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# School and University Partnerships: The Role of Teacher Education Institutions and Primary Schools in the Development of Preservice Teachers' Science Teaching Efficacy

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# School and University Partnerships: The Role of Teacher Education Institutions and Primary Schools in the Development of Preservice Teachers' Science Teaching Efficacy

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*Abstract: Science in the Australian primary school context is in a state of renewal with the recent implementation of the Australian Curriculum: Science. Despite this curriculum renewal, the results of primary students in science have remained static. Science in Australia has been identified as one of the least taught subjects in the primary school curriculum, and therefore, the role of the teacher is paramount. Research has explored the significant impact that tertiary education and practical experience, including the role of the science teacher educator and mentor teacher, can have on preservice teachers, in relation to either increasing or calibrating science teaching efficacy beliefs. Such research is significant due to the correlation between teaching self-efficacy and performance. Following a commentary on literature in this field, this article will present recommendations for the development of science partnerships between tertiary institutions and primary schools in Australia.*

## Introduction

In this article, we review the literature on the role of teacher education courses and practical experience in the development of preservice science teaching efficacy. The article comments on the context of Australian primary science education to situate the discussion. Research that examines the role of science coursework and practical experience in tertiary settings and the associated impact on preservice teaching efficacy is discussed. Following a commentary on literature in this field, some recommendations and challenges for the development of partnerships between tertiary institutions and schools are presented, with the aim of improving the quality of primary science education in Australia.

## The Context of Science in Australian Primary Schools

A fundamental report about the status of science teaching and learning in Australia (Rennie, Goodrum & Hackling, 2001) identified a significant gap between the ideal and actual world of teaching and learning science. Issues in primary schools included inconsistency between schools in terms of science curriculum delivery, lack of reporting of students' knowledge and skill achievement in science, and problems with the resourcing of science including materials and facilities.

One recommendation of the report produced by Rennie et al. (2001) was to cultivate a national focus on developing curriculum and professional development resources to support the teaching and learning of science. An outcome from this report was the development of the *Primary Connections* project, an initiative of the Australian Academy of Science supported by government, independent and Catholic schools and all states and territories (Hackling, 2006). *Primary Connections* is essentially a science professional learning program, which is supported by curriculum resources for all compulsory primary school years based on Bybee's 5E's model (1997). Prior to this approach, a series called *Primary Investigations,* also produced by the Australian Academy of Science, was used sporadically in Australian primary schools. This approach waned in popularity due to variance in it meeting different state science curricula and the increasing focus on literacy and numeracy programs (Aubusson, 2002). The *Primary Connections* approach and the associated curriculum resources have had significant uptake across Australia with over 56% of schools using the materials in some capacity, particularly due to the connections with the *Australian Curriculum: Science* (Australian Academy of Science, 2011). The Australian Capital Territory, South Australia, Western Australia and Queensland have had the highest proportions of schools using the materials (Australian Academy of Science, 2011). New South Wales has had the lowest uptake of *Primary Connections,* partially due to the difficulty of matching the approach with the requirements of the Science and Technology syllabus used in this state (Skamp 2012). Schools that have implemented *Primary Connections* have reported an increased focus on science within the curriculum and higher levels of teacher confidence when teaching science (Hackling & Prain, 2005; Skamp, 2012).

Despite science being included as one of the first four learning areas in the *Australian Curriculum* in 2010, several challenges continue to exist with the teaching and learning of science in primary schools in Australia. Science is one of the least taught learning areas in primary schools in Australia, with an average of 45 minutes or 3 % of the total weekly teaching time dedicated to it (Angus, Olney & Ainley, 2007). In examining the impact of the *Primary* Connections approach to primary science, Hackling and Prain (2005) identified that many Australian primary school teachers lacked confidence with teaching science prior to the implementation of the project, supporting earlier research about science teaching confidence (Palmer, 2001; Yates & Goodrum, 1990). Many primary teachers identify challenges such as locating resources, lacking time to prepare and teach science, and understanding research into the ways in which students learn science, as impeding their performance in science teaching (Skamp, 2012).

Another significant concern for science educators in relation to science education is student performance in science across Australia. Analysis of the 2011 *Trends in International Mathematics and Science Study* (TIMSS) shows that student performance in Year 4 and 8 has remained fairly stagnant over the past 20 years, while other countries such as Korea, Singapore and Finland, have made significant improvements (Thomson, Hillman, Wernert, Schmid, Buckley & Munene, 2012). In the most recent TIMSS, results from Australia Year Four students was lower than eighteen countries, including the United Kingdom, the United States of America, and most Asian countries (Thomson et al., 2012).

Looking at science in the Australian curriculum at a broader level, Goodrum, Druhan and Abbs (2011) identified that in 2010, only half of the Australian Year 12 cohort were studying a science subject, which has decreased from approximately 90% in the early nineties. These authors believe more work needs to be done in order to engage students with science during the compulsory years of schooling.

In order for some of the issues described above to be adequately addressed, it is firstly important to examine the beliefs and attitudes of the teachers involved, as teacher beliefs can be either an impediment or catalyst for the teaching of science (Skamp, 2012). Ucar (2012) argues that teacher education programs play a significant role in the development of teaching beliefs including self-efficacy, which impacts upon every aspect of the teaching process. These observations open up a critical dialogue within the concept of self-efficacy in relation to science preservice teachers, and the role of universities and schools in developing this teaching efficacy. This article aims to explore the importance of teacher education programs and schools on preservice science teaching efficacy by recognising the importance of preservice education in the development of teaching efficacy, and the impact that this may have on future teaching performance.

## The Relationship between Self-Efficacy and Science Teaching

Self-efficacy is situated within a social cognitive theoretical framework that has primarily been developed through the work of Albert Bandura. Self-efficacy emphasises the role of learning in a social context that impacts on the development of social behaviours in humans (Bandura, 1986). According to Bandura (2001, 1997, 1993), the core feature of what makes human agents in their own lives is their own self-belief in their ability to exercise some sense of control over their own behaviour and of their environment. Bandura refers to this as an individual's perceived self-efficacy which impacts on how people think, feel, behave and motivate themselves. Therefore, it seems reasonable to assume that those people who have a low personal efficacy will avoid situations and activities that they believe they are not capable of doing, which can significantly influence their ongoing personal development (Bandura, 1993).

It is important to note that personal efficacy beliefs are not simply predictors of future performance (Bandura, 1989). Tschnannen-Moran, Woolfolk-Hoy and Hoy (1998) emphasise that personal efficacy is about how individuals perceive their own competence, and does not focus on the level of competence itself. Further to this, Bandura (1997) states "there is a marked difference between possessing sub skills and being able to integrate them into appropriate courses of action and to execute them well under difficult circumstances" (p. 37). It therefore follows that people with the same skill level may perform a given task differently depending on differences in their perceived self-efficacy (Bandura, 1997). The role of context is therefore important when examining these beliefs (Skamp, 2012). In teaching, self-efficacy does not simply relate to teachers' ability to transmit knowledge in a specific learning area such as science, but will be influenced by their ability to create an effective learning environment, use and locate resources, and encourage parental involvement (Bandura, 1997).

Self-efficacy is thought to be composed of two components. As Enochs and Riggs (1990) state, "behaviour is enacted when people only expect specific behaviour to result in desirable outcomes (outcome expectancy), but they also believe in their own ability to perform the behaviour" (p. 2). As discussed in this quote the first component is personal efficacy, which is considered to be the belief that an individual has about whether he or she can successfully complete a skill to produce the desired behaviour (Ling & Richardson, 2009). The second is outcome expectancy, which is the belief that an action will result in the desired outcome (Swars & Dooley, 2011).

In the context of science teaching, Enoch and Riggs (1990) developed an instrument to quantitatively measure efficacy when teaching science called the Science Teaching Efficacy Belief Instrument (STEBI). This instrument measures both science teaching outcome expectancy (STOE) and personal science teaching efficacy (PSTE), and has been adapted for use with both inservice teachers (STEBI-A) and preservice teachers (STEBI-B).

An individual's sense of personal efficacy may be developed or cultivated in several ways. According to Bandura (1997, 1994) the primary or most effective source of a person's self-efficacy is through mastery experiences. By achieving success in a mastery experience, a person is more likely to be confident in his or her own abilities. Bandura (1994) believes that in order to develop a resilient self-efficacy, an individual must have experience in overcoming challenges in mastery experiences using a persistent effort. The second source of efficacy identified is through vicarious experiences and modelling from other people (Bandura, 1997, 1994). A third potential source of efficacy beliefs is through social persuasion (Bandura, 1997, 1994). Bandura (1994) believes that those who are persuaded that they are capable of successfully completing a various task are more likely to persevere with a given task, even when they experience bouts of self-doubt. The fourth source of efficacy is through a person's reaction and perception of their physical and emotive states (Bandura, 1997, 1994: Henson, 2001). More recent research suggests that mastery experiences may be formed as a result of, or in combination with the other three sources (Brand & Wilkins, 2007). Mansfield and Woods-McConney (2012) researched the efficacy sources of teachers teaching science in primary Western Australian schools. Their data supported the importance of mastery experience, vicarious experience and physiological and affective states as sources of personal science teaching efficacy. However, they found no data to support the distinct role of social/ verbal persuasion, but claimed that it may have occurred implicitly through vicarious and mastery experiences (Mansfield & Woods-McConney, 2012).

Science education is one area where self-efficacy research has been significant, with science teaching efficacy connected to actual classroom practice (Enoch & Riggs, 1990; Smith & Southerland, 2007; Tschannen- Moran et al., 1998). Many studies have explored the self-efficacy of preservice teachers in relation to their science teaching (Avery & Meyer, 2012; Bleicher, 2007; Cannon & Scharmann, 1996; Howitt, 2007; Ling & Richardson, 2009). Preservice early childhood and primary teachers often have low science teaching efficacy at the initial stages of a preservice science methods course (Bleicher, 2007; Hechter, 2011; Yoon, Pedretti, Bencze, Hewitt, Perris & Van Oostveen, 2006). Mulholland and Wallace (2000) claimed that this was a result of being 'non- science people' required to teach science. This is reasonable, considering that most primary teachers are required to teach all learning areas in the Australian context, although each learning area has its own approaches and focuses. Moscovici and Osisioma (2008) believe that some preservice primary teachers experience 'sciencephobia' at various levels, which the authors believe stems from unsuccessful science learning in the past. Preservice teachers, regardless of their previous experiences in science, enter university science methods courses with preconceived ideas about what science teaching and learning should look like (Hubbard & Abell, 2005). Data from another research study (Bleicher & Lindgren, 2005) showed that while most preservice teachers entered a science methods course with weak science backgrounds, all students, regardless of their own abilities, expressed concerns about their abilities to teach science to children.

## Teacher Education Programs and the Development of Science Teaching Efficacy

The preservice stage of teacher education is important in relation to the development of beliefs about science teaching and learning. This includes science teaching efficacy, which is impacted by the coursework and practical experience provided within the degree (Labone, 2004: Poulou, 2007). Labone (2004) argues that it is during the preservice years of a teaching degree that self-efficacy beliefs are most malleable, and it is therefore important to provide enactive mastery experiences during this period to aid in the process of self-efficacy development. Abell and Bryan (2007) argued that all learners come into science teacher education programs with ideas about the nature of science and what science teaching is like. Therefore, these authors maintain that in order to learn how to teach science, these learners need to have an opportunity to clarify their ideas, challenge them where necessary, find suitable alternatives and apply these new ideas (Abell & Bryan, 2007). It is important to determine what information preservice teachers use that impacts upon their personal beliefs and confidence, in order to assist universities in planning for extra development opportunities, or redevelop their coursework and practical experiences to help increase preservice teachers' self-efficacy (O'Neill & Stephenson, 2012). The role of science methods courses and science teacher educators in impacting on science teaching efficacy becomes important to examine.

### The Impact of Science Methods Units on Developing Preservice Teaching Efficacy

In Australian teacher education programs, the Australian Institute of Teacher and School Leadership Limited [AITSL] states that in a four year Bachelor of Education degree, the equivalent of one eighth of a year, needs to be focused on the content and teaching of science (AITSL, 2011). Science methods units are one way that universities can meet this requirement. As opposed to science content units, which aim to improve science content knowledge, science methods units are designed to focus on improving both the content knowledge and teaching skills in relation to teaching science. As a result of this approach, the same amount of content is certainly not covered as in science units, but the purpose of science methods units is to assist preservice teachers with proven approaches and practical strategies to assist them when teaching science in a classroom, thus improving their pedagogical content knowledge (Howitt, 2007). Many studies have examined the impact of science methods course on the self-efficacy of preservice teachers (Brand & Wilkins, 2007; Bautista, 2011; Cone, 2009b; Palmer, 2006a). Even in the case of negative prior experiences with science, such as high school, a well-designed science methods course can increase the confidence of preservice teachers when learning science and may also impact on their future teaching of science (Bleicher, 2007). This finding is supported by further research, which demonstrated that students who began a science methods course as 'fearful' or 'disinterested' and with low levels of science teaching efficacy, completed with much higher levels of confidence (Bleicher, 2009). Similarly, Palmer (2006b) found that learning content and pedagogical knowledge about science, and being involved in simulated modelling, increased student teachers' confidence when teaching science. Interestingly, Palmer (2006a) identified no significant change in science teaching self-efficacy levels of preservice teachers from immediately after a science methods course to nine months later. He argued that if a carefully thought out science methods course is completed one year before the end of a degree, these higher levels of science teaching efficacy can persist into the first years of teaching.

The focus and structure of a science methods unit needs to be considered in terms of the influence on science teaching efficacy. Bleicher and Lindgren (2005) argued that while many believe there should be more science methods units included in preservice teacher education degrees, instead the focus should be on the actual design of the methods course, by including experiential learning or mastery experiences, as well as opportunities for discussion and reflection. Incorporating meaningful assignments and discussion within a science methods course may also impact on the science teaching efficacy of student teachers (Gunning & Mensah, 2011). Ensuring that *activity based* science coursework is incorporated within a science methods course has been found to lead to an increase in the confidence of preservice teachers (Enoch, Scharmann & Riggs, 1995). In a qualitative study of preservice early childhood teachers of science, critical incident vignettes showed that participants had an opportunity to interact with science in a meaningful learning environment, participate and observe a range of teaching and learning strategies, and "see the world through the eyes of a child" (Howitt & Venville, 2009, p. 227). The authors proposed that science methods courses need to provide opportunities for preservice teachers to re-engage with science and experience what it is like to be curious, as young children often are with science.

Further, research that examined the use of exemplars of science teaching in a structured science methods course saw an increase in the science teaching self-efficacy of participants (Yoon et al., 2006). This position is supported by Buss (2010) who argued that a primary aim of a teaching degree should be to assist preservice students in developing the confidence to teach science. A significant aspect of this position is to provide students with opportunities to view effective science teachers delivering instruction, thereby increasing opportunities for science teaching efficacy development through vicarious experiences.

In some universities, there have been attempts to deliberately integrate science methods units and a practical experience. Research conducted in the USA by Swars and Dooley (2011) found that by meaningfully integrating science coursework and a practicum led to significant increases in science teaching self-efficacy. Such a finding is supported by Australian research (Jones, 2008) that examined an approach to building collaborative professional development between preservice and inservice teachers. When analysing the impact of a carefully constructed science methods course and practicum, Smolleck and Morgan (2011) identified that for preservice teachers to use inquiry-based approaches when they become teachers, they need opportunities and support to experience success when teaching with this approach. These authors suggested that this must be the core work of teacher educators, knowing that preservice teachers' science teaching efficacy is malleable and that changing teacher attitudes is at the heart of educational reform.

#### Science Teacher Educators

As previously illustrated, science methods courses can have an impact on the science teaching efficacy of preservice teachers. Therefore, the role of the science teacher educator is paramount. Science teacher educators are responsible for planning the teaching and learning experiences within the course, providing feedback to impact on performance, and modelling effective science teaching practices. Implications of research conducted by Mansfield and Woods-McConney (2012) emphasised the role of the science teacher educator in assisting students to seek out collaboration with other teachers of science, and to thereby provide more extensive science teaching experiences. This approach is supported by Howitt (2007) who asked preservice teachers what characteristics of the teacher educator were most valuable to their overall science learning experience. The characteristics identified were enthusiasm, use of humour, passion for science, and an approachable and friendly nature, thereby acting as a role model for preservice teachers. Howitt (2007) suggested that the teacher educator is central to the science teaching experiences that occur in a science methods course because they are directly responsible for all aspects within that course, including course structure, learning experiences and assessment.

Research has examined the direct relationship between the science teacher educator and the development of self-efficacy. One study found that a teacher educator's modelling and incorporation of innovative teaching strategies had a positive impact on preservice teachers' science teaching efficacy (Bleicher, 2007). Poulou (2007) argued that teacher educators may help students achieve *calibration* by assisting them to find a match between their self-efficacy and their actual capabilities. This notion of calibration occurs by either helping preservice teachers reduce the negative beliefs or promoting the positive or realistic aspects of their teaching performance (Poulou, 2007). Both Poulou (2007) and Hubbard and Abell (2005) highlight the importance of a relationship between the teacher educator and classroom teachers in schools, in supporting the development of preservice teachers' teaching efficacy.

## The Role of Practical Experiences in the Development of Science Teaching Efficacy

In the Australian context, no fewer than eighty days of practical experience needs to be included within initial teacher education degrees (AITSL, 2011). However, the components and structure of these practical experiences vary at different universities. Some universities that incorporate a large amount of practical experience in their degrees actually use this as a marketing tool for prospective students. Interestingly, it is probable that some students will not view a lot of science being taught in primary schools even if they complete a large amount of practical experiences. This outcome may be due to the fact that their cooperating classroom teacher does not enjoy teaching science or struggles with the demands of a crowded curriculum with little time for teaching science. This is supported by a research study by Mulholland and Wallace (2003) where the participants had seldom opportunities for viewing or teaching science during their practical experience.

Interestingly, more practical experience is not always associated with higher levels of self-efficacy but may instead act as another way in which teaching efficacy is calibrated or may even negatively impact upon teaching beliefs. One study found that the practical experience had no impact on personal science teaching efficacy (Yilmaz & Çavaş, 2008). Other studies have identified decreases in personal science teaching efficacy following a teaching practicum (Settlage, Southerland, Smith & Ceglie, 2009; Utley, Moseley & Bryant, 2005). In examining the durability of science teaching efficacy from immediately after a science methods course to nine months after, Palmer (2006a) identified that of the small number of students whose self-efficacy did decrease, many did not actually have the opportunity to teach science while on their practical experience which was during this nine-month period. He argued that a practical experience was an influential factor on the durability of science teaching efficacy (Palmer, 2006a), and therefore a practical experience needs to provide preservice teachers with ample opportunities to actually teach science. Similarly, Settlage et al. (2009) found that the positive increase of science teaching efficacy that was seen as a result of the science methods course was not completely lost after the practicum, meaning that the self-efficacy scores were still higher than prior to the science methods course. While the aim of a science methods course is to increase confidence in teaching and learning about science, the role of a practical experience is to assist with calibrating these beliefs and to assist preservice students to develop resilient efficacy beliefs (Labone, 2004; Poulou, 2007).

In contrast to these studies, other research has identified school placement as a major source of gaining confidence to teach science. However, in the absence of this source science methods courses played an important role (Howitt, 2007). To emphasise the importance of preservice teachers actually teaching science on their practicum, research by Cantrell, Young and Moore (2003) saw a significant increase in personal science teaching efficacy when preservice teachers actually taught science for more than three hours on a three week practical experience. This is in contrast to another study that found that the more practical experience that students had, the lower the self-efficacy of the preservice teachers (Capa Adyin & Woolfolk Hoy, 2005).

In most practical experiences, primary student teachers are placed within a generalist classroom. However, in Varma and Hanuscin's (2008) research, preservice teachers were placed in a specialist science teacher's classroom. Most of the students reported that the experience was consistent with what they had previously learnt in their science methods course and the authors noted that these experiences provided a guaranteed opportunity for preservice teachers to see science being taught. However, these authors argue that it remains unclear the extent to which this type of practical experience has on improving science teaching efficacy and teaching performance, if they do not see the connections to how this will translate in a generalist primary classroom.

The role of the cooperating teacher in impacting on preservice teacher self-efficacy also needs to be considered. An American study exploring the role of the cooperating teacher on the personal efficacy of preservice teachers found that there was a moderate, positive correlation between interactions with a cooperating teacher and the personal efficacy of student teachers (Hamman, Oliveraz, Lesley, Button, Chan, Griffith & Elliot, 2006). In this same study, the factor that impacted most significantly on student teacher's perceptions of their own capabilities was related to the amount of guidance they received from their cooperating teachers. Another study identified positive correlations between the relationship of the cooperating teacher and the student teacher, and a supportive environment, on the positive self-efficacy of the preservice teacher (Capa Adyin & Woolfolk Hoy, 2005). Mulholland and Wallace (2001) maintain that a major constraint that impacted on participants in their Australian science teaching efficacy research was a lack of positive role models demonstrating effective science teaching.

Several studies have focused on the critical elements that lead to a positive practical experience. Cooperating teachers in research conducted by Kenny (2012) identified communication as critical to success within a teaching practicum and also emphasised the importance of student teachers being prepared and organised for their teaching experiences. Indeed, Hudson (2005) found that student teachers need to be provided with opportunities to talk about how they teach science, arguing that this needs to be provided in an environment where the mentor is attentive and encourages the preservice teacher to reflect on practice.

The actual nature of the practical experience can also be significant. Hudson and McRobbie's research (2003) showed that fourth year preservice teachers involved in a science mentoring intervention improved their pedagogical knowledge and understanding of system requirements. Mentors in this study also reported that the structured intervention increased their confidence in their preservice teacher's ability to teach science and in their own mentoring abilities. As was evident from this study, practical experiences can be mutually beneficial to both the preservice teacher and cooperating teacher. A program developed that incorporated preservice teachers working with practicing teachers to teach a science program of work, identified significant benefits to the practicing teacher (Jones, 2008). These benefits included increased confidence to teach science, an increase in student engagement in science and reflection on their own personal science teaching practice.

## Challenges and Recommendations

This discussion has explored current research that suggests both teacher education programs and schools play a significant role in the development of science teaching efficacy. In the Australian primary education context, the authors propose several recommendations. Preservice teachers need to observe science being taught and have an opportunity to teach science throughout their teaching degrees. There are several ways that this can be facilitated. Firstly, the quality of the science units and the role of the science teacher educator need to be examined in the Australian context (Bleicher & Lindgren, 2005; Howitt, 2007). Considering the requirements of science within initial teacher education degrees (AITSL, 2011), science units need to be continually evaluated in terms of how they reflect best practice and current research, and whether or not they adequately prepare preservice teachers for teaching science in a generalist primary classroom. A significant aspect of this evaluation needs to focus on examining student efficacy beliefs about teaching and learning science to assist with planning meaningful learning experiences to foster or challenge these beliefs (Abell & Bryan, 2007; O'Neill & Stephenson, 2012). Opportunities for mastery and vicarious experiences need to be deliberately planned for in science methods units, due to the importance of these experiences in impacting on science teaching efficacy (Mansfield & Woods-McConney, 2012).

Paramount to the quality of science methods courses is the role of science teacher educators. Science teacher educators are role models (Howitt, 2007) and therefore need to be passionate about science as a learning area within the primary classroom, be approachable to students, create a positive classroom environment, and model 'trialled and tested' teaching and learning strategies with students. As part of their role, science teacher educators need to assist preservice teachers with locating and using significant resources to teach science, such as the *Primary Connections*, which have been proven to positively impact on teacher beliefs in teaching science (Hackling, 2005; Skamp, 2012). However, this recommendation cannot simply occur from the university perspective due to the identified significance of practical experiences and context in developing science teaching efficacy through providing opportunities for mastery experiences (Skamp, 2012). Universities can ensure that teaching science is a requirement for successful completion of a practical experience in teacher education degrees. Making the teaching and assessment of science a requirement on practical experiences, plays an important role in increasing the durability and resiliency of science teaching efficacy beliefs in preservice teachers (Labone, 2004; Palmer, 2006a; Poulou, 2007). However, in order for the practical experience to positively influence science teaching efficacy, the cooperating teacher is significant (Capa Adyin & Woolfolk Hoy, 2005). Teachers who are exemplars of teaching science should be identified by primary schools and supported in mentoring preservice teachers on practicum. While not a new recommendation, the current data on primary science teaching suggest that it is increasingly evident that this approach will require support from leadership teams within primary schools so that it does not significantly add to the increasing workload of primary teachers. Science teacher educators can also assist in developing structured mentoring systems, to ensure there are benefits for both the preservice and classroom teachers (Hudson & McRobbie, 2003).

As science specialist teachers become more common in Australian primary schools, further exploration of placing preservice teachers in specialist science classrooms may be warranted, in line with the research conducted by Varma and Hanuscin (2008). Research that examines the impact of this approach on science teaching efficacy and the correlation with science teaching performance when teaching in a generalist classroom would be worthy of future studies in the Australian context.

A second recommendation is that universities and primary schools need to develop reciprocal relationships in the area of science education. Examples of this reciprocal relationship may involve schools taking preservice teachers for practical experiences, or allowing university classes to observe or work with students in the area of science education. Australian teaching universities could increasingly offer professional development for primary schools in teaching science and provide ongoing support to develop best practice that reflects up-to-date research. With the current implementation of the *Australian Curriculum: Science*, there may be a significant desire for primary schools to provide additional skills for teachers in the area of science. As in the case of professional development offered in training teachers with the *Primary Connections* program, this may positively impact upon the confidence and enjoyment of those teaching science. Skamp (2012) identified that this approach had led to increases in the teaching of science and that there were positive outcomes for the science learning of students. Universities and science teacher educators may also assist schools with induction procedures for new teachers to assist them with teaching science effectively in the primary school context. Roehrig and Luft (2006) identified that university supported induction experiences could assist new teachers to implement inquiry based approaches to teaching science. More formal investigation of this in the Australian context is warranted.

A final recommendation is that Australian universities, educational jurisdictions and professional associations should continue to support early career teachers in teaching and learning about science. As teaching beliefs, including self-efficacy, are malleable in the preservice years (Smolleck & Morgan, 2011) and in the early stages of a teaching career, there is a significant opportunity to further enhance science teaching efficacy. Further research that examines how this could occur would be beneficial.

It is important to acknowledge the challenges of developing school and university partnerships in the area of science teacher education. While the significance of science cannot be underestimated, it competes with other areas in an ever-increasing curriculum in Australian schools. This is also true of science education units at tertiary institutions. A potential ongoing challenge is how universities and schools can prioritise science within this environment. A second significant challenge is the bureaucracy involved with monitoring preservice teachers in their development to teach science. Universities produce large numbers of preservice teachers and ensuring that all of these teachers have an experience of seeing quality science being taught and actually teaching it themselves is challenging. Again, the role of the science teacher educator is important in this process (Howitt, 2007). Regardless of the difficulty, it is a significant and important task to undertake.

## Conclusion

This article has discussed and analysed current and significant research in relation to the role of tertiary education institutions and schools in relation to the science-teaching efficacy of preservice teachers. The current science educational climate in Australia was briefly explored to provide a context for this issue and why it is important. The theoretical framework of the study in relation to social cognitive theory and self-efficacy were briefly discussed, and the link between self-efficacy and science teaching was identified. The role of teacher education programs, science methods courses, the science teacher educator and practical experiences, and how this impacts on preservice teachers was discussed. This discussion highlighted the importance of preservice teachers becoming confident about teaching science and also that these beliefs are impacted on or calibrated through their practical experiences so that they are resilient to the realistic demands and challenges of beginning teaching. Recommendations for the development of partnerships between universities and primary schools were put forth and challenges identified. However, even when taking these challenges into account, the significance of both universities and schools in developing science teaching efficacy is crucial, and developing partnerships to enhance this needs to be considered a priority by those involved in science teacher education in Australia.

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