students are challenged and supported to develop deeper level understanding of major science ideas and to connect and extend ideas across lessons and contexts. They are challenged to develop higher order thinking and to think laterally in solving science-based problems.

3. Science is linked with students' lives and interests

Student interests and concerns are acknowledged in framing learning sequences. Links between students' interests, science knowledge, and the real world are constantly emphasised

4. Students' individual learning needs and preferences are catered for

A range of strategies is used to monitor and respond to students' different learning needs and preferences, and to their social and personal needs. There is a focused and sympathetic response to the range of ideas, interests, and abilities of students.

5. Assessment is embedded within the science learning strategy

Monitoring of student learning is varied and continuous, focuses on significant science understandings, and contributes to planning at a number of levels. A range of styles of assessment tasks is used to reflect different aspects of science and types of understanding

6. The nature of science is represented in its different aspects

Science is presented as a significant human enterprise with varied investigative traditions and constantly evolving understandings, which also has important social, personal and technological dimensions. The successes and limitations of science are acknowledged and discussed.

7. The classroom is linked with the broader community.

A variety of links are made between the classroom program and the local and broader community. These links emphasise the broad relevance and social and cultural implications of science, and frame the learning of science within a wider setting.

8. Learning technologies are exploited for their learning potentialities

Learning technologies are used strategically for increasing the effectiveness of, and student control over, learning in science. Students use information and communication technology (ICT) in a variety of ways that reflect their use by professional scientists.

Figure 1: The SIS Components of effective teaching and learning in science

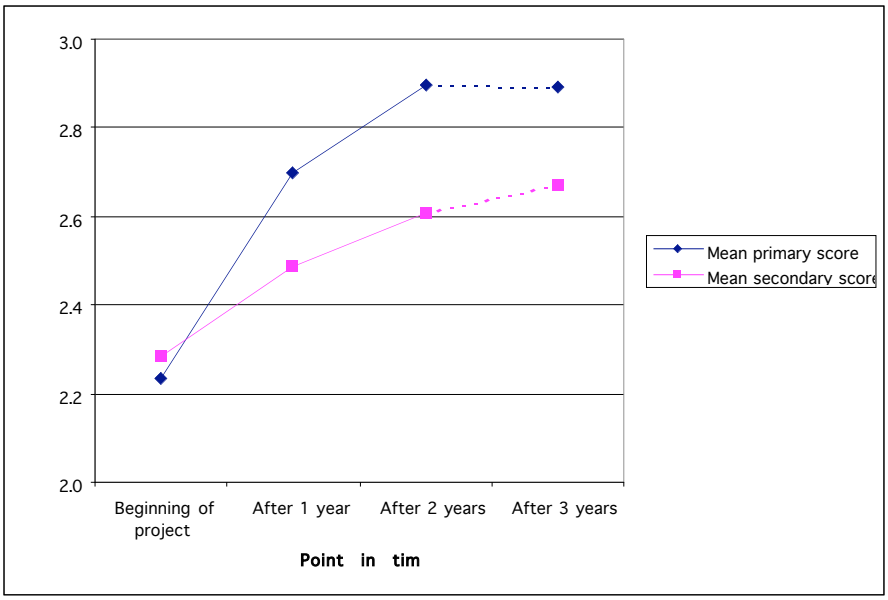

Figure 2: Changes in mean Component Map scores over three years

The real transformation has been in the reconceptualisation of professional learning around pedagogy. And the real strength of the component mapping has been promoting change.

Teacher professional learning

The SI model is based on an action planning process in which schools and teachers first audit their practice against the Principles, then develop initiatives and Action Plans arising from these. They are supported in this by instruments and documentation, consultants, some time release, and a school coordinator. Early in the SIS project it was realised that the leadership of the school coordinator was critical in determining the pace and depth of change. Thus, the SI model incorporates an initial 'leading change' workshop in which coordinators are introduced to the project and given professional development in leadership. Principals are also briefed about expectations and the need for support. The model, which is shown in Figure 3, also incorporates advice concerning actions within the school to support the process.

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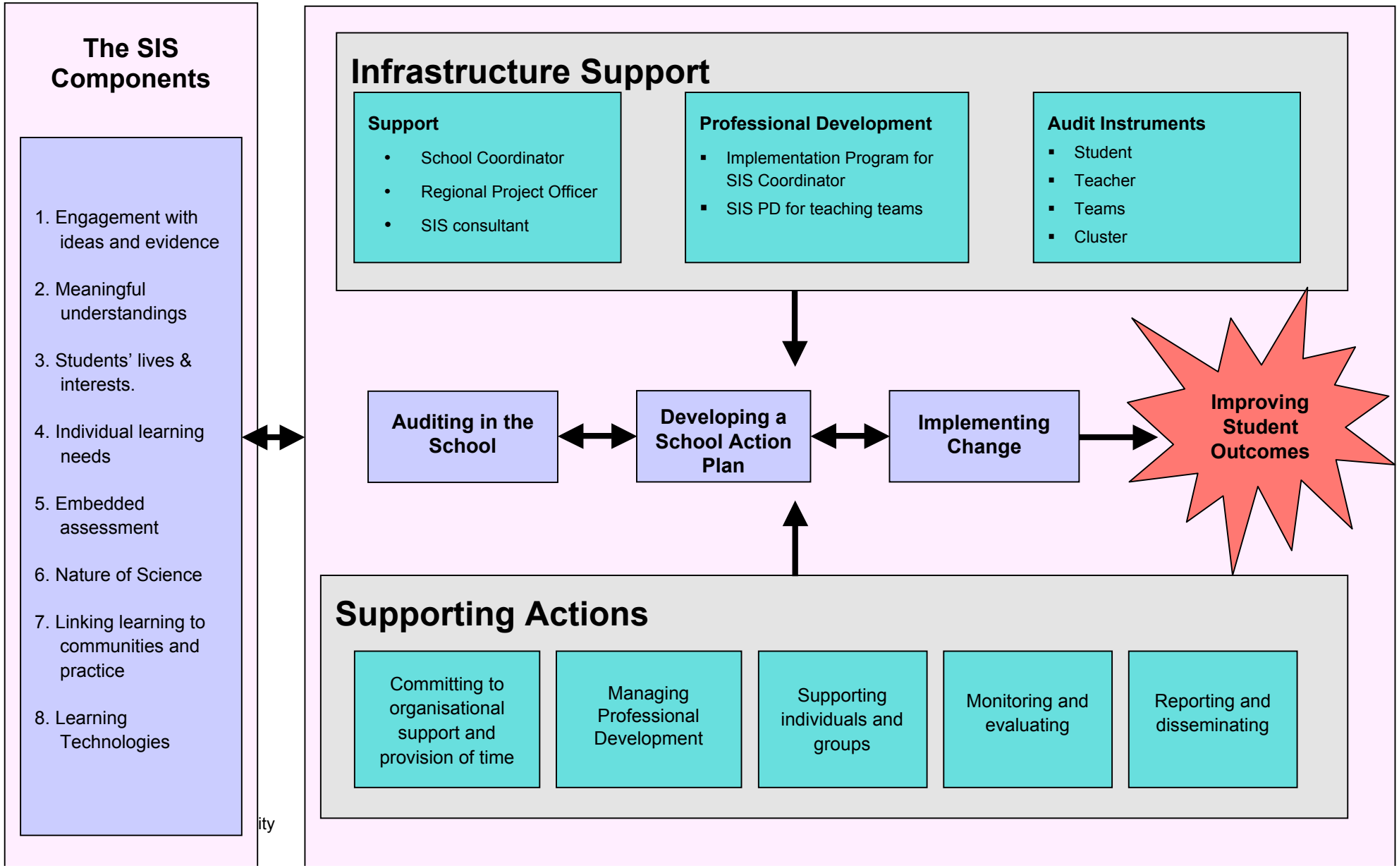
Figure 3: The SIS Strategy



The real focus within the model is the professional learning team, which undertakes the audit and review process and development of the Action Plan. One of the major successes of SIS was the way science teams worked to develop a shared view of teaching and learning, rather than focus on organisational matters. Table 1 shows data from an evaluation questionnaire given to coordinators, making judgments about the operation of the science team. The figures show a remarkable change in the extent to which the science team acts as a unit focused on curriculum and pedagogy, over two years of the project.

Table 1

Percentage of Phase 1&2 SIS Coordinators judging the science team to be operating at high or very high level

	Prim. N=48	Prim. N=48	Sec. N=41	Sec.. N=41
The science team in our school:	Pre-project	Current	Pre-project	Current
a. Regularly discusses science teaching and learning issues	2	64	15	78
b. Has a shared vision of the purpose and direction of science in the school.	4	89	9	68
c. Has a shared view of effective classroom teaching and learning in science	7	81	9	65
d. Is focused on improving student learning outcomes in science	10	87	26	74
e. Is committed to ensuring that students find science interesting and relevant	20	94	28	90
f. Has an agreed process for assessment of student learning in science	2	44	22	46
g. Plans together effectively	14	85	12	68
h. Has a coherent staff PD program focused on teaching and learning	18	73	13	59
i. Support each other in teaching and learning strategies	27	83	22	85
j. Promotes science effectively within the school community	5	79	8	65

Factors affecting the outcomes in individual schools

The SIS research team identified factors determining the outcome of the project in schools, to incorporate in advice to schools, and refine the support structures that were put in place. This involved an analysis by a review meeting of the research team with consultants who had been active in advising and monitoring schools across the state. The analysis identified a set of factors that are particularly critical in determining a school's success in improving science teaching and learning. These factors are shown in Table 2.

Table 2

Critical success factors for the SI Model

Coordinator:	Status within school, degree of organisation, leadership qualities.
School leadership:	Leadership commitment; and actions related to support and commitment
School culture:	A culture of change existing in the school and acknowledgement of the need for change A positive attitude and willingness to try things The ability to share ideas and be open with each other concerning their classroom practice
Access to support and resources:	Time and resource support External support and prompting from consultants, Networks/clusters: to share ideas, PD. Access to physical resources

It was this analysis that led, during the ongoing planning of SIS, to an emphasis in the materials, structure and advice given to schools, on coordinator leadership and focus on supporting group processes, on involvement of the school leadership team and commitment of the school to the process, and to the structure of the pd to emphasis action at the group planning level.

Principles embodied in the SI Model

The School Innovation approach to change represents a complex and nuanced view of the nature of change in schools, of teacher learning and development, and of the purposes of teaching and learning within key learning areas. There were a number of principles central to the operation and success of SIS, and these have been supported by experience with the later projects.

Teacher learning

The *view of teacher learning* represented within the project encompasses input of ideas from outside, from within the group, and individual reflection. Ownership of the development process resides in the science team, and the individual teachers. The science team is conceived of as the engine of change; as the site within which professional dialogue and interaction takes place. Within the approach, opportunities are created for teachers to reflect on their practice, to interact with more or less knowledgeable colleagues, and to be challenged and supported to reflect on their beliefs and commitments concerning teaching and learning.

The view of quality teaching and learning that forms the core vision of these projects is caste in a way that explicitly challenges traditional practices, in a language generated by teacher informants. The Components, while broadly generic, are sufficiently explicit in their descriptions of practice to challenge orthodoxy, and to form the basis for monitoring teacher development. They are pitched at a level that foregrounds student learning, and challenges teacher beliefs and commitments. As a set, they comprise a strong pedagogical statement (similar in many ways to that promoted by Productive Pedagogies, and also to PEEL principles; Baird & Northfield, 1992).

Local ownership and control

Local control and ownership of the change process is central to the SI Model. This is a critical condition for effective change cited in most teacher change literature (eg. Guskey & Huberman, 1995). The Strategy provides a detailed process and structured support for teachers working together as a team to develop a shared vision of purpose and of teaching and learning.

Leadership

The SI Model provides a structure within which Coordinators exercise leadership in managing the change process. This issue of leadership became increasingly clear over the life of the project, and advice and support on the role, and principles of working with teachers at different levels were developed and promoted in a handbook, in workshops, and in a 'leading change' program.

Attention to the school community

Firstly, its structures recognise the different school community aspects within which teachers, the main agents in teaching and learning, operate. The commitment of and relationship between the school leadership, the science team and the teacher in the classroom have all been researched and theorised within the approach. The SI Strategy operates at all these levels to support and monitor the change process.

Subsequent and further projects

The SI Model, from 2003, has been extended to a range of further projects in Victorian and nationally, including the 'Principles of Learning and Teaching P-12' (PoLT), a major Government pedagogy initiative, and the research project 'Improving Middle Years Mathematics and Science' (IMYMS). Both these projects operate through school clusters involving between 3 and 10 primary and secondary schools, with a full time 'cluster educator' driving the process. A statewide extension of SIS to mathematics and technology is also being rolled out, still focusing on individual schools.

Evaluations of PoLT and IMYMS have confirmed the efficacy of elements of the SI model, including the focus on pedagogy and the value of the component mapping process in supporting pedagogical discussion and reflection, the focus on the team as the engine of change, and the importance of the factors in Table 2. The operation of these projects, with features that are variations on the original model developed through SIS, have also thrown up difficulties. This allows us to make some observations about important features of the model. The experience of these projects has highlighted:

- *The need for a well defined team with a shared agenda:* the cluster organization has brought with it the possibility of a dispersed responsibility that dissipates resolve for change. The fact that a cluster team will involve teachers who do not naturally have a shared responsibility for development , has meant in some cases that planned initiatives do not flow through to the classroom. One of the problems that has arisen with mixed secondary – primary school clusters is that the agendas and needs are sufficiently different that secondary school teachers have felt outsiders in the process of change which is often driven by primary school teachers.
  On the other hand, the cluster structure has opened up a remarkable outlet for many teachers to plan and share with a wider range of colleagues, leading to a rich range of ideas.
- *The need for a sharp focus:* SIS schools focused on strategic initiatives based around one or two SIS Components. In PoLT the complexity of a broader canvas led in some cases to a dissipation of energy, in that initiatives owned by teachers from a variety of

learning areas made it more difficult to achieve consensus on the ground, with some learning areas tending to ignore the impetus for change.

- *The need for particular support features:*
    - A critical friend / team leader with commitment to and insight into science pedagogy. With IMYMS the cluster educator was not necessarily well versed in science or mathematics, and played a very different role compared to the Regional Project Officers in SIS.
    - Access to professional learning resources. In particular, focused professional development sessions which helped schools identify pathways forward were successful features of both SIS and PoLT.
    - Access to materials and time to plan. In the cluster model most of the time resource went to the cluster educator sometimes leaving insufficient time for teachers to plan in teams.
- The need for networking to affirm and access ideas: cluster meetings and project workshops were important features of these projects, giving a sense of collegial support and enabling ideas and initiatives to be shared and celebrated.

Two other projects have been associated with SIS. The Primary Connections project is an Australia wide initiative supported by the Academy of Science and the Australian Government. It focuses particularly on the literacies of science, and involves the writing of units of work for participating schools, which are modified according to school needs. Part of the process involves supporting individual schools in a national week long workshop to plan units together that are consistent with the 5E framework. There are also processes built in, based on the SI model, that support teams of teachers to focus on pedagogy and plan the implementation process.

The SINUS project in Germany is, like SIS, a school focused change process targeted at the level of individual schools. Groups of teachers plan together, based on their choice from ‘modules’ that lay out core principles of teaching and learning in science. The modules include such thingsas ‘cumulative learning’, ‘inquiry and scientific investigations’, and ‘strengthening students’ responsibility for their learning’. Schools and teachers are supported by network arrangements, and by a system of consultants.

Core support features of school based, continuous professional learning.

Taking these projects together allows us to validate the key features, described above, of the professional learning support structures that have been successful in promoting improvement. The way these key support features appear in each project is laid out in Table 3.

Table 3:
Support features for school based continuous professional learning

Support feature	**SIS/IMYMS**	**Primary Connections**	**SINUS**
A clear framework and clarity of focus	The SIS Components act as a focusing framework	The 5E's which form the basic structure of a science unit, and principles of literacy	The modules around which schools base their project,
Support for team processes	Instruments to support auditing of science team processes, advice based on research, and a 'leading change' workshop for coordinators.	Protocols for team based collaboration and decision making, and support for this at a national workshop.	Appointment of a school coordinator,.
Access to specific professional development support.	SIS and PoLT included PD sessions to support schools' action planning in specific areas.	Self contained support through a national workshop and follow up state based workshops.	PD on specific modules was provided.
Network support	Network meetings were run for SIS in which schools shared. For IMYMS and PoLT cluster meetings fulfilled this role but there were also wider meetings.	The workshops provided considerable opportunity for discussion across state boundaries.	Schools are arranged in networks, supported by local coordinators and technicians
Critical friend	Regional Project Officers provide support. Including organization of meetings, PD	Provided through network meetings.	University staff are engaged to act as critical friends.
Encouragement of ownership	The action planning process gives schools ownership of the change process	Each school is able to modify the materials to suit, and has reasonable scope for tailoring the materials.	Schools decide their own projects and manage the change process.

Conclusion

In each of the projects described, working with an explicit learning and teaching framework (eg. The SIS Components) have proved productive in supporting pedagogical discussions, and in providing a basis for transformative action to improve teacher practice and student learning. One of the issues in broadening the scope of the SI model to encompass clusters, and more complex notions of professional learning teams, and a more generic formulation of pedagogy, is the extent to which this compromises the effectiveness of the model. For encouraging teachers and schools to reflect on their practice and commit to a process of continuous professional learning, a number of support features are critical. These amount to clarity of vision, flexibility and ownership, timely and targeted PD, and outside support in the form of critical friends and/or effective network arrangements. The different projects described above incorporate these features in different ways and to a different extent, but in each project most if not all of these are represented.

These features are similar to those that have been advocated in the literature for some time, but it is only now that projects attempting system wide change are taking them seriously.

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