Science Teacher Educator Partnerships with Schools (STEPS): Developing an Interpretive Framework for Primary Science Teacher Education

Linda Hobbs[1], Mellita Jones[2], Jeff King[3], Gail Chittleborough[1], Christine Redman[4], Coral Campbell[1], John Kenny[5], Sandra Herbert[1]

[1]Deakin University, [2]Australian Catholic University, [3]RMIT University, [4]University of Melbourne, [5]University of Tasmania

l.hobbs@deakin.edu.au

The STEPS Project responds to international concern about primary teachers' lack of science knowledge and confidence to teach science, and recent questioning of the effectiveness of traditional approaches to teacher education. The project reviews and builds on established, innovative and successful practices at five universities, to develop and promote a framework supporting school-based approaches to pre-service teacher education. This paper will outline the processes involved in developing an Interpretive Framework, which will be a key outcome of the project. The Interpretive Framework identifies key elements to assist teacher educators in planning, implementing and sustaining school-based approaches to teacher education.

Background

The STEPS Project responds to international concern about primary teachers' lack of science knowledge and confidence to teach science, and recent questioning of the effectiveness of traditional approaches to teacher education. The STEPS Project's focus on science teacher education is grounded in the reported disengagement of students from science, and concerns about the amount and quality of science teaching in primary schools. The quality of science education has been the focus of a number of research projects nationally and internationally (e.g. Dobson, 2003; European Commission, 2011; Goodrum, Hackling & Rennie, 2001; Goodrum, Druhan, & Abbs, 2011). These studies consistently report that students are 'turned off' science across the middle years of schooling, and that, in the primary years, science is approached in a disconnected fashion or not at all (Keys, 2005; Tytler, Osbourne, Williams, Tytler, Cripps-Clark, 2008). In particular, the relevance of science to young people's lives

and the particular pedagogies being adopted by teachers of science have been questioned. There are indications that a large proportion of primary teachers have low levels of confidence and background knowledge in science, which impacts both their willingness and ability to teach science effectively. These are critical areas of concern when considered in combination with other studies that show that the development of children's understandings is fundamentally tied to the quality of teaching (Darling-Hammond, 2000; DEST, 2003). These studies have highlighted the need for significant improvements in current and future primary teachers' attitudes, personal efficacy and ability to teach science effectively.

Concern about the preparation of teachers is not limited to science. In the past decade there have been a number of inquiries into the quality of Australian teacher education that persistently challenge the manner and effectiveness of initial teacher education programs, so many in fact that Louden (2008) wrote of the "101 damnations" of initial teacher education. Criticisms about initial teacher education claim that it is overly theoretical and does little to assist pre-service teachers to make links between theoretical components learned at university and the 'real world' of the classroom (House of Representatives, 2007; Parliament of Victoria, 2005). There is a widespread call for teacher education to address this theory-practice divide and stronger partnerships with schools seems to offers a way forward in achieving this (Australian Council of Deans of Education [ACDE], 2004).

The use of school-university partnerships to address the theory-practice divide in teacher education has had an increasing focus in international teacher education studies in recent years (e.g. Darling-Hammond, 2005; Ryan, Jones & Walta, 2012; Patrick, Peach, Pocknee, Webb, Fletcher, Pretto, 2011). Darling-Hammond (2006) purports that the integration of course-work and fieldwork help pre-service teachers to better "understand theory, to apply concepts they are learning in their course work, and to better support student learning" (p. 307). This integration of theory and practice, through the key role of reflection, better prepares pre-service teachers to "handle the problems of everyday teaching through theory-guided action" (Korthagen, Loughran & Russell, 2006, p. 1021). Darling-Hammond (2006) asserts that teacher education programs need to provide opportunities for pre-service teachers to analyse and apply theory, reflect on their subsequent practice, and have further opportunities to retry and improve.

The project outlined in this paper collates and analyses the deliberations of teacher educators who have successfully established partnerships with schools for the purpose of school-based delivery of science teacher education. The paper outlines how the approach to these deliberations led to the development of an interpretive framework that identifies the distinctive nature of this school-based practice and thus presents the general principles that others may attend to in order to commence, refine or grow their own school-based, partnership approaches to teacher education. The establishment of such a framework should also help to identify the general principles that foster successful partnership outcomes that address the concerns outlined above about science teacher education and teacher education generally.

Context

Eight science teacher educators from five universities across Victoria and Tasmania (Deakin University, University of Tasmania, Australian Catholic University, RMIT University, and University of Melbourne) successfully collaborated on the joint Office of Learning and Teaching (OLT) grant application that funds the

STEPS Project. Each of the partner institutions contains a school-based component in their science teacher education program. The study has a two-part approach representing 1) the development and 2) the implementation of the interpretive framework. The focus of the study was for the teacher educators involved to share their particular cases and underpinning theories, generation of data relating to teaching and learning at each site, and insights from relevant literature, to inform the development and refinement of the interpretive framework. Once the interpretive framework is developed it will be used as a lens to examine other institutions' school-based practices and thus provide feedback for its further refinement. This process is reflected in the intended outcomes of the STEPS study, which are:

- providing a synthesis of the variety of teaching and reflective practices and informing theories;
- documentation of exemplars of innovative pedagogies emerging form the different cases;
- creation of an interpretive framework informed by contemporary practice;
- determination of sustainable methods for establishing and maintaining effective school-university partnerships generalizable across a range of contexts;
- facilitate uptake of innovative school-based practices within the sector.

The project deliverables include the publication of the interpretive framework, the project team case studies, a database of universities and schools who are involved in school-based science teacher education programs, an annotated bibliography and a project website.

Methods:

The STEPS Project adopts a multiple case study methodology. Yin (2009) explains that the multiple case study approach, involves a number of single cases where each site "might be the subject of an individual case study, but the study as a whole covers several [sites] and in this way uses a multiple-case design" (p. 53). Our study adopted the multiple-case design, as each university campus acted as a 'site' and presented their individual case(s) of school-based science teacher education for which data collection occurred. There were a total of five universities and eight campuses involved in the study (three campuses from one university, two campuses from another, and one campus from each of the remaining universities) providing an ideal number of cases for a multiple case study design (Stake, 2006).

Careful selection of the cases was also important in the design so that a diverse range of approaches and experiences are informing the project outcomes; in this way, the study can be placed within a holistic case study design (Yin, 2009). The holistic case study design allows both the common and unique features of individual cases to be considered and thus enables the incorporation of a range of contexts. Stake (2006) indicates the importance of the selection of cases in terms of diversity of context in order to demonstrate "how the program or phenomenon appears in different contexts" (Stake, 2006, p. 27). The range of contexts represented in the present project includes programs from metropolitan, regional, and rural university campus locations; small and large pre-service teacher cohorts; school-based approaches embedded in coursework and practicum; and different partnership approaches ranging from co-

operative to collaborative (Kruger, Davies, Eckersley, Newell & Cherednichenko, 2009). Representing this diversity of contexts was essential in ensuring that the interpretive framework would be transferable across a range of contexts and could enhance the potential for greater uptake within and beyond other teacher education programs.

Developing the Interpretive Framework

The development of the interpretive framework was iterative in its approach in that data collection occurred in phases and each phase informed the aspects included in the framework and its refinement as time went on. The initial phase (Phase 1) involved the sharing and documentation of current practice and subsequent cross-case analysis to identify common and unique features of the various cases. This was followed by an analysis of literature (Phase 2) that situated the cross-case analysis within the learning of the broader sector, allowing for a deeper analysis of practice, and assisting the identification of key themes that would inform the interpretive framework (Figure 1).

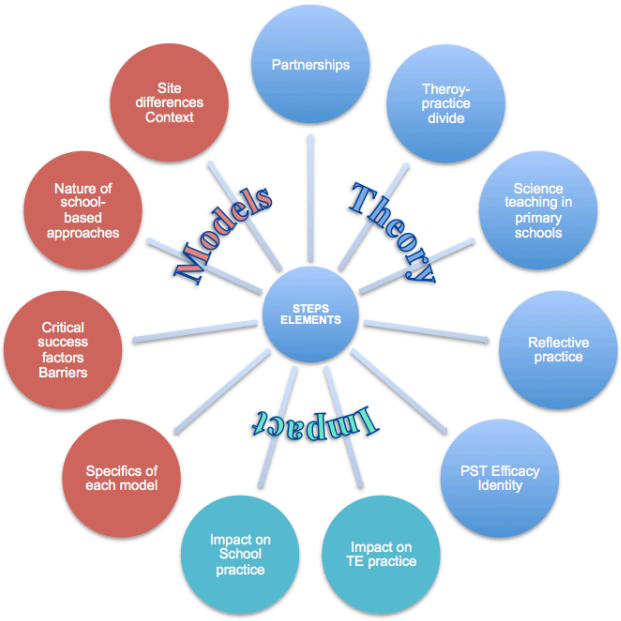

Figure 1. Key themes informing the interpretive framework at Phase 2

Phase 3 involved data collection from key stakeholders within the individual case studies. Data included questionnaires and interviews with pre-service teachers and interviews with university tutors and school teachers and principals involved in the current year's program. These data ensured that the development of the interpretive framework would be informed by the experiences of the students, tutors, and school key stakeholders.

These multiple sources of data have assisted the project team in confirming the key elements of the multiple cases, thereby ensuring the credibility and reliability of the framework. Stake (2006) claims that at least three sources of confirmation are needed for data to provide "assurances that key meanings are not overlooked" (p. 33).

Adding to the credibility and reliability of the findings was the longitudinal, purposive, and collaborative approach adopted by the project team.

The approach was *longitudinal* in that an extended timeline of meetings and events provided time for appropriate analysis and reflection on individual and

collective data, and discussions about the analyses and implications of emerging findings (Figure 2). Meetings included face-to-face meetings at critical moments of the project, including: pre-funding when the project was conceptualised and roles were defined; commencement of the project through a two-day retreat to clarify tasks and roles; and after Phase 3 data collection where the parameters for the framework were established (that is, key stakeholders and elements of practices we wanted represented in the framework). In between these important face-to-face meetings were a series of teleconferences with the project team, project evaluator and the reference group.

Figure 2: Working longitudinally – project timeline

The project team was *purposive* in that the shared philosophy about science education, science teacher education, and the project goals and outcomes were established very early (pre-funding meeting) and provided a clear vision that was maintained throughout the project team's work. A retreat at the beginning of the first year enabled all project members to regroup, realign themselves with what had been promised, and redefine the project direction, in order to turn the proposal into a plan of action before we dispersed to our respective sites. This shared philosophy enabled the team to establish a clear focus and clear and obtainable outcomes for the project and its associated research opportunities. Working alongside the project evaluator from application development enhanced this purposive work because project outcomes were consistently placed at the center of discussions around data collection and analysis.

Finally, the project team adopted a collaborative approach by *working together and alongside* one another. Working together involved team meetings between all team members or smaller working groups to interrogate ideas in light of the individual perspectives of cases, the literature and other research that each member brought to the project. The team also had individual roles and responsibilities within the project, which were completed by working alongside one another. These roles were defined at the pre-proposal phase, and were designed to be substantive and tailored contributions. Role distribution provided opportunities for individual contributions to the team's output and enhanced the sense of ownership felt by individual team members. A sense of trust, responsibility and ethics was established through this focus on collaboration.

The Interpretive Framework

The interpretive framework is actually a document in which practice is exemplified, contextualized and summarized to allow for maximum transferability. Only the summary component is reported in this paper and is represented below in two tables. Accompanying the Interpretive Framework will be the conceptual framework—consisting of the state of primary science education, partnership theory, and self-efficacy and identity theory—and vignettes that highlight and contextualize key elements of the two tables.

The first table (Table 1) represents the practices that universities and/or schools could use to initiate or grow established partnerships. The elements of this table represent the key areas of focus for ensuring that partnerships consider the range of needs, purposes, constraints and activities.

The second table (Table 2) represents the range of practices that might exist within a particular partnership that reflect the needs and purpose of the partners involved. The project team labored over the typology represented in each of the tables, and particularly in Table 2 where the types of partnerships: Connective, Generative and Transformative, are labeled. It was important to the team that, whilst the framework reflected a hierarchy of partnership type (aligned with Kruger et al.'s (2009) co-operative to collaborative partnership), it was not value-laden because each type of partnership is important, valued and serves a particular need or purpose.

The project team intends the interpretive framework to:

- Be broad enough to allow for depth of theoretical exploration within the different dimensions;
- Have practical application;
- Have theoretical application;
- Draw on current practice;
- Draw on current literature;
- Lead to new practice;
- Support the development of new practice; and
- Encompass all elements of establishing and implementing practice.

It is hoped that both schools and universities would be able to use the framework to initiate or grow practice.

Table 1
Growing University-School Partnerships (GUSP)

	A. Need and Rationale	B. Institutional and Unit Demands	C. Partnerships	D. Curriculum Development (for children)	E. Elements of practice (PSTs & Teachers)
1. Initiation Phase	Identify mutual and differing needs and provide rationale	Identify constraints and affordances governing the approach to partnership development	Negotiate and define value and parameters defining the nature of the partnership	Conceptualise an approach to PST interaction with children.	*For Universities:* Establish guiding principles for practice that can occur within the partnership. *For Schools:* Consider options for level of involvement in feedback and personal reflection.
2. Implementation Phase	Be mindful of the needs and rationale and be responsive to emerging needs	Manage, compromise, justify and respond to demands (limitations and possibilities)	Maintaining and working with partners to meet individual and differing needs of partners	*For Universities:* Developing and implementing subject-related and general content and pedagogy *For Schools:* Be aware of PST interactions with children.	*For Universities:* Draw on informing theories, and modeling reflective practice and subject-related content and pedagogy. *For Schools:* Reflect on current level of involvement in feedback and professional learning.
3. Evaluation Phase	Evaluating the needs and rationales for their continued relevance and future possibilities.	Evaluating against institutional demands and considering different possibilities & approaches.	Evaluating the nature of the partnership to respond to current and future needs and possibilities.	*For Universities:* Rethink, redevelop curriculum while drawing on reflections and research. *For Schools:* Evaluate children's engagement and learning to determine continued involvement.	*For Universities:* Examining effectiveness of practices in response to institutional, unit, and partnership changes and needs. *For Schools:* Evaluate current practices and consider future levels of involvement in feedback and professional learning interests/needs

Table 2
Representations of Partnership Practices (RPP)

	A. Need and Rationale	B. Institutional structures	C. Nature of partnership	D. Linking theory with practice
1. Connective	Engagement based on provision of curriculum or other service need.	Partnership activities are short-term and opportunistic and sit within existing structure.	Partners provide short-term services with a focus on one partner's needs but with mutual benefits and value for all.	Partners recognise schools as important sites for PSTs to link theory and practice.
2. Generative	Partners recognise opportunities for mutual professional learning	Partnership activities are considered long-term and are planned and catered for in the teacher education and school programs.	Partners jointly plan the structure of the school-based practices to the benefit of both.	Opportunities exist for both partners to reflect on practice that may be linked to theory.
3. Transformative	Partner involvement based on active professional learning	Partnerships are embedded in the ongoing structures and practices of the institutions.	Partners take joint responsibility for mutually agreed practices and outcomes that are embedded in their respective core outcomes.	Both partners engage explicitly in reflective inquiry guided by theories of professional identity development.

The project is now at Phase 4 where a final refinement of the framework will occur through its use by other teacher educators as a lens to examine school-based approaches. Generating data from other universities, through the lens of the developing Interpretive Framework, should ensure that a greater range of perspectives and practices are informing the project outcomes and enhance the validity of the framework as an instrument for establishing and growing partnerships.

References

Australian Council of Deans of Education (ACDE). (2004). *Submission to the Victorian Parliamentary Inquiry into the suitability of pre-service teacher training in Victoria*.

Darling-Hammond, L. (2006). Constructing 21st century teacher education. *Journal of Teacher Education*, *57*(3), 300-314.

Darling-Hammond, L. (Ed.). (2005). *Professional development schools. Schools for developing a profession*. New York: Teachers College Press.

Dobson, I. (2003). *Science at the crossroads? A study of trends in university science from Dawkins to now 1989-2002*, Centre for Population and Urban Research, Monash University. A study commissioned by the Australian Council of Deans of Science.

European Commission. (2011). *Science education in Europe: National policies, practices and research*. Education, Audiovisual and Culture Executive Agency (EACEA). Retrieved from: http://eacea.ec.europa.eu/education/eurydice

Goodrum, D., Druhan, A. & Abbs, J. (2011). *The status and quality of Year 11 and 12 science in Australian School*. Report to Office of the Chief Scientist and funded by the Australian. Government Department of Innovation, Industry, Science, Research and Tertiary Education.

Goodrum, D., Hackling, M. & Rennie, L. (2001). *The status and quality of teaching and learning of science in Australian schools: A research report*. Canberra, Department of Education, Training and Youth Affairs.

House of Representatives. (2007). *Top of the class. Report on the inquiry into teacher education*. [Electronic version]. Retrieved from: http:/www.aph.gov.au/house/committee/evt/teachereduc/report/front.pdf

Koballa, T. & Tippins, D. (2001). Portraits of professional development models in science teacher education: a synthesis of perspectives and issues. In D. Lavoie & W. Roth (Eds.), *Models of science teacher preparation*. Netherlands: Kluwer Academic Publishers.

Korthagen, F., Loughran, J., & Russell, T. (2006). Developing fundamental principles for teacher education programs and practices. *Teaching and Teacher Education*, *22*, 1020-1041.

Kruger, T., Davies, A., Eckersley, B., Newell, F. & Cherednichenko, B. (2009). *Effective and Sustainable University-School Partnerships. Beyond determined efforts of inspired individuals*. Canberra: Teaching Australia. Electronic version http://hdl.voced.edu.au/10707/144200

Louden, W. (2008). 101 Damnations: the persistence of criticism and the absence of evidence about teacher education in Australia, *Teachers and Teaching: theory and practice, 14*(4), 357-368.

Parliament of Victoria, Education and Training Committee, (2005). *Step up, step in, step out. Report on the suitability of pre-service teacher training in Victoria*. (Melbourne: Victorian Government Printer).

Patrick, C-j., Peach, D., Pocknee, C., Webb, F., Fletcher, M., Pretto, G. (2008, December). *The WIL [Work Integrated Learning] report: A national scoping study*. [Australian Learning and Teaching Council (ALTC) Final report]. Brisbane: Queensland University of Technology. Retrieved from: http://eprints.qut.edu.au/44065/1/WIL-Report-grants-project-jan09.pdf

Ryan, J., Jones, M. & Walta, C. (2012). Creating a sustainable and supportive practicum for rural and regional areas. *Australian and International Journal of Rural Education 22*(1), 57-72.

Stake, R. (2006). *Multiple case study analysis*. New York: The Guilford Press.
Tytler, R. (2007). *Re-Imagining science education: Engaging students in science for Australia's future*. Australian Education Review. Australian Council for Educational Research. Retrieved from: http://www.acer.edu.au/documents/AER51_ReimaginingSciEdu.pdf
Tytler, R., Osborne, J., Williams, G., Tytler, K., Cripps Clark, J. (2008). *Opening up pathways: Engagements in STEM across the primary-secondary school transition*. Canberra: DEEWR.
Yin, R. (2009). *Case study research: Design and methods (4th Ed.)*. Thousand Oaks, CA: Sage Publications.

Acknowledgements

Support for this publication has been provided by the Australian Government Office for Learning and Teaching. The views expressed in this publication do not necessarily reflect the views of the Australian Government Office for Learning and Teaching.