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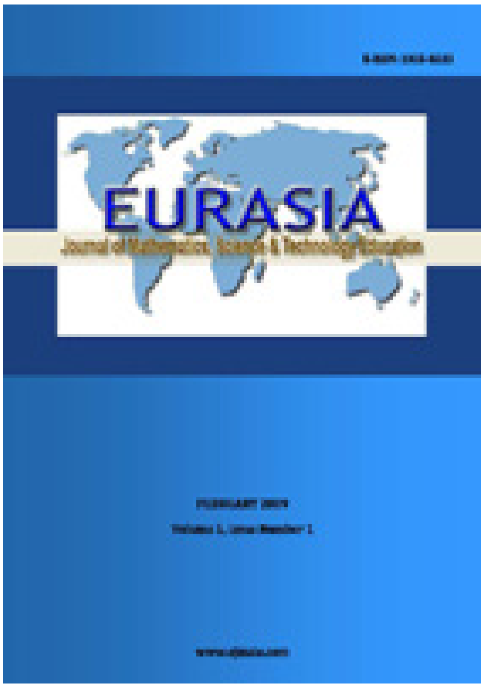

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There has been recent concern over the variable quality of science teaching in New Zealand primary schools. One reason suggested has been the relatively low levels of science education components in initial teacher education (ITE) programmes. This paper follows a cohort of recent teacher graduates from a science education course in their ITE programme through the first two years of their teaching career. Their beliefs in science education, their confidence in their science subject matter knowledge and pedagogical content knowledge, and use of strategies suggested in their ITE science course were explored. It was found that the teachers retained their positive views of science in the curriculum, and confidence in their ability to teach science grew. The use of student and investigation-centred teaching strategies increased as the new teachers experienced success with the approaches. These outcomes are discussed in light of recent changes in primary curriculum emphasis on literacy and numeracy, and ITE science course contractions.

Keywords: Fun, interest, learning, motivation, hands-on science, kindergarten education

INTRODUCTION

Research presented here is drawn from a longitudinal study exploring persistence and changes in the stated beliefs, practices and experiences of primary teachers teaching science during the early years of their teaching career. Participants had completed a one-year Graduate Diploma of Teaching (Primary) at a New Zealand university at the end of 2006 and were surveyed at the end of their first and second teaching years. This study focuses on three questions:

How do early career primary teachers' beliefs about teaching and learning of science change over the first two years of practice? What factors influence any change?

Do early career primary teachers implement teaching strategies experienced in their Initial Teacher Education course? If so, in their perception, how effective were they and what influenced their choice of strategy?

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What do early career teachers perceive has assisted or hindered teaching science through investigation?

Theoretical framework

Against a backdrop of concern over the state of science education in New Zealand primary schools (Gluckman, 2011), and contracting initial teacher education (ITE) primary science courses in Colleges of Education, the issue of content for such courses is being reviewed. Bull, Gilbert, Barwick, Hipkins and Baker (2010) reflect the view that "primary teachers' knowledge and confidence … is an obstacle to quality science teaching in primary schools" (p.22). Conner (2009) suggests that ITE programmes face: "…competing demands to provide quality content, theory and experience for participants … whilst simultaneously ensuring that beginning teachers demonstrate the multiple competencies of "qualities" required for graduation and induction into the profession." (p. 121).

A key finding from the Teacher Education for the Future Project (Conner, 2008) was that ITE programmes needed to include "new ways of knowing"

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State of the literature

- There have been few medium to long-term studies of early teaching practice of recent primary science teaching graduates from initial teacher training establishments in New Zealand or globally.
- In a New Zealand context Bull, Gilbert, Barwick, Hipkins and Baker (2010) suggest that "primary teachers' knowledge and confidence … is an obstacle to quality science teaching in primary schools" (p.22).
- The quality of preservice teachers' science experience important factor on their development of interest in learning and motivation for teaching science. Conner (2008) suggests the focus of initial teacher educations needs to be on developing pedagogical content knowledge.

Contribution of this paper to the literature

- Our findings provide support for claims that teacher preparation programs must provide hands-on experiences that promote positive attitudes toward science
- When student teachers considered the activities fun, interesting, and of learning potential they were more likely to use those activities in their own classroom, which has important implications for science education.
- Providing experiences which pre-service teachers enjoy, which stimulate their curiosity, and which teach content while modelling inquiry methods may be a key to breaking the loop of the inadequate teaching of science.

and of knowing how knowledge is created. The science education course at the centre of this study embodied this principle as it applies to the teaching and learning of science. The course emphasised developing pedagogical content knowledge (PCK) focused on the "complex connections between the content and processes of learning" (Conner, 2009).

Often student teachers' subject matter knowledge (SMK) is not strong. However, content knowledge alone does not make a teacher. Shulman (1986, 1987) suggested a range of seven knowledge domains needed for teaching. These included general teacher knowledge domains that relate across curriculum areas such as knowledge of learners and their development and knowledge of educational contexts. These are commonly covered in general teacher education courses. Those domains most closely aligned to a curriculum studies course such as that associated with this study are content knowledge or SMK, curriculum knowledge, and PCK. More recent knowledge frameworks for teacher education also include these domains in varying combinations and forms (e.g. Cochran, DeRuiter & King, 1993; Darling-Hammond & Bransford, 2005; Grant & Gillette, 2006). Of the three subject-related domains, the most complex is PCK. Shulman described this knowledge as including useful instructional strategies as well as knowledge of common student difficulties relating to a topic. Kind's (2009) review provides a comprehensive summary of a considerable body of research pertaining to the nature and development of PCK. She suggests that deliberate and explicit utilisation of PCK would benefit science teacher education by assisting new teachers to understand how it would develop their practice.

PCK orientations to science

Magnusson, Krajcik and Borko (1999) conceptualised a model for PCK development useful for planning teacher education programmes in science. They argued that one of the most influential components of PCK is the teacher's orientation to teaching the subject, an aspect first described by Grossman (1990). Magnusson et al. (1999) defined this component as referring to "teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level" (p. 97). They argued that such knowledge and beliefs guide instructional decisions about teaching strategies, selection of teaching resources, and evaluation of student learning. Orientation to teaching science therefore forms the overarching focus of this research. Do the orientations to teaching science of new teachers fresh from their ITE programme reflect those espoused in that programme and, if so, are these beliefs sustained as these teachers gain experience in teaching science over the first years of classroom practice? Do their stated beliefs and goals for science teaching match with the instructional strategies they have tried and found useful? What factors have influenced new teachers' choice of strategies and challenged their beliefs about teaching science?

Access to and confidence in SMK

An additional factor explored in this research is access to SMK. Content knowledge for primary teachers has been an ongoing issue for the science education community in New Zealand and internationally (Appleton, 2006; Education Review Office, 2002, 2004, 2010; Harlen, 1999; Lewthwaite, 2000; Osborne & Simon, 1996; Russell, Qualter & McGuin, 1995). SMK includes both syntactic and substantive elements (Shulman, 1987). In terms of syntactic knowledge, the perspective of the nature of science promoted in the ITE courses here is one in which theories about how the world works are developed by people and that these ideas change over time as new evidence is presented, discussed and critiqued by the scientific community. This view of science is developed in lectures and reinforced in tutorials as pre-service teachers explore different aspects of science. New Zealand primary teachers themselves also see this as a major issue: deficiency in content knowledge was identified as one of the major concerns expressed by primary teachers in implementing the 1993 New Zealand science curriculum (McGee et al., 2003). As a result of studies identifying issues of teacher knowledge and confidence in the United Kingdom in the 1990s, science was made a core subject along with literacy and mathematics, and a minimum number of hours was set for science education in primary teacher preparation. A study (Sharp et al., 2009) shows significant improvement in the numbers of teachers feeling prepared to teach all elements of the science curriculum and perceiving no impediments to the teaching of primary science. In New Zealand, anecdotally, hours for primary teacher education in science are reducing rather than increasing. The nature of the New Zealand national curriculum and its delivery is also not overly prescribed, making the selection of appropriate topics for which to develop content knowledge in ITE difficult. The ITE course undertaken by the teachers in this study emphasised access to appropriate content knowledge for primary science rather than development of content knowledge *per se*. The usefulness of this approach is of interest in terms of its effect on new teachers' belief in their ability to teach science and access the knowledge they need.

Investigation in science

In their study into what needed to be taught in school science, Osborne, Ratcliffe, Collins, Millar, and Duschl (2003) highlighted the value of teaching about the nature of science as well as teaching the substantive concepts of science. There has been a recent shift internationally toward emphasising the importance of procedural knowledge as an essential part of understanding the nature of science (Glaesser, Gott, & Roberts, 2009; Roberts, 2004; Roberts, Gott, & Glaesser, 2009). Additionally, the significance of evidence of scientific inquiry is a core attribute of science that is being incorporated into science teaching (Gott & Roberts, 2008; Ratcliffe & Millar, 2009; Roberts, 2009). Students are naturally curious and love investigating. Let's capture their imagination as the best teachers do by offering students flexibility in letting them explore ideas through investigation. (Tytler, 2007, p. iv)

The elements of investigation and evidence have been emphasised in the ITE programme in both lectures and laboratory-tutorials.

New Zealand curricula 1993 and 2007

At the outset of this study, science education in New Zealand followed *Science in the New Zealand Curriculum* (*SiNZC*) (Ministry of Education, 1993). The characteristics of this curriculum were: openness to enable teachers to select topics relevant to their students, and the integration of content with the development of scientific skills and attitudes, and with understanding about the nature of science. *SiNZC* promoted education in meaningful contexts. The curriculum itself did not prescribe details of content to be covered, but rather provided broad objectives covering a range of overarching science concepts. Toward the end of the study, *SiNZC* was replaced by the *New Zealand Curriculum* (Ministry of Education, 2007). Many of the science concepts embedded in the 1993 document remain in the new curriculum; however, there is increased emphasis on integrating learning about the Nature of Science with science content.

New Zealand primary school system – levels of autonomy

Within the New Zealand education system there is a high level of professional autonomy. The national curriculum provides a general framework around which individual schools and clusters of teachers (syndicates) devise their own local interpretation of the national aims and objectives. Such school curricula are central to classroom practice, and newly graduated teachers are generally expected to operate within this interpretation. If there is a significant difference between the science philosophy of the school and that espoused by the ITE programme, then tension is created for the recent graduate teacher.

The ITE primary course 2006

In the 2006 primary graduate diploma programme, the science education course consisted of 12 hours of lectures and 12 two-hour practical tutorials. Lectures and tutorials had a pedagogical focus set in contexts that assisted with developing their SMK and their PCK. A social-constructivist (Tobin, 1993) approach to science learning is encouraged which was in congruence with the approach promoted by *SiNZC* (Ministry of Education, 1993) and the *New Zealand Curriculum* (Ministry of Education, 2007). As well as supporting pre-service teachers in learning ways to address conceptual development, the course modelled the teaching of science in ways that assist students to investigate their own questions and to develop and discuss explanatory theories using evidence. Pre-service teachers were scaffolded in tutorials and through written feedback to complete an assignment requiring them to build their content knowledge of a science topic of their choice, identify primary students' common alternative conceptions about their topic, design and carry out an appropriate diagnostic activity with a group of students, and then plan a short lesson sequence to address an aspect of science learning identified as appropriate for the students based on their findings from the diagnostic activity. Because of the timing of the course practicum placement, there was no requirement to teach the planned sequence.

Pre-service primary teachers were introduced to, and encouraged to use, resources commonly available in New Zealand classrooms. The *Building Science Concepts* (BSC) series of 64 primary science teacher books published for the Ministry of Education in the early 2000s contain both subject matter and pedagogical content and cover a range of contexts (http://www.tki.org.nz/r/science/curriculum/bsc/index_e.php). Subject matter presented in these books includes the related key science ideas and a summary of the science background to a particular topic that is written in easily accessible language for primary teachers. Pedagogical content presented includes: alternative conceptions commonly held by students; diagnostic activities designed to help teachers identify students' underlying science ideas about the topic; activities that will help students consider the relevant science ideas; and key aspects to watch for as students engage with the activities. These books have been issued free to New Zealand primary schools.

Thus pre-service primary teachers were supported to develop ways of building both their SMK and their PCK, although the latter would be described as "untried" PCK (Appleton, 2006, p. 48) as not all pre-service primary teachers had the opportunity to teach science on their practicum. Only two-thirds of participants indicated that they had taught science on practicum placements.

METHODS

Participants

The research was conducted among volunteers from a pre-service primary school teacher education course. Participants were primary teachers (n = 33 of 50) at the end of their ITE. The entry requirement for teaching at primary level (teaching Years 1-8, ages 5-12) is any tertiary degree. In this cohort only two primary pre-service teachers had science degrees. The pre-service teachers were males and females between the ages of 21 and 50 and were a mixture of ethnicities including New Zealand European, Māori, Pacific Nations, and Asian. The predominant ethnicity was New Zealand European.

Questionnaire

A questionnaire that comprised a mixture of Likert-scale, selected and ranked responses, and open-ended questions provided comparative data. The questionnaire was piloted to ensure common understandings of the questions and administered at the end of the course before the participants began their first teaching practice. It was administered again, in a slightly modified form, late in 2008. All researchers collaborated in coding and processing the responses to reduce bias. Grbich's (2007) frame of block and file method was used for analysis of open-ended questions. Responses for qualitative data were sorted as themes emerged.

Individual interviews

These were semi-structured, recorded and transcribed, then coded.

Focus group interviews

Two focus group interviews were held, one immediately preceding the first professional year, the other at the conclusion of the second. Each interview was semi-structured, with prewritten questions but allowing participant driven thoughts to be explored too. The interviews were audio-recorded, transcribed, and coded for themes.

RESULTS

Beliefs about science education

Over the three years of the study there has been sustained belief in the importance of science as a curriculum area, and in the application of a social constructivist approach to teaching science. Prior to their first teaching position, newly graduated primary teachers saw science as an important curriculum area, commenting that:

…I believe very strongly in a child wondering and being curious and science being an avenue for that…" (GH, 2006); …I think it is very important it links in with any other area of the curriculum in some way and yeah it encourages children to ask questions and make science interesting to them and maybe make it their favourite subject, and that they always want to come back for more and you can see that they are engages into what they are really doing… (ED, 2006); "Well I guess when you say science it's so broad, but when you are talking about stuff like learning about the water cycle, I mean to me it is really important and people need to get out of their heads that there is no water shortage and that there is only one amount, there may be a shortage of clear water, so I guess when it relates

Table1. Reported ease of teaching science in 2006, 2007, and 2008*

	Reported ease of teaching science					
Year	1	2	3	4	5	6
2006		2	2	9	6	6
2007		1		2	1	1
2008				3		

* *Scored on a six-point Likert scale with 6 indicating very easy and 1 very difficult*

directly to people's lives, I think it makes it more relevant and so that is what I value, the conservation side of it…" (KM, 2006)

They expressed a positive shift in their attitude toward science teaching during ITE. The graduates reported improvements in personal attributes such as level of interest, understanding, and confidence: "Incredibly important – knowing about the world around you and how it works and how you fit." (SL,2007). Several graduates commented on the importance of science in understanding environmental issues.

Following one year's practice social constructivist views remained strong: "[they learn by] working it out for themselves…by becoming serious themselves, by questioning" (ED, 2007). One teacher was challenged in reconciling the transmission-style science teaching of her past learning with a more constructivist approach, but was nevertheless committed to developing this within her science teaching; "I wouldn't be doing the kids a service if, I think, if I went in the way I'd been taught" (GH, 2007). Additionally there was increasing realisation about the tentative nature of scientific knowledge; "realising that as we keep discovering things that sometimes we haven't got it right. We think this is the way it is at the moment but in another ten years we may have a different angle on it" (AN, 2007).

After two years' teaching experience the responses were more holistic, seeing science as a context or vehicle within which to teach a wider skill set. Typical statements included: "…at this stage of primary teaching [science] is more of a context to enable us to teach process skills. Thinking skills being the main concern" (AN, 2008); "[science] Promotes thinking skills as well as imaginative and creative skills as well as problem solving skills I see great value in looking at and enhancing a curiosity about the world we live in" (GH, 2008); "Yes [science] is essential to provide students with a rounded education. It teaches students how the world works" (SL, 2008); and "… the skills you learn in science cannot be learnt as easily in other areas – e.g. experiments, problem solving, research skills" (SL, 2008).

Confidence in the classroom

Respondents reported being reasonably confident in teaching science throughout the three years surveyed. The mode of 4 on the six-point Likert scale was maintained across all three surveys (see Table 1). Immediately following graduation most primary teachers (29/33) expressed feeling well prepared by their pre-service science course. Most (24/33) indicated that they were confident or very confident about their ability to teach science. A large majority (30/33) credited their pre-service science education course as a reason for this, and a smaller number credited their experiences in the classroom or their associate teachers. Primary pre-service teachers' reservations focused on their own effectiveness and perceived lack of knowledge. A third (12/33) of the teachers indicated they had no science teaching reservations prior to beginning teaching; however, a similar number (11/33) described feeling apprehensive. By the end of two years none of the teachers surveyed reported any reservations or apprehension, and most described their feelings about teaching science as enjoyable in statements such as: "I enjoy science and finding new ways to teach it is a challenge and fun" (AN, 2008), "I always enjoy it and so do the students", and "I enjoy teaching, science is part of that process" (GH, 2008).

Teachers reported little had changed in their beliefs about the nature of science teaching; Not a lot has changed. Science at this level is a context through which you produce meaningful learning experiences for children" (AN, 2008), qualifying this with "If anything has changed it is only that I am more aware of different approaches to children based on what sort of class you have in front of you" (AN, 2008).

By the end of the second year's practice, growth in confidence by remaining participants was attributed to, "Growing experience as a teacher and the support of my colleges" (AN, 2008), and "time doing it really and reflecting on what worked and didn't work" (GH, 2008).

Subject matter knowledge

Teachers' perception of their existing science SMK indicated moderate confidence sustained over the three years surveyed; the mode consistently being 4 on a six-point Likert scale (see Figure 1). Predictably, teachers reported greater confidence in biological and geological topics than the physical sciences, "Physics is the hardest to teach and understand", and "My preference would be biology" (AN, 2008).

Regarding accessing science content, teachers consistently indicate a high level of confidence, reporting a mode of 5 on the six-point Likert scale (see Figure 2).

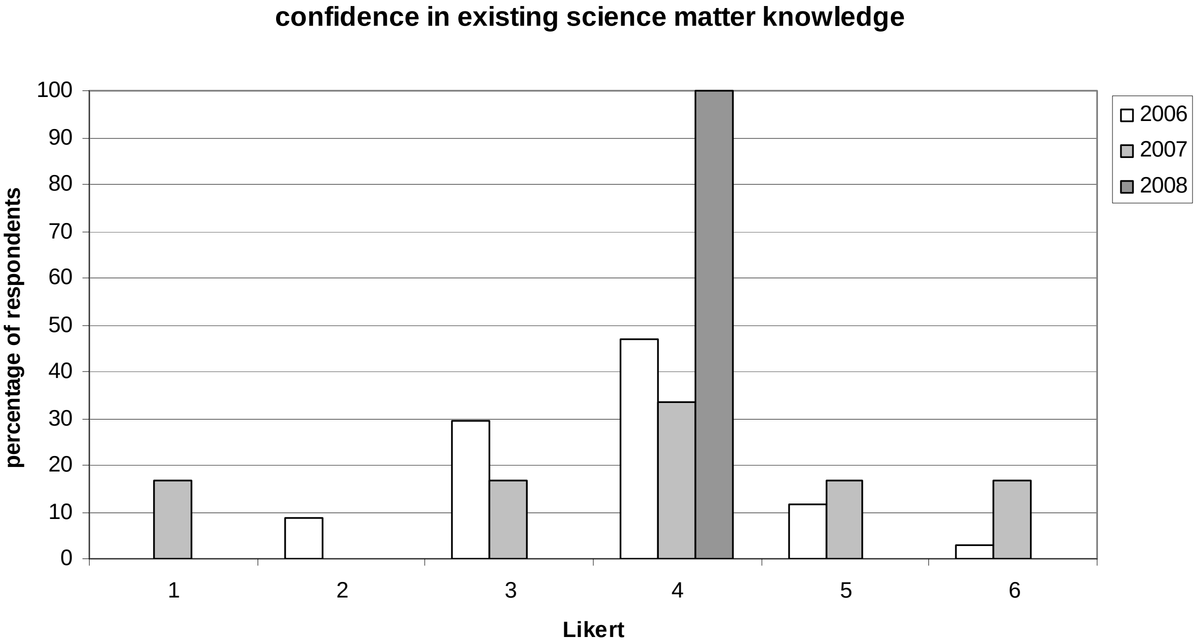

Figure 1. Teacher confidence in their own subject matter knowledge in science between 2006 and 2008. A score of 6 represents very confident, 1 represents not at all confident

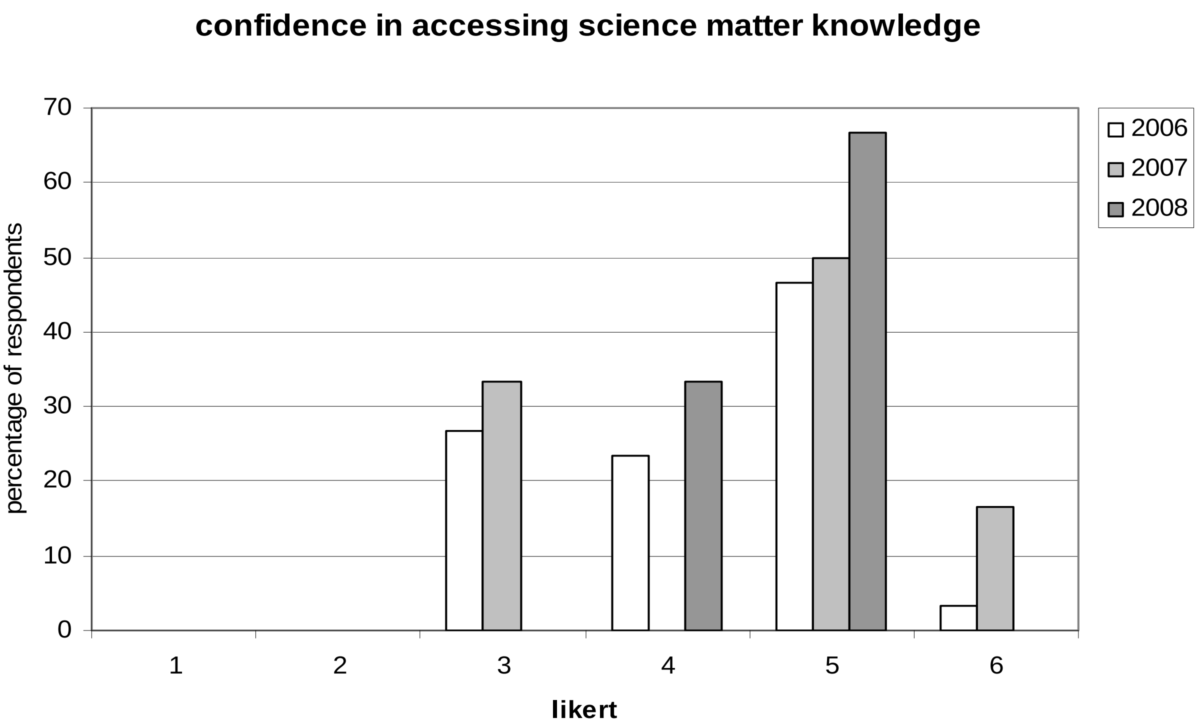

Figure 2.Teacher confidence in accessing science subject matter knowledge between 2006 and 2008. A score of 6 represents very confident, 1 represents not at all confident

The slight trend toward increasing confidence in accessing SMK, the mean score increasing from 4.3 in 2006, to 4.5 and 4.7 in 2007 and 2008 respectively must be seen in the context of a declining survey participation rate and the high overall confidence of the remaining participants.

Recent teacher graduates indicated that their ability to access SMK had developed as a result of their ITE courses (30/33), though they said they lacked confidence in doing so. Asked which aspects of the ITE course supported their ability to access new SMK, the primary teachers reported: gaining confidence in accessing SMK from BSC (11), tutorials (9), web-based resources (6), experiments/class activities (5), sample teaching resources provided (5), and sharing ideas with peers (2).

Teaching strategies and pedagogical approach from ITE

There was broad uptake and continued use of strategies advocated in the ITE course (see Table 2). Of particular note was the high use of practical investigation, experimentation, predict-explain-observe-explain (PEOE) strategies, which were emphasised in the course and align well with participants' expressed belief in constructivist approaches to teaching science, and the importance of investigation to stimulate curiosity. There was an increase in Participants increased their involvement in field trips, and were increasingly teaching in context use of the internet as a teaching tool. Use of analogies, models, and discussion continued to be well employed. Following two years practice one teacher continued to report that

"What I have found is that I have built onto what was learned at college. Science teaching is more dependent on what is in the team planning from school. The effort to look at information presented at college requires time and this is a precious commodity" (AN, 2008).

There was 95 percent reported agreement across all years that where particular strategies were used they were successful; though responses did not distinguish between success from a teaching or learning perspective.

DISCUSSION AND RECOMMENDATIONS

In their paper, *Inspired by Science*, Bull et al. (2010) cite the 2010 Education Review Office report *Science in years 5-8: Capable and Competent Teaching* as reporting :

… that most primary teachers did not have a science background and that low levels of science knowledge and science teaching expertise contributed to variation of quality of science teaching… (p. 22)

Also of concern were the relatively low levels of science specialisation in pre-service programmes compared to international norms. It was heartening to see that new teachers graduating from this course remained firm in their beliefs about the value of science education. Throughout the study period the teachers' confidence in their ability to teach science was maintained or improved slightly. As might be expected, primary teachers were initially not very confident in their existing SMK but as they gained experience there was noticeable improvement in their ability to access appropriate SMK. Teachers identified the BSC books as particularly helpful in developing this knowledge and providing concept-based practical activities. This supports Appleton's (2006) view of "activities that work" (p. 38) as being a starting point for the development of primary teachers' knowledge useful for teaching science. It also validates the New Zealand Government's initiative in supporting primary teachers with this resource and shows the usefulness of modelling its use in ITE.

Magnusson et al. (1999) outlined a range of orientations to teaching science (the teacher's knowledge and beliefs about the purposes and goals for teaching science) and the teaching approaches associated with them. A more didactic orientation is associated with the goal of transmitting the facts of science where the characteristics of the teaching approach include that the teacher conveys information, and questions to students are to hold them accountable for knowing the facts produced by science. These authors provide research evidence showing how such

Table 2. Reported use of teaching strategies introduced in the ITE course

Strategies introduced in ITE course	Percentage of responses		
	2006	2007	2008
Investigations	42	67	100
Cooperative group work	42	17	100
PEOE's	36	50	100
Experiments	36	50	100
Formative assessment	33	0	100
Summative assessment	33	0	100
Group discussion	30	33	100
Student generated questions	30	0	100
Diagnostic assessment	30	0	100
Models	27	67	67
Analogies	27	33	100
Stories	27	33	67
Demonstrations	27	17	100
Teacher led discussion	27	17	100
Worksheets	27	0	100
Use of internet	18	33	100
Games	18	0	0
Integrated approach	18	0	67
Use of video	15	17	67
Copying notes from board	12	0	100
Fieldtrips	9	100	0
Teaching in context	9	33	67
Making notes from book	9	0	67
Text books	6	33	67
Culturally relevant activities	6	0	67
n	33	6	3

orientations may influence the development of PCK accordingly. Teachers in the current study reported limited appetite for transmissive didactic strategies, preferring active involvement of students over passive. Although overall there was more support for group discussion than teacher-led discussion, teachers continued supporting teacher-led discussions. Assessment and a learning strategy was initially supported at low levels but did not feature at the end of the first year; however, it was taken up by all remaining participants by the end of their second teaching year. This could be related to improved use of assessment information in planning and subsequent teaching.

The more teachers observed successful learning outcomes for their students arising from practical investigation and group dialogue, the more persuaded they became of the value of the strategies as evidenced by the increasing adoption of investigations, PEOE's, experiments, and cooperative group work. We observed in our courses that student teachers appreciate practice at using the BSC books in the context of carrying out practical investigations; the more they engaged with this resource, the more confident they became at using it, the implication for the design of ITE courses in science education being the need to prioritise and advocate for laboratory-tutorial sessions in a university climate that is tending to promote lecturing. For early career teachers such practice could be built into in-service professional development. Teachers interviewed placed importance on practical work in developing science concepts; however, as Magnusson, et al. (1999) point out, it is not so much the inclusion of practical work, but the nature of the teaching that surrounds it that is indicative of teachers' approaches and orientations to science teaching, while at this early stage of their teacher development the use of practical work to develop science concepts appears to be a valuable insight to have gained. As teacher-educators we need to pay particular attention to student-teacher beliefs about the purpose of investigative pedagogies and reflect on how they use investigative strategies in their teaching practice, in particular, the pedagogy of connecting science content knowledge to evidence from practical investigation.

A recent change in NZ primary school practice has been an increasing emphasis on numeracy and literacy. This has resulted from government policy changes (Tolley, 2009), and has been intensified by the introduction of National Standards (Ministry of Education, 2009a, 2009b). As a corollary to this, many primary schools include inquiry-based cross-curricular programmes that integrate some of the remaining learning areas, in particular science, social sciences, and technology. According to Bull et al. (2010), the result is likely to be that "science will have a very low profile in today's primary schools" (p. 7). ITE courses in science education need to prepare student teachers for this. We suggest there is a need for research into how early-career teachers integrate science into such programmes without excessive dilution or loss of the science component and the influence of ITE programmes on their practice.

CONCLUSIONS AND DISCUSSION

The findings of this study were similar to the findings of Jarrett (1998) in an American university, suggesting that, across cultures, the fun, interest, and learning potential of activities are highly related and motivational. The strongest correlation, between fun and interest, suggests that activities that involve the student in a playful way are the activities the students find most interesting. That these activities are also rated high in learning potential suggests that things people don't already know or understand may be most interesting and fun. The activity survey and voluntary evaluations showed that preservice teachers' interest increased and they were more enthusiastic about learning and teaching science through hands-on instruction. Our findings provide support for claims that teacher preparation programs must provide hands-on experiences that promote positive attitudes toward science (Marcuccio & Marshall, 1993; Glass, Aiuto, & Andersen, 1993). Also these findings are consistent with rearch on interest and attitudes (Palmer, 2004:2009; Minger & Simpson, 2006), and motivation theory (Glasser, 1998). Clearly, playful hands-on science activities fostered their interest, curiosity and participation in science activities. Students exibited enthusiasm in participating in activities and also in implementing their assigments. The hands-on activities had a large effect on young women's interest in science and their ability to use scientific reasoning.

Of the investigations which students rated as most fun, three are often considered toys: bubbles, paper helicopters, and Cartesian divers. The other two involved processes of living things which students observed in ways which were new to them. Student teachers especially liked the variety of inquiry-based activities and resources available in their environment, especially observing silk worms' life stages, feeding crickets to a toad, and observing snails. This finding corresponds to suggestions that science activities should be interesting and suitable for kindergarten chidren (Ünal &Akman, 2006; Ayvacı, 2010). Student teachers showed less interest and were less playful with other activities, such as dissolution experiments, cake making, observing plants in pots with and without drainage, and testing paper towel absorption. It would be useful to collect more detailed information on how much students learned about science from the more/less interesting and playful activities.

The finding that when students considered the activities fun, interesting, and of learning potential they were more likely to expect to use those activities in their own classroom has important implications for science education. This finding corresponds to research on successful informal science education programs reporting that participants rated the programs as fun (Kumagai, 1996; Hide, 1998; Murphy, 2000; Revetta & Das, 2002; King, 2006; Lakin 2006). This finding suggests that learning has motivational value in that the more students feel they learn, the more enjoyment and involvement they have in doing science activities (Ames, 1992; Stepans et al., 2001; Palmer, 2002; Bulunuz & Jarrett, 2008). Student teachers gained usable information about new instructional methods and became involved in students' laboratory experiences and independent projects, so they learned how to use hands-on activities and field trips in their own science lessons. Finally, most of the preservice kindergarten teachers reported great satisfaction with the science course. Through their own participation, they had opportunities to reflect on childrens' thinking and motivation. Many said it was one of their best experiences in behaving playfully.

This research suggests that qualities of activities in method courses may significantly influence teachers' enjoyment and promote engagement with science. Many of these hands-on activities had clear and positive benefits for the kindergarten teachers, hopefully motivating them to make science more interesting and enjoyable for children. Providing experiences which pre-service teachers enjoy, which stimulate their curiosity, and which teach content while modelling inquiry methods may be a key to breaking the loop of the inadequate teaching of science. One implication of this study is that more fun hands-on activities throughout the curriculum might promote future teachers' learning and motivation in other areas.

Additional research should be conducted to determine which activities will be used by the kindergarten teachers when they have their own classrooms and how often the teachers conduct investigations with their children.

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