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A Partnership Based Approach to Professional Learning: Pre-Service and In-Service Teachers Working Together to Teach Primary Science

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Abstract: *This paper reports on a partnership based approach for preparing pre-service primary teachers to teach science. It involved forming three-way or "triadic" partnerships, consisting of a final year pre-service primary teacher and an in-service colleague, to teach science in the colleague teacher's classroom, with the support of a teacher-educator. The pre-service teachers had to collaboratively plan, develop and deliver a sequence of science lessons and take major responsibility for teaching a 90 minute science lesson, at least once a week over a six week period.*

The data was collected during 2007 and 2008. The pre-service teachers kept a reflective journal of their experiences using a process devised to guide and support them. The results indicated improved attitudes to and confidence in teaching science for the pre-service teachers and their in-service colleagues. The results indicate triadic partnership approach may be an effective way to support teacher professional learning in science.

Background

This paper explores an approach to teacher professional learning based on three-way partnerships or "triads". The approach was originally designed to prepare pre-service teachers to teach science by giving them an authentic teaching experience that would supplement their normal practicum. The chosen research topic necessarily covered a range of concerns from both the general teacher education literature as well as the science education literature. Both of these aspects are discussed in the literature review.

The teacher education literature identifies basically two conceptions of teaching: a "craft" conception, where teaching is viewed as a series of definable technical skills to be mastered; and a professional conception, where it is seen as more complex, involving a process of career-long learning (Dalmau & Guõjónsdóttir, 2002; Elliot, 1998; Groundwater-Smith, Ewing & Le Cornu, 2006; Grushka, Hinde McLeod & Reynolds, 2005).

From a craft perspective, teacher preparation is focused on practicing a range of skills and techniques that can be demonstrated and practiced in real teaching situations. Ducharme & Ducharme (1996: 1035) pointed out that pre-service teachers often come from a craft perspective, being more focused on learning the "tricks of the trade". In this view, good teaching can be defined by a list of competencies, lending itself to behavioural positivist approaches to teacher education, where the elements of good teaching are clearly defined (Grushka, et al., 2005). This has led to calls for teacher preparation to be centred in school settings rather than universities and the adoption of an 'apprenticeship' model for teacher training.

A professional conception of teaching, however, suggests the pre-service teacher is a "reflective practitioner" (Schőn, 1983). Understanding teaching involves teachers coming to a deeper understanding of their work by reflecting on their experience. Schőn (1983) argued, however, that experience alone does not lead to professional growth. For pre-service teachers, school experience presents a chance to inquire into their teaching practice and develop their own theories of teaching. By posing questions or identifying problems from their experience, practitioners engage in a form of reflective inquiry or "praxis" (Schőn, 1983) leading to changes in practice. In this view, teaching is more than simply mastering skills and techniques: it also implies the development of expertise and the ability to apply their knowledge and skills in non-standard situations, where beliefs, judgment and questions of morality and justice may be required (Groundwater-Smith et al., 2006, pp. 152-179). Practitioners collect and analyse evidence from their experience, explore the underlying theories, values and assumptions behind their actions to inform their future practices and develop their own theories of teaching. Similar approaches to experiential learning proposed include action research, practitioner research, and action learning (Zuber-Skerritt, 2001; Kemmis & McTaggart, 2000; Elliot, 1991).

Regardless of the conception of teaching, some form of practical experience is a common to most teacher education programs, and is widely considered the most important element by both pre-service and in-service teachers (Groundwater-Smith, et al., 2006, p. 154). The practical teaching experience is highly regarded because it is provides authentic professional learning opportunities that cannot be replaced or easily simulated (Groundwater-Smith, et al., 2006; McCaleb, Borko & Arends, 1992).

In 2007, however, a standing committee of the House of Representatives in the Australian Government (SCEVT) delivered a report, called the *Top of the class*, which revealed there is considerable debate about what constitutes an effective practical teaching experience in teacher education. Although it is seen as a "crucial stage in teacher preparation" the choice of placement was often based on administrative convenience rather than what would provide a "quality experience" (McIntyre, Byrd & Foxx, 1996, p. 173). The choice of colleagues to work with the pre-service teachers is also usually outside of the control of the University.

In the absence of agreement about the nature of teaching practicum, the value of simply providing more unfocused practical experience for pre-service teachers is not necessarily going to be effective, but the debate highlights a key element of the problem with many pre-service teaching programs: the apparent separation of theory and practice (SCEVT, 2007). Citing Lemlech & Kaplan (1990), McIntyre et al. (1996: 173) commented that "the commonly structured student teaching practice prepares teacher candidates for the loneliness of the classroom, not for reflection and collegiality." They also noted that pre-service teachers "often observe practices in the classroom that contradict what college instructors consider appropriate practice" which can lead pre-service teachers to doubt the "worthiness" of what they are learning on campus (p.175). McIntyre et al. (1996), however, argued that the apparent gap presents a learning opportunity for pre-service teachers to reflect on how the differences between theory and practice appear in their own experience, and claimed, in doing so they should develop a more integrated view of the "real world": as consisting of both the school and the university.

Ducharme & Ducharme (1996, p.1038) argued that the needs of all pre-service teachers are not the same and suggested more targeted "training" for different contexts, warning that "(t)eacher educators must learn the degree to which phrases like 'reflective practitioner' go beyond glib descriptors of programs. They need to learn appropriate mixes between theory and practice for different kinds of candidates." It is this notion of targetting professional experiences to suit the needs of a particular cohort of pre-service teachers that led to the partnership in science project which is at the

heart of this paper. The participating pre-service teachers were also encouraged to adopt a "reflective" approach to their work by the use of a reflective framework, which is discussed in more detail later.

The Science Education Context

The choice of science education as the context for this study is both timely and deliberate. It continues to be an area receiving significant interest on National and State level with evidence of falling enrolments in science courses and predictions of negative implications for Australia's long term economic prosperity (DEST, 2003; Goodrum, et al, 2001; Lyons 2006; Tytler, 2007).

Mulholland & Wallace (2003) discussed the specific problems associated with preparing primary teachers to teach science within the broader context of teacher development. They explored the difficulties faced by pre-service teachers as they made a series of transitions or "border crossings" in their development from novices to experienced teachers. These included the transitions firstly from pre-service to in-service teachers, initially intent on "survival"; then undertaking further development from non-science learners to science teachers. In the two case studies they explored, they concluded the transition to teaching science was "more difficult than teaching other subjects" because it required specialised knowledge and skills and presented challenges for class management due to hands-on activities. They claimed that "(m)any teachers find the crossing impossible and do not attempt science teaching" (p. 893). They commented that supervising teachers tend to have little time allocated to science, so good science teaching was rarely modelled for most primary pre-service teachers.

This explains how the under-teaching of science in primary schools has become a long-standing problem, stemming from a widely recognized lack of confidence of many primary teachers with science (Goodrum, Hackling & Rennie, 2001; Appleton, 1992; Henderson, 1992; Hand & Peterson, 1995; Tyler 2007). The problem is pervasive as it affects both in-service and pre-service teachers. Goodrum et al. (2001, p.56) explained that "(p)rimary teachers usually take a degree in teaching and their background knowledge in science is very variable, with many lacking confidence in their background knowledge and competence in science." This view was also supported in a report (DEST 2003):

> …in their initial training, primary teachers mostly do not specialise in science and mathematics. As a result, many primary teachers who teach mathematics and science lack the necessary expertise and confidence, and may even actively dislike mathematics and science. (p.56)

In addressing the national importance of science for the economy and the development of a more "scientifically literate" or "scientifically capable" society, modern curricula (e.g. National Curriculum Board, 2008) also highlight the need for more science related professional development (PD) for in-service primary teachers in addition to more attention to science in pre-service teaching programs (DEST, 2003), as a means of increasing the quality of science education in schools:

> Many primary school teachers …need to be supported by professional development and curriculum resources to build up their confidence and competence to teach science. (Goodrum, et al., 2001: 172)

Increasingly, however, accountability pressures within education systems in Australia, have concentrated on lifting students' literacy and numeracy performance. While these are desirable goals, they have tended to reduce the time teachers in schools devote to subjects such as science (Goodrum et al., 2001, p. 158; Kenny & Colvill, 2008). Coupled with their lack of confidence with science, this tends to perpetuate the problem of under teaching of science. As a result, most pre-service primary

teachers do not see good science teaching modelled in schools or gain experience in teaching science during their normal school practicum (Howitt, 2007; XXXX, 2009; Skamp, 1989).

As noted above, this has implications not only for the preparation of pre-service primary teachers, but also their in-service colleagues, all of whom may be required to teach science under the emerging national and state curricula in Australia. The specific needs of primary teachers and the long-standing nature of the problem, imply a more targetted approach to the preparation to teach science is needed.

In referring to the notion of science related pedagogical content knowledge (PCK) (Shulman, 1987), Tytler (2007, p.58) suggested that "primary teachers need to have included, as part of their initial training, a mixture of science content knowledge and pedagogical content knowledge (PCK) in order to confidently teach science in primary school." Others, however, claim that requiring primary teachers to learn science content may actually be counter-productive (Appleton 2005; Baker, 1994; Hand & Peterson, 1995; Howitt, 2007; Palmer, 2006; Skamp, 1989). Mulholland & Wallace (2003) suggested that, as generalist teachers, the support needs for primary teachers are different to those of specialist teachers of science and that this should be taken into account within their training.

Professional Learning Partnerships- the "Triadic" Approach

A partnership may be defined as a relationship set-up for a common purpose that functions in a way dependent on the attributes that each party brings to the situation (Smedley & Van Rooy, 1996). A partnership implies a more equal arrangement than normal supervisor-novice situation that applies in the practicum. The lack confidence with science makes it a useful vehicle for a partnership approach, as the in-service and pre-service teachers may approach the task of teaching science as one of mutual professional learning. This paper reports on a project that was created to address the problems, as outlined above, associated with the preparation of pre-service teachers to teach science in primary schools. A partnership based approach is also in line with calls in recent reports on teacher education (DEST, 2003; SCEVT, 2007):

> …to make teacher education … relevant to the demands of classroom learning in the 21st century, more flexible to respond to generational and changing expectations, and more of a close working partnership between the higher education institutions and the schools. (DEST, 2003, p.123)

Triadic or 'three-way' partnerships were established, each involving a pre-service primary teacher and an in-service colleague teacher, with the support of the science teacher-educator, for the purpose of teaching science in the colleague teacher's class. The triadic partnerships recognised that each participant brought different experience, knowledge and skills to the situation of teaching science. More specifically, in this research project, the teacher-educator had to establish the communication links with the schools, provide information about the project, and collect and analyse the research data.

Structurally, the professional learning triads can be represented as in Figure 1, with each consisting of a pre-service primary teacher, their in-service colleague teacher and the science teacher-education specialist from the university (who was also the researcher).

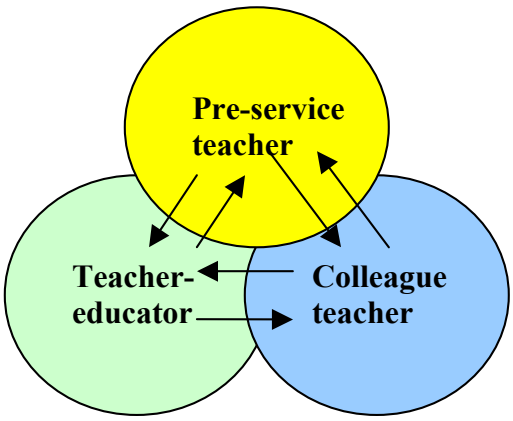

Figure 1: The professional learning triad

This diagram implies equal degrees of communication within the triads between all the parties. In practice, during 2007 and 2008, the direct communication between the teacher-educator and the colleague teachers consisted mainly of teacher responses to the questionnaires and interviews; emails to organise the teaching arrangements; and some limited face to face discussions, usually related to situations where the pre-service teacher was encountering difficulties. During the planning phase in the first four weeks of semester, the teacher-educator also provided pedagogical support for the pre-service teachers.

Initial contact with between the colleague teachers was to be arranged by the pre-service teachers within the first two weeks. The pre-service teachers were expected, with the support of their teacher-educator, to bring to the partnership knowledge of current trends and resources in primary science and a willingness to try out science. They had the main responsibility to negotiate a topic and plan the science based learning experiences.

The colleague teachers were not expected to assess the pre-service teacher, but to support them with advice on their general pedagogical skills, knowledge of the class group, the school environment, the learning context and effective student management practices.

The communications between the teacher-educator and the pre-service teachers occurred in university class discussions, both before and after the teaching episodes, and through the reflective journals of the pre-service teachers throughout the unit. The requirement to keep a reflective journal was consistent with promoting a professional conception of teaching. The pre-service teachers were required to reflect on their experience at each stage of the program and the teacher-educator regularly provided feedback in class and through written comments in their reflective journals.

As Pedro (2005) noted, many teacher education programs and professional development programs for practising teachers are based on “reflective practice”, but the term is not necessarily well understood. Russell (2005) argued the process of reflection needs to be explicitly taught to students. To support the pre-service teachers, a reflective framework was provided, based on one put forward by Grushka, Hinde McLeod, & Reynolds (2005) (See Table 1). This framework encouraged to the pre-service teachers supported reflection on their practice by providing a series of questions that may be relevant to each phase: planning, teaching and evaluation. The process was modified to encouraged them to think more deeply about their experience as teachers by prompting reflection on three levels: a personal (first person) level; a collaborative level with their colleague teachers and peers (second person reflection); and finally with reference to educational theory (third person reflection), in line with the model of action research as suggested by Reason (2001).

Focus questions	Action research stages		
	Phase one planning: "Reflection for action"	**Phase two teaching: "Reflection in action"**	**Phase three evaluating: "Reflection on action"**
First Person What key issues or significant events have arisen for me? What do I think or feel about this issue me as a teacher?	• What is the basis of task I have to perform? • How do I feel about this task? • What specific aspects or individual circumstances do I need to be aware of with this class? • How can I put my beliefs into action? • How well do I know the chosen topic? • Are there sufficient resources? • What evidence will I collect about student learning?	• Why am I teaching this? • How is my class responding to the topic? • How is my class management going? • Are the groups working well? • Is my lesson going as planned? • Did any significant issues about my teaching come up today? • What do I need do to address these issues?	• How well did the lesson sequence go? • How did the students respond? • What evidence do I have about the children's learning? • How can I improve the lesson sequence? • What did I learn about my own teaching of science?
Second Person What do my peers and colleagues think about these issues? How do their ideas compare with mine?	• What organisational and class issues do I need to find out about? • What specific issues will I discuss with my peers, colleague teacher or lecturer? • What do my peers and colleagues think of my ideas and plans? • How will this feedback improve my plans?	• What advice do my colleagues and peers have on this issue? • How is my colleague teacher engaging with the activities? • How well do we cooperate within the class? • Are my plans and expectations realistic or do I need to change?	• What useful feedback did I get from my colleague teacher? Lecturer? Peers? • How suitable was this material for this group? • What changes would I make to the sequence next time?
Third person What does the literature have to say about this issue? What do I believe about this issue in the light of existing theory?	• What does the literature say about how to structure the learning? • How is the theory relevant to this task? • How would I describe the school setting? • How does the literature suggest I should approach this task?	• Is there any literature I can refer to for advice on this issue? • Do I have adequate support and resources to meet the expectations? • What does the theory suggest can be done to address the issue?	• How did my experience here relate to my initial beliefs about teaching science in primary schools? • Does the topic need to be change to make it more relevant? • How did my beliefs about teaching science change as a result of this experience?

Table 1: Reflective Framework Provide to Pre-service Teachers (Adapted from Gushka et al., 2005).

Links to Teacher's Professional Learning

Triads are discussed elsewhere in the literature in relation to the supervision of pre-service teachers, usually in the context of normal practicum situations (McIntyre et al. 1996; Hastings & Squires, 2002). McIntyre et al. (1996, p.178) describe the role of the teacher-educator in a triad, as helping pre-service teachers to critically analyse their teaching, acting as a liaison between the schools

and university and helping to set common expectations for all concerned. Hastings & Squires (2002) provided for a similar description, but in this case the teacher-educator was a specially trained school-based teacher as opposed to university based. The teacher-educator role in the approach discussed here was in accord in these other models, so it therefore offered multiple levels of support for the pre-service teachers. At different stages in the project, they could seek help from one or all of the teacher-educator, their peers and their colleague teacher.

In the triads set-up by Hastings & Squires (2002) for teacher education purposes, the role of the school-based teacher-educators was to essentially mentor several pre-service teachers and to liaise directly with their or "co-operating" or colleague teachers to discuss progress of the pre-service teachers. One spin-off of note flowing from their research was the professional development (PD) benefits for the colleague teachers. The potential for PD of the participating teachers was also noted in the triadic partnership approach (XXXX, 2009).

There is an extensive literature extolling the characteristics of effective teacher PD, with a general consensus that "one-off" PD activities have limited value (Henderson, 2006; Westling, Herzog, Cooper-Duffy, Prohn & Ray 2006; Webb, Robertson & Fluck, 2005). Garet, Porter, Desimone, Birman & Yoon (2001) proposed a model for teacher PD which identified various dimensions including its: "structural features", linked to the design of the PD activities; and "core features", concerned with the substance of the PD (Table 2).

Structural features	Core features
Form: Concerns the type of PD activities involved: e.g. workshops, or reform activities such as mentoring	*Content:* Concerns the degree of specificity of content of PD (e.g. subject specific content or more general teaching)
Duration: Concerns the span of time involved in the PD activity	*Active learning:* Concerns the nature of the learning involved in the PD
Collective participation: Is concerned with the degree of emphasis on group learning.	*Coherence:* Concerns the degree that PD fits with broader educational agendas to reform teaching

Table 2: Modified characteristics of Teacher PD (Based on Garet *et al.*, 2001)

In this model, the structural features for teacher PD range from one-off workshops to activities extending over a longer period. The core features include a range of PD activities from those with a narrow or subject specific content scope, such as those aimed at building on current specialized knowledge, to activities aimed at transformative change in teaching practice based on action learning. Garet et al. (2001) suggests activities aimed at transformative change should be structured as "reform" activities i.e.: they should last for an extended duration in time; and provide opportunities for teacher for collaboration, mentoring, and learning from experience and should occur within the context of their normal work as far as possible. Webb et al. (2005) concurred with this view.

The structure of the triadic partnership approach reflects strong parallels with the description of reform PD activities described above. Although the experienced in-service teachers may be some way ahead compared to their pre-service counterparts in terms of becoming a teacher, they many are likely to need support to undertake the significant "border crossing" to become teachers of science; a professional learning journey that is no doubt transformative in nature for these individuals(Mulholland & Wallace, 2003).

Links to Pre-service Teacher Education

Providing opportunities for authentic science teaching experiences has been suggested as an effective means of building the science PCK of pre-service primary teachers (Howitt 2007; XXXX, 2009; Palmer 2006). Palmer (2006: 337), explored "self-efficacy" in the context of pre-service teachers and their preparation to teach science, and argued it is a legitimate goal for teacher education because it "is concerned with judgments about how well one can organise and execute courses of action". He proposed that "authentic" learning situations promote self- efficacy because they require "vigorous and persistent efforts" and "contain many ambiguous, unpredictable and often stressful elements." Howitt (2007) also argued for authentic science learning experiences to build the confidence and capability of pre-service teachers to teach science. The critical question is: "How can authentic teaching experiences in science be organised within teacher education program, when, as has been argued above, the normal practical teaching experiences in a teacher education course are unlikely to provide opportunities to teach science?"

Mentoring is also often proposed as an effective means to build the confidence of in-experienced teachers. Hudson (2005) proposed five factors that characterise the quality of mentors: their personal attributes, their knowledge of system requirements, their pedagogical knowledge, their ability to model good practice and their ability to provide constructive feedback. DEST (2003, p.153) noted the subject specific challenges associated with preparing science teachers to teach science and suggested the development of science specialists to act as mentors and curriculum leaders to support primary teachers. DEST (2003, p.56) also concluded that the development of this level of mentor expertise in science "will require very considerable effort extending over many years." Thus the task of building mentoring capability in science would necessarily involve firstly identifying suitable experienced teachers to be mentors and then, for the majority, a significant investment in their professional development to build their capability in the teaching of science, so Hudson (2005) doubted that most primary teachers would be able to fulfill the mentoring role in science, due to their lack of pedagogical knowledge and confidence with science.

XXXX (2009) argued that, by working in tandem to support the pre-service teacher in the triadic partnerships, the teacher-educator and the colleague teacher are able to provide the five factors of effective mentoring proposed by Hudson (2005). Assuming that both have the desired personal attributes to be mentors, model good practice and provide valuable feedback; the teacher-educator provides specialized science PCK, while the colleague teachers provide general pedagogical knowledge as well as knowledge of the local and systemic context in which the teaching episodes are to occur.

The triadic model, therefore, incorporates the authentic learning and key elements of mentoring to prepare pre-service primary teachers to become science educators. Firstly, the pre-service teachers are required to engage in an authentic science teaching program in the colleague's classroom, where they are expected to plan and take major responsibility for teaching a sequence of work in science. Secondly, they are supported in this exercise by the teacher-educator and the colleague teacher. With these characteristics and its correspondence to the structural and core features of effective PD discussed above, indications are that the triadic approach should provide an effective professional learning experience for both the pre-service and their in-service colleagues.

Structure of the Elective Science Unit

The pre-service primary teacher participants had chosen this science elective as part of their study program in the final year of a Bachelor of Education (B.Ed.) course at the University of

Tasmania. The elective required each to work with a volunteer colleague teacher in a school to teach science. When principals were contacted to ascertain interest in participating, the proposal was well received and subsequently the teachers who expressed interest out-numbered the pre-service teachers available, indicating that the program was addressing an unmet need in these schools.

The basic schedule for the elective science unit in 2007 and 2008 is shown in Table 3. It involved three phases: a planning phase, a teaching phase and an evaluation phase. Early in the unit, each pre-service teacher chose an in-service colleague teacher to work with from a list of volunteers. With the support of their teacher-educator, the pre-service teachers were expected to negotiate a topic and work collaboratively to plan, deliver and evaluate a science based unit of work in the class of their colleague teacher. They were required to teach a minimum of six 90 minutes lessons spread over six weeks, and to take major responsibility for the design and delivery of the teaching program.

Week	Main activities
Weeks 1-4 Phase 1- Planning (Reflection *for* action)	• Introductory lecture, explanation of the unit and assessment. Establishment of action learning groups. • Preparation for teaching episodes. • Reflective journal submitted
Week 5-10 Phase 2 -Teaching (Reflection *in* action)	• Delivery of teaching in school. • Reflective journal submitted
Week 11-13 Phase 3 - Evaluation (Reflection *on* action)	• Reflection and evaluation on your experience. • Reflective Journal submitted.
Week 14	• Submission of all remaining assessment items.

Table 3: Schedule of the partnership program

Methodology

An action research methodology was adopted for the research project which began in 2007 and is on-going. This allowed the structure of the program and the reflective processes to be refined in cycles of reflective action (Zuber-Skerritt, 2001). In this paper, the aim is to consider the effectiveness of the triadic partnership approach as a model for targetted professional learning in science for both pre-service and in-service primary teachers.

The interpretive nature of an action research approach was most appropriate because of the exploratory nature of the study. A more controlled study approach was not suitable due to the wide variation in teaching conditions to be encountered by the pre-service teachers. These included the size and location of the schools, number of students in the classes, the levels of experience of the colleague teachers and their confidence with science, the socio-economic background of the communities, the presence of special needs students, etc. The classes taught by the pre-service teachers ranged from prep to grade 7 and a range of science topics were chosen in collaboration with their colleague teachers.

A mixed methods approach was used to collect data. Colleague teachers and principals were sent an initial questionnaire, prior to the teaching episodes, to gather background data. This provided quantitative data in the form of closed Likert responses to specific questions about their perceptions of the status of science in their schools and their initial attitudes to science. There were also some open text response questions which provide qualitative data. In addition, the lecturer-researcher kept a

reflective journal and relevant electronic communication such as emails as well as the pre-service teacher's contributions to a discussion board. He also retained records of informal interviews with pre-service teachers, principals and colleague teachers.

In 2007, a second questionnaire for teachers and principals followed immediately after the teaching phase had ended. In addition, a third questionnaire was sent to the colleague teachers six months after the teaching to gauge any longer term effects. The later questionnaires and provided further qualitative data. In 2008, the second and third for the questionnaires to the colleague teachers were replaced by a semi-structured interview, in an attempt to improve the response rates for the post teaching data.

The main sources of data the pre-service teachers was their reflective journals and the anonymous responses to the University's formal unit Student Evaluation of Teaching and Learning (SETL), which consisted of closed Likert questions and open comment items. The reflective journals were analysed for emerging themes and were triangulated against the data from the colleague teachers which added validity to the findings (Denzin & Lincoln, 2000; Zeichner & Noffke, 2001).

Methods and analysis of the data

During 2007-2008, a total of 18 Tasmanian schools participated in the study, consisting of 15 government and 3 private primary schools. The government schools were located in Northern Tasmania and included 13 primary and 2 district high schools (years K-10). One of the private schools and one of the government schools participated in both years. In total 43 pre-service teachers participated in the program each assigned to their respective volunteer colleague teachers.

The data collected from each group of participants will be discussed in turn below, followed by an overall discussion of the learning from the project so far. Four key themes emerged from the qualitative data which added depth to the quantitative data. The quotes chosen helped to describe the learning from the experience are indicative of the responses.

1. Collaborative planning
2. Establishing the partnership
3. Gaining professional confidence and developing PCK
4. Professional learning for teachers

Pre-service teachers

As encouraging the pre-service teachers to become reflective practitioners was a key goal of the project the pre-service teachers were supported in developing their journals with a reflective framework (Appendix). This included a broad range of questions to guide their reflection on their experience and encourage peer discussion reflection and making links between theory and practice. The journals were collected periodically by email and returned with written feedback by the teacher-educator.

Planning phase

For the first four weeks, the pre-service teachers attended lectures and tutorials at the university and were expected to initiate contact and arrange to meet with their colleague teacher and class prior to the commencement of the teaching phase. From the comments in their journals and class discussions, the pre-service teachers fell into two broad categories: those who felt confident with science but who wanted more experience teaching it; and those who lacked confidence, but recognized it as a gap in their experience they wanted to address. All of the pre-service teachers felt under considerable pressure

from the beginning due to having to negotiate a topic with their colleague teacher and the perceived difficulties with teaching science, but the structure of the class was designed to support them:

> After talking with others in the class it seems that most of us are in the same boat. We are all nervous to be teaching science but also realise that it is an exciting prospect, and a huge learning curve for our teaching. We have been able to support one another in our fears and give each other encouragement, and ideas on science based areas.
>
> Pre-service teacher- Maddy

In the early stages, the pre-service teachers were understandably focussed on their planning skills, and trying to make contact to talk things through with their colleague teacher.

> I have spoken to my fellow peers about the issue of not being able to establish contact with my colleague teacher and I have found that many of them area having the same issue also which makes me feel a little less stressed! A lot of them are finding that while both parties are trying to make contact, they just keep missing each other as school hours, uni timetables or work seem to clash.
>
> Pre-service teacher- Loretta

> There was very little time to work collaboratively with the colleague teacher and peers during the planning phase because of how late the meeting with my colleague teacher was, this meant that my planning was slightly more rushed than I would normally prefer.
>
> Pre-service teacher- Angela

The specific challenge of planning a science lesson sequence and actually teaching it was noted by nearly all the pre-service teachers. The fact that it was to be sequence of lessons added an extra dimension of difficulty, even for the few who had taught some science in their school practicum experiences:

> It will be the first time since I have been at University that I have had to plan a unit to run for this length of time and I am quite nervous about it. The fact that it is a science unit makes me even more nervous. This is probably because I have a limited knowledge of science and am not overly confident about it and the science that I have experienced while on practicum has centred on one-off experiments and writing up a report
>
> Pre-service teacher- Michael

As the literature points out, there are particular concerns with teaching a science class which tended to exaggerate the difficulties in the minds of the pre-service teachers, but the support offered by their peers was valuable:

> Talking to my peers, particularly those also working with 5/6 classes has been interesting. Their experiences so far with science are varied, though most of them seem to have taught science at least once. When planning their units and lessons a lot of them express concerns about keeping science investigations safely controlled, an issue that I hadn't even thought of. They speak from experiences where some students got out of hand fairly quickly and made the lesson difficult and dangerous to manage.
>
> Pre-service teacher- Kalinda

The authenticity of the task became more evident as time went on:

> After our first tutorial I was pretty excited with what lay ahead. I believed from the outset that this class would benefit me in that I will feel more capable to teach a science strand in a classroom. This become more and more apparent as the actual teaching phase of the unit went along.
>
> Pre-service teacher- Jeff

Eventually evidence emerged of growing confidence as the peer support began to pay dividends and the relationship with their colleague became established:

> The idea for the unit of work I had was not like anything my colleague teacher or peers had planned. At first my colleague teacher asked me to do a unit of work on electricity. I came to her with the idea of crime scene investigation and she loved it. I explained the rough idea and showed her my unit plan.
>
> Pre-service teacher- Mary

> I have finished my unit plan after modifying the learning sequence overview, engage phase and adding standards and stages to the curriculum focus. All these changes occurred from the suggestions which came from the collaborative planning session. I have two activities planned for early finishers which I previously had not thought about until our collaborative planning session when one of the groups mentioned the idea.
>
> Pre-service teacher- Steph

Teaching phase

When it came to the teaching phase, the authenticity of the task soon highlighted significant pedagogical questions for the students to address. These provided a link between theory and practice. The relevance of the pedagogical skills and success in their teaching led to a growth in the confidence of the pre-service teachers:

> As my colleague teacher wanted me to focus on problem solving and collaborative work, I was unsure about whether to assess the students on their ability to work in a group, or whether to focus solely on assessing the science. Through discussing this in my peer group and with [lecturer], I have decided to assess both, as the students are learning science collaboratively, and both are equally important in this case.
>
> Pre-service teacher- Natalie

> Something wonderful happened today!! I think students have made a realization that they are still learning even though they are having fun …students would come up and talk to me about their observations of three states of matter …like when they were at home and they had a drink or were eating something. They had made the link between their new understandings and their everyday life.
>
> Pre-service teacher- Sharon

The relationship and discussions with their colleague teachers was a valuable element in the learning and confidence of the pre-service teachers, particularly around the general pedagogical skills required to manage a science class. Despite two examples where the colleague teachers did not fully engage and took the opportunity of having the student to do other things, nearly all the pre-service teachers reported that their colleagues were very supportive:

> After school had finished, Annette and I spent about an hour discussing the lesson and planning for future teaching. I was able to raise my behaviour management concerns, and ask other questions, which I found really helpful. The most useful information she gave me regarding managing behaviour, was a deeper understanding of certain students and some of the tactics and strategies they respond best to.
>
> Pre-service teacher Kalinda

The indications were that a good relationship with their colleague teacher had a direct bearing on the pre-service teachers' confidence in their planning and organisation and tended to lower their anxiety levels. In the next iteration of the project, if resources allow, the plan is to facilitate a face to face meeting between the pre-service teachers and the colleague teachers by bringing into the latter into the university. It is hoped that this would help to establish the relationship, clarify expectations of all parties and assist with the collection of research data.

Post teaching phase

Further data on the success of the approach from the point of view of the pre-service teachers was gathered at the end of the unit through the anonymous SETL questionnaire. It contained some

questions that were pertinent to the study and. The response options to the Likert questions included five categories: Strongly Disagree (SD=1), Disagree (D=2), Undecided (U= 3), Agree (A=4) or Strongly Agree (SA=5).

The 2007 responses, from 16 (out of 23) pre-service teachers in the first iteration are summarised in Table 4. They were consistent with qualitative data from the reflective journals. Overall, the results indicated that the pre-service teachers found the unit very worthwhile, with the "mean of means" score at 4.28. Although some reported the workload was demanding, there was a high level of satisfaction evident, with strong agreement that they had "developed skills needed by professionals in this field" (4.53) and that the "learning experiences outside the classroom were rewarding" (4.57).

> My first reaction was shock at the workload that was to be completed in this unit. As the semester unfolded, I felt more at ease and found the workload was not as difficult to manage as I first thought; this was due to the planning that was undertaken in class time in the first three weeks.
>
> Pre-service teacher- Christine

In 2008, after some refinements to the reflective process and the assessment to reduce the workload demands on the pre-service teachers, the 13 (out of 18) respondents to the SETL returned a "mean of mean" score of 4.33 indicating continued satisfaction with the unit.

Question from SETL Response data (N_2=16)	**Mean**	**Std Dev.**	**A or SA**
1. "Assignments tied in with the unit objectives"	4.06	1.2	13
2. "I have learned to make connections between this unit and my profession"	4.13	1.3	14
3. "Learning experiences outside the classroom were rewarding"	4.57	1.7	13
4. " I have developed skills needed by professionals in this field"	4.53	1.2	15
5. "The reflective process in the subject helped me to think deeply about the issues."	3.93	1.4	11
6. "The school experience in teaching science has added to my confidence in this subject."	4.43	0.6	15
Mean of Means	**4.28**		

Table 4: Relevant responses to statements from 2007 Unit SETL questionnaire.

It is hoped that this positive experience and growth in confidence the reported by the pre-service teachers will encourage them to continue to teach science, and there was some evidence that this might happen:

> My professional beliefs about teaching science have changed over the course of this unit, as I have noticed that although I have read a lot about children constructing their own learning, this became evident through my experiences.
>
> Pre-service teacher- Samantha

> Since undertaking this module and having the experience of teaching science out in the classroom, I feel more confident with not only teaching the subject of science but teaching overall as it has given us that extra experience.
>
> Pre-service teacher- Jemma

> My involvement in this unit … has really changed my perspective on science in the primary classroom. It has been a positive change, I now realise that there is so much you can do with science in the classroom and how you can link it with other curriculum areas.

Pre-service teacher- Jacki

The positive effect on the of the confidence of the pre-service teachers to teach science from having a successful teaching experience in this project came through clearly and was consistent with findings by Palmer (2006) and Howitt (2007). In some cases they also revealed positive effects on the attitudes of their colleague teachers:

> After having such a positive experience with teaching science and along with some of the research I have read I feel so motivated to learn more about science and how to teach it in schools. I want to plan many more science lessons and hopefully encourage my colleagues to take on science teaching. The teacher that I have recently worked with had very rarely taught science however after being involved in my science lesson she was very motivated and is already wanting me to help her put together another science unit.
>
> Pre-service teacher- Caroline
>
> It is an empowering feeling when you develop and then deliver a unit that "goes off" without any major issues. After my first lesson, my colleague teacher shared that science was not her strong point and that I made it look really easy and "fun" for the students. She also admitted that she did not often teach it as she was not confident in that area… she actually thanked me for showing her that science was not that difficult to teach.
>
> Pre-service teacher- Cindy

Further research is planned to follow-up with the pre-service teachers, after their graduation, to explore if their reported gains in confidence have actually led to them teaching science in their own classes.

Data from in-school participants

Comments similar to those of Cindy above, reporting benefits for their colleague teacher's attitudes to science, were made by a number of the pre-service teachers. The reactions of the in-school participants will be explored in more detail in this section using data collected from the principals and the colleague teachers.

After the placements were confirmed, the principal and colleague teachers were sent an initial questionnaire before the teaching began. This was designed to ascertain background information, their attitudes towards science, and to clarify their expectations and reasons for being involved in the project.

In 2007 a second questionnaire was sent immediately after the teaching phase, to gauge their reactions to and opinions of the project. A third questionnaire was sent only to the colleague teachers six months later. There was a notable drop-off in the response rates for the later questionnaires. Table 5 gives a summary of the number of responses by each group each year but 21 (of 24) teachers and 10 (of 10) principals responded to at least one of the three questionnaires. In 2008 the principals received only an initial questionnaire while the second and third questionnaires were replaced by an interview of the teachers soon after the teaching finished. Fourteen (of 19) teachers and 6 (of 10) principals responded to at least one of the items.

Year	Population (N)	Initial questionnaire	Second questionnaire	2007-Third questionnaire	Interview 2008 only
Principals					
2007	10	9	8	NA	NA
2008	10	5	NA	NA	NA
Total	**18***	**14**	**8**	**NA**	**NA**
Teachers					

2007	24	15	11	5	NA
2008	19	11	NA	NA	12
Total	**43**	**26**	**11**	**5**	**12**

Table 5: No. of responses, 2007 & 2008. *Note: Two principals participated in both years.

A summary of responses to the Likert questions on the initial questionnaire is shown in Table 6. The first four questions were common to both groups, but questions 5 and 6 appeared only in the version of the questionnaire given to the teachers.

Questions	SD	D	U	A	SA	Mean
Questions common to both Principals and Teachers						
1. My school values science in the curriculum.						
Principal responses	0	2	2	8	2	3.7
Teacher responses	1	0	3	17	4	3.9
2. My school is well resourced to do science.						
Principal responses	0	3	6	5	0	3.2
Teacher responses	2	7	9	5	0	2.7
3. I see the value of science in the curriculum						
Principal responses	1	0	0	6	7	4.3
Teacher responses	1	0	0	10	14	4.4
4. I feel that more time needs to be devoted to science at our school.						
Principal responses	0	1	2	3	8	4.3
Teacher responses	0	2	9	10	2	3.5
Questions specific to Teachers						
5. My own school experiences with learning science were positive.						
Teacher responses only	1	3	6	14	0	3.4
6. I feel I have to know a lot about a science topic before I feel confident to teach it.						
Teacher responses only	0	7	5	12	0	3.2

Table 6: Responses to Likert questions on initial questionnaire: Teachers and principals, 2007-2008.

For the initial questionnaire, responses were received from 14 principals and 24 teachers. The results were consistent over both years. The mean responses showed general agreement between the principals and the teachers to questions 1 and 3, revealing a general recognition of the value of science in the curriculum. This may reflect of the fact that science was a strategic priority for many of these schools and teachers see the valuable curriculum links it offers:

> Science is a priority in 2007. Science enables us to teach inquiry thinking. Science is a way to lead boys into literacy
>
> Principal- Charles

> Science can offer an insight and understanding of the world around us, stimulate and interest all students and provide a starting place and an avenue for those who have a strong leaning towards a scientific future
>
> Colleague teacher- Brenda

There was less agreement between the principals and teachers when it came to the question of resourcing to do science. As a group, the principals were not so sure about level of resourcing, but the teachers seemed even less so. There was also some divergence between the groups on the question of time to be devoted to science again with the teachers being less certain. The teachers generally rated the level of resources for science lower than the principals. This probably reflects the feelings about the

"barriers" to doing science which came through in the qualitative responses and was consistent with other studies referred to earlier (Goodrum et al., 2001; Kenny & Colvill, 2008)

Questions 5 and 6 revealed a degree of ambivalence towards science among the teachers. In question 5, most of them reported positive experiences with science in their own school experience, but 10 were unsure or disagreed with the statement. In question 6, over half (12) revealed doubts about their level of subject content knowledge and a further 5 were unsure.

The principals

The partnership project was well received overall by the principals and teachers involved. Except for one school in 2007, where two pre-service teachers came to their classes under prepared, all the principals praised the initiative. When asked why they chose to be involved in the project, most reported that they saw potential benefits for their respective schools flowing from participation. Seven of the ten principals referred to benefits to their curriculum, recognising that science was a priority area for their school so this study happened to fit well with their strategic plans. In other cases, the principals saw it as a PD opportunity for some of their staff, who lacked confidence with science.

> To promote science in the curriculum, and to support the pre service needs of future teachers
>
> Principal-Debbie

Colleague teachers

When asked about their expectations of the program, 16 of the teachers mentioned that they hoped to learn from the pre-service teacher and get ideas for teaching science:

> I hope to learn from the student teacher who will be working with my class. Just having someone point you in the right direction, or recommend some great resources can get the ball rolling.
>
> Colleague teacher- Melinda
>
> Hopefully gain some ideas and knowledge from B.Ed. student teacher.
>
> Teacher Cassie
>
> Ensure the children get to develop some scientific concepts this term, and motivate me to get a bit more science back into the curriculum!
>
> Colleague teacher- Olivia
>
> I am looking for new ideas for teaching science, as well as seeing how students are being asked to plan and prepare the lessons.
>
> Colleague teacher- Marcus

Overall response from the teachers to the program was very positive. As referred to earlier, of the 43 participants there were only two cases where the colleague teachers were critical of the performance of their pre-service teacher. In each case, the pre-service teachers concerned had not made early contact with their colleague teacher during the planning phase and had therefore not been properly briefed about the class group prior to the teaching phase.

This was partly due to difficulties in communicating with busy teachers, which hindered the establishment of the partnerships and hampered the pre-service teacher's preparation for the teaching. The lack of time to collaborate on planning meant the pre-service teachers concerned did not get to know their class as well as they might have. The colleagues affected were clearly disappointed:

> I was really hoping to have learnt something more valuable from this experience. I was hoping that the pre-service teacher would have some great ideas and strategies. I'm quite disappointed that this

> wasn't the case and hope that the course is tweaked in the future so as both pre-service and practising teachers find it a worthwhile process.
>
> Colleague teacher- Geraldine

Although unfortunate, these cases led to improvements in the collaborative planning process in 2008, with a greater emphasis on establishing the partnerships as soon as possible. Further improvements are planned for the next iteration, as mentioned above, by facilitating a face to face meeting between the participating colleague teachers and the pre-service teachers at the university. This would be in tune with recommendations on triadic partnerships by Hastings & Squires (2002) as well as McIntyre et al. (1996). Despite these few set-backs, the Department of Education in Tasmania demonstrated its confidence in the project by agreeing to fund the release of teachers to participate in the program as part of their PD in future.

When asked what they saw as the constraints to teaching science, the data was consistent with research reported earlier in that it identified time, lack of resources and the "crowded curriculum" as key barriers:

> There are just too many subject areas to cram into a week, and with a main focus being placed on mathematics and literacy I find that I often run out of time to include areas like science etc.
>
> Colleague teacher- Kristi-Lee

Generally, the school-based staff had high expectations of the pre-service teachers and this as a professional development opportunity to be exposed to fresh ideas and approaches to teaching science and for some space to reflect on their own teaching:

> I think that by having a "specialist" science teacher in my classroom I will become more motivate to teach science more regularly.
>
> Colleague teacher- Cassie

> Mainly to give me a bit more of a focus on science… to make me unpack the new science curriculum
>
> Colleague teacher- Rhonda

Indeed, in the post-teaching data, the vast majority of the teachers pointed to specific benefits from their participation, including awareness of resources and the ability to reflect on their own teaching:

> Sitting back an observing as you can when someone else is running a session, umm, I got to see quite a bit I didn't know about quite a few of the kids…one example one little boy who's literacy is really poor but was so engaged and listened and focuses and that was really good to see, that was…I hadn't picked up that interest before …
>
> Colleague Teacher- Noelene

> Observing another person teach enables me the opportunity to reflect on my own teaching practice and allows me to observe classroom dynamics as well as student engagement and progress.
>
> Colleague teacher- Ursula

While in general there was a lack of confidence with science amongst the colleague teachers, they were not a homogeneous group. In some cases, where the colleague teacher was less confident with science and had previously been reluctant to do science, there was evidence of a change in their attitudes to teaching science:

> Science doesn't have to be difficult. Science doesn't require lots of equipment. Science is fun
>
> Colleague teacher- Shirley

> I tend to do only what I have to… I am almost 'science phobic'. I now feel more confident about attempting science activities.
>
> Colleague teacher- Melinda

In particular, some colleague teachers were impressed when they noticed the enthusiastic response of *their own students in their own classroom* as they engaged in the science activities, and this seemed to be a powerful motivator for them to question their own attitudes to science:

> Made me stop and think about the importance of science in the early childhood section: inquiry and thinking skills and a better understanding of science activities in the classroom. My science was previously ad-hoc but now I am more aware of what is possible.
>
> Colleague teacher- Rhonda

A small number of the colleague teachers self-identified as very confident with and committed to science. While not originally the focus of the study, there was some evidence that these teachers could also benefit from working in partnership with the pre-service teachers, which adds value to the original conception of the triads as a source of teacher PD for those lacking in confidence:

> As a specialist science teacher, having a keen, committed and enthusiastic pre-service teacher with me has renewed my passion for my subject area.
>
> Colleague teacher- Hennie
>
> It allows me to reflect on my teaching, to see what works for me and what doesn't, as well as seeing that my techniques may not always be suitable for others. I have gained new ideas for teaching science as well as gaining access to University resources that I have not used before ie digital microscope.
>
> Colleague teacher- Marcus

When asked about the value of the program for their students, the teachers offered enthusiastic responses and indicated the work was able to be carried over into other work in the classroom:

> They loved it and learnt Heaps!!!! We did lots of other science related things on growth on the other days when the uni student was not present.
>
> Colleague teacher- Clara
>
> They have definitely benefited, as it was the first science they had done all year. Now I have them wanting to do more… I will have to step up!
>
> Colleague teacher- Melinda

After the teaching episodes, the second questionnaire (2007) and the interviews (2008) revealed evidence of mutual learning flowing from the partnerships and supported the triadic partnerships as a means for PD:

> It was a great 6 weeks with both me and the students learning a lot
>
> Colleague teacher- Shirley
>
> Yes, it has added to my knowledge of science and its place in the classroom
>
> Colleague teacher- Brenda
>
> Very positive and reciprocal: I have got ideas from her and she has learned from me.
>
> Colleague teacher- Genevieve

In 2007, a third questionnaire was administered six months after the completion of the teaching phase to ascertain if there were any longer term effects. While the response rate was low, with only 6 of the 23 colleague teachers responding to the questionnaire, there was some evidence of longer term benefits arising from the project and a willingness to continue:

> Definitely a change in attitude. I found a fantastic book in our school library full of science activities and sheets ready to go for the children to fill in when they completed the experiment. It also has a teacher section for every experiment explaining what to look for and some guiding questions. I feel confident to take science now because of this book but it was watching (pre-service teacher) take science with my class that encouraged me to seek out a book such as this.
>
> Colleague teacher- Sally

As an endorsement of the approach, strong support was expressed by the principals and colleague teachers and willingness to continue to be involved in future offerings:

> Please give me a call next year if you would like to continue the program. It was a very positive experience for Thomas and myself.
>
> Colleague teacher- Jerry

Discussion

Based on the experience so far, the approach seems to be beneficial to both the pre-service and the in-service teachers. The triadic partnership approach has the potential to enhance the normal practical teaching experiences by providing authentic learning experiences that link the theory and practice in an area such as science which the pre-service teachers may otherwise not have the opportunity to experience.

The structure and core features of the triadic partnership approach are consistent with the characteristics of effective PD and it has potential to be a cost-effective way to provide a transformative PD for opportunity teachers, because the teachers are not required to spend large amounts of time out of their classrooms. The Tasmanian Department of Education recognised this potential and agreed to support teachers who participated in the next phase of development by funding their release from their classrooms to attend a PD session in the lead up to the third iteration.

The effects on the confidence of the pre-service teachers, reported in detail in XXXX (2009), were also consistent with other examples of collaborative professional learning experiences in science (Jones, 2008; Murphy, Beggs, Carlisle & Greenwood, 2008). The question of whether involvement in the project actually led to any sustained long-term change in practice in terms of science teaching will be the subject of further research. The purpose of this paper was to outline the triadic partnership approach and discuss its potential as a targetted approach to pre-service teacher preparation to teach science and as a source of PD in science for in-service colleagues.

Further research is also planned to refine the approach and increase its effectiveness by identifying the key elements of the most successful partnerships. For example, in the next iteration, the plan is to provide an initial PD session and funds to enable the colleague teachers to attend briefing session at the university. This face to face session should facilitate the establishment of the partnerships, improve understanding and clarify the expectations. It will also offer opportunities for input into the program and facilitate the collection of research and evaluation data.

While science was the area of the primary curriculum targetted in this study, there is no inherent reason why the same approach could not be applied to other specialist areas of the curriculum, such as music, art, physical education or drama, but this would also need to be the subject of further research.

Conclusions

The problem of a general lack of confidence of practicing primary teachers with the content and processes of science results in limited opportunities for pre-service teachers to see good science teaching modelled or to experience teaching science in their normal practicum. This perpetuates the under teaching of science occurring in primary schools.

The triadic partnership approach designed to obviate problems with mentoring in primary science because the roles of the teacher-educator and the colleague teacher compliment each other. Working in tandem, they ensure each of the five key factors of good mentoring is present (Hudson, 2005). Thus the approach has the potential to build the confidence of pre-service teachers to teach science.

The potential of the approach as a viable means of providing PD for teachers in science and assisting with meeting strategic priorities was recognised by the principals. The colleague teachers reported it gave them an opportunity to reflect on their own attitudes to teaching science. Due to these

benefits, the triadic partnerships could prove to be a cost effective form professional learning because it provides PD for teachers with minimal time out of their classrooms. Future research is planned to explore the long term effects of the triadic partnership approach on science teaching practice of those who participated to more clearly identify the key factors which contribute to the formation of effective partnerships.

The authentic nature of the learning situations and links to good practice in teacher PD are clearly strengths of the triadic partnership approach to professional learning. They suggest that the model may be applicable to preparing teachers in specialist areas other than science education, but this idea will require further research.

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