

Evaluation of the Science by Doing Stage One Professional Learning Approach 2010



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Disclaimer

The views expressed herein do not necessarily represent the views of the Australian Government Department of Education, Employment and Workplace Relations.

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Executive Summary

Background to the Science by Doing Stage One Project

The Science by Doing Stage One project is a national initiative for the improvement of secondary science education. It is managed by the Australian Academy of Science and funded by the Australian Government. The Science by Doing (SbD) project is built around a professional learning approach (PLA) that focuses on the development, in a school science department, of a professional learning community (PLC). The SbD PLA has four components: professional learning workshops, professional learning resources, curriculum resources and visits to schools by SbD team members. During Terms 2 and 3 in 2010, SbD was trialled in 28 schools, including at least one in every Australian state and territory. This evaluation was designed to assess the effectiveness of the SbD PLA during the trial period. It was focused on four questions about the SbD PLA, namely,

- a) how successful is the PLA in improving pedagogical practice?
- b) what factors are important in enhancing the PLA?
- c) what factors inhibit the implementation of the PLA?
- d) how can the PLA be improved?

A mixed method design was used to collect both qualitative and quantitative data from School Coordinators and teachers involved in the SbD project. Data collection included surveys administered during the initial professional learning workshop in April, 2010 and the workshop at the end of the trial in October, and interviews undertaken with 9 Coordinators, 31 teachers and 5 principals during visits to 9 of the 28 participating schools in four states. Field notes were also made during each workshop and school visit.

Context of the SbD Stage One Implementation

SbD is a professional learning project aimed at assisting teachers to enhance their pedagogical skills to improve student learning through the development of a PLC in their science department. The SbD PLA included professional learning resources for teachers as well as student curriculum resources. Teachers were introduced to the resources during a workshop and on return to their schools were supported by visits by the SbD team. For SbD to be successful, it has to become integral to how teachers work within their schools and their classrooms.

The findings of the SbD project must be considered in the context of the conditions that prevail in our schools. Teachers are busy doing a range of tasks besides teaching; schools are very variable in terms of their location, their administrative structure, the cohesiveness of their teacher cohort and the nature of their student population; and change takes considerable time and effort. Making SbD a priority in teachers' busy lives was a major challenge, particularly as it was a trial over only two terms; long enough to make a start towards significant change, but not to consolidate it, even if staff were amenable and willing to participate.

The SbD project has a clear focus on student outcomes, the SbD resources were carefully crafted, evidenced-based, and of excellent quality. The SbD team is knowledgeable and motivated to support teachers and School Coordinators. The SbD team endeavoured to

engage the support of Principals and provided each school with a \$1000 SbD grant which could offset costs. Importantly, SbD delivered a very successful initial professional learning workshop that enabled the School Coordinators to become familiar with the resources and understand the aims of the SbD project. These positive features were important contributors to the outcomes of the SbD trial.

Findings

Success of the PLA in Improving Pedagogical Practice

The SbD PLA achieved considerable success in assisting School Coordinators to implement a PLC and improving pedagogical practice. The empirical data from the two workshop surveys show clear progress towards the development of a PLC in schools' science departments. Coordinators' ratings on 12 of 15 indicators of an effective professional learning community based on the SbD definition of a PLC showed statistically significant improvement, most with large effect sizes. Overall, School Coordinators believed that constructive change was happening.

Qualitative data obtained by interviews with teachers during school visits and from School Coordinators' written responses to the final workshop survey are complementary to, and consistent with, the empirical findings. Teachers and Coordinators agreed there was an increase in time spent discussing curriculum and pedagogy. Formal discussions focused on the teacher professional learning resources and the suggestions within them stimulated teachers to try out new skills and techniques. There was increased sharing of ideas and openness amongst teachers about planning, student learning and the success of strategies they had tried.

No empirical data are available to attest to improved student learning because the resources are new and no comparative study was possible. However, teachers and Coordinators believed that student learning was enhanced, that students were more engaged, more enthusiastic, and asked more and higher level questions when using the SbD resources. Many of these teachers believed this resulted in greater learning and improved work quality. There was some concern for lower ability students relating to reading level or the need for more structure in the curriculum resources, and for very able students who may have got a bit bored. This underlines the need for flexibility within the modules.

Factors that Enhance the Implementation of the PLA

The teacher professional learning resources and the student curriculum resources were central to the SbD PLA. The initial professional learning workshop in April for School Coordinators was an important introduction to the SbD resources and assisted Coordinators to begin planning their "vision" for introducing SbD in their schools. The resources provided something tangible for School Coordinators to work with and for teachers to focus on. Because they were evidence-based, and there was a range of "entry points" through the CDs, the DVDs and the booklets themselves, the resources provided a coherent, flexible framework that appealed to teachers in different ways. The initial resistance from those teachers unwilling to deal with yet another new thing was allayed when they realised SbD wasn't all new and different but often affirming and reassuring of their current practice. The discussion amongst teachers around the resources helped to build the PLC.

Effective leadership within the school enhanced the PLA. Effective leaders were respected teachers able to see how individual teachers could be helped to embrace SbD.

Effective leaders were able to harness the talent within the school, had a clear vision of where they wanted to go and were able to plan how they were going to get there.

The SbD PLA benefitted from Principals whose support was visible, such as by attending SbD meetings, allocating additional time so that teachers could meet, and enabling the School Coordinator to have time release to deliver the SbD professional learning and assist novice teachers. This was particularly important in schools where there was limited meeting time or teachers were not co-located. External support from the SbD team was important to School Coordinators because it gave credibility to the project and validity to the Coordinators' efforts.

Factors that Inhibit the Implementation of the PLA

Finding time was the problem most commonly identified by School Coordinators and by teachers. Implementing change takes time and effort, and it was a major challenge for Coordinators to get teachers together for meetings so as to get a "critical mass" to begin moving forward. Some schools were able to use the SbD funding to buy time for staff to meet and this was beneficial. Coordinators believed that regular staff meetings were needed, at least every two weeks, to facilitate staff planning and communication. School Coordinators emphasised the importance of making best use of the time they had by ensuring that meetings had a specific goal so there was a sense of achievement when it was reached.

Coordinators believed that teachers needed to change their way of thinking about their teaching, and open their minds to the possibility that there are different and more effective pedagogical approaches. Changing pedagogical thinking requires ongoing reflection about teaching and student learning, so that learning, rather than teaching, becomes the focus of teachers' thinking about their practice. More progress towards the development of a PLC occurred in those science departments already functioning well, with communicative and friendly staff. In the small number that were not, interpersonal issues needed to be brought into the open and resolved before progress could be made.

How Can the PLA Be Improved?

The findings of this evaluation suggest that the SbD PLA is on the right track, and improving it requires enhancement rather than significant change.

The SbD teacher professional learning resources were accepted as containing valuable advice and suggestions for changing pedagogical practice. However they were differentially relevant to teachers with different experiences and motivation. Successful modules were those that contained a variety of concrete suggestions for improving practice that teachers could try and then reflect on the outcomes. Ideally, modules must be professionally produced, easy to handle, appealing to look at and desirable to use. Much of this has already been achieved.

Outcomes from the two curriculum modules were most effective when teachers read the materials and planned their lessons according to students' needs. The curriculum resources are important ways to support inquiry-based teaching and learning, and the complementarity between the content and structure of the curriculum resources and the pedagogical approaches inherent in the professional learning resources must be maintained. Further, teachers appreciated the availability of some content electronically and made good use of it, such as by using interactive whiteboards. The high production quality of the student materials was recognised and appreciated by teachers and by most of the students.

The introductory workshop was critical to the successful take up of the SbD program. The coverage was comprehensive and the concepts challenging, but there was time for discussion and reflection. Free time, when people are all accommodated in the same place, is effective in promoting reflection. More advance information about the focus in the SbD program on professional learning rather than student curriculum resources, could help teachers arrive well prepared for the initial workshop. Although expensive, it would be beneficial to involve two teachers from each school in the introductory workshop.

Visits by the SbD team and their availability by phone and email were appreciated by School Coordinators. School visits are an expensive part of the PLA, but during a trial period visits are essential. It may not be feasible to consider intensive visits as a necessary part of a much larger roll-out, however online and telephone support should be continued. Some of the supporting benefits of team member visits could be achieved if there were to be designated Departmental officers trained and available for support. Additional professional learning workshops would also be beneficial, perhaps locally based to ease cost.

Recommendations

The following recommendations are made on the basis of how SbD was implemented during 2010 and should be interpreted in that context.

Recommendation 1

Professional learning workshops assist teachers to become familiar with the concept of a professional learning community and the SbD resources, and enables them to begin planning the introduction of Science by Doing in their school. The introductory workshop must be continued with consideration giving to involving more than one person from each school. Consideration should also be given to an additional workshop, perhaps locally based, after one or two terms to consolidate progress.

Recommendation 2

Introductory material for the initial professional learning workshop should be reviewed to ensure that principals and teachers become cognisant of the professional learning focus of SbD and the overall structure of the program.

Recommendation 3

The teachers' professional learning resources are the backbone of the SbD professional learning approach. There should be some revision of content to maximise flexibility and appeal to teachers with variable levels of experience. The following should be considered:

- *Additional modules that focus on specific issues, such as dealing with students with cultural differences.*
- *The production of a module for laboratory technicians.*
- *The production of a module relating to the development and characteristics of a PLC.*
- *The placement of an overview flowchart or guide to the suite of resources in the end papers of each module.*

Recommendation 4

Some revisions to the student resources are required and these should be made in the context of feedback from the teachers who used them. The focus on inquiry-based learning should be maintained. Ensure that revised, and any new, resources link clearly to the Australian Curriculum: Science.

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Evaluation of the Science by Doing Stage One Professional Learning Approach, 2010

Background to the Science by Doing Stage One Project

The Science by Doing Stage One project is a national initiative for the improvement of secondary science education. It is managed by the Australian Academy of Science (AAS) and funded by the Australian Government. The Science by Doing (SbD) project is built around a Professional Learning Approach (PLA) that focuses on the development, in school science departments, of Professional Learning Communities. The SbD definition of a professional learning community (PLC) is consistent with that of Bolam et al. (2005), namely

An effective professional learning community has the capacity to promote and sustain the learning of all professionals in the school community with the collective purpose of enhancing student learning. (p. iii)

The SbD project took the view that the most effective and self-sustaining approach to professional learning in science is undertaken by the science teachers and science support staff within a school. This would be facilitated through the leadership of a Science Coordinator, likely to be the Head of Department. To assist the development of a PLC within a school's science department, SbD developed and implemented a comprehensive approach to teachers' professional learning.

The SbD Professional Learning Approach

Extensive research indicates consensus that teacher change involves considerable effort, is a complex process, and needs significant time and support for the effects to become noticeable (see, for example, Guskey, 2002). Supporting the development of a PLC in a school will require a carefully constructed, but easily understandable, approach to teachers' professional learning. Considerable work by the SbD team resulted in the development of a schema for a PLA. The schema is based on work by Bolam et al. (2005), who explored the experiences of PLCs in schools. They concluded that

An effective professional learning community (EPLC) fully exhibits eight key characteristics: shared values and vision; collective responsibility for pupils' learning; collaboration focused on learning; individual and collective professional learning, reflective professional enquiry, openness, networks and partnerships; inclusive membership; mutual trust, respect and support. (p. i)

Further, Bolam et al. concluded that

PLCs are created, managed and sustained through four key operational processes, optimising resources and structures, promoting individual and collective learning, explicit promotion and sustaining of an EPLC, and leadership and management. (p. i)

The SbD Team operationalised these key characteristics into the more readily accessible schema shown in Figure 1, which is taken from the *Science by Doing Professional Learning Approach* brochure (AAS, 2010). The Bolam et al. (2005) findings were also used in the design of the evaluation tools.

How will the PLA work in practice?

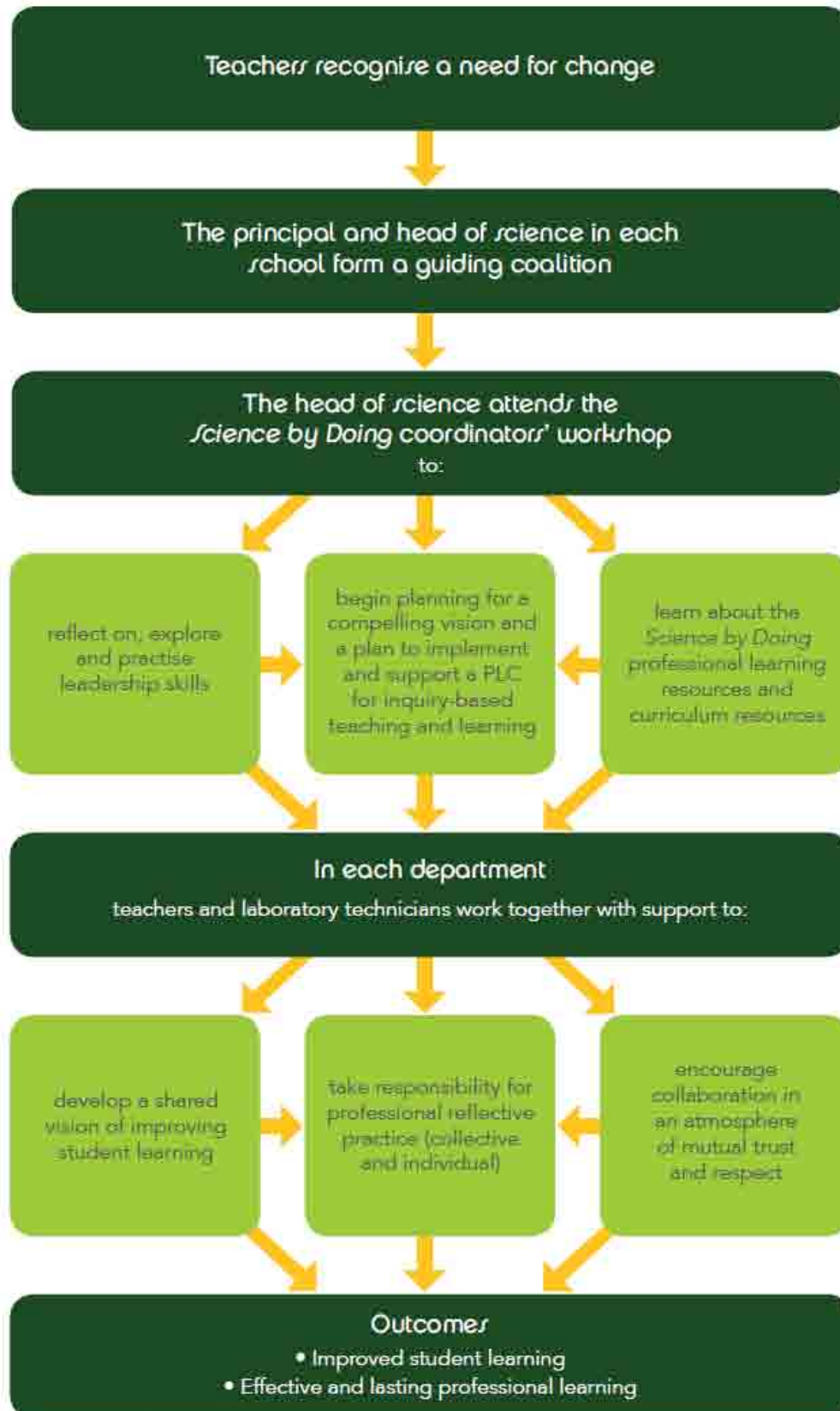


Figure 1. The Science by Doing Professional Learning Approach (AAS, 2010)

The SbD PLA was implemented in a national trial during Terms 2 and 3 in 2010. Two kinds of resources were prepared for this trial: The professional learning resources consisted of five modules (*Leading for Change*, *Inquiry-based Teaching*, *Assessment*, *Student Learning* and *Effective Questioning*), each of which comprised a succinct but comprehensive booklet of supporting information, a DVD showing modelling of the targeted topic/pedagogy and a CD-ROM designed to enable teachers to explore and practise the relevant skills. The curriculum resources consisted of five booklets: a content topic, entitled *Enough Water Fit for Drinking*, and a topic to promote student investigation, entitled *Doing Science Investigations*, each of which had a student workbook and a teachers' guide; and a step-by-step guide to inquiry, entitled *Inquiry DIY Guide*.

Schools were invited to participate in the SbD trial late in 2009 by completing an expression of interest form. This required school principals to describe their school's population, explain their interest in SbD, and describe the strengths of their nominated School Coordinator. The Principal's signature confirmed the commitment of the school to the project. A total of 28 schools was selected to ensure diversity in terms of geography, size, type and student composition. At least one school was involved in every state and territory.

The two banks of resources were introduced to the chosen School Coordinators during a 3-day workshop April 7 – 9, 2010. Teachers were asked to use at least three of the professional learning resources and to have at least one class use each of the curriculum resources over the two-term trial period. During these two terms, a SbD team member visited each school two or three times to offer support. At the end of the trial, a synthesising, end-of-trial workshop was held on October 14, 2010. Thus, overall, the PLA comprised four components, the professional learning resources, the curriculum resources, the professional learning workshops and the support of the SbD team during the trial. In addition, each participating school received a support fund of \$1,000 for the implementation of SbD.

Design of the Evaluation

The evaluation was designed to assess the outcomes of the SbD PLA during the trial period. It was focused on four questions about the SbD PLA, namely,

- a) how successful is the PLA in improving pedagogical practice?
- b) what factors are important in enhancing the PLA?
- c) what factors inhibit the implementation of the PLA?
- d) how can the PLA be improved?

A mixed method design was used to collect both qualitative and quantitative data using surveys, field notes and interviews. These were framed in the context of the Bolam et al. (2005) model of an effective PLC, as adopted by the SbD PLA. Data collection occurred in three stages, associated with the initial professional learning workshop, a number of school visits, and the final professional learning workshop. Ethics approval for the project was granted by Curtin University (Approval Number RD-28-10) and ethics approval was sought and obtained from the relevant government department within each of the four states where visits occurred.

Stage One: Professional Learning Workshop, April 2010

A two-part survey was used to evaluate the effectiveness of the initial Professional Learning Workshop (PLW) and to provide baseline data for the progress of the school science staff towards becoming a PLC. A copy of the program for the initial PLW appears as Appendix 1.

Part A was completed by School Coordinators at the beginning of the initial PLW, and collected data about the amount and use of time devoted to science staff meetings, School Coordinators' estimation of the developmental stage of their science department as a PLC, and the School Coordinators' expectations of the PLW. A copy of Part A appears in Appendix 2.

Part B was completed at the end of this PLW, and acquired data about how well the School Coordinators' expectations of the PLW were met, the impact of the PLW on School Coordinator's enthusiasm about participation in SbD, their ratings of a number of indicators of an effective PLC (based on the SbD PLA model and the Bolam et al., 2005 work on an effective PLC), their expectations of the task ahead, and their ratings of the effectiveness of the PLW. A copy of Part B appears in Appendix 3.

The evaluator attended the full workshop and made field notes about the activities and discussion amongst participants.

Stage Two: School Visits

School visits were used to collect data about the progress of development of the PLCs in the science departments of each school. Permission to approach schools was obtained from all relevant Jurisdictions and times for visits were negotiated with the School Coordinator (through the Principal). Visits were progressive through late in Term 2 and during Term 3. In total, nine schools were visited in four states.

Data were collected by semi-structured interviews with the School Coordinator, occasionally the Principal and as many staff as possible according to the time of the visit and availability of staff at the school. Interview questions were focused on these areas:

- the processes (optimising resources, promoting professional learning – individual and collective, and leading and managing) and the three outcomes (student learning, professional learning, and shared understanding of the PLC) of the Bolam et al. (2005) model of an effective PLC.
- the challenges experienced by School Coordinators and teachers and how they were overcome (or not).
- School Coordinators' and teachers' overall satisfaction with progress towards a PLC in their science department.
- teachers' and School Coordinators' perceptions of any changes in students' engagement and attitudes towards learning, and their actual learning.

Interviews were held with each School Coordinator, a total of 31 teachers and 5 principals (principals in other visited schools were either absent or otherwise unavailable during the time of the visit). Copies of the interview questions for School Coordinators and teachers are included as Appendix 4.

Stage Three: Survey at Final Professional Development Workshop

The final survey was administered to all School Coordinators at the beginning of the final PLW. The program for this one-day workshop appears in Appendix 5. The final survey had two purposes. First, it sought information for comparison with data obtained in Stage One using the initial PLW surveys in order to determine progress in the development of a PLC. In particular, this included the amount and use of time devoted to science staff meetings, the School Coordinators' ratings of a number of indicators of an effective PLC, their estimation of the stage of the science department as a PLC and their reasons for this.

In addition, the final survey collected data about the School Coordinators' perceptions of the relative importance of aspects of the PLA in helping them to implement a PLC in their science department, the inhibiting and facilitating factors that affected their implementation of the PLC, their perceptions of any changes in students' learning, their plans for next term and any advice they may have for the SbD team. A copy of the final survey is included as Appendix 6.

As for the initial workshop, the evaluator attended the final workshop and made field notes about the activities and discussion amongst participants.

Data analysis

Data were analysed and reported by aggregating across schools or teachers within schools. It was not intended that schools or teachers would be identified by name in data reporting. Quantitative data obtained through rating questions were amalgamated and displayed using descriptive statistics in tables and/or graphs, as appropriate. Where direct comparisons between perceptions at the initial and final workshops could be made, such as changes in rating of progress towards developing a PLC, tests of statistical significance were made and effect sizes calculated. Qualitative data from responses to open-ended survey questions and interviews were read carefully and ideas and concepts clustered to prepare syntheses of views obtained.

Findings from the Initial Workshop Survey

The three-day professional learning workshop for the 28 School Coordinators participating in the SbD Project was evaluated with a two-part survey. Part A, administered in the opening session, aimed to determine the extent to which participants considered that their science staff worked together as a professional learning community. Part B was completed at the end of the workshop, was longer and obtained participants' views of the value of the workshop, the nature of the professional practice amongst teachers within the science staff, and their expectations for the task that lay ahead. The following overview documents the findings of the workshop evaluation. A copy of the program for the workshop appears in Appendix 1, Part A of the Survey in Appendix 2, and Part B of the Survey in Appendix 3.

Part A: Survey in Opening Session

Staff meeting time

To gain an impression of the usual formal communication amongst science staff at their school, participants were asked, "On average, how many hours would your Science Department meet each week?" and to make any explanatory comment they thought was necessary. The average meeting time was 51 minutes, but it ranged from 12 minutes (calculated from one 2-hour meeting per term) to 2.5 hours. However, these times refer only to formal meetings, and 14 of the 28 participants mentioned that teachers met frequently but informally and also communicated by email. It seems reasonable to conclude that the average effective meeting time exceeds 51 minutes.

Participants were asked to estimate what proportion of meeting time would likely be devoted to each of four kinds of activity. As the results in Figure 2 reveal, about 45% of time, on average, is spent on administration and around 40% on issues relating to curriculum and pedagogy, with the remainder spent dealing with other issues.

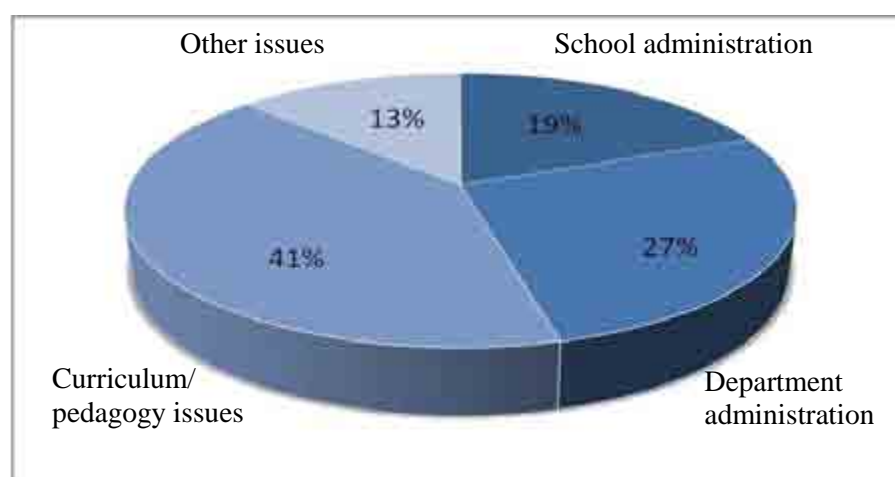


Figure 2. Allocation of Time Spent During Staff Meetings

Professional Learning Community

School Coordinators were asked to rate the extent to which their science staff worked as a professional learning community. At this early stage, participants might not have been familiar with this term so the SbD definition from Bolam et al. (2005) was provided, as follows:

An effective professional learning community has the capacity to promote and sustain the learning of all professionals in the school community with the collective purpose of enhancing student learning.

Participants were asked to consider **their** Science Department in terms of this description and to choose which of four statements fit best. Table 1 shows each statement and the number of participants who chose it. None chose the most complete definition of a professional learning community (level 3), but two ticked between the top two levels and are included in the 11 participants (39%) choosing level 2, “a developing professional learning community”. Half of the participants chose level 1, “beginning the journey towards a professional learning community” (including one who ticked between this and the level above). The remaining three participants chose “not yet started to become a professional learning community”, including one participant who left the workshop early.

Table 1. Participants’ Ratings of Their Science Department

Level	Description of Science Department Level as a Professional Learning Community	Number Selecting (n= 28)
3	A mature, well-established professional learning community	-
2	A developing professional learning community	11
1	Beginning the journey towards a professional learning community	14
0	Not yet started to become a professional learning community	3

Participants were asked to provide further comment or explanation for their rating of their science department. Varied comments were offered, but there were several common themes. The first was the range of teacher experience in the school. Many schools had a mix of teacher experience, ranging from very experienced teachers to relatively fresh graduates, who needed to “find their feet” as teachers. A second theme related to teacher turnover, as new staff, even if experienced, still needed time to become used to a new school environment. A third theme, more common amongst the schools with well-established staff, was the recognition that things could be done differently, and better. In some cases the stimulus for this thinking was a new Head entering a mature, established faculty. In other schools it was a revitalization of thinking in the light of impending curriculum change, or a realization that students were not achieving their full potential. Participants who rated their professional learning community highly often made comments about a current communicative, cooperative staff, even if it included new comers. One of the two participants who viewed their department as “not yet started” was in a newly established school and the other was in the midst of coping with major curriculum change and staff were time poor.

In sum, Table 1 indicates that there is considerable opportunity for the Science by Doing Stage One project to assist science staff to develop a professional learning community.

Expectations from the Workshop

The final question on Part A of the survey asked participants what they hoped to gain from the workshop. Their written responses were grouped into seven clusters of expectations, ranked in Table 2 according to frequency of response. The most common hopes were student-focused, related to benefiting students through new ideas, new resources and more exciting ways to teach. The next three clusters were more teacher-focused, relating to teachers’ professional learning, change management to a more productive teaching and an understanding of what SbD is about. Three participants were looking forward to net-working opportunities to meet like-minded teachers. Two participants referred to support for science in light of the national curriculum, or for working science into the school curriculum.

Table 2. What Participants Hoped to Gain from the Workshop

Nature of Response	Number Mentioning (n=28)
Ways to improve teaching to benefit students	12
Ideas/resources for teachers to use with students	11
Approaches to managing change in my department	8
Professional learning ideas for staff to develop skills	7
Better understanding of Science by Doing and how it will work	4
Meeting like-minded people	3
Support for science curriculum development	2

Note: Some participants noted more than one expectation, so total exceeds 28.

Part B: Survey at Conclusion of Workshop

Meeting Participants’ Expectations about the Workshop

The first question on the second part of the survey asked participants whether their expectations from the workshop were realized and to explain their response. The responses, shown in Table 3, were very positive, with 25 of the 27 remaining participants (one had left early) reporting that their expectations had been met and most indicating that they were exceeded.

Nearly half of the participants (13 of 27) remarked on the high quality of the resources they had received, rarely distinguishing between resources for students and resources for professional learning. Eight participants referred to their hopes of working positively with their staff to develop a professional learning community and seven commented on clarity of understanding the purpose of SbD. Three commented on their

ability to network, and five made other comments. Two appreciated the time given to familiarize themselves with the resources, one felt daunted by the task ahead, and one had hoped to get further with his own plan of action. Finally, one participant commented that there was a greater emphasis on skills to develop a professional learning community than on science inquiry, but it wasn't clear whether or not this was considered to be a good thing.

Table 3. Meeting of Participants' Expectations from the Workshop

Nature of Response	Number Mentioning (n=27)
Yes, expectations met or exceeded	25
Great resources	13
Looking forward to developing a professional learning community	8
Science by Doing and professional learning community aims clear	7
Networking with others	3
Other comments	5

Note: Some participants gave more than one reason, so total exceeds 28.

Effectiveness of the Workshop

Participants' views of the effectiveness of the workshop were determined through a series of seven items about the workshop and its outcomes for them. Each statement was rated on a scale of 1 (low) to 5 (high) and the results appear in Table 4.

Table 4. Participants' Views of the Workshop Presentations

Learning Experience	Participants' Ratings (n=27)					Mean Rating
	1	2	3	4	5	
a. The delivery of the workshop sessions modelled the inquiry process	1	1	3	19	3	3.8
b. The workshop sessions assisted me to develop a plan of action for establishing and supporting a PLC	-	2	8	14	3	3.7
c. The workshop sessions enhanced my understanding of inquiry-based teaching and learning.	-	4	1	9	13	4.1
d. The workshop sessions enhanced my understanding of the Science by Doing project and its resources.	-	-	1	6	20	4.7
e. The pace of learning suited my needs.	-	2	4	17	4	3.8
f. My own views and attitudes were valued.	-	-	1	13	13	4.4
g. My confidence in using inquiry-based teaching was enhanced.	1	1	3	12	10	4.1

Table 4 shows that participants ascribed high value to the workshop presentations, with means close to 4 on the 5-point rating scale. The highest mean (4.7) revealed enhanced understanding of SbD. Other high means, all over 4, indicated that participants believed that their own views and attitudes were valued, and their understanding and confidence about inquiry based teaching and SbD were enhanced. The lowest mean (3.7) was for the most difficult outcome: developing a plan for establishing their own professional learning community.

Questions asking participants to rate their enthusiasm for science by doing before and after the workshop indicated that there was a significant enhancement, with a mean score increasing by a whole unit on the 5-point rating scale, from 3.8 to 4.8. The results are shown in Table 5 and graphed in Figure 3, which shows clearly the increase in enthusiasm at the end of the workshop.

Table 5. Participants' Enthusiasm Before and After the Workshop

How enthusiastic were you about the Science by Doing Professional Learning Workshop?	Participants' Ratings (n=27)					Mean Rating
	1	2	3	4	5	
a. before your participation?	-	1	7	14	5	3.8
b. after your participation?	-	-	1	3	23	4.8

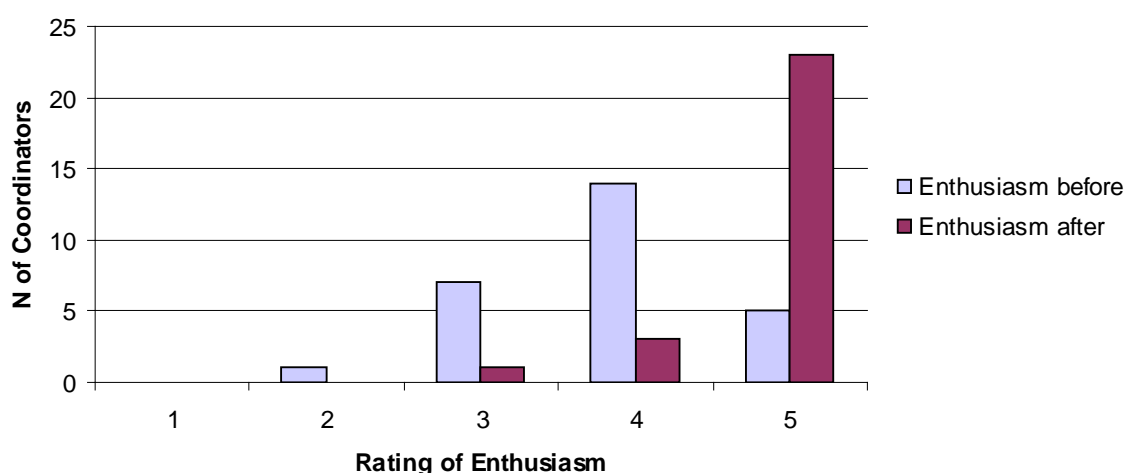


Figure 3. School Coordinators' Enthusiasm Before and After the April Workshop

Communication and Cooperation in Their Science Department

As a means of establishing a baseline picture of the participants' perceptions of various aspects of the current functioning of their science department, participants were asked to rate 15 statements on a 10-point scale. These statements were designed to reflect indicators of a PLC (Bolam et al., 2005) that could assist to measure changes at the end of the trial period. The statements and participants' ratings of them are reported in Table 6. Although the table is rather complex, it seems appropriate to report the data fully, rather than

collapsing it to create a more simple table. To assist discussion, the statements are listed in descending order of the mean rating, whereas they were randomly ordered in the survey.

Table 6. Participants' Ratings of Aspects of Their Science Department

Science teachers in my school (n=27)	Not very often										Almost always	Mean rating
	1	2	3	4	5	6	7	8	9	10		
1 Discuss ways to help students learn more effectively	-	-	-	2	4	5	6	7	-	3	6.9	
2 We feel valued, trusted and respected by the other science teachers	1	-	1	2	2	4	7	3	5	2	6.8	
3 Share a common set of values about student learning	-	-	1	5	2	1	10	4	3	1	6.6	
4 Analyse and discuss assessment strategies	-	-	3	1	2	6	8	3	-	4	6.6	
5 Create contexts to promote student confidence to learn	-	1	2	1	4	8	6	3	1	1	6.1	
6 Share their pedagogical successes and failures	-	2	1	4	2	3	9	3	2	1	6.1	
7 Take collective responsibility for student learning	-	1	1	5	5	2	7	5	1	-	5.9	
8 Take responsibility to enhance our own professional learning	-	1	1	3	9	4	3	4	2	-	5.8	
9 Include lab technicians in our discussions and decision-making	1	3	4	1	1	1	8	3	2	2	5.8	
10 Have opportunities to take leadership roles	-	1	-	5	8	3	8	2	-	-	5.6	
11 Share a common vision about where our department is heading	-	3	4	3	4	3	4	3	2	1	5.5	
12 Share a common vision about leadership	-	1	-	10	4	4	6	2	-	-	5.3	
13 Seek and use feedback from students to improve our teaching	-	1	2	6	6	6	4	1	1	-	5.3	
14 Work in partnerships to teach more effectively	-	5	3	3	1	7	3	2	2	1	5.3	
15 Try to observe each other teaching to improve our own practice	7	7	6	2	4	1	-	-	-	-	2.7	

The results in Table 6 reveal an unsurprising picture. All but one of the means are 5.3 or above, which is somewhere around the midpoint (5.5) of the rating scale. The low mean (2.7, statement 15) relates to the frequency of teachers observing each other, something for which teachers rarely have time, or are given encouragement, to do. The second highest

mean of 6.8 (statement 2) indicates that, on average, there is a strong degree of mutual trust amongst the teachers within most participants' science departments. Note, however, that the ratings ranged from 1 to 10.

The other five means above 6.0 are for statements relating specifically to student learning; ways to help students learn (statement 1), sharing values about learning (statement 3), assessment strategies (statement 4), student confidence to learn (statement 5) and teachers sharing pedagogical successes and failures (statement 6). Perhaps this is not surprising, as dedicated teachers put high value on doing their best for their students.

The next set of means, between 5.3 and 5.9, inclusive, relate more to teachers themselves. They refer to taking responsibility for student learning (statement 7), their own professional learning (statement 8), including laboratory technicians in decision making (statement 9), and three statements related to leadership (10, 11 and 12). Finally, there are two statements about using student feedback (statement 13) and working in partnerships (statement 14) to improve teaching.

Even bearing in mind that these clusters of means are not far apart and there is a wide spread of responses to most statements, the results suggest that teachers give more importance to their teaching and student learning, than to their own development and ways that they can use information, such as student feedback, to reflect on their practice and find ways to improve it. In turn, this suggests that the SbD project has considerable scope to facilitate an improvement in these indicators of science teachers' sharing and working together to build a professional learning community.

Expectations Beyond the Workshop

Participants were asked to indicate how easy they expected their task of implementing the aims and resources of the Science by Doing Stage One project back in their schools. Table 7 reports the responses to three statements relating to their expectations. The results show that participants felt quite confident about using the student-based curriculum responses, but less confident about the professional development resources, and least confident about how easy it would be to develop a professional learning community. This set of responses is very understandable, and quite consistent with the results in Table 6.

Table 7. Participants' Expectations Beyond the Science by Doing Workshop

How easy do you think it will be to	Participants' Ratings (n=27)					Mean Rating
	Not very easy		Very easy			
	1	2	3	4	5	
a. develop a professional learning community in your science department?	1	6	14	4	2	3.0
b. use the Science by Doing professional learning resources in your science department?	1	1	12	12	1	3.4
c. use the Science by Doing curriculum resources in your science department?	-	-	1	12	14	4.4

The Challenge that Lay Ahead

Moving a whole department is indeed a challenge. Participants were asked, in an open-ended question, what excited them most about the challenge that lay ahead. The responses were clustered into several groups and the results are reported in Table 8.

More than half of the participants (15 of 27) referred to the central tenet of the SbD workshop: developing a professional learning community. More than a third mentioned encouraging students to be more enthusiastic about and/or engaged in science. Ten participants referred to seeing more inquiry-based teaching, and four others referred more generally to improving the quality of teaching. Several of these teachers specified benefit to students through improved outcomes. Three teachers were looking forward to keeping connections with other schools and three mentioned using the new curriculum resources.

Table 8. What Excited Participants about the Challenge Ahead

Nature of Response	Number Mentioning (n=27)
Working with science staff to develop professional learning community	15
Encouraging students to be more enthusiastic/engaged with science	10
Teaching becoming more inquiry-based	7
Benefit to students through improved outcomes	5
Improve the quality of teaching	4
Continue relationships with others met during program	3
Using new creative curriculum resources	3

Note: Some participants noted more than one expectation, so total exceeds 28.

Improving the Science by Doing Workshop

The SbD Workshop was run over three days and the organizers were keen to determine which aspects of the Workshop were most valued by participants, and which might be dropped if the program were run over two days instead of three. Participants were asked for their judgment on what should definitely be included and what could be dropped if the time were reduced to two days. There was a big range of responses to what should be retained, from “everything” to naming particular sessions, for example, the Quetacon visit was well-received. In terms of what could be left out, 12 participants either said “nothing” or left the space blank. Of the remaining 15, 7 felt the Botanic garden visit was unnecessary, and 6 suggested the panel discussion was not useful. Four participants thought that the three professional learning sessions could be condensed to two sessions, however, 6 others considered them all essential. Four participants considered the reflective practice session was not required. One suggested a shorter welcome session, and two suggested perhaps some of the resources could be sent out ahead for participants to view.

In sum, it seems that the workshop was appreciated by all of the participants, and possibly only one or two could suggest sufficient material to be dropped so that it lasted just two days. One remarked that “all was needed but the days were long enough”.

Reasons for the Success of the Science by Doing Professional Learning Workshop

The findings from the surveys that refer to participants’ enjoyment and perceived value to them of the workshop are summarized in several tables. Table 2 reports what participants hoped to gain from the workshop and the contents of that table indicate that their hopes were met or exceeded. Table 5 shows that participants’ enthusiasm about SdD was enhanced by their workshop experiences. Further, when asked what could be left out of the workshop if it were to be shorter, nearly all participants had very little to suggest, indicating that all aspects (except perhaps the Botanic Garden visit) were considered essential. All of these findings confirm that participants thought the Workshop was successful and found it a valuable experience.

Most telling, however, were participants’ views of the workshop presentations, reported in Table 4. These were very positive overall and hold the key to understanding the success of the workshop. This can be explained in the context of seminal work by Loucks-Horsley, Love, Stiles, Mundry, and Hewson (2003), who teased out the key characteristics of effective professional development. The first three characteristics are that effective professional development “is driven by a well-defined image of effective classroom learning and teaching, provides opportunities for teachers to build their content and pedagogical content knowledge and examine practice, [and] is research-based and engages teachers as adult learners in the learning approaches they will use with their students” (p. 44). The findings in Table 4 show that the workshop delivery was perceived to model the inquiry process (a well-defined approach to effective teaching), and participants’ understanding of, and confidence in using, inquiry-based teaching were enhanced. They understood more about the SbD project and its resources, thus building their pedagogical knowledge, and they felt that their views and attitudes were valued, so they were respected as adult learners.

Loucks-Horsley et al. (2003) also identified that effective professional development “provides opportunities for teachers to collaborate with colleagues and other experts to improve their practice, [and] supports them to serve in leadership roles” (p. 44). The Workshop provided considerable opportunities for structured, as well as informal, networking amongst participants, and Table 4 shows that they believed that they were assisted to develop their plan of action to develop a professional learning community (item b). These findings suggest that they were supported to improve their practice and serve as leaders in their departments.

In sum, these findings directly reflect five of the characteristics of effective professional development. Whether or not the promise of a successful workshop is fulfilled would be determined by the outcomes in the following months after participants returned to their schools.

Findings from School Visits and Interviews

Schools were visited for two reasons; first, to interview the SbD Coordinators about their perceptions of progress, and second, to talk to the teachers who were using the SbD resources and who, unlike the Coordinators, had not attended the professional learning workshop. Further, if Principals were available to meet, then their support for the project might also be assessed. During Terms 2 and 3, but mostly late in Term 3, nine schools in four states were visited. Four were inner city schools, three were located in suburbs, and two were in rural areas. During visits, discussions were held with all nine coordinators (seven of whom were also head of science), five principals (three others were absent and one unavailable on the day of visit) and a total of 31 classroom teachers.

Interview questions for both teachers and coordinators were prepared and sent to the schools prior to the visit. Copies of these questions are available in Appendix 4. Interviews were carried out as informally as possible, allowing interviewees to discuss the topics that were important to them, while also ensuring that answers were obtained to the key questions. These were focused on four issues, the use of the SbD resources in developing a professional learning community, challenges experienced, satisfaction with progress, and perceptions of changes in students' engagement and attitudes towards learning. In the following sections, teachers' ideas about each of these four foci are described. It is important to note that all schools were unique; each had its own context and ways of teachers working together and implementing SbD. The following descriptions are based on information obtained only from the schools visited and thus may not be representative of all schools.

Using the SbD Resources to Develop a Professional Learning Community

During the PLW in April, School Coordinators were introduced to the SbD teacher professional learning resources and student curriculum resources. To fulfil the requirements of the SbD Stage One project in Terms 2 and 3, School Coordinators were challenged to introduce three professional learning resources, to have at least one class do the unit *Enough Water Fit for Drinking*, and at least one class to use the *Doing Science Investigations* booklet. Further, teachers who were not using either of the curriculum resources were to be asked to teach at least two inquiry lessons using the *Inquiry DIY Guide*. None of the schools visited was able to achieve these targets. All were able to meet the target for the curriculum resources; most had more than one class doing each unit, and all but one school used at least one of the teacher PL resources.

Implementing the SbD resources involved three key issues for School Coordinators. First, time had to be found for staff to meet together so that they could be introduced to the SbD resources. Second, there needed to be a (preferably consensual) plan for the choice and implementation of both the professional learning and curriculum resources. Third, there needed to be a mechanism to ensure continuing commitment to the implementation. School Coordinators addressed these issues in different ways.

Organising staff meetings

Considerable creativity in finding sufficient time to meet was required by the School Coordinator in some schools. Two Coordinators tried to introduce a professional learning resource module at a usual staff meeting but found time far too short to be effective. Instead, most School Coordinators held dedicated meetings after school; "when teachers were tired

so I had to be bright”, as one Coordinator put it. The most effective solution, received very positively by staff in those schools, was to take an afternoon, off campus, and use some of the SbD funding to provide catering for the staff. This enabled sufficient time to introduce a resource, view some of the DVD and/or CD, and discuss various aspects of the resource.

Choice of resources

Five schools started with the *Effective Questioning* resource, and three with *Inquiry Based Teaching*. It seemed that *Effective Questioning* was the more successful, because it gave specific, practical skills that teachers could observe and quantify, such as the type of question asked, cognitive level, length of wait time, and tips that teachers could try, such as the flip cards and use of pop-sticks. At all schools where time had been spent on this module, teachers were able to recount ways they had made use of these strategies, or had become more aware of and reflective about their use of questioning. In three schools, classroom observations with a focus on recording about questioning had occurred, and there were plans to do this in other schools. There was also recognition that questioning was a cross-curricular skill, and two schools were planning to use the module for whole school professional development. One teacher appreciated the idea of teachers watching each other, likening it to clinical observation, and said “you can define the focus of observation, give feedback and if you have some measurement to reflect on, you know what to do and therefore what needs to change”.

Working with *Inquiry-based Teaching* seemed to be less fruitful, not because its implementation was less focused, but because its content was less “quantifiable”. Further, much of it was familiar to teachers. As one third year out teacher noted, the “skills are relevant and straight from Uni 101”. Another felt “a feeling of repetitiveness for where teachers are at”.

The third most used resource was *Assessment*, which at least the School Coordinator had looked at in some detail. At one school it was passed over due to its familiarity, but others were looking forward to tackling it in Term 4, and hoped to be able to improve their end-of-year assessments. In another school, the head of science was working his way through the *Leadership for Change* module. He was in his first year of this position, was not the School Coordinator, and reported he was finding it very useful.

The familiarity of content in the professional learning modules was a two-edged sword. On one edge, the positive outcomes were that the skills were recognised as beneficial and indicative of exemplary pedagogy. More experienced teachers, sometimes reluctant to get involved, became more favourable disposed towards SbD when they recognised they were using at least some of the espoused skills. One Head of Science noted that “experienced teachers are sometimes negative, they don’t know what IBT is, then recognise it as what they do. It is a reawakening, a validation of their own practice”. Teachers and School Coordinators used phrases such as “reaffirming practice”, “refreshing skills”, “revisiting and reflecting on good teaching”. But on the other edge, some teachers felt a bit insulted. At one school, the School Coordinator reported that teachers did not look at *Student Learning* “because it looked very primary school. They didn’t believe it would work with teenagers”. Even so, this Coordinator and a colleague were trying out cooperative learning in their classrooms where students were engaged in *Doing Science Investigations*. One young teacher summed it up: “It’s a difficult balance, it’s a lot like best practice as in my training, but for other teachers it is like teaching them to suck eggs.”

Ensuring continuing commitment

The April professional learning workshop occurred just before Term 2 and many school timetables already had been set for Term 2. Consequently, after two terms of trial period, some schools had experienced SbD for only one term, because there was insufficient flexibility remaining in Term 2 planning, especially for use of the curriculum resources. School Coordinators in the eight schools visited that were actively implementing the professional learning resources had plans to continue through Term 4, and into 2011. Tempering the expectations for 2011 for some schools was a lack of knowledge about who would remain on staff. This is not a SbD issue; it is a real school issue that impacts negatively on forward planning for department heads as well as those teachers whose position is not permanent. For Term 4, however, all School Coordinators had plans in place to continue with implementation of the professional learning resources, either beginning a new module, or consolidating skills with the module(s) they were currently addressing. All were aware of the need for continuity, “keeping things on the boil”, as one Coordinator put it. She had made the flip cards for assisting questioning for use by other teachers as one means of keeping teachers focused.

Challenges Experienced in Developing a Professional Learning Community

The two most important factors affecting the implementation of the SbD project were the quality of professional relationships amongst staff within the science department and the ability to find time for staff to meet and work together. A third factor related to administrative matters that interfered with teachers’ teaching and planning.

Professional relationships

In seven of the nine schools visited, staff relationships were positive and professional. In the smaller schools, particularly in the rural schools where staff turnover was low, staff knew each other very well, were supportive of each other and comments were made such as, “we get on, we don’t put each other down” and “the culture is non-threatening in this school”. In larger schools, staff were also friendly and supportive but it seemed easier for one or two teachers to sit back and take little action in relation to the SbD professional learning resources, although some were active in using the curriculum resources.

The eighth school was large, staff were very friendly and supportive but the middle school teachers and the senior school teachers were in separate buildings and never timetabled to meet. The middle school science teachers had no timetabled meeting time, although the senior school teachers did. Fortunately, the SbD School Coordinator, who was a very experienced teacher located in the middle school, had some time release allowing visits to the senior school, including their staff meetings, where the SbD resources could be introduced and assistance provided to teachers who needed it. Although two senior teachers ignored the SbD resources, relationships amongst staff were still comfortable.

The ninth school was attracted to SbD as a means of promoting the development of a PLC amongst the science staff, and the School Coordinator (and several other teachers) were enthusiastic to begin implementation. However, progress was blocked by the actions of one staff member actively antagonistic towards SbD. This meant that relationship problems had to be addressed as a priority to prevent the department from becoming dysfunctional and SbD was shelved for the trial period. Although disappointed by the lack of progress, the

Coordinator felt that there “were a lot of positives” in terms of sorting out the professional relationships, and that there was a good prospect for some progress to be made in Term 4, and certainly in 2011. Several other staff were very keen for this to eventuate.

Time for staff to meet

Teachers at every school reported insufficient scheduled meeting time for science staff. While some schools had regular weekly or fortnightly meetings, many of these were devoted to general staff matters, rather than enabling subject staff to meet. In some large schools, staff committee meetings focused on whole-school issues, and subject staff were timetabled to meet only once or twice a term. Here, reports back about school issues took time away from science staff being able to talk about science teaching and learning. Further, teachers found that even scheduled subject-based meetings were apt to be “taken over” by whole-school issues unrelated to teaching science. Thus, although School Coordinators in several schools managed to wrestle some professional learning time and meet off campus, or after school, for several hours, there still had not been enough time to enable the amount of teacher interaction which School Coordinators considered adequate to progress the SbD project. In schools where Principals were demonstrably supportive of the SbD program, there was usually some additional time or increased flexibility to enable teachers to meet, or for School Coordinators to have a time fraction of relief to assist other teachers in implementing SbD.

Administrative matters

Several administrative issues imposed upon schools caused concern to teachers. In all schools, there was concern about the impending implementation of the national curriculum for science. At the time of visiting, the final version had not been released and although teachers had access to interim versions, there remained considerable uncertainty about what it would mean for program planning and where modules like the SbD curriculum resources might fit. Teachers foresaw a considerable time commitment in reworking their teaching plans. There were also state initiatives imposed on schools. For example, in one state, new standards for upper school subjects were being introduced and teachers were busy rewriting assessment materials for Years 11 and 12. In another, a pedagogical approach which matched the 5Es was being introduced. Whether or not these changes would eventually facilitate teaching was not at issue, for the moment, they were causing additional work for teachers and associated stress.

A further stress in one state was related to the way temporary teachers were frequently transferred between schools, resulting in some schools not knowing who their full staff would be in 2011. Of course, some teachers also did not know where they would be in the next year and wondered if the commitment they might make to SbD would be of any use in their next school. Such uncertainty makes forward planning difficult and is stressful for all staff.

Satisfaction with Progress

Although no school had met the challenge of implementing three professional learning resources during the trial period, as well as the student curriculum resources, many School Coordinators were satisfied with the progress they had made. Given the interruptions to planning, the limited time to meet and the other pressures on teachers, it seemed that the

School Coordinators had done as much as was possible in their own circumstances. Every school was different, and progress has to be judged in the context of those differences.

Progress was facilitated by a communicative staff. In one of the smaller schools, the School Coordinator considered that the teachers working together and observing each other was a noted success because it promoted discussion about pedagogy amongst them. As a result, the Coordinator thought that there was some change in teachers' dispositions.

At one large school, teachers thought the School Coordinator had a difficult job introducing SbD because there were so many teachers and so many things happening. They felt that this was where resistance came from, resistance that they considered was not deliberate, but rather a consequence of too many things being loaded onto teachers. Teachers in other schools commented on the amount of non-teaching things teachers had to do, and how this impacted progress in the introduction of something new, because teachers did not have time to concentrate on it. Further, teachers tended to focus on the curriculum resources, rather than the professional learning resources, because their first priority was their students. Over all, School Coordinators were cognisant of the difficulty of their task and the impediments to progress. Although some were unhappy with progress made so far, they recognised that two terms was a short time to instigate change, let alone embed it in all teachers' practice, and all were satisfied that the introduction of SbD was worthwhile and had plans to continue with its implementation.

Changes in Students' Engagement and Attitudes towards Learning

Every school had classes doing *Enough Water Fit for Drinking* and *Doing Science Investigations*. Teachers have provided detailed feedback about the student workbooks and teachers' guides to the SbD team. In this report, the focus is on the place of the curriculum resources in the SbD program, so specific comments about format and content are not discussed here.

In general terms, the curriculum resources were received positively by teachers and thought by them to have engaged students in ways that promoted learning. For example, one teacher stated,

students gained conceptual understanding and developed investigation skills through 'doing' science. Using the resources established positive attitudes towards hands on learning, academic engagement and effort. Students persevered in the face of challenges encountered during their investigations, took more risks, worked in teams and asked for assistance when needed. They learned skills that can be transferred to other areas at school and abroad, including self-motivation.

A teacher at another school noted: "no one lost their book – that's a good sign!"

Most teachers recognised that the professional learning resources and curriculum resources, although separate, were part of an overall approach, but many had difficulty in articulating the connection. Most recognised that the underpinning framework was inquiry-based teaching, and there were still a few who were not quite sure what that was. After working with one or other of the teacher modules, some were happy to think it was what they "were doing anyway". Whether or not they really were inquiry teachers was a moot point, with at least one School Coordinator expressing doubts about this. Such a view validates the importance of inter-teacher observation, and in two schools where an external "mentor", or "coach" visited the school and assisted in organising "study lessons" which were aimed at demonstrating particular pedagogical skills that other teachers could observe,

there seemed to be positive gains. More than half of the teachers interviewed were able to give examples of using some inquiry skills while using the curriculum resources. One teacher related that

Students have thoroughly enjoyed some of the new fun ways of me asking questions. I think the repetition of these each lesson for maybe only 10 minutes has attributed to fact memorisation. The change has occurred because it was fun. The quality of their prac reports is slightly improved due to the investigation planner. I conscientiously ask more open-ended questions.

Other teachers were trying cooperative learning techniques, with varying success, and a number were either introducing note-booking, or changing the ways that students used their notebooks, so that they became more valuable as a record for students and a means of formative assessment by teachers.

The importance of teachers' positive response to the curriculum resources should not be under-estimated. There is considerable research that emphasises that unless teachers can see that change in their practice will benefit students, they will not change. Guskey (2002), for example, propounds a model of teacher change indicating that change in teachers' beliefs and attitudes will not occur until teachers see a change in students' learning outcomes. There were signs in most schools visited that there were changes in student outcomes, although in many cases, final assessments had not been completed.

Findings from the Final Workshop Survey

The one-day concluding professional learning workshop for the School Coordinators was held on October 14, 2010, early in Term 4. It was attended by 27 of the 28 School Coordinators (one school sent a representative in place of the School Coordinator, and another school was unable to participate). The purpose of the workshop was to engage the School Coordinators in a debriefing session, during which information could be obtained about the overall success of the SbD trial, how the PLA could be improved, and what plans Coordinators were making for future involvement in SbD. A program for the workshop appears in Appendix 5. School Coordinators were asked to complete a survey, shown in Appendix 6, which was administered in the first session of the workshop. It aimed to determine the progress participants thought had been made towards developing a PLC in their department and their perceptions of how their science staff worked together as a professional learning community. Questions to gather this information were repeated from the April survey as a quantitative way to measure progress. In addition, a number of open-ended questions were asked about the factors which had challenged and assisted science coordinators and their staff to implement a PLC, their views of student learning, and what they intended to do next.

Staff meeting time during Term 3

School coordinators were asked, “How many hours did your Science Department meet during Term 3?” The average meeting time was 69 minutes per week, an increase of 18 minutes from April’s average of 51 minutes. Several participants mentioned that in addition to the formal staff meetings were some meetings devoted to SbD. One school that had four 1-hour meetings during the term managed an extra 14 hours for teachers to meet for SbD, but others had much less time. Several schools mentioned regular informal discussions before school, at recess, or during lunch time.

As in the initial workshop, participants were asked to estimate what proportion of meeting time was devoted to each of four kinds of activity: school administration, department administration, curriculum/pedagogy issues, and other issues. In April, participants had reported that, on average, the time spent on these four activities was 19%, 27%, 41% and 13%, respectively (see Figure 2). The results for this question in October revealed that these proportions of time were very similar, at 18%, 26%, 44% and 12%, respectively. However, several Coordinators pointed out that these estimations were for formal meetings only. School Coordinators were asked if the nature and purpose of their meetings had changed, and most noted a greater focus on curriculum and pedagogy, with several pointing out that the SbD resources were discussed at meetings additional to the usual staff meetings.

Overall, however, in 18 of the 27 schools, formal meeting time for science staff averaged an hour or less per week, and a bit over 40% of this was devoted to curricular and pedagogical matters. Without a further time allocation, this proportion was difficult to change. Progress on SbD, in most cases, had to be dealt with in additional meetings, if such were possible, and informal discussions during recess or lunch time.

Progress towards a Professional Learning Community

At the April Workshop, School Coordinators were asked to rate the extent to which their science staff worked as a professional learning community and this question was asked again in October. As before, the SbD definition was provided, as follows:

An effective professional learning community has the capacity to promote and sustain the learning of all professionals in the school community with the collective purpose of enhancing student learning.

At each workshop, participants were asked to consider **their** Science Department in terms of this description and to choose which of four statements fit best. Table 9 shows each statement and the number of participants who chose it at each workshop.

Table 9. Participants' Ratings of Their Science Department as a PLC in April and October

Level	Description of Science Department Level as a Professional Learning Community	Number Selecting April (n= 28)	Number Selecting October (n= 27)
3	A mature, well-established professional learning community	-	5
2	A developing professional learning community	11	15
1	Beginning the journey towards a professional learning community	14	7
0	Not yet started to become a professional learning community	3	0

In April, no school Coordinator chose the most complete definition of a professional learning community (level 3), but two ticked between the top two levels and are included in total for level 2, 14 participants chose level 1, and the remaining 3 participants chose “not yet started to become a professional learning community”, including one participant who left the workshop early.

Table 9 shows an improved position in October, with 5 School Coordinators indicating that their school had become a mature, well-established professional learning community, and 15 indicated a developing professional learning community, including 2 who indicated a point between levels 2 and 3. The remaining 7 schools were rated at level 1, including 2 who checked between levels 1 and 2. These results are very encouraging, and are depicted in Figure 4.

In written comments, participants explained why they thought their science department had changed, or not, as a PLC. There were 6 schools whose rating did not change, but generally a positive comment was made, for example, a Coordinator who rated the department at level 2 on both occasions wrote

During the past few months most faculty members have taken a more serious approach to reflecting on the teaching, discussing professional resources and presenting feedback about their use. This has been a positive improvement.

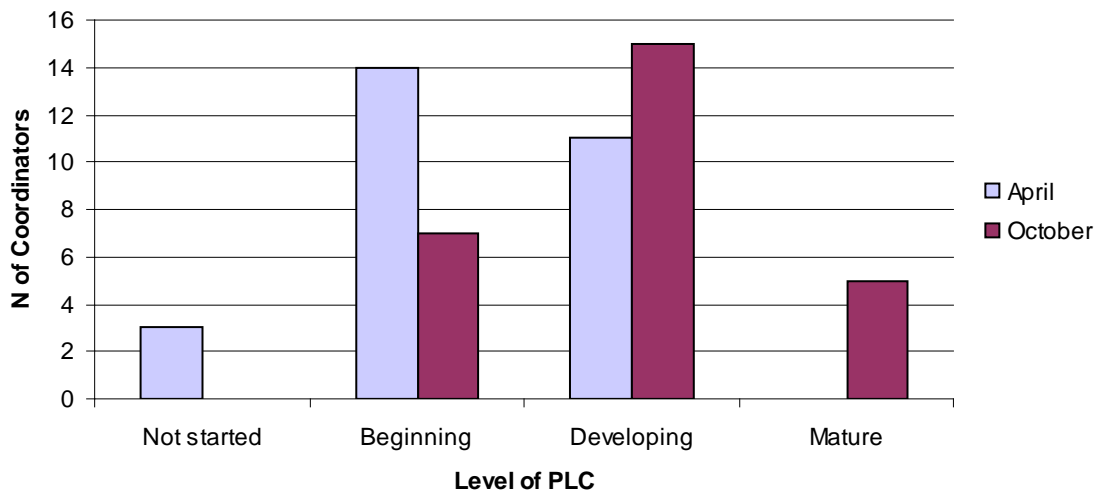


Figure 4. School Coordinators' Ratings of their Science Department as a PLC

One Coordinator who in October rated their department as level 3, wrote “much, much more discussion about specific classroom experiences and feedback on trying things discussed in the PLC unit just covered”. Another whose rating was Level 1 noted, “The department is now thinking more about professional learning where it did not happen before. Incidental conversations are also happening in the staff room”. In another school, the Coordinator wrote that the staff “can now see the benefit of learning discussions although [we] still struggle to find time for it”.

In sum, even in those schools where the ratings were not high, School Coordinators were able to make some encouraging comments.

Progress in Communication and Cooperation in the Science Department

At the end of the April Workshop, participants were asked to rate 15 aspects of their science department on a 10-point rating scale. These aspects were indicators of an effective PLC and were derived from the SbD PLA model and the work by Bolam et al. (2005). Table 6, presented earlier, reported the ratings given to those aspects ranked in order of the mean rating. School Coordinators were asked to rate these aspects again in October, as a way of measuring perceived change. Both the April and October ratings are presented here, in Tables 10 to 14 and, for ease of inspection, are clustered into four groups, relating to teachers' shared vision; teachers taking responsibility for student learning; teachers taking responsibility for their own learning; and encouraging collaboration, mutual trust and respect. These clusters are based on the model for the SbD PLA displayed in Figure 1 (AAS, 2010).

The comparative results are in Tables 10 to 14, where items are identified by the letter used in the survey shown in Appendix 6. The number of School Coordinators choosing each rating category is reported for April and for October. The final column in the table reports the mean rating. The number of responding Science Coordinators is 27 on each occasion. Of the 28 Coordinators attending the April workshop, one left early, leaving 27 to complete the April survey. A replacement teacher from this school attended the workshop in October, but another school was unable to send a representative. Thus 26 people completed

both surveys, but the 27th person was different on the two occasions, so care must be taken in interpreting these findings because they are not based on exactly the same people.

Table 10. Science Department’s Shared Vision: Participants’ Ratings in April and October

Science teachers in my school (n=27)		Not very often										Mean rating
		1	2	3	4	5	6	7	8	9	10	
a	Share a common vision about where our department is heading											
	April	-	3	4	3	4	3	4	3	2	1	5.5
	October	-	-	-	1	-	2	13	5	5	1	7.5
b	Share a common set of values about student learning											
	April	-	-	1	5	2	1	10	4	3	1	6.6
	October	-	-	-	2	1	3	7	7	6	1	7.4
c	Share a common vision about leadership											
	April	-	1	-	10	4	4	6	2	-	-	5.3
	October*	-	-	2	2	4	6	5	6	1	-	6.2
n	Include lab technicians in our discussions and decision-making											
	April*	1	3	4	1	1	1	8	3	2	2	5.8
	October	1	2	-	1	4	2	3	2	7	5	7.1

* One School Coordinator omitted this item.

Table 10 reports four aspects relating to developing a shared vision within the science department of improving student learning. Inspection of both the numbers of responses in each category and the mean rating for each item reveals the same pattern: On average, and on every indicator, School Coordinators chose higher ratings in October than in April and, consequently, the mean rating is higher. This was especially evident for sharing a common vision about where the department was heading (statement a), with a mean difference of 2 points on the rating scale.

A similar pattern of change is shown in Tables 11 and 12, the two tables that cover teachers’ responsibility for students’ learning (Table 11) and their own learning (Table 12). The indicators shown in Table 11 were some of those rated most highly in April, and they have been rated even more highly in October. For example, “discussing ways to help students learn more effectively” (statement f) was the most highly rated indicator in April, and remains so, with a rating increase from 6.9 to 8.0.

The ratings for teachers’ willingness to take responsibility for their own learning are reported in Table 12. All of these indicators have increased ratings in October compared to April. The lowest rated aspect, “try to observe each other teaching to improve our own practice” (statement l) remains the lowest, but there have been impressive improvements in some schools, with nine Coordinators rating it 7 or above, whereas none did in April.

Table 11. Science Teachers Taking Responsibility for Student Learning: Participants' Ratings in April and October

Science teachers in my school (n=27)		Not very often										Almost always	Mean rating
		1	2	3	4	5	6	7	8	9	10		
d	Take collective responsibility for student learning												
	April	-	1	1	5	5	2	7	5	1	-	5.9	
	October	-	-	-	-	3	5	7	4	7	1	7.4	
e	Create contexts to promote student confidence to learn												
	April	-	1	2	1	4	8	6	3	1	1	6.1	
	October	-	-	-	-	-	5	10	7	5	-	7.4	
f	Discuss ways to help students learn more effectively												
	April	-	-	-	2	4	5	6	7	-	3	6.9	
	October	-	-	-	-	-	2	9	5	10	1	8.0	
j	Analyse and discuss assessment strategies												
	April	-	-	3	1	2	6	8	3	-	4	6.6	
	October	-	-	-	3	4	2	6	5	4	3	7.1	

Table 12. Teachers' Willingness to Take Responsibility for Their Own Learning: Participants' Ratings in April and October

Science teachers in my school (n=27)		Not very often										Almost always	Mean rating
		1	2	3	4	5	6	7	8	9	10		
h	Take responsibility to enhance our own professional learning												
	April	-	1	1	3	9	4	3	4	2	-	5.8	
	October	-	1	-	1	6	4	6	5	4	-	7.4	
i	Seek and use feedback from students to improve our teaching												
	April	-	1	2	6	6	6	4	1	1	-	5.3	
	October	-	-	3	5	3	7	4	3	2	-	5.8	
k	Work in partnerships to teach more effectively												
	April	-	5	3	3	1	7	3	2	2	1	5.3	
	October	-	1	-	2	2	4	6	5	4	3	7.1	
l	Try to observe each other teaching to improve our own practice												
	April	7	7	6	2	4	1	-	-	-	-	2.7	
	October	4	4	2	3	2	3	3	1	3	2	5.0	

Table 13 shows the dimension of a PLC that encourages collaboration in an atmosphere of mutual trust and respect. There are three indicators in this cluster, and all show a positive increase in ratings. The first of these, “we feel valued, trusted and respected by the other science teachers” (statement o) was rated second highest in April, suggesting that most of the science departments participating in the SbD trial were already fairly coherent, but in fact ten School Coordinators rated their department at 6 or below. This number had reduced to four in October. The Coordinators who rated their science departments at 1 and 3 in April, now rated them at 3 and 5 respectively, indicating some improvement. However, the coordinator in the school where SbD was shelved due to staff issues reduced the rating from 7 to 4, a recognition of the disruption in that department.

Table 13. Science Teachers’ Collaboration, Trust and Respect: Participants’ Ratings in April and October

Science teachers in my school (n=27)		Not very often								Almost always		Mean rating
		1	2	3	4	5	6	7	8	9	10	
o	We feel valued, trusted and respected by the other science teachers											
	April	1	-	1	2	2	4	7	3	5	2	6.8
	October	-	-	1	-	3	-	8	7	4	4	7.6
g	Share their pedagogical successes and failures											
	April	-	2	1	4	2	3	9	3	2	1	6.1
	October	-	-	-	3	1	3	2	10	6	2	7.5
m	Have opportunities to take leadership roles											
	April	-	1	-	5	8	3	8	2	-	-	5.6
	October	-	-	-	2	2	6	6	6	2	3	7.1

Table 14 summarises the changes in School Coordinators’ ratings of the 15 indicators of the PLC in their science department. It provides the mean scores of the 26 participants who attended both the April and the October professional learning workshops. Table 14 also reports the results of a dependent *t*-test for the statistical significance of the difference between each pair of means, and an estimate of the effect size of the difference.¹ The final column of Table 14 reports the effect sizes and most are large. Three changes were not statistically significant, and these related to teachers taking responsibility for their own learning, using feedback from students to improve their teaching and a related statement, analysing and discussing assessment strategies. The smallest effect size was for the indicator “we feel valued, trusted and respected by the other science teachers” (statement o), but as this item was scored highest in April, and second highest in October, there may be a ceiling effect at work.

¹ An effect size of 1.0 indicates that the difference between a pair of means is one standard deviation. It is generally accepted that an effect size of 0.2 is described as small, 0.5 is described as medium, and 0.8 is described as large.

Table 14. Differences in School Coordinators' Perceptions of PLC: Ratings in April and October

Science teachers in my school (n=26)	Mean score		t-value	ES†	
	April	October			
Share a common vision					
a	Share a common vision about where our department is heading	5.35	7.50	5.30**	1.11
b	Share a common set of values about student learning	6.50	7.42	3.55**	0.53
c	Share a common vision about leadership	5.28	6.16	2.64*	0.54
n	Include lab technicians in our discussions and decision-making	5.85	7.15	2.82**	0.48
Teachers take responsibility for student learning					
d	Take collective responsibility for student learning	5.92	7.42	4.76**	0.89
e	Create contexts to promote student confidence to learn	6.12	7.38	3.07**	0.85
f	Discuss ways to help students learn more effectively	6.77	7.88	4.08**	0.80
j	Analyse and discuss assessment strategies	6.50	7.04	1.15	NS
Teachers take responsibility for own learning					
h	Take responsibility to enhance our own professional learning	5.69	6.54	1.96	NS
i	Seek and use feedback from students to improve our teaching	5.27	5.65	0.98	NS
k	Work in partnerships to teach more effectively	5.15	7.00	4.14**	0.85
l	Try to observe each other teaching to improve our own practice	2.65	4.77	4.48**	0.84
Collaboration, trust and respect					
o	We feel valued, trusted and respected by the other science teachers	6.81	7.54	3.72**	0.32
g	Share their pedagogical successes and failures	6.08	7.50	3.55**	0.73
m	Have opportunities to take leadership roles	5.58	7.00	3.82**	0.92

* $p < .05$, ** $p < .01$

† ES = Effect Size is the difference between the mean scores in standard deviation units, calculated by taking into account these data are correlated.

Factors Assisting the Implementation of a PLC

School Coordinators were asked to rate the importance of six factors in helping them to implement a PLC in their science department. The results are presented in Table 15. Clearly, the opening workshop in April was most important, closely followed by the professional learning resources. The Coordinator who responded “2” to this item was in a small school where there was a resistant staff member. The curriculum resources and visits by a SbD team member both had an average rating of 4 out of 5. The other two items, having discretionary funding and having the support of the Principal, had average ratings above the midpoint of “3”, but the ratings were spread out, particularly for the Principal. However, the raw scores indicate little correlation between this item and School Coordinators’ rating of the level of development of their PLC, suggesting that the variation may be associated with the nature of the Principal, and that an enthusiastic staff could still make progress even if the Principal was not actively supportive.

Table 15. Participants’ Perceptions of Factors Affecting the Implementation of a PLC

How important was each factor? (n=27)	Not very important		Very important			Mean Rating
	1	2	3	4	5	
a. The introductory workshop in April	-	-	2	7	17	4.6
b. Having the teacher professional learning resources	-	1	3	9	14	4.3
c. Having the student curriculum materials.	-	-	8	11	8	4.0
d. Having some discretionary funding.	1	2	5	11	8	3.8
e. The support of the Principal.	3	6	7	1	10	3.3
f. Having visits from a member of the Science by Doing team	-	1	7	9	10	4.0

The perceived importance of the visit from the SbD Team is interesting. At the October workshop, team members involved in school visits stated their doubts that they had much effect, partly because they did not know all teachers and thus felt limited in being able to offer personal support. However, feedback in workshop discussion indicated that their visits were perceived as valuable for four reasons. First, because they were external visitors, their visit gave the SbD project credibility; it wasn’t “just one more thing” teachers were being asked to do. As one teacher said at the October workshop, “it made it real, teachers could see I wasn’t trying to pull the wool over their eyes”. The second reason, also related to credibility, was that the visit raised the profile of both science and SbD in the school, and this was important in keeping the principals on side. Third, the visit was motivating, both in terms of reminding teachers to keep a focus on SbD, and motivating them personally, by helping Science Coordinators remember that they were doing something important. Fourth, an external person who thoroughly understood SbD was a very important sounding board with whom teachers could talk about progress and difficulties.

Challenges in Developing a PLC

School Coordinators were asked what had been the main challenges for them, and for their staff, in implementing a PLC. Naturally there was some overlap in the responses so the two questions are dealt with together.

Not surprisingly, given the findings from school visits, time was the main challenge. All but three coordinators mentioned time, finding time for everyone to meet together (which was simply not possible in two schools), time for staff to discuss issues related to SbD, plan their approach to the student resources as well as the professional learning resources, and time for the Coordinator to assist other teachers. As one Coordinator opined, “great intentions only turn into reality when provided with time for professional discussion and reflection”.

The second major challenge was team building. This involved the Coordinator motivating other teachers, developing a sense of trust and openness, finding strategies that could involve everyone, and helping the staff to work together as a team. Pushing against this was a lack of interest by some older teachers in wanting to change, and general resistance, at least in the beginning, to the SbD strategies as something new and/or different. In three schools, there was active negativity from one teacher which, in one case, resulted in SbD being set aside until the issues could be resolved. One Coordinator summed up the importance of teacher motivation: “They need to want to do it. You can deliver the material. However, they need to want to trial the strategies in their classes. Some teachers will learn about new strategies but then are reluctant to trial them in their classes”.

The third challenge for the School Coordinator was raising and maintaining SbD as a priority. Just making it important enough to deserve attention in the context of teachers’ other responsibilities was one part of the challenge, but another part was other curriculum or administrative changes that were being thrust upon schools that teachers had to deal with.

Factors that Helped in Developing a PLC

The factors that assisted were those that were able to address the challenges. Time was an important factor. In schools where there was opportunity to have meetings devoted to SbD and teachers had time to work together in a focused way, with a clear objective to achieve, significant progress was made. The professional learning resources were of assistance and mentioned as such by more than half of the Coordinators, because they provided a focus for discussion. The *Effective Questioning* module was especially useful because it provided skills that could be observed and practised.

More than half of the School Coordinators referred positively to the willingness of staff to share, their enthusiasm and desire to improve student learning. When teachers were mutually supportive, their role was made much easier. Sometimes it was just a few teachers who wanted to “give it a go” or “try something new”, and these teachers were able to “bring the others along with them”. A third of teachers mentioned the valuable support of visits by a SbD team member, whose enthusiasm was a boost to the Coordinator and other teachers.

A number of School Coordinators mentioned other issues, such as the funding available from the project which allowed them to provide good food to teachers during additional professional development sessions. Some mentioned the support of the Principal, and one mentioned a Departmental coach who was available to support the implementation.

Some example comments from the School Coordinators follow.

The resources were wonderful. Support given by [the SbD team member] incredible. Financial assistance allowed me to provide time for teachers to meet and discuss/plan/work through curriculum resources.

Having involvement in the SbD program, the workshop provided me with a lot of information and resources. I am new to the leadership role and gained a lot of confidence and assurance that what we are trying to achieve in science at our school is on the right track.

Commitment and enthusiasm of [a] caring group of teachers. Value seen in PLC after a few meetings. Change in teaching seen when having worked with colleagues. Money to feed teachers well.

Workshop. Prepared units. Admin support, however, was mainly spiritual. Staff cooperation – very open to trial and “got right into it”.

Overall, the value School Coordinators assigned in their comments to the April workshop, resources, funding, Principal’s support and the SbD team visits is quite consistent with the ratings reported in Table 15, the factors affecting implementation of a PLC.

Perceptions of Students’ Learning

School Coordinators were asked to write about their perceptions of student learning during the SbD trial. Although evaluation of the quality of the student resources was not a focus of this evaluation, it is important that teachers are able to see benefits from using the materials and the inquiry-based learning approach, because if they do not see improved outcomes, there will be little encouragement to continue with the program. Coordinators made a range of comments relating to students’ responses to the curriculum materials, but only two made comments that related to changes teachers made because of their involvement in the program. These two comments follow.

[Students] enjoyed new (to them) jigsaws, concept maps, even more chance to do group work. Confidence improved by questioning, wait time and discuss with your neighbour before answering. Enjoyed ABCD, yes/no flip cards.²

Teachers felt students did provide “better” answers etc. when some of the questioning techniques implemented, so [there was a] general feeling of better learning.

School Coordinators commented on students’ affective responses. Student enjoyment and/or increased engagement were mentioned by 18 of the 27 coordinators, and three others referred to increased confidence. At one school, “students enjoyed activities, [there was] improved relationships between teacher and student – became more positive”. In terms of cognitive outcomes, three Coordinators believed that students developed higher-order thinking skills, and 6 more considered their marks or the quality of their work had improved. Two Coordinators were not sure about this, particularly for the lower ability students who they thought needed more structure, and ESL students who had problems with reading. One suggested the materials were “OK” for the “above average student but they became a bit boring”.

Ten Coordinators commented on the increased amount of practical work students were doing and this seemed to be one of the reasons for increased engagement and enjoyment. The quality of discussion also increased in the classroom, with seven

² These are strategies from the *Effective Questioning* module.

Coordinators mentioning that students were asking good questions. For example, one described delight in their students' approach:

I have observed engagement in the classroom from students who in the past have struggled with the formal classroom environment. More fabulous questions that promote discussion amongst the students. They are learning so much from each other and using me as the referee/judge to see who was on the right track. Students weren't afraid to say what they thought.

However, five Coordinators commented on the struggle to persuade students to reflect and think for themselves. One pointed out that, apart from the few independent learners who liked this way of learning, the students tended to prefer the teacher-delivered structured lesson. One Coordinator's concern about the lower ability students, and the succinct and positive comments of another Coordinator are compared below.

Top ability groups saw the approach as more of a challenge and responded to greater interaction with other students while working. Weaker students needed more direction [to] follow the resources and [take] smaller steps.

Kids engaged. Get to do open-ended investigation (some for first time). Digital resources were great in Water. Learnt to talk well in groups. Really understand water. Changed their minds and could justify with evidence. Water-recycling – “yuk” – “foul” – “necessary” – “a really good idea” – “safe”. Asked lots of questions. Work quality improved.

Overall, it seems that School Coordinators (some of whom were not actually using the curriculum resources in their own classrooms) perceived that the responses of students to the SbD resources varied according to which of the two modules they were working on, the skills of the teacher and the ability of the student. None of this is surprising, but overall, the responses are generally positive.

Plans for What Happens Next

School Coordinators were asked about their plans for what happens next. The most common response, mentioned by 12 coordinators, was the intention to trial other professional learning resources or go through the one(s) they had already considered to consolidate the skills. Seven Coordinators indicated that they would continue with the curriculum units; one was considering a more cross-curricular approach, teaching the Water module with geography. Nine Coordinators expressed their plan to continue the great start they had, and build on the current enthusiasm amongst staff, improving, sharing and observing each other. Finally, Coordinators hoped for more time for meetings, and two had lengthy professional development meetings planned for Term 4.

The Australian Curriculum: Science remains an issue for teachers, with the final version not released at the time of the October workshop. There was an underlying uncertainty about what this would mean for their present curriculum, with some Coordinators mentioning anticipated stress for teachers having to rework their current units. Having the SbD student resources that demonstrated close fit to the new curriculum was perceived to be of considerable benefit to teachers.

Advice to the SbD Team to Improve the PLA Approach

Although this question focused on advice to the SbD team, many of the suggestions were about support in schools, such as longer and regular meeting times, the need for

support from the Principal, and the need for the school team to “bond and feel comfortable with one another”. However, there were several specific suggestions for the SbD resources, such as having classroom posters to remind teachers and students about questioning skills, to have an additional module on PLCs, and one about *Leading for Change Part 2*.

Several more general suggestions could be discerned in the responses. One general theme was the need to have a longer time period for implementation. Although this was mentioned specifically by four Coordinators, discussion at the October workshop indicated that all Coordinators realised that implementing a PLC was a lengthy process and there had not been sufficient time to achieve that goal.

It was also clear that progress was dependent on the quality of the professional relationships and the degree of cohesiveness amongst the science staff. Suggestions to promote good relationships included more opportunities for networking amongst teachers in schools involved in SbD, such as at the April workshop, and it was suggested that more than one teacher per school be involved in the professional learning opportunity provided by that workshop. The feeling of isolation experienced by several Coordinators, particularly those with less experience, was ameliorated to some extent by visits from the SbD team.

Another theme related to the SbD teacher professional learning resources. There was a feeling that they were “patchy”, in the sense that some, such as the *Assessment* module, was too low key for many experienced teachers, but others, such as *Effective Questioning* had something for every one. In terms of curriculum resources, differentiation was suggested for “schools of varying demographics”. There was also a request that more units be developed.

Perhaps the most direct advice to the SbD team was that they “continue with their positive attitude. Reassure others that change won’t happen overnight. Present evidence that it is a worthwhile process both for teachers and students”.

Summary and Conclusions

The evaluation was designed to assess the outcomes of the SbD PLA during the trial period and was focused on four questions about the SbD PLA, namely,

- a) how successful is the PLA in improving pedagogical practice?
- b) what factors are important in enhancing the PLA?
- c) what factors inhibit the implementation of the PLA?
- d) how can the PLA be improved?

The PLA comprised four components, the professional learning resources, the curriculum resources, the professional development workshops and the support of the SbD team during the trial. These four components are based around the notion of developing a PLC that, within most high schools, will be the science department. Leadership within that department is an important part of developing the PLC.

The data collection occurred in the three phases of the implementation of the SbD trial: surveys to collect baseline data administered at the initial professional learning workshop, school visits to talk to teachers involved in SbD, a survey administered at the final workshop at the end of the trial period and field notes taken of the discussion at both workshops and during school visits. These data were synthesised to respond to the four questions that drove the evaluation.

Success of the PLA in Improving Pedagogical Practice

The success or otherwise of the SbD project must be considered in the context of the conditions that prevail in our schools. For SbD to be successful, it has to become integral to how schools operate and how teachers work within them. Three considerations are crucial.

First, teachers are busy, not just busy teaching, but busy performing a range of administrative and pastoral care roles, as well as planning ahead for change, such as the introduction of a national curriculum. A key challenge is how to make SbD a priority in teachers' busy lives. Second, schools are different. Their students vary in terms of their ability, their cultural backgrounds, their motivations and their priorities. The composition of their cohort of teachers varies, in terms of experience in years, training and pre-teaching background, as well as their motivation, enthusiasm and willingness to try something new. Third, change takes time and effort, and making what is essentially a cultural change in the development of a PLC is a very big challenge. In the context of these considerations, introducing SbD could not be an easy task.

In terms of the trial of SbD Stage One, there were additional difficulties. The trial began in Term 2, so some School Coordinators had difficulty adjusting the already planned science programs to include the SbD student resources. It was also difficult to disrupt other "fixed" factors, such as school timetables, to find sufficient time for staff to meet. Further, the trial of SbD could last only two terms; long enough to make a start towards significant change, but not to consolidate it, even if staff were amenable and willing to participate.

Despite these challenges, there were many things in SbD's favour. First, the project has a clear focus on student outcomes, and teachers are certainly concerned with their students' learning. Second, the SbD resources were carefully crafted and were evidenced-based, particularly the professional learning resources. Even if teachers thought some of the skills and ideas were basic, they did not think they were wrong. Further, the resources were

of excellent quality; they were colourful, appealing and incorporated ICT to a significant degree. Third, SbD had a dedicated, enthusiastic, knowledgeable and empathetic team who could support teachers and School Coordinators. Fourth, the SbD team recognised that the support of Principals was essential, and went to considerable lengths to engage that support, including the \$1000 grant which allayed some fears relating to cost. Finally, SbD delivered an initial professional learning workshop that, in the eyes of the School Coordinators, was very successful, mirroring as it did, what research has demonstrated to be the “essential characteristics” of a professional learning program (Loucks-Horsley et al., 2003).

In the context of all of these considerations, how successful was the SbD PLA in improving pedagogical practice? In sum, the outcomes were very positive. The empirical data from the two surveys during workshops for School Coordinators are telling. Table 9, which compares Coordinators’ rating of the PLC within their science departments over the two occasions, shows clear progress overall. Tables 10 to 14, and especially Table 14, which compare 15 indicators of an effective learning community based on the SbD definition of a PLC and the Bolam et al. (2005) report, are persuasive. Overall, School Coordinators believed that constructive change was happening. There were very few Coordinators who rated any of these aspects at a lower level in October than in April, and in those cases, there were usually professional relationships at issue.

Qualitative data obtained by interviews with teachers during school visits and from School Coordinators’ written responses to the final workshop survey are complementary to, and consistent with, the empirical findings. Teachers and Coordinators agreed that there was much more discussion about pedagogy during meetings and also during informal lunchtime and recess conversations. The more formal of these discussions used the professional learning resources as a focus, and the suggestions within them stimulated teachers to try out new skills and techniques. Where “study lessons”, or other planned opportunities for teachers to observe other teachers, took place, the animated and “quality discussions” that ensued were reported to be very beneficial. Both teachers and Coordinators remarked on the increased sharing of ideas about student learning and successful strategies they had tried. Some mentioned the greater openness amongst teachers in terms of sounding out ideas about their planning, and asking for ideas to solve problems they perceived in the class. The use of the curriculum resources also had this effect in some of the schools visited, where teachers delivering the same module team-taught and/or jointly planned their approach and activities.

In terms of improving student learning, no empirical data are available because there are no valid comparisons between students’ outcomes in terms of learning from the resources because they had not been tried before. Further, there are only teachers’ perceptions about whether or not students’ outcomes improved when teachers endeavoured to use some of the suggested strategies, such as those in the *Effective Questioning* module, for example. However, there was considerable evidence that teachers and Coordinators believed that student learning was enhanced. Most teachers firmly believed that students were more engaged, more enthusiastic, and asked more and higher level, questions when using the SbD resources. Many of these teacher believed this resulted in greater learning and improved work quality. There was some concern for lower ability students relating to reading level or the need for more structure in the curriculum resources, and for very able students said to have got a bit bored. This underlines the need for flexibility within the modules.

Factors that Enhance the Implementation of the PLA

The factors that enhanced the implementation of the PLA during SbD Stage One relate to the SbD resources, within-school leadership and support.

The SbD resources

It is important to emphasise that SbD Stage One is not simply a curriculum project implementing curriculum resources; it is a professional learning project supported by professional learning resources for teachers as well as curriculum resources for students (which include teacher guides). The SbD PLA could not have been implemented without both of these kinds of resources. There is little research evidence that implementing new curriculum resources by themselves actually changes teachers' practice. Teacher support is also required. The focus in SbD was to enable teachers in science departments to develop professional learning communities, and to do that, the assistance of professional learning resources was essential to provide a tangible guide and reminder of what SbD was about.

The initial professional learning workshop in April for School Coordinators was an important introduction to the SbD resources. This detailed "walk-through" of the resources and the opportunity, in a supportive, non-threatening environment, to begin planning their "vision" for introducing SbD in their schools, was a strong beginning for the Coordinators. When they returned to their school, Coordinators had a bundle of attractive materials to show and tell, and a concrete focus for the task ahead. The curriculum resources provided as modules ready for use with classes, and the professional learning resources were able to be used in team or individual situations. Working with these resources assisted some teachers to remember, reflect on, and renew old strategies, and introduced others to new skills and suggested ways to practice them. Importantly, the discussion amongst teachers around both kinds of resources helped to build the PLC.

Within-school leadership

Effective leadership within the school was a factor that enhanced the PLA. Effective leaders were not overbearing, rather they were teachers respected by other staff as both people and pedagogues. Effective leaders were able to see how individual teachers could be helped so that all staff could get to be on the "same page", as one Coordinator put it. Effective leaders could tell which teachers needed "reminding" of skills and which needed help to develop them. They were able to harness the talent within the school and deal with the "dinosaurs".³ Effective leaders also had a clear vision of where they wanted to go and were able to plan how they were going to get there. The April workshop was significant in helping them articulate this vision.

Support for the SbD PLA

Like any innovative project, the SbD PLA benefitted from support. At the school level, support from the Principal was considered to be essential in many schools and important in others. School Coordinators stated that principals needed to do more than

³ Dinosaur was the term used by some teachers for staff members who were resistant to change. Usually they were older, experienced (and often respected) teachers considered to be set in their ways. Some of these teachers were happy to opt out, paying lip service to SbD and continuing their usual practice. Other teachers were actively negative and disrupted other teachers' efforts. The generally expressed hopes were that the former group of "dinosaurs" would see the benefits of SbD and join in, whereas it was hoped that the one or two teachers in the latter category would move schools.

provide verbal support, they needed to be visibly supportive, by attending SbD sessions or meetings and/or allocating additional time so that teachers could meet. Some School Coordinators found it helpful to communicate with their Principal about what kind of support they would like, because although positive about SbD, Principals sometimes did not have the vision to see what was needed. Enabling the School Coordinator to have some time release to deliver professional learning and assist novice teachers, was essential in larger schools and particularly those where there was limited meeting time or teachers were scattered in different locations.

Support that was external to the school came from the SbD team, and this was important to School Coordinators because it gave validity to the project and the efforts Coordinators were making in their schools. Although team members wondered about the value of their visit, Coordinators thought the visit gave visibility and credibility to SbD and it took the focus off the Coordinator. Further, the team member was a knowledgeable, experienced person with whom the Coordinator could discuss their progress and seek advice about issues that were troublesome.

Coordinators also suggested that support from the State Departments, or other school authorities, by training their representatives to assist schools and teachers with SbD, would give overt support for the project.

Factors that Inhibit the Implementation of the PLA

The two major factors inhibiting the implementation of the PLA were lack of time changing teachers' mindsets. Both of these factors are umbrella terms for a range of smaller issues.

Finding time

Finding time was the problem most commonly identified by School Coordinators and by teachers during school visits. Implementing change takes time and effort, and not being able to get teachers together for meetings, so as to get a "critical mass" of teachers moving forward, was a major challenge for School Coordinators. The average formal meeting time per week was about an hour, but that was very variable, and Coordinators complained that often departmental meetings were "taken over" by school issues. In one school visited, there was no scheduled meeting time for middle school teachers who were implementing the student curriculum materials. Although some schools were able to use the SbD funding to buy time (and catering) for staff to meet, this was not always possible.

There was a consensus amongst the Coordinators that regular staff meetings were needed, at least every two weeks, and that these be held at a "proper" time of the day, not after school when everyone was tired. Further, this meeting time should be built into the school calendar from the beginning of the year, so that meetings were considered central to staff planning and communication, and not peripheral. Given that time was a precious commodity, some School Coordinators emphasised that it was important to make best use of the time they had by ensuring that meetings have a specific goal so there is a sense of achievement when it is reached.

Changing mindsets

At the April workshop, School Coordinators were asked how easy they thought it would be to develop a PLC in their science department, to use the profession learning

resources and to use the curriculum resources. The results reported in Table 7 indicated a decreasing expectation of easiness in these three things, and the results of the trial show that these expectations were realistic. Coordinators found it easy to have teachers use the curriculum resources and experienced varying difficulty in using the professional learning resources. Developing a PLC that involved all science staff, was the biggest challenge.

“Changing teachers’ mindsets”, a number of Coordinators pointed out, was the biggest hurdle in developing a PLC. These Coordinators believed that teachers needed to change their way of thinking about their teaching, and open their minds to the possibility that may be different and more effective pedagogical approaches. This opening of minds was essential if there were to be a cultural change within their department. Of course some departments were already functioning well, with communicative and friendly staff, but others were not. It is when there is the prospect of change, when teachers suddenly find that they are expected to work together, rather than in parallel, that little personal issues or conflicts come to the fore. Whilst potentially fatal to developing a PLC involving all of the science staff, if these interpersonal issues can be brought into the open and resolved, then progress can be made that is beneficial to everyone.

Changing pedagogical thinking requires ongoing reflection about teaching that becomes routine. It needs regular discussion about student learning, so that learning, rather than teaching, becomes the focus of teachers’ thinking about their practice. One Coordinator referred to a “hook” to get teachers on side at the start, before beginning the SbD workshops to introduce the professional learning materials. These resources were essential because they provided something tangible for School Coordinators to work with and for teachers to focus on. Because they were evidence-based, and there was a range of “entry points” through the CDs, the DVDs and the booklets themselves, the resources provided a coherent, flexible framework that could appeal to teachers in different ways. The initial resistance from those teachers unwilling to incorporate yet another new and different thing into their busy lives was allayed when they realised SbD wasn’t all new and different but in many cases affirming and reassuring. For these teachers, SbD was providing something new that would enhance, rather than require change in, their pedagogical practice. This realisation went a considerable way in getting teachers “on board” and willing to participate in a developing PLC.

How Can the PLA Be Improved?

The findings of this evaluation suggest that the SbD PLA is on the right track, and improving it requires enhancement rather than significant change. Each of the four parts of the PLA are considered in turn: the teacher professional learning resources, the curriculum resources, the professional development workshops and the support of the SbD team during the trial.

The SbD professional learning resources

The SbD professional learning resources were generally well received. They were accepted as containing valuable advice and suggestions for changing pedagogical practice and were not criticised in terms of overall content, but rather as being differentially relevant to different teachers. This is not surprising; the issue is what to do about it. Successful modules were those that contained a variety of concrete suggestions for improving practice, at a level that might be described as “middle of the road”, that is, recognised by some younger teachers as “Uni 101”; familiar, but reaffirming, for very experienced teachers; and

“spot on” for teachers somewhere between. Some modules have done that more successfully than others, and Coordinators have provided feedback to the SbD team. What must be avoided is a presentation that can be perceived as a bit insulting to the experienced staff by teaching them “to suck eggs”. Ideally, modules must be professionally produced, easy to handle, appealing to look at and desirable to use. Much of this has already been achieved.

The student curriculum resources

Teachers are always anxious to have something they can use straightaway in their classrooms. To some extent the two curriculum modules were able to be used in this way, but not optimally. Just like any other curriculum resource, the outcome is most effective if teachers read their guides and the materials and plan according to the needs of their class. (Being part of a PLC helps to do this, because teachers work together.) School Coordinators and teachers have provided suggestions for some structural and content level changes which the SbD team is currently addressing. The curriculum resources are important as ways to support inquiry-based teaching and learning, and the complementarity between the content and structure of the curriculum resources and the pedagogical approaches inherent in the professional learning resources must be maintained. Further, the availability of some content electronically was appreciated by teachers who could make good use of this format, such as by using interactive whiteboards. The high production quality of the curriculum materials was recognised and appreciated by teachers and by most of the students.

The professional development workshops

The introductory workshop was critical to the successful take up of the SbD program and it is difficult to see how this could be shortened to less than two full days. The present format was successful and because the coverage is comprehensive and the concepts challenging, there must be time for discussion and reflection built in. Going “off-campus” for reflection, such as the trip to the Botanic Garden, was not successful, partly because time was too limited and the surroundings were distracting to reflection. Free time, when people are all accommodated in the same place, is easier and probably more effective. More advance information about the nature of the SbD program, particularly the focus on professional learning rather than curriculum resources, could help teachers arrive more prepared for what will be expected of them.

Although expensive, it would be beneficial to involve two teachers from each school in the introductory workshop. This was a suggestion from some School Coordinators as a way to provide them with additional support back at school, both in terms of having someone immediately on side but also to be a sounding board as progress is planned. It is not possible for the SbD team to visit as often as Coordinators would like, and that also is expensive. Another means of support might be the setting up of localised, between school networks. Some Coordinators attempted to do this, but it often wasn’t successful because it takes time and organisation to find common meeting times. Nevertheless it is something to be encouraged.

The support of the SbD team

Visits by the SbD team, as well as their availability by phone and email, was appreciated by School Coordinators. The travel required is an expensive part of the PLA, but during a trial period it is essential. In looking ahead, it is not feasible to consider intensive visits as a necessary part of a much larger roll-out, however, online and telephone support should be continued. Some of the supporting benefits of team member visits could be

achieved if there were to be designated Departmental officers trained and available for support. Additional professional learning workshops would be beneficial, perhaps locally based to ease cost.

Recommendations

The following recommendations are made on the basis of how SbD was implemented during 2010 and should be interpreted in that context. The recommendations flow from the summary and conclusions reported above.

Professional Learning Workshops

Recommendation 1

Professional learning workshops assist teachers to become familiar with the concept of a professional learning community and the SbD resources, and enables them to begin planning the introduction of Science by Doing in their school. The introductory workshop must be continued with consideration giving to involving more than one person from each school. Consideration should also be given to an additional workshop, perhaps locally based, after one or two terms to consolidate progress.

Recommendation 2

Introductory material for the initial professional learning workshop should be reviewed to ensure that principals and teachers become cognisant of the professional learning focus of SbD and the overall structure of the program.

Teacher Professional Learning Resources

Recommendation 3

The teachers' professional learning resources are the backbone of the SbD professional learning approach. There should be some revision of content to maximise flexibility and appeal to teachers with variable levels of experience. The following should be considered:

- *Additional modules that focus on specific issues, such as dealing with students with cultural differences.*
- *The production of a module for laboratory technicians.*
- *The production of a module relating to the development and characteristics of a PLC.*
- *The placement of an overview flowchart or guide to the suite of resources in the end papers of each module.*

Student Curriculum Resources

Recommendation 4

Some revisions to the student resources are required and these should be made in the context of feedback from the teachers who used them. The focus on inquiry-based learning should be maintained. Ensure that revised, and any new, resources link clearly to the Australian Curriculum: Science.

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Appendix 1. Copy of the Initial Science by Doing Professional Learning Workshop, April 2010

Science by Doing School Coordinators' Workshop

April 7-9, 2010

By the end of the 3 day workshop participants will have:

- developed a plan of action for establishing and supporting their science department as a professional learning community (PLC)
- enhanced their understanding of inquiry-based teaching and learning
- an understanding of the *Science by Doing* Project and its resources

Day 1 Focus: PLC & Inquiry	
9.00-10am	Welcome to the Academy of Science. Acknowledgement of Country Official launch of <i>Science by Doing</i>
10.00-10.30am	Morning Tea
10.30-12.00pm	Professional Learning Community (PLC) 1
12.00-1.00pm	Inquiry 1
1.00-1.45pm	Lunch
1.45-2.15pm	Inquiry 2
2.15-3.45pm	Assessment
3.45-4.00pm	End of day reflection
4.00pm	Afternoon Tea will be available. Participants may wish to explore resources further. Close
6.00pm	Informal BBQ At University House in the Fellows Garden

Day 2 Focus: PLC & Curriculum Units	
9.00-9.10am	Introduction
9.10-11.00am	Curriculum Units
11.00-11.30am	Morning Tea
11.30-1.00pm	PLC 2
1.00-1.45pm	Lunch
1.45-3.30pm	Effective Questioning, Student Learning, Inquiry DIY Guide
3.30-4.30pm	Reflection in Botanic Gardens
6.00pm	Pickup from University House
6.30pm	Dinner at Questacon

Day 3 Focus: PLC & Reflective Practice	
9.00-9.10am	Introduction
9.10-10.10am	Reflective Practice
10.10-10.30am	Data collection
10.30-11.00am	Morning Tea
11.00-12.20pm	PLC 3
12.20- 1.00pm	Panel discussion and planning time
1.00-1.45pm	Group photo & Lunch
1.45-2.15pm	Sharing plans
2.15-2.30pm	Evaluation
2.30-3.00pm	Celebration & certificates
3.00pm	Close

Appendix 2. Copy of Initial Survey Part A

As part of our evaluation, please tell us your views about the SbD Professional Learning Workshop.

Name of your School _____

Part A: To be completed at the BEGINNING of the workshop

1. On average, how many hours would your Science Department meet each week? ___ hours.
Please make any explanatory comment you think is necessary.

2. During your meetings, please estimate what amount of time would likely be devoted to

	Approximate % of time
• School administration	_____
• Department administration	_____
• Curriculum/pedagogy issues	_____
• Other issues	_____
Total	100%

3. **Science by Doing** describes a Professional Learning Community in this way:

An effective professional learning community has the capacity to promote and sustain the learning of all professionals in the school community with the collective purpose of enhancing student learning.

Consider **your** Science Department in terms of this description. Which statement below fits best?

- | | |
|--------------------------|---|
| <input type="checkbox"/> | A mature, well-established professional learning community |
| <input type="checkbox"/> | A developing professional learning community |
| <input type="checkbox"/> | Beginning the journey towards a professional learning community |
| <input type="checkbox"/> | Not yet started to become a professional learning community |

4. Please provide further comment or explanation for your response to Q 3

5. What do you hope to gain from this workshop?

Appendix 3. Copy of Initial Survey Part B

As part of our evaluation, please tell us your reflections on the SbD Professional Learning Workshop.

Name of your School _____

Part B: To be completed at the END of the workshop

6. Were your expectations of what you hope to gain from this workshop realised? Please explain.

7. For each of the following statements, please give your rating by circling one of the 10 numbers.

Science teachers in my school	Not very often	Almost always
a Share a common vision about where our department is heading	1 2 3 4 5 6 7 8 9 10	
b Share a common set of values about student learning	1 2 3 4 5 6 7 8 9 10	
c Share a common vision about leadership	1 2 3 4 5 6 7 8 9 10	
d Take collective responsibility for student learning	1 2 3 4 5 6 7 8 9 10	
e Create contexts to promote student confidence to learn	1 2 3 4 5 6 7 8 9 10	
f Discuss ways to help students learn more effectively	1 2 3 4 5 6 7 8 9 10	
g Share their pedagogical successes and failures	1 2 3 4 5 6 7 8 9 10	
h Take responsibility to enhance our own professional learning	1 2 3 4 5 6 7 8 9 10	
i Seek and use feedback from students to improve our teaching	1 2 3 4 5 6 7 8 9 10	
j Analyse and discuss assessment strategies	1 2 3 4 5 6 7 8 9 10	
k Work in partnerships to teach more effectively	1 2 3 4 5 6 7 8 9 10	
l Try to observe each other teaching to improve our own practice	1 2 3 4 5 6 7 8 9 10	
m Have opportunities to take leadership roles	1 2 3 4 5 6 7 8 9 10	
n Include lab technicians in our discussions and decision-making	1 2 3 4 5 6 7 8 9 10	
o We feel valued, trusted and respected by the other science teachers	1 2 3 4 5 6 7 8 9 10	

8. Please rate your enthusiasm by circling the most suitable of the five numbers.

Impact of the Science by Doing Professional Learning Workshop	Not very enthused	Very enthused
a How enthused were you about the SbD project before your participation in the Professional Learning Workshop?	1 2 3 4 5	
b How enthused are you about the SbD project after your participation in the Professional Learning Workshop?	1 2 3 4 5	

9. Please rate your expectations beyond the Workshop by circling the most suitable of the five numbers.

Expectations beyond the Science by Doing Professional Learning Workshop	Not very easy					Very easy
a How easy do you think it will be to develop a Professional Learning Community in your Science Department?	1	2	3	4	5	
b How easy do you think it will be to use the SbD professional learning resources in your Science Department?	1	2	3	4	5	
c How easy do you think it will be to use the SbD curriculum resources in your Science Department?	1	2	3	4	5	

10. How effective was the Workshop in terms of the following criteria?

Learning experience	Not very easy					Very easy
a The delivery of the workshop sessions modelled the inquiry process	1	2	3	4	5	
b The workshop sessions assisted me to develop a plan of action for establishing and supporting a PLC	1	2	3	4	5	
c The workshop sessions enhanced my understanding of inquiry-based teaching and learning.	1	2	3	4	5	
d The workshop sessions enhanced my understanding of the SbD project and its resources.	1	2	3	4	5	
e The pace of learning suited my needs.	1	2	3	4	5	
f My own views and attitudes were valued.	1	2	3	4	5	
g My confidence in using inquiry-based teaching was enhanced.	1	2	3	4	5	

11. If the Science by Doing Coordinators Professional Learning Workshop was run over 2 days instead of 3 days, what would you suggest be

definitely included?

left out?

12. What excites you most about the challenge that lies ahead?

THANK YOU VERY MUCH FOR YOUR TIME, AND GOOD LUCK

Appendix 4. Copy of Interview Questions

School Coordinator Interview Questions

Thank you for giving me the time to talk to you about your involvement in the Science by Doing Project.

1. In your view, how has the SbD project enabled you to participate in the development of professional learning community in your science department? (For example, do staff meetings have a greater focus on pedagogical issues compared to general administration and organisational issues?)
2. What kind of challenges did you face as school coordinator in assisting your staff to work towards the development of a professional learning community? Were these challenges overcome? If so, how? If not, what are your thoughts about this?
3. How satisfied, overall, are you as School Coordinator, with progress towards a professional learning community in their science department? What are your thoughts about this?
4. Did you notice any changes in students' engagement and attitudes towards learning, and in their actual learning that you can attribute to the SbD project? If so, what kinds of change? To what do you attribute any change?

Teacher Interview Questions

Thank you for giving me the time to talk to you about your involvement in the Science by Doing Project.

1. In your view, how has the SbD project enabled you to participate in the development of professional learning community in your science department? (For example, do staff meetings have a greater focus on pedagogical issues compared to general administration and organisational issues?)
2. What kind of challenges do you think your school coordinator faced in assisting your staff to work towards the development of a professional learning community? Were these challenges overcome? If so, how? If not, what are your thoughts about this?
3. Did you notice any changes in students' engagement and attitudes towards learning, and in their actual learning that you can attribute to the SbD project? If so, what kinds of change? To what do you attribute any change?

Appendix 5. Copy of the Final Science by Doing Professional Learning Workshop, October 2010

9.00am	<p>Welcome Purpose of workshop Outline of day – suggestions for changes or inclusions Collection of feedback forms</p>
9.15am	Evaluation of Professional Learning Approach
10.00am	<p>Reflections from <i>Science by Doing</i> team Each SbD team member will provide a brief impression of their visits during Terms 2 & 3</p>
10.30am	Morning tea
10.50am	<p>Improving the Professional Learning Approach (PLA) Group of 4 will discuss the following questions:</p> <ul style="list-style-type: none"> • What were the main challenges? • What were the successes? • How important were the following factors in the PLA? Workshop PL resources Curriculum resources Your leadership/principal Support visit from <i>Science by Doing</i> Other factors <p>Using this discussion devise the ideal PLA for schools</p>
12 noon	<p>The ideal Professional Learning Approach Each group reports and outlines their ideal PLA. From these reports develop a final large group ideal PLA.</p>
12.30pm	Lunch
1.00pm	<p>Discussion circles GROUP A What next for <i>Science by Doing</i>? Provide a copy of the <i>Science by Doing</i> proposal. Discussion points:</p> <ul style="list-style-type: none"> • What is your reaction to the proposal? • If only half the funding was available how would you modify the proposal? <p>GROUP B What next for the resources? Outline the revision process and appraise different ways of publishing and providing the Professional Learning and Curriculum resources.</p>
1.30pm	GROUPS A and B swap
2.00pm	<p>What next for your leadership? In pairs reflect on what you are learning about yourself as a leader (prompt questions provided)</p>
2.30pm	<p>Future hopes and action Prepare a personal letter that will be posted to you in January 2011.</p>
2.45pm	Keeping in touch with each other and <i>Science by Doing</i>
3.00pm	Thank you and Farewell

Appendix 6. Copy of Final Survey

As part of our evaluation, please reflect on your experiences implementing the SbD Professional Learning Approach.

Name of your School _____

1. On average, how many hours did your Science Department meet during Term 3? _____ hours.

2. During your meetings, please estimate what amount of time would likely be devoted to

	Approximate % of time
• School administration	_____
• Department administration	_____
• Curriculum/pedagogy issues	_____
• Other issues	_____
Total	100%

In your view, has the purpose and nature of your meetings changed in relation to Science by Doing?

3. For each of the following statements, please give your rating by circling one of the 10 numbers.

Science teachers in my school	Not very often	1	2	3	4	5	6	7	8	9	10	Almost always
a Share a common vision about where our department is heading	1	2	3	4	5	6	7	8	9	10		
b Share a common set of values about student learning	1	2	3	4	5	6	7	8	9	10		
c Share a common vision about leadership	1	2	3	4	5	6	7	8	9	10		
d Take collective responsibility for student learning	1	2	3	4	5	6	7	8	9	10		
e Create contexts to promote student confidence to learn	1	2	3	4	5	6	7	8	9	10		
f Discuss ways to help students learn more effectively	1	2	3	4	5	6	7	8	9	10		
g Share their pedagogical successes and failures	1	2	3	4	5	6	7	8	9	10		
h Take responsibility to enhance our own professional learning	1	2	3	4	5	6	7	8	9	10		
i Seek and use feedback from students to improve our teaching	1	2	3	4	5	6	7	8	9	10		
j Analyse and discuss assessment strategies	1	2	3	4	5	6	7	8	9	10		
k Work in partnerships to teach more effectively	1	2	3	4	5	6	7	8	9	10		
l Try to observe each other teaching to improve our own practice	1	2	3	4	5	6	7	8	9	10		
m Have opportunities to take leadership roles	1	2	3	4	5	6	7	8	9	10		
n Include lab technicians in our discussions and decision-making	1	2	3	4	5	6	7	8	9	10		
o Feel valued, trusted and respected by the other science teachers	1	2	3	4	5	6	7	8	9	10		

4. Science by Doing describes a Professional Learning Community in this way:

An effective professional learning community has the capacity to promote and sustain the learning of all professionals in the school community with the collective purpose of enhancing student learning.

Consider **your** Science Department in terms of this description. Which statement below fits best?

- A mature, well-established professional learning community
- A developing professional learning community
- Beginning the journey towards a professional learning community
- Not yet started to become a professional learning community

Do you feel your science department has changed as a professional learning community? Yes or No
Why, or why not?

5. How important were the following factors in helping you to implement a professional learning community in your science department?

How important was each factor?	Not very important				Very important
a The introductory workshop in April	1	2	3	4	5
b Having the teacher professional learning resources	1	2	3	4	5
c Having the student curriculum materials.	1	2	3	4	5
d Having some discretionary funding.	1	2	3	4	5
e The support of the Principal.	1	2	3	4	5
f Having visits from a member of the Science by Doing team	1	2	3	4	5

6. What have been the main challenges for **you** in implementing a professional learning community?

7. What have been the main challenges for **your staff** in implementing a professional learning community?

8. What were the factors that helped **you** to implement a professional learning community?

