CHAPTER 6
KNOWLEDGE RENEWEL IN THE 21ST CENTURY: DEVELOPING A PROFESSIONAL NETWORK OF BIOLOGY TEACHERS

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Abstract

Research into effective strategies for the professional development of science teachers, and in particular biology teachers, is an important area of study. Given the rapidly expanding knowledge and interest (in both the media and scientific arena) in areas such as biotechnology, stem cell research and gene therapies, to name but a few, it seems increasingly important that biology teachers remain up-to-date with such advances. "This expansion in what counts as biotechnology is important for science and math teachers to know as they prepare students for their roles as modern citizens, scientific workers, and postsecondary students" (Tate & Malancharuvil-Berkes, 2006, p. 283). With enrolments in biology, chemistry and physics by year 12 students in Australian schools dropping by 29, 25 and 23% respectively between 1990 and 2001 (Fullarton, Walker, Ainley, & Hillman, 2003; Lyons, 2006) it could be argued that lack of teacher expertise is a contributing factor in these declines. These regressions have prompted "questions about future levels of scientific literacy and technological expertise" (Lyons, 2006, p. 285).

THE CONTEXT

The *PD* 2000 Australia report (McRae, Ainsworth, Groves, Rowland, & Zbar, 2001) presents the most recent snapshot of professional development practices by Australian teachers and schools. It defines the term 'professional development' (or PD) as "deliberate processes designed for the purposes of teacher post-initial professionally related education and training" (McRae et al., 2001, p. 3). Loucks-Horsley, Hewson, Love and Stiles (1998, p. xiv) use the term PD "to mean the opportunities offered to educators to develop new knowledge, skills, approaches, and dispositions to improve their effectiveness in their classrooms and organizations".

In order for Australia to remain competitive in an increasingly technological global community, it needs to attract and retain quality teachers of science who are equipped to stimulate the interest of today's student (Dekkers & DeLaeter, 2001). A recent audit of science, engineering and technology skills (SET) (Australian Government: Department of Education Science and Training, 2006), identified that there is a "strong perception that Australia lacks sufficient suitably qualified secondary school science teachers, which impacts adversely on student engagement in SET" (Australian Government: Department of Education Science and Training, 2006, p. x). The report highlighted a number of issues that will affect this productivity into the future including "concerns about the quality of science education'" (Australian Government: Department of Education Science and Training, 2006, p. iii). "Australia's productivity and success in the highly competitive global market is increasingly reliant on science" (Australian Government: Department of Education Science and Training, 2006, p. iii). Concerns of a brain drain, with scientists pursuing careers outside Australia and a general lack of future scientists (due to a 'dumbing down' of curriculum content and a lack of qualified teachers equipped to incorporate the latest scientific knowledge into their classrooms) has been well documented in the media in recent times. This has implications for the future knowledge economy of Australia. A similar problem has been identified in the USA with Bybee & Fuchs (2006) identifying links between science and technology and global economies. In a review of 12 reports compiled from sectors including business, industry and government, these authors identified one crucial common element. "Almost without exception, the reports mentioned the critical role of science and technology in the economy" (Bybee & Fuchs, 2006, p. 350). If there are declining numbers of students studying the sciences in Years 11 & 12, combined with well documented concerns about the quality of science teachers in our schools, then Australia is at risk of being left behind, particularly in the lucrative areas of science and technology research and development.

In the Australian Science Teachers Association (ASTA) submission to the SET audit, "serious concerns about the ongoing provision of professional development for the teachers of science" (Australian Science Teachers Association, 2006, p. 10) were identified as contributing to the shortage of SET professionals for the future.

> Teachers do not have the access to stay in touch with current scientific research and career information and hence are not

> always good public relations machines for science careers. (Australian Science Teachers Association, 2006, p. 3)

The ASTA National Professional Standards for Highly Accomplished Teachers of Science state that "highly accomplished teachers of science have an extensive knowledge of science, science education and students" (Australian Science Teachers Association, 2006, p. 3).

It is recognised that there is a correlation between teacher knowledge and how teachers teach (Justi & van Driel, 2005). The effectiveness of teachers is an important and complex area of study. Indeed "the teacher is the most significant factor effecting student learning and achievement" (Tytler, Waldrip, & Griffiths, 2002, p. 11). The content knowledge of teachers is only one component of what makes a teacher effective. The other part of this equation is whether teachers know how to successfully teach this new knowledge to students (Traianou, 2006).

The School Innovation in Science Project (SIS) conducted in Victoria between 2000 and 2002 aimed to describe the practices of effective teachers (Tytler, 2002). One of the outcomes of this project is a list of eight components that "describe the effective teaching and learning of science" (Tytler et al., 2002). One of these components states that "science is linked with students' lives and interests" (Tyler, Waldrip, & Griffiths, 2004, p. 177). This provides further justification for the need for Biology teachers (in this context) to update their content knowledge in line with current scientific issues.

A large volume of research makes clear the importance of science teachers maintaining and upgrading their knowledge base (content) for their teaching areas (Butler Kahle & Kronebusch, 2003; Cavanagh, 2004; Feldstein & Benner, 2004; Garet, Porter, Desimore, Birman, & Yoon, 2001). "Some teachers have not read a professional book or journal since they were required to do so in their pre-service classes" (Stephens & Boldt, 2004, p. 704). Mulholland and Wallace (2005) identified the need for a strong knowledge base and the often limited development of this knowledge base over time. As suggested by the ASTA submission, the content teachers learnt during teacher-training is "not necessarily the way their students will need to be taught in the 21st Century" (Neiss, 2005, p. 509). This is especially the case in the rapidly changing area of biological science. It was also noted by ASTA:

> …that the aging structure of the science teaching workforce with limited knowledge on the emerging fields within science, such as biotechnology and nanotechnology, are going to have difficulty in providing the type of information and enthusiasm

> about these fields that would entice students to pursue rewarding careers in science. (Australian Science Teachers Association, 2006, p. 4)

It can therefore be suggested that there is a significant need for the development of suitable strategies for ongoing teacher PD with an emphasis on the emerging knowledge areas in science. It could be argued that the biological sciences, in particular the areas of gene therapy, stem cell research including therapeutic coning, disease detection and control (e.g. H5N1- bird flu, HIV/AIDS) are now so regularly reported in the media that it is vital that teachers maintain a good working knowledge of these topics and others as they emerge. The relevance and importance of these issues to students should not be discounted and provide a perfect opportunity for teachers to stimulate interest.

PROFESSIONAL DEVELOPMENT

A large variety of PD models utilised by science teachers have been described by various authors (Adey et al., 2004; Bell & Gilbert, 1996; Loucks-Horsley et al., 1998). It is beyond the scope of this chapter to describe them all; however a few provide relevant points of comparison. Three general characteristics can be used to describe PD models- the timeframe within which the PD is undertaken; the grouping of the participants and the presentation mode used.

Traditionally teacher PD consisted of a session or group of sessions over the course of a day presented by an 'expert'. After this brief time commitment teachers were then left to their own devices as to how to best make use of this new knowledge and skills. There was often no ongoing support, reflection or discussion. As a consequence, "there is universal condemnation in the research literature on professional development for the one-shot 'INSET' day as a method of bringing about any real change in teaching practice" (Adey, Hewitt, Hewitt, & Landau, 2004, p. 161). The alternatives where teachers participate in the PD over a longer timeframe, with opportunities for reflection on implementation are generally accepted as being more beneficial.

There are generally two frameworks for the grouping of participants. Firstly, those that involve individual teachers, sometimes grouped by subject areas or interests and often undertaking PD with similarly grouped teachers from different schools or districts. The second general model involves a whole school approach. Tytler, Smith, Grover and Brown (1999) examined the experiences of participants in professional development sessions such as these. This research found that the perceived effectiveness of these different models is determined by a number of factors including; teacher experience, subject area and the different types of knowledge associated with different disciplines and school culture. Participants in both types of PD identified the social element of the sessions as a positive element contributing to the success of the programs (Tytler et al., 1999). This social element is what makes the use of ongoing professional networks attractive and a relevant area of study.

The presentation mode can involve an 'expert' talking to teachers, sometimes in a formal lecture format, or more informal sessions where teachers work together collaboratively. Being part of a 'discourse community' rather than being 'talked at' by 'experts' empowers teachers and makes them feel that their knowledge and experience is respected (Lieberman & McLaughlin, 1992). Bell and Gilbert (1996) in their 'social-personal-professional' model of PD found that 'collegial relationships were important as they provided opportunities for listening, contributing, discussing, supporting, giving feedback and reflecting on their teaching' (p. 26). Before a discussion on the use of professional networks, it is valuable to discuss where the concept of teachers working together - rather than being 'talked to' (as is the case in many traditional PD models), originated.

Showers and Joyce (1980) suggested 'peer coaching' as a valuable strategy for the professional development of teachers. They suggested that the use of weekly seminars allowed teachers to practice and implement content and resulted in increased implementation of these strategies in the classroom.

> Teachers who had a coaching relationship – that is, who shared aspects of teaching, planned together and pooled their experiences- practiced new skills and strategies more frequently and applied them more appropriately than did their counterparts who worked alone (Showers & Joyce, 1996, p. 14).

In this way teachers are able to share resources, strategies and knowledge in a supportive environment that is tailored to their specific needs. This is particularly suited to a group of teachers from the one subject area such as biology.

Teachers working together in networks are just one example of 'collaborative learning communities' where teachers work together and exchange dialogue about practice in a safe, supportive environment (Snow-Gerono, 2005). Other phrases such as "collegial study groups", "professional learning communities" (Dana & Yendol-Silva, 2003), "knowledge communities" (Craig, 1995) and "peer coaching" (Showers & Joyce, 1996) are also used. Results from a study by Briscoe and Peters (1997) indicated that collaboration between science teachers provided opportunities to share both content and pedagogical knowledge and encouraged participants to take risks and implement new ideas. Kahle & Kronebusch (2003) also make the suggestion that subject matter be combined with pedagogical training in order to make professional development relevant and create "a seamless transition into practice" (p. 586).

This flexibility and specificity offered by a professional network is what makes this form of professional development attractive. "A network is an organised professional community that has a common theme or purpose. Individuals join networks to share their own knowledge and experience with other network members and learn from other network participants" (Loucks-Horsley, Hewson, Love, & Stiles, 1998, p. 142). Teachers working collaboratively to achieve a shared goal feel empowered to continue learning and are often able to significantly change their instructional practices (Beatty, 2000; Brownell, Adams, Sindelar, & Waldron, 2006; Weidemann & Barr Humphrey, 2002). "Belonging to networks gives teachers fresh ways of thinking about education quality and application" (Lieberman & McLaughlin, 1992, p. 673).

Within the education community these networks can work together to improve knowledge of subject matter or address pedagogy issues or sometimes both (Loucks-Horsley et al., 1998; Pennell & Firestone, 1998). Networks are often established for a variety of other purposes; however, the network for this study will be subject specific and concentrate on enhancing the content knowledge of Biology teachers in secondary schools.

Justi and van Driel (2005) have identified a lack of research into knowledge development of teachers in specific content areas. "Subject-area collaboratives focus specifically on the critical examination of practice in a particular discipline, evaluating and developing new pedagogies and deepening teachers' content knowledge" (Lieberman & McLaughlin, 1992, p. 674). In this way participants are able to shape their learning and have direct input into the content of the sessions. It is this personal input that makes professional networks different from more traditional PD programs. Indeed many conventional programs fail to address the particular needs of teachers, but are generic or rather 'one-shot workshops' with no ongoing follow-up or support (Adey et al., 2004; Justi & van Driel, 2005; Lieberman & McLaughlin, 1992; Pennell

& Firestone, 1998). Garet et al (2001) in a survey of 1027 maths and science teachers emphasised the importance of subject-matter focus and the construction of groups consisting of "participants from the same school, grade or subject" (Garet et al., 2001, p. 915).

Indeed, one of the attractive aspects of professional networks is the social component and interaction with other teachers with similar interests (Bell & Gilbert, 1996; Lieberman & McLaughlin, 1992; Loucks-Horsley et al., 1998; Weidemann & Barr Humphrey, 2002). "Teachers need supportive, collegial communities when inquiring into significant questions about subject matter" (Jeanpierre, Oberhauser, & Freeman, 2005, p. 671).

Loucks-Horsley et al (1998) identify a number of assumptions about teachers and learning in the context of professional networks.

- The social nature of adults means they benefit from interacting with other teachers with similar interests.
- Improvements in practice can be achieved when mechanisms are provided for teachers to share knowledge and experience.
- If members of the network share common beliefs and work together, meaningful improvement can be made in education programs.

In order for a professional network to be a success (as determined by participants) a number of factors need to be addressed. Firstly, professional networks cannot be too rigidly tied to policy or formal guidelines. "Networks succeed because they respond to participants' professional needs" (Pennell & Firestone, 1998, p. 356). Members of the network give the network an identity through their common interests and goals (Lieberman & McLaughlin, 1992). Constructed rather than delivered programs allow participants to "build the agenda by sharing their own ideas. Constructed programs reflect quite closely the skills and interests of the teachers who attend" (Pennell & Firestone, 1998, p. 355).

Secondly, good communication is vital (Loucks-Horsley et al., 1998; Weidemann & Barr Humphrey, 2002). All members must be able to benefit from others input and ground rules are necessary to maintain a high standard (Loucks-Horsley et al., 1998). Again collaboration and negotiation between participants can be used to formulate these ground rules and communication protocols.

Facilitation and leadership issues are the third factor to be considered. The determination of leaders is often influenced by whether the network is formal or informal. Good leadership is critical to sustain the momentum of the network (Loucks-Horsley et al., 1998). Participation in professional networks also provides the opportunity for teachers to adopt leadership roles and develop skills in this area whilst sharing their knowledge (Lieberman & McLaughlin, 1992).

IMPLEMENTATION

In order for a professional network to be relevant and successful for its participants, a number of implementation requirements must be established. Loucks-Horsley et al., (1998) identified four implementation requirements. Firstly, there needs to be a clear focus and purpose for the activity. If participants are unclear about the purpose of the network, sustainability is unlikely. Unlike the more traditional models of PD, where content are often generic, professional networks lend themselves to focused activities targeted at the needs of the participants. “Those who join the network establish a sense of identity through the pursuit of activities relating to their common interests and objectives” (Lieberman & McLaughlin, 1992, p.674). In a safe and supportive environment Biology teachers would be able to learn new content material, try out new techniques for disseminating this to students and regain their enthusiasm for their subject area (Lieberman & McLaughlin, 1992).

Secondly, interaction between participants will be determined by the size of the network. Whilst electronic networks can often sustain large numbers, face-to face networks need sufficient participants to allow for adequate interactions, but more complex leadership structures are required for larger groups (Loucks-Horsley et al., 1998). The size of the professional network therefore determines the third implementation requirement – communication guidelines. Newsletters, discussion groups and classroom visits are a few of the strategies suggested by Loucks-Horsley et al. (1998).

Monitoring the progress and value of the network is the fourth implementation requirement. “Asking members to comment regularly on their satisfaction with the network and suggest ideas for improvement can keep a network strong and vital” (Loucks-Horsley et al., 1998, p. 146). Traditional methods of evaluating PD where success is determined by student achievement limits the possibility of networks to illustrate the potential of teacher learning (Lieberman & McLaughlin, 1992).

A WAY FORWARD

This chapter offers a possible solution to the emerging crisis in science education. An ongoing and competent supply of SET skills has been identified by the Australian Government as a high priority (Australian

Government: Department of Education Science and Training, 2006). Both the Australian Government and the Australian Science Teachers Association (through recent reports) have identified concerns about "declining participation in SET study which relates to an inadequate supply of suitably qualified teachers" (Australian Government: Department of Education Science and Training, 2006, p. 49).

The establishment of ongoing professional networks between biology teachers with links to the scientific community can offer an opportunity to enhance the quality of science teachers. Teachers who participate in professional networks report 'experiencing a sense of professional renewal' (Pennell & Firestone, 1998, p. 356) and 'belonging to networks gives teachers fresh ways of thinking about education quality and application' (Lieberman & McLaughlin, 1992, p. 673). It is proposed that renewed interest by teachers in their subject areas combined with up–to-date content knowledge that is relevant to the world their students live in, will contribute positively to students enthusiasm for science.

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