Contextual Opportunities for Teacher Professional Learning: The Experience of One Science Department

Wayne Melville
Lakehead University, Ontario, CANADA

Bevis Yaxley
Curtin University of Technology, Perth, AUSTRALIA

In this article we investigate the changing context for teacher professional learning potentially afforded by the conceptual change from professional development to professional learning. Using a narrative case study methodology, we utilize the *Best Evidence Synthesis Iteration* developed by Timperley, Wilson, Barrar and Fung (2007) to analyse the teachers' responses to the changing context within their school. Our analysis reveals three important findings: the negligible impact of school policy on the work of the teachers, the willingness of teachers to utilize appropriate expertise, regardless of the source of that expertise, and the manner in which these teachers have developed a community in which teaching practices, both individual and corporate, can be discussed and critiqued. The clear implication of these findings is that it is teachers, working within the department and wider science education community, who were making the conceptual change from professional development to professional learning.

Keywords: School Subject Departments, Teacher Professional Learning, Teacher Leadership, Communities of Practice.

INTRODUCTION

It is generally accepted that teachers are at the heart of efforts to reform education. This strategic position ensures that they are rarely far from the reform front. In the persistent press of high standards for all students, the ongoing learning of teachers is seen as fundamental to improving the teaching and learning that occurs in schools. Adding to the complexity of this pressure is the growing realisation that traditional forms of teacher professional development could potentially "limit teachers' access to knowledge, no matter where they

teach" (Randi & Zeichner, 2004, p. 181). This realisation has prompted researchers to reconsider conceptualizations of professional development and professional learning, and the relationships that teachers and schools have with these conceptualizations. These dynamic relationships may underlie many of the tensions that exist in the field of teacher learning.

In this article it is our intention to consider how teachers in one science department utilized the professional learning opportunities within their school. The context for our study is a secondary (Grades 7 to 12) school in the Australian state of Tasmania. The school has a reputation for high academic standards and is well regarded in the local area. The science department was staffed by ten teachers, six of who were employed on a full-time basis. With two exceptions, all of the teachers possessed undergraduate degrees with at least one science major, and most also taught other subjects, usually mathematics. Each teacher, with one

Correspondence to: Wayne Melville, PhD in Science Education, Lakehead University, Faculty of Education, 955 Oliver Road, Thunder Bay P7B 5E1, Ontario, CANADA
E -mail: wmelvill@lakeheadu.ca

exception, had at least five years experience in science classrooms.

Our article is in five parts. We start by discussing the theoretical shift that is occurring from professional development to professional learning and introducing our research question. The second section focuses on the wider professional learning context that provides the specific conditions for teacher professional learning. In the third section we discuss the use of narrative as a form of inquiry and the theoretical framework that has been employed in the analysis of the data. This framework is derived from the work of Timperley, Wilson, Barrar and Fung (2007). The penultimate section contains our analysis and discussion, while the final section outlines our conclusions and potential implications for teacher practice.

The Shift between Professional Development and Professional Learning

In an increasingly competitive and globalised world, it is understandable that teachers, schools and education authorities are concerned with teacher learning. As organisations, schools and education authorities are concerned with the promotion of specific organisational goals (Randi & Zeichner, 2004). For this reason, the training of teachers to implement particular practices has been the focus of historical professional development activities. In a review of the literature, Loucks-Horsley, Hewson, Love and Stiles (1998, p. 37) found that professional development from the early 1970's was centred on the importation of "outside expertise" into schools, with the purpose of increasing teacher knowledge about a particular program. This traditional model has continued, as evidenced by Ward, St. John and Laine (1999, p. 2):

> For the purposes of this study, we define teacher professional development as those state programs designed to prepare teachers for improved performance by enhancing their knowledge, skills, and motivation to improve learning for all students. Such programs might involve services offered through state professional development offices or intermediate education agencies …

Lord (1994, pp. 190-191) has outlined four contradictions in this traditionally dominant conceptualization of professional development. The first of these contradictions emphasises the failure of utilitarian, short term professional development work, which is often demanded by teachers, to provide long-term substantive change. As a result of focussing on short term results, the perception of teaching as an unskilled occupation is maintained. Second, by attempting to reach a maximum number of teachers at the district level, professional development activities can become "precariously thin" with little or no long-term

benefit. The third contradiction relates to the sketchy and isolated nature of any implemented reforms, which are often not followed up. As a result, teachers are restricted in their ability to critically review their reform efforts and the effectiveness of different teaching practices. Finally, teacher development under this conceptualization denies teachers the opportunity to expand their subject knowledge or experiment with inquiry based teaching strategies, even as bureaucracies demand that teachers embrace these strategies in their classrooms. Taken together, these contradictions suggest a different conceptualization of teachers' learning needs. This is the shift that we have investigated in this article.

Many authors believe that the majority of current professional development practices do not reflect the current theoretical understandings of best practice. Darling-Hammond and Sykes (1999, p. 134), for example, refer to critics of professional development who believe that current practices are "shallow and fragmented." Ryan (1996, p. 7) describes current professional development practice as the "two or three days that were student free - where staff gathered together to listen to a keynote address from a visiting expert … the mandatory discussion groups … followed and that was that until next term." Cibulka and Nakayama (2000, p. 6) describe one of "the most grievous faults" of current professional development efforts is that "the goals and content of these efforts is prescribed for teachers, rather than by them." Darling-Hammond and Sykes (1999, p. 134) comprehensively fault current practices as:

> Focusing on district-mandated, generic instructional skills of teachers "trained" as individuals by an outside "expert" away from their job site. Because this training is fragmented, piecemeal, and often based on instructional fads, it is viewed as a frill, easily dispensed with in tough financial times. Perhaps most damaging, these workshops, although they often respond to expressed teacher needs, are seldom explicitly linked to what schools expect students know and be able to do.

Despite such indictment, the majority of professional development activities remain "the same as it has always been – a variety of short term specific activities designed to introduce teachers to new curricular practices" (Randi & Zeichner, 2004, p. 189).

Clandinin and Connelly (1995) believe that a major contributor to current professional development practices being externally controlled is the notion that teachers have an incomplete form of professional knowledge. This view of professional development proposes that teachers have been taught that they have incomplete knowledge, and that their learning needs can be met through professional development offered by outside experts. Teachers are not seen to be "knowers

who can teach one another" (Clandinin & Connelly, 1995, p. 126). Lampert (1985, p. 191) discusses the same conceptualization of teacher learning as arising "out of the work of social science researchers and government policy makers." The frequent result of this research is that a teacher is seen as "a technical-production manager who has the responsibility for monitoring the efficiency with which learning is being accomplished."

If current professional development practices are accepted, the notion of professional development may be seen as not being "professional" in the full sense of the word (McCullough, Helsby and Knight, 2000). "Professional" development would tend to undermine the professionalism of the teachers involved, as externally imposed knowledge and prescriptions could "reduce teachers' power to decide on goals and methods and effectively make them technicians following someone else's designs" (McCullough et al. 2000, p. 82). This is not to say that teachers do not learn from undertaking current professional development practices, but it would indicate that professional development is distinct from, and not synonymous with, professional learning. This distinction is far from clear in the literature, with "professional development" and "professional learning" often appearing as synonyms (Melville, 2005).

Professional learning can be described as the work that teachers undertake for learning's sake, rather than simply acting as the "passive recipients of other's ideas" (Randi & Zeichner, 2004, p. 188). According to this conceptualization, the goal of the individual teacher is to focus on "working to learn more effectually" (Randi & Zeichner, 2004, p. 183). Consequently, the responsibility for learning rests more with the teacher than with the school or employing organisation. For this reason professional learning can be seen as a "move beyond the dominant modes" of delivered professional development (Lord, 1994, p. 183). For Lord, this movement involves teachers taking:

> … *opportunities to voice and share doubts and frustrations as well as successes and exemplars. They need to ask questions about their own teaching and the teaching of their colleagues' teaching. They need to recognise that these questions and how they and their colleagues go about raising them, addressing them, and on occasion even answering them constitute the major focus of professional [development]* (p. 183).

Wilson and Berne (1999) identify three characteristics of professional learning in the literature. These are the involvement of teachers in redefining their teaching practice, the teacher activation of their own learning and the importance of teacher discourses around teaching and learning. Lieberman (1996, pp. 187-188) describes a dynamic continuum from "direct teaching" through "learning in school" to "learning out

of school." The shift from the predominant "direct teaching" to "learning out of school" is seen as significant, implying that "teacher development opportunities must become integral to the restructuring of schools" (Lieberman, 1996, p. 187). It is the investigation of this nascent shift between professional development and professional learning in the context of a school science department that is the subject of this article. The guiding question for this investigation is: "How do science teachers utilize the contextual opportunities afforded by changing conceptualizations of professional learning within a school science department?" In order to address this question, we make use of the work of Timperley et al. (2007).

The Wider Context of Professional Learning Opportunities

In seeking to understand the context of teacher professional learning, it is first necessary to consider the wider sociocultural context in which "learning activities occur and strongly influences how teachers may understand and respond to learning opportunities" (Timperley et al. 2007, p. 25). Within this larger context, the professional learning context provides the specific conditions for professional learning. At the time of our research, the sociocultural context was being shaped at a number of interconnected levels. At the state level, beginning in 2001, the Tasmanian Secondary Assessment Board began a review of the science curriculum in Tasmanian schools. The Secondary Assessment Board was a statutory authority charged with providing curriculum in Tasmanian schools, the inter-school moderation of these subjects, and the public examination of university entrance subjects. In 2001, expressions of interest were requested from classroom teachers to be involved in the curriculum review process. Four teachers from the science department in the study school, Rob, Stuart, Zoe and Maddie, participated in this review which continued into 2002. One decision of the review was to undertake a rewriting of the science curriculum, with the intention of promoting the use of constructivist pedagogies. Two of the teachers from the department, Stuart and Zoe, were subsequently involved in developing new science curriculum in the areas of general science and biology, while the third, Maddie, was involved in consultations as to the form of external examination of the new physics curriculum. Rob, as the chair of the science department, participated in a number of the planning meetings. The involvement of these teachers in this work was to shape the discourse of the department.

At the school level two different policies attempted to encourage teacher professional development, and later, professional learning. In 2000, the school implemented an unwritten policy designed to enforce

participation in teacher "professional development." This policy required teachers to demonstrate that they have been involved in 12 hours of their own time, annually, in professional development activities. The definition of these activities was the responsibility of individual teachers. Teachers who did not comply with this requirement were required to spend an extra two days at school at the end of the school year. By the end of 2002 the policy was seen to be unworkable and was rescinded. In January 2003, a newly appointed Principal implemented a new policy. This new, also unwritten, policy stressed that teachers were to be available to undertake "professional learning" in scheduled subject department meeting times after school, although the administration never made clear what activities constituted professional learning. Teachers, working in their departments, were left to develop their own professional learning contexts, decide on the content of their learning, and undertake their own learning activities.

METHODOLOGY

For this article, a narrative case study methodology is employed to examine the relationship between the science teachers and the changing professional learning context. Narratives as stories are potentially influential tools for qualitative researchers. Narrative "is a way of characterizing the phenomena of human experience and its study is appropriate to many social science fields" (Connelly & Clandinin, 1999, p. 2). For Polkinghorne (1995, p. 5) narrative descriptions "exhibit human activity as purposeful engagement with the world. Narrative is the type of discourse composition that draws together diverse events, happenings and actions of human lives into thematically unified goal-directed purposes."

This article developed out of a larger study into the professional learning of a school-based department of science teachers (Melville, 2005). The principal data was provided by tape recording the monthly science department staff meetings over a period of two years. The tape recordings were transcribed to provide the field text for the research. The other source of data in this article is the text of a letter sent by one teacher to the school administration in September 2003.

Data for this article were analysed using the strategy of narrative analysis (Polkinghorne, 1995). This form of analysis allows for data to be selected from the larger data set and configured to form a 'coherent developmental account… bringing an order and meaningfulness that is not apparent in the data themselves' (Polkinghorne, 1995, p. 17). Using narrative analysis, events were assembled in narrative form to illustrate and exemplify the theoretical professional learning framework of Timperley et al. (2007). In their

Best Evidence Synthesis, Timperley et al. (2007) examined a range of studies into the opportunities and processes that influence teacher professional learning and consequently, student learning. In producing their synthesis, Timperley et al. (2007), highlighted three fundamental components of a framework for analysing the efficacy of professional learning experiences: the professional learning context, the content of the professional learning opportunities and the activities that are constructed to promote learning. While it is clear that all three components interact with each other at many levels, it is the professional learning context that is the specific focus of this article.

Relating specifically to science education, the synthesis incorporated eight core studies and five supplementary studies that were explicitly focussed on "promoting student learning in science or improving student attitudes towards science" (Timperley et al. p. 99). In terms of the context of the professional learning opportunities, the synthesis identified nine areas that can be considered to have an impact "in terms of changing the teaching of science in ways that led to positive outcomes for students" (Timperley et al. 2007, p. 103). These areas, and their brief descriptors (Timperley et al. p. 104), are:

1. *Infrastructural supports: These include funding and/or teacher release time for the professional learning. The studies that were analysed did not provide conclusive evidence as to the impact of these supports on teacher professional learning.*

2. *Coherence with policy: In this area, approaches to science teaching are promoted that are consistent with both current research findings and with their policy contexts. This is an important consideration, for "all cases of professional development that led to positive outcomes for students were part of wider and coherent movements in science teaching and learning that were underpinned by strong research bases" (Timperley et al, 2007, p. 105)*

3. *Voluntary or compulsory: Volunteering was not a necessary condition for successful professional development, neither was it a guarantee of change. The content and form of the professional learning opportunities were more important than volunteering in achieving teacher "buy-in" (Timperley et al, 2007, p. 103).*

4. *Individual or whole-school: A similar proportion of studies involved teachers participating in professional development independently of their school colleagues, and teachers participating as part of a whole science department or school. Core studies in which teachers participated independently of their school colleagues developed collegial groups among participants.*

5. *External expertise: All the core studies involved expertise from outside the participants' school environments. "Cascading" models of professional development in which*

external providers trained teachers as trainers had mixed outcomes but could be successful under certain circumstances.

6. *School leadership: Insufficient information was provided to draw conclusions about school leaders' involvement. As the school provided little leadership in shaping the professional learning context for the teachers in this department, this area has not been analysed.*

7. *Time and frequency: All core studies involved professional development over extended periods of at least one school year, with some up to five years, with relatively frequent input, particularly in the initial stages. One-off learning opportunities may be sufficient to bring about changes that are of limited scope, but not substantive changes in practice and outcomes.*

8. *Prevailing discourses: Some cases of professional development were successful despite initial differences between the prevailing discourses of the teachers and the ideas being promoted.*

9. *Professional learning goals: In all the interventions in the core studies, professional learning goals specific to science were explicitly shared with teachers.*

ANALYSIS AND DISCUSSION

Timperley et al (2007) have synthesised nine areas which provide the context of teacher professional learning opportunities. As the conceptualization of teacher professional learning evolves along the continuum proposed by Lieberman (1996), there is a need to investigate how teachers can utilize the new contextual opportunities that are afforded to them if they are to move towards the changes recommended for teachers in authoritative documents such as the National Science Education Standards [NSES] (National Research Council, 1996, p. 52). Using the contextual framework synthesised by Timperley et al (2007), it is possible to analyse how teachers in one science department can utilize new professional learning opportunities.

Infrastructural supports

Under both the professional development policy (2000-2002) and the professional learning policy that the school implemented in 2003, departmental meetings were considered part of the teachers' workload, and hence no funding or release time was allocated to them. The purpose of the 2003 policy change was explicit; each subject department was required to focus its scheduled departmental meetings on teacher professional learning. As Rob, the science chair, reported in February 2003: "Our department meetings, our science ones, are to be more along the lines of professional learning, rather than information

dissemination." Under both policies, the school did provide release time for teachers who were engaged in the writing of the new science curriculum, while the Department of Education also funded travel and meals for these teachers. Consequently, the infrastructural support was limited to only four teachers.

The data is inconclusive regarding the effectiveness of the teacher release time for the teachers involved in the curriculum project. The only teacher to explicitly express a change in their teaching practice as a result of engagement with the external meetings was Rob, the science chair. At a planning meeting early in 2002, he was given a document, *The status and quality of teaching and learning of science in Australian schools* (Goodrum, Hackling & Rennie, 2001) that piqued his interest: "It is very interesting, what they've found is that teachers believe that they are teaching in certain way, and that kids are learning in a certain way, and the teachers' opinion is totally different from the students' opinion" (March 2002). By April 2002, he was beginning to question his teaching strategies, especially in relation to the top science students he taught. Part of this questioning involved conversations with his colleagues:

Rob: The top year 10 science class I teach is really focussed on knowledge and theory, because they are the students who are going to go onto year 11 and 12.

Maddie: Yes, but is that knowledge and theory being applied to practical situations?

Rob: Don't know, probably not for me, but then it's probably my fault in the way that I teach it (April 2002).

By June 2002, the impact of the curriculum project on Rob had become clear:

I suppose going to those preliminary science writing workshops made me sit back and think about what we are doing here, and how we're teaching it, and in particular, how I'm teaching it. I suppose with my teaching, I need to head more towards more investigative work for students, more hands on science with them. I suppose bringing experimental design into my teaching, with my years 9 and 10's I struggle to give them an experiment that they can design themselves. What are we covering and how we are covering it, especially how are we teaching students to be scientists and investigate and question. (June 2002).

The provision of infrastructural supports had provided the opportunity for four teachers to be involved in a curriculum writing project at the state level. The data reveals, however, that only one teacher explicitly questioned his own teaching as a result of the meetings. Rob was "tinkering" with his teaching (Huberman, 1992, p. 137). This is important as it is through tinkering that "an individualised embryo of knowledge creation [which if] more systematic, more

collective and explicitly managed … is transformed into knowledge creation" (Hargreaves, 2000, p. 231). Tinkering is the process through which teachers can take a good idea and develop it into "something worth subjecting to more systematic validation" (p. 231). Tinkering with ideas, in the form of personal reflection and/or public discourse amongst teachers, is an important consideration in professional learning. The impact of the infrastructural supports is difficult to gauge. For Rob, the meetings appear to have had a swift personal impact, for the other teachers the impact appears to have been delayed. As a result, it may be necessary for researchers to take a long-term view of the impact of infrastructural supports. A clear risk is that, viewed over the short-term, it may be difficult "for any conclusions to be drawn about the impact of their presence or absence" (Timperley et al., 2007, p. 104)

Coherence with policy

Over the course of the data collection, the teachers in the department did begin to emphasise many of characteristics of inquiry-based instruction, such as described in documents like the NSES. This gradual change in emphasis was not however, coherent. From engagement with the curriculum writing process in 2002, material such as *The status and quality of teaching and learning of science in Australian schools* report did become available in the department. This report clearly influenced Rob, but the change did not really influence the majority of teachers until another teacher, Jenny, proposed a public exhibition of student inquiries in September 2003. As Jenny wrote in that month, the exhibition was to:

1. *Showcase the scientific research work being conducted by grade 9 and 10 students at the school.*
2. *Allow students an opportunity to "speak to" their research before judges and the general public (their parents and friends).*
3. *Raise public awareness of the importance and relevance of science to our lives today.*
4. *Create models and exemplars of students' work to assist teachers embarking upon this approach to curriculum delivery.*

It is my belief that conducting independent scientific research allows students an opportunity to address all of the above key elements.

- *In order to decide upon a topic for research, students must demonstrate some curiosity and sense of inquiry in relation to some scientific phenomenon and reflect deeply upon the best pathway to pursue to answer their questions.*
- *When communicating with one another during the process, or with the public when completed, students need to utilize different modes of communication.*
- *Numeracy, in relation to their quantitative evaluations*

- *Literacy, in verbal and written communication*
- *Information technology, in compiling their results*
- *In personal terms, while conducting the research, students need to: set firm goals (both short and long term) and pursue them; be ethical in presenting "true" results; avoid plagiarism; and maintain good relationships with co-workers.*
- *In social terms, students need to value the diversity of their working groups and allow equal representation. They must show understanding and act democratically toward one another. Only in this way can a future that will hold benefit for all, emerge.*
- *With view to our world, hopefully they will come to understand the systems already in place, their benefits and limitations and how these can be modified to create more sustainable futures.*

The role of Jenny in leading this change of emphasis towards science as inquiry is interesting, as it appears to support the work of Judson and Lawson (2007) on the role of constructivist teachers in departmental communications. A conclusion that can be drawn from this is that the teachers in this department "view constructivist teachers as leaders" (Judson & Lawson, 2007, p. 501). While Rob was the school appointed head of science, Jenny had established a reputation for teaching science as inquiry. When the teachers began moving towards teaching science as inquiry, it was Jenny who was identified as a leader. As Judson and Lawson (2007, p. 501) explain, constructivist teachers are "sought out for guidance more frequently than would be expected by virtue of a formal position (e.g., department chair), and thus, the person finds themselves in a leadership role." The promotion of science as inquiry also parallels the emphases in science education being promoted in documents such as the NSES. The exhibition, which has been held each year since 2003, has been well supported by the department's teachers.

Voluntary or compulsory

Timperley et al. (2007, p. 105) have noted that "volunteering is neither a necessary condition for, nor a guarantee of, positive outcomes … what is important is that teachers 'buy in' at some point." The data appears to support this contention. Under the 2000 policy, teachers had complete discretion regarding the form and duration of activities they were engaged in. The 2003 professional learning policy stressed that teachers were to be available for regular, after school departmental meetings. However, depending on the day of the meeting, the part-time teachers may, or may not, have been in the school. As a result, of the 10 teachers in the department, only the six full-time teachers were recorded as making substantive contributions to the discourses around the science curriculum project and

the shift towards science as inquiry. This is significant, for conceptualising the subject department as the primary context for teacher professional learning is founded on two premises. These are the importance of the subject department as the principal site for the development of both relationships and teachers' social identity as teachers of their subject (Siskin, 1994). The role of conversation in shaping the meanings, identities and practices that teachers bring to their work is not to be underestimated (Coburn, 2001; Hill, 2001; Judson & Lawson, 2007; Siskin, 1994). For part-time teachers, it would be reasonable to speculate that "buy in" is a more difficult process as the development of both relationships and identities require both engagement and long-term commitment: "teaching has always evolved like other complex, culturally embedded activities— slowly and incrementally" (Stigler & Hiebert, 1999, p. 132). The limited professional learning opportunities for part-time teachers may make it difficult for them to move from "learning in school" to "learning out of school" on Lieberman's (1996) professional learning continuum.

Individual or whole school

A common feature of both school policies was that teachers were mandated to undertake professional learning. A key difference was the form of activity: the 2000 policy was far more individualistic than the 2003 policy which mandated that teachers would make themselves available for departmental meetings focussed on professional learning. The 2003 policy would seem to echo the "frequently heard claim that effective professional development must involve whole staff or departments" (Timperley et al. 2007, p. 106). The reality of the professional learning opportunities available to teachers in this department was, however, far more complex. As we have seen, Rob questioned his teaching as a direct result of his involvement in the science curriculum program. For Stuart, engagement in the curriculum project had provided opportunities to verbalise what was important in science education:

These are the things that we thought were essential… an understanding of the language and structure of the subject, the basic ideas and concepts… and developing those cross subject links… scientific literacy, the terminology and the language of science, and the scientific method (June 2002).

For Zoe, the curriculum project opened up new possibilities for the delivery of the curriculum:

One idea is to put things like aquaculture, agricultural science and geology in a framework curriculum that could be done from the point of view of a local industry… you know the sort of project science that Jack has been doing with his lower ability students (June, 2002).

Jenny was not involved in the science curriculum project, but was an active member of the Australian Science Teachers Association. In December, 2002, she reported on how the work of a science teacher in the state of New South Wales may be useful in the developing the work of the department.

I was talking to a woman from New South Wales who was going off on a bursary to an overseas university. She won an award to do this … what she wants to do now is to set up firstly in their school, and then extend it through New South Wales in general. She's got chemistry and physics and biology, and she is one of the sharpest operators that you would meet anywhere.

Professional learning can be situated either individually or corporately, internally or externally, to the department. A critical role of the department as both an organisation and as a community is to provide opportunities for all teachers to learn from their colleagues (Melville & Wallace, 2007). Teachers do not respond to change in isolation, for the subject department(s) to which they belong can provide a community of practice in which meanings, identities and practices can be negotiated and reified (Hodkinson & Hodkinson, 2002; Wenger, 1998). The primacy of the subject in these negotiations and reifications is argued by Siskin (1994) and Helms (1998, p. 831), who states that the identities of science teachers are defined by the subject matter to a "greater or lesser degree."

External expertise

Access to external expertise appears to be a pre-requisite for teachers to move towards inquiry-based science teaching, as teachers require support "in terms of extending theoretical knowledge and translating it into practice" (Timperley, et al. 2007, p. 106). As discussed in the section above, the teachers in this department had established a number of links with teachers in other schools, curriculum designers with the Tasmanian Department of Education, and subject associations. Input from these external experts was relayed into the department and discussed during the meetings. This raises two important issues for teachers and external expertise. The first is the obvious: the absolute need for teachers having the opportunity to communicate with both experts and their colleagues (who may in some cases be one and the same): "Learning communities are driven by conversations that allow teachers to co-construct understanding of issues and build collective sense making" (Judson & Lawson, 2007, p. 491). The second is the risk departments run if those conversations are not properly grounded in the theoretical knowledge base of an education reform. Using the example of Jenny's proposal for an exhibition of student's scientific inquiries highlights this potential

problem. In her September 2003 proposal, Jenny specifically linked the exhibition to the new Tasmanian Essential Learnings Framework curriculum that the school was looking to implement in 2004 or 2005. Jenny wrote "It is *my* belief that conducting independent scientific research allows students an opportunity to address all of the key elements [of the Essential Learnings]" (October 2003, author's emphasis). At the time, the new curriculum framework was still the subject of much speculation. There is a potential danger here that the understandings of one individual teacher, which influenced the practices of this department, are misinterpretations or superficial interpretations of the reform. What is needed in such situations is for teachers to undertake "a critical dialogue about practice and ideas" (Wilson & Berne, 1999, p. 186)

Time and frequency

The data presented in this paper was collected in 2002 and 2003, by the audio recording of the science department meetings that were scheduled every six weeks throughout the school year. The change of policy in 2003 prompted a revision of the purposes of the meetings. As Rob explained:

Our department meetings are to be more along the lines of professional learning, rather than information dissemination. There's an expectation that the meetings will be from 3.15 to 4.15 minimum, and during that time we do some professional learning, which might mean that we take turns in presenting something. You only need to talk about something that you might do in class, an experiment that you might do (February, 2003).

Stuart had experience in this form of departmental meeting from his previous school:

We did that sort of system a couple of years ago, where each person took a meeting, and one person who was new to science teaching brought in their Year 8 practical books, and then people went through and discussed: why did you give this person a C and this person a B, which helped moderate things very nicely. One person did something on teaching about models, using models in science and some of the problems that you run across in using models. It doesn't need to be much, and if it is addressing problems that people have already mentioned, well, it helps everybody (February, 2003).

This model was progressively implemented over the course of the year. The formal use of time for professional learning, in addition to the informal, such as: "when you are talk to people over lunch. Like that conversation the other day about vectors, and making sure that the students were doing the same style with their vector work" (Stuart, February, 2003) are both

opportunities for professional learning (Feldman, 1994, p. 1).

As evidence of the importance of time in achieving educational changes, many of the issues that were discussed in 2002 and 2003 began to come to fruition in 2004 and 2005. Among these changes were the introduction of an open inquiry research topic into grades 9 and 10, a greater emphasis on teaching scientific research skills in grades 7 and 8, the continued growth of the science exhibition, and looking at assessment methods to reflect the ongoing changes in the teaching of science.

Prevailing discourses

This department, over the course of two years, begun to shift towards an inquiry based approach to science teaching. The implementation of the exhibition has already been discussed, but this was just aspect of a larger shift in emphasis. In June 2002, Zoe expressed a concern about the lack of learning the processes of science:

Can I put in a strong plea that experimental design is incorporated. I mean there should be some of that incorporated every year. I still get kids trying to do senior biology who really don't have much idea of really basic principles of design for experiments. You can do it in grade 7 with the notion of fair tests and only varying one thing. It can be done quite easily, but it becomes difficult further up the school, when they have not met it.

In December 2002, when the department met to consider the content to be taught in the 2003 school year, Jenny proposed a research topic, and how it could be organised:

It could be organised by a couple of different methods. One way would be that you go unit one, research block, unit two, and unit three. That means that they have their research finished half way through the year. One of the other options would be that you start doing unit one, and then have a research day every two weeks, which is probably a better way to go.

Rob was already looking at the implications of this proposal for both assessment and those students who struggled with science: "That work would be a major part of their assessment; you could just about assess every criterion. Jill, would your kids be alright with this?"

It was decided that an investigative topic be developed for those students who struggled with science. The selection of this topic was to be at the discretion of the teacher, based on their knowledge of the students' interests and abilities. For these students, it was also decided that they should have the opportunity to develop their research skills, but to provide the extra support that they would require.

In doing so, change in the department mirrors the core studies that were investigated by Timperley et al. (2007). In these studies, departments moved towards a science as inquiry stance. The data also shows this shift to be a slow, non-linear process. Engagement with the science curriculum project and the science subject association lead to teachers beginning to question their own classroom teaching, and seeking ways to incorporate not just the *products* of science, but also the *process* of science (Bybee, Carlson-Powell & Trowbridge, 2008). In changing their discourses, these teachers took advantage of the opportunities offered by vague school policies to frame the questions that needed to be addressed in their specific context. Professional learning occurs when "teachers learn collaboratively … where participants struggle along with others to construct meaningful local knowledge and where inquiry is regarded as part of larger efforts to transform teaching, learning and schooling" (Cochran-Smith & Lytle, 1999, p. 278). There is also a strong ethic of practicality in teacher professional learning: "what works and what doesn't [for] this teacher in this context … [a] complex and potent combination of purpose, person, politics and workplace constraints" (Hargreaves, 1994, p. 12). Hence learning involves both the desire, and the opportunity, to develop new ways of thinking about practice. As Ridden (1996, p. 27) states, professional learning requires:

> *Finding ways to challenge [teachers'] thinking; to assist them to evaluate their own practice; to encourage them to take risks with new behaviours, new practices and new ideas; to assist them through the process of working with those new practices; to celebrate with them the successes and reflect with them on the failures that will probably be part of the process; to help them set and achieve personal goals.*

Professional learning goals

Timperley et al. (2007, p. 108) found that "In all the core studies, professional learning goals and underpinning, theoretical principles specifically related to the teaching and learning of science were made explicit to teachers." This department is different, as the teachers did not explicitly set out the learning goals that they aspired to. Rather, through engagement in science education activities external to the department, and their own indigenous expertise and experience, they began to shape their goals as they moved forward. In doing so, they took advantage of two important factors. The first was the school's lack of specificity in defining the meaning of "professional learning." This meant that teachers in the department were able to develop their ideas around science education free from a school level mandate as to what was acceptable. The second was that teachers felt confident in being able to express their

difficulties at the meetings. As Lord (1994, p. 183) says, professional learning requires:

> *… opportunities to voice and share doubts and frustrations as well as successes and exemplars. They need to ask questions about their own teaching and the teaching of their colleagues' teaching. They need to recognise that these questions and how they and their colleagues go about raising them, addressing them, and on occasion even answering them constitute the major focus of professional [development].*

The teachers in this science department, over a period of the two years, began to recast their teaching and learning towards a stance of science as inquiry. There are a number of conclusions that can be drawn from their work, and also important implications for other teachers and departments.

CONCLUSIONS AND IMPLICATIONS

The guiding question for this investigation was: "How do science teachers utilize the contextual opportunities afforded by changing conceptualizations of professional learning within a school science department?" Using the work of Timperley et al. (2007), we have sought to describe how the context of one science department allowed the teachers in that department to implement gradual changes in the way science was taught in their school. This emphasis on the department is important for two reasons. The first is the well established position that departments have in the work and learning of teachers (Horn, 2005; Ritchie & Rigano, 2002; Siskin, 1994; Talbert, 2002; Visscher & Witziers, 2004). Second, as a ubiquitous organisational feature of secondary schools, departments provide "structural arrangements and instruments … at the disposal of school management to promote the professional development and learning of teachers" (Visscher & Witziers, 2004, p. 786). While there are many issues associated with the effective use of these "arrangements and instruments," the fact remains that they are extant.

There are three salient points arising from the data analysis. The first is the negligible impact by either school policy on the work of the teachers in the department. The second is the willingness of teachers to utilize appropriate expertise, regardless of the source of that expertise. The third is the manner in which these teachers have developed a community in which teaching practices, both individual and corporate, can be discussed and critiqued. The clear implication of these points is that it was the teachers, working within the department and wider science education community, who were making the conceptual change from professional development to professional learning.

The change at the school level, from the 2000 professional development policy to the 2003 professional learning policy had a negligible impact on the teachers in the department. Given the lack of specificity as to the meanings that school applied to the terms professional development and professional learning, this is not surprising. However, that is not the full story. The 2000 policy was targeted at individuals, who were to complete 12 hours per year of their own professional development, however they wished to define those activities. The 2003 policy, in contrast, focuses teacher professional learning at the department level. Given the important role departments potentially play in teacher learning, this is an important change. Unfortunately, there is no extant data to indicate the administrations' reasoning behind this change of emphasis. By situating teacher professional learning at the department level, the school administration may have sought to open up opportunities for teachers to redefine their teaching practices, activate their own learning and engage in the important discourses around teaching and learning (Wilson & Berne, 1999). The teachers in this department, however, were already engaged in these activities before the policy change. This implies that the answer(s) to the research question lies not in school level policies; rather it lies with the teachers themselves.

The teachers displayed a willingness to look beyond the department for appropriate expertise in their professional learning. The majority of full-time teachers were voluntarily involved in the science curriculum project or developing strong links to other teachers though the national science subject association. For those involved in the curriculum project, the hours involved far exceeded the requirements of the 2000 professional development policy: "endless days working on a biology curriculum" (Zoe, February, 2003). This array of external expertise was foundational in shaping the context of the teachers' professional learning opportunities. The input of expertise from a range of external sources, and the opportunity to share that input within the regular departmental meetings strengthened the "conceptual infrastructure" (Horn, 2005) of the department. Such strengthening can occur when individual teachers have the opportunity to bring understandings from different expert sources and coordinate those understandings through "multiple and ongoing occasions to reflect on their meanings collectively" (Horn, 2005, p. 229). In this department, access to a range of external experts, and the coordination of discourse around science education as being about both the products and process of science gave a measure of coherence with current understandings of science as inquiry. A key component of the context for professional learning for these teachers is, therefore, the capacity to work in a range of

science education communities and act as knowledge "brokers" (Wenger, 1998) between those communities.

The community of practice (Wenger, 1998) developed by these teachers appears to reflect the five themes suggested by Lieberman and Grolnick (1997). The first is that the majority of the full-time teachers were focussed on a particular objective, the science curriculum project. From this initial objective, there was a progression to the teaching of science as inquiry. The second theme is the development of a community in which the teachers "had voice and commitment to the group, learnt to collaborate and strove for consensus" (Wilson & Berne, 1999, p. 190). The third theme, directly related to the change in policy was that the teachers had the time to talk – the departmental meetings were to focus on teaching and learning. Talking was not restricted to the meetings, however, conversations around teaching and learning also occurred on a regular basis. The fourth theme of facilitative leadership is also clear as different teachers provided leadership at different times: particularly on the case of Jenny. The fifth theme of funding is related directly to the school, which provided time release for the teachers to attend the curriculum meetings, and the Department of Education, which covered the teachers' costs. An important point to remember is that the teachers in this department had developed these features of a functioning community of practice without formal guidance or assistance. Their work in developing a community of practice also reflects the findings of Sahin (2004, p. 82), who stated that:

> Teachers felt that it was important to have social and professional support systems of peers and collaborators to act freely and professionally in the teaching profession. They felt that to have ready access and support for science and mathematics teachers from professionals and experts from areas of science, mathematics, technology, and research not only helps their professional development but also gives them a sense of being valued and respected.

Mindful of the limitations of generalising too far from research into one science department, the data appears to suggest that the conceptual shift between professional development and professional learning is not one that can be imposed by school administrators. School policies may have limited impact on the conceptual change, although it must be acknowledged that the policy change in this school did focus learning on the department, rather than the individuals within the department. Given the minimal impact of school level policies and the clear capacity for the teachers to shape their own professional learning context, it would appear reasonable to propose that it is the teachers who have made the conceptual change from professional development to professional learning. In making this conceptual change, the department appears to be acting simultaneously as both a community of practice and as

an organization that is reforming science teaching learning by creating "agreement on what is worth achieving, and they set in motion internal processes by which people progressively learn how to do what they need to do in order to achieve what is worthwhile" (Ingvarson, 2002, p. 13).

The experience of this department demonstrates that teachers are in a position to shape the context of their own professional learning. If this is the case, why is reform in science education often defined as the "new organization of materials for teachers to use?" (Yager, 2005, p. 16). If the conceptual change is the province of teachers working in both their own departments and wider professional communities, then science teachers may be well advised to see themselves:

> *less as consumers and more as providers of knowledge concerning teaching … less as followers and more as leaders … less as persons housed in a classroom and more as a member of a professional community … not as "the target" for change, but as a source and facilitator of change (Yager, 2005, pp. 17-18).*

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