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'Risky fun' or 'Authentic science'? How teachers' beliefs influence their practice during a professional development programme on outdoor learning

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ABSTRACT
Teaching outdoors has been established as an important pedagogical strategy; however, science classes rarely take place outside. Previous research has identified characteristics of teachers who have integrated out-of-classroom opportunities into their teaching repertoire; yet little is understood as to why teachers make these different pedagogical decisions. This paper explores the relationship between secondary science teachers' beliefs and their pedagogical practice during a two-year professional development programme associated with the 'Thinking Beyond the Classroom' project. Using data from lesson observations, interviews, session questionnaires and field notes, six teacher case studies were developed from participants completing the programme. Data analysis reveals that teachers who successfully taught outside generally held social constructivist beliefs about learning and valued 'authentic' science opportunities. Conversely, teachers who were less successful in teaching outside generally held traditional learning beliefs and simply valued the outdoors for the novelty and potential for fun. All the case study teachers were concerned about managing student learning outside, and for the majority, their concerns influenced their subsequent pedagogical practice. The findings are discussed in detail, as are the implications for pre-service and in-service professional development programmes related to outdoor science learning.

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Introduction

Taking science learning outdoors, rather than leaving it in the classroom, offers unique opportunities for students to develop and deepen cognitive, affective, social and behavioural understandings and skills (Rickinson et al., 2004). Over the last decade, momentum has been building to increase opportunities for student learning outside the classroom. In the USA, for example, this change can be recognised in the growth of the 'No Child Left Inside' movement (No Child Left Inside Coalition, 2013). In England, it was evident in the creation of the Council for Learning Outside the Classroom which was initiated by the government (Department of Education and Skills, 2006).

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However, O'Donnell, Morris, and Wilson (2006) found that whilst secondary schools (11–16 years) in England frequently offered lessons outside in physical education, music, mathematics and art and design, science lessons were rarely reported. Furthermore, whilst there is a perception that in the past secondary science lessons frequently took place outside—a claim which is usually specific to biology/ecology fieldwork, rather than science in general (e.g. Barker, Slingsby, & Tilling, 2002)—some researchers are more sceptical, claiming that there is little evidence of a decline in outdoor teaching (Lock, 2010), the underuse being an invariant historic artefact (O'Donnell et al., 2006).

Accepting the low provision of outdoor science teaching as an ongoing trend, the reasons reported are couched in the polemic of increased concerns over health and safety, curriculum changes and insufficient resources for fieldwork (Lock, 2010). Although these reasons might partially explain the underuse of the outdoors, I suggest that the explanation is more complex, as some science departments and teachers are able to circumvent these barriers and conduct frequent lessons out of the classroom (Dillon & Dickie, 2012).

Hence, there is a differentiation amongst teachers' use of the outdoors. There are those teachers who are found to be 'avid users' and those found to be 'regular users' (Kisiel, 2014). That is, compared to 'regular' teachers, avid users are identified as being able to create opportunities by adjusting their practice, working around challenges in structures of authority and encouraging colleagues to see the potential of out-of-classroom teaching. More specifically, Tal, Lavie Alon, and Morag (2014) list exemplar practices of teachers in field trips to natural settings to include activities that enable active learning and provide substantial interaction with the environment. Whilst these studies tell us that characteristics of teachers' practice can be categorised, as Kisiel (2014) accepts, they do not explain why teachers make different pedagogical decisions concerning opportunities outside the classroom.

Whilst the important role that science teachers' beliefs have in informing pedagogical decisions is widely accepted (Wallace, 2014), beliefs have been rather neglected as a conceptual lens in understanding outdoor pedagogical choices. Haney, Czerniak, and Lumpe (1996) reported that science teachers' beliefs were a strong predictor of their intentions to implement reform-based strategies. More recently, Thomson and Gregory (2013) argued that without the education community understanding how teachers' beliefs relate to their practice or to student outcomes, the gap between education reforms and teachers' practice will persist. Reform, in this study's context, relates to the teachers' shift towards using the outdoors to teach science. Hence, the critical questions are as follows: how do science teacher's beliefs influence their decisions regarding whether or not to teach outdoors, and how to teach outside?

The context of this article, exploring the relationship between science teachers' beliefs and their pedagogical practice, was a two-year professional development programme (2007–2009)—'Thinking Beyond the Classroom'—that was funded by the Primary Science Trust, formerly the AstraZenca Science Teaching Trust. The study was undertaken with six secondary science teachers participating and completing the professional development programme working in five London schools.

The study was unique as I sought not only to provide a deeper understanding of the role that secondary science teacher's beliefs have in decision-making, but also to explore the interrelationship between the various beliefs concerned with outdoor teaching. Whilst this article will add to the small but emerging set of studies that examine the complexity

of teacher's beliefs (Bryan, 2012), through exploring the specific context of the outdoor and the interrelationship between beliefs and practice, the research additionally presents a more thorough explanation as to why and how secondary science teachers teach outside. Such insights will inform future outdoor science professional development programmes so that providers may be better able to take into consideration their participants' beliefs.

Beliefs and pedagogy

This study draws on teachers' beliefs and self-efficacy as two conceptual lenses to understand how teachers make pedagogical decisions about learning outside the classroom. Using Luft, Roehing, Brooks, and Austin's (2003) conceptualisation, beliefs are understood as 'personal constructs', formed over time, and as 'propositions considered to be true by the individual' and 'based on personal judgement and evaluation' (pp. 1–2). Teachers' beliefs provide a mechanism for pedagogical decision-making, directing the teaching strategies chosen prior to, and during, a lesson. For the majority of teachers, it is argued that they do not acknowledge the status and influence of their beliefs on their practice (Kagan, 1992).

Teachers espousing similar beliefs concerning how children learn have been identified with homogeneous practices. For example, teachers who believe children learn through the transmission of knowledge, that is, teachers holding traditional beliefs, frequently use teacher-centred pedagogy such as lecturing strategies (Laplante, 1997; Verjovsky & Waldegg, 2005). Specific to learning out of the classroom, Karnezou, Avgitidou, and Kariotoglou (2013) identified Greek primary and secondary teachers visiting a science and technology museum as either holding beliefs that the experience afforded cognitive gains or affective gains. Compared to teachers who held affective-gain beliefs, teachers with cognitive-gain beliefs were identified as having homogenous practice in that they prepared students for the visit, fostered students' interactions with the exhibits and organised follow-up activities.

So far I have presented the belief/practice relationship as simple and linear. However, there is growing evidence that suggests that the relationship is more complex and beliefs and practice are not always in congruence (Karnezou et al., 2013; Savasci & Berlin, 2012). For example, Kang and Wallace (2004) and Mansour (2013) found that teachers who espoused social constructivist beliefs concerning learning—that is, those who believed that children learned by building on their prior knowledge and through group discussions—were frequently observed using teacher-centred lecturing strategies which are more aligned with teachers holding traditional beliefs.

Contextual and sociocultural factors, such as school intake, departmental colleagues, curriculum constraints and examination demands, have been identified as explanatory factors in the incongruence between teachers' espoused beliefs and their practice (Kang & Wallace, 2004; Lumpe, Czerniak, Haney, & Beltyukova, 2012; Mansour, 2013). However, such contextual differences do not necessarily explain why teachers in the same school, with similar identified espoused beliefs, make different pedagogical decisions.

As I have argued above, the belief/practice relationship is complex and I accept Pajares' (1992) assertion that to understand a teacher's decision-making—in this case to use the outdoors—the interrelationship between related beliefs, rather than a single belief, must

be explored. In considering this interrelationship, Rokeach (1968) and Tsai (2002, 2007) offer two contrasting but complementary conceptualisations of the interplay between multiple beliefs and outcomes. Rokeach (1968) proposed that beliefs could be ordered along a central peripheral dimension determined by their strength of connectedness. 'Core' beliefs are those more centrally held compared to 'peripheral' beliefs. Formed very early in life, core beliefs are difficult to alter, whereas peripheral beliefs, shaped later by accumulation and education, are more open to external influences. Hence, core beliefs impact peripheral beliefs and have a greater influence on action outcomes. So, for example, where a core belief might concern how children learn, a peripheral belief might concern how children should be taught: the belief about learning theory is more stable and influential than the belief about pedagogy.

Related to the idea of belief connectivity, Tsai (2002) identified secondary school science teachers with three closely aligned and interrelated beliefs. The three congruent beliefs, described as nested beliefs, were how children learn; how to teach; and the nature of science, or science epistemology. Tsai's study found that generally teachers espousing transmissionist beliefs about learning held empiricist/positivist science epistemologies and believed teaching should be teacher-centred. Teachers with such 'traditional' nested beliefs reported that they prioritised teaching science content knowledge over the nature of science or scientific skills. A weakness in Tsai's study was that teachers were not observed teaching to judge whether their espoused beliefs were aligned with their practice; in this study I explore this relationship.

Self-efficacy and pedagogy

The second conceptual lens I use in this paper derives from Bandura's (1997) theory of self-efficacy, which is related to beliefs in that it 'is concerned not with the skills one has, but with the judgement of what one can do with whatever skills one possesses' (Bandura, 1986, p. 391). Hence, the concept relates to teachers' beliefs in their future ability, or more specifically a judgement of their own ability 'to organise and execute the courses of action required to successfully accomplish a specific teaching task in a particular context' (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998, p. 233). A teacher with high self-efficacy is thought to behave in a productive manner, gaining personal satisfaction from the endeavour. Conversely, a teacher with low self-efficacy is predicted to exhibit a behaviour of resignation and an attitude of apathy (Tschannen-Moran & Johnson, 2011). Hence, in terms of the current study, it was anticipated that teachers' self-efficacy, that is, their future belief in their capability, would influence their engagement in the professional development programme and how they taught science outside.

Teachers' self-efficacy to teach science is positively influenced when participating in extended professional development programmes (Lumpe et al., 2012; McKinnon & Lamberts, 2014). Bandura (1997) identified four principle sources of information informing self-efficacy as: mastery experiences, to set a goal and muster everything it takes to succeed; vicarious experiences, or more simply, observing people attempting a challenge; social/verbal persuasion, to be assured by another that you possess the capabilities to perform the activity; and physiological and emotional state, how capability is judged through a particular 'state'. Mastery experiences have been consistently identified as the most influential source of self-efficacy (e.g. Bandura, 1997). Going further, Palmer

(2006, 2011) proposed that teachers could access mastery experiences both through teaching the activities, that is, enactive mastery, and through understanding the theories underpinning the programme, that is, cognitive mastery. As this study took place during a professional development programme, it was important to establish an awareness of how the sources and strategies might influence teachers' beliefs and self-efficacy.

Methods

This study was an interpretive multiple case study conducted from a social constructivism perspective (Ball, 2004; Denzin & Lincoln, 2008). Reflecting on Vygotsky's (1978) perspective of social constructivism, language was an important mediator for participant and researcher's meaning making (Blaikie, 2007). Hence, the study aimed to offer potential new insights—rather than a definitive answer—into teachers' pedagogical decision-making.

Study context and professional development programme

I conducted the study alongside a two-year professional development programme —'Thinking beyond the classroom' with the aim to enhance in-service secondary science teachers' pedagogy outside the classroom and co-construct 10 outdoor science activities. Broadly, I consider the outdoors as *a space without a roof*, which includes school playgrounds, sports fields, local green squares and parks (King & Glackin, 2010). All the outdoor spaces teachers used were easily accessed during a normal one-hour lesson.

The programme's activities were underpinned by elements of two pedagogical approaches with evidence for enhancing student attainment—Cognitive Acceleration through Science Education (CASE) (Shayer & Adey, 2002) and Assessment for Learning (Black & Wiliam, 1998). This pedagogical positioning, broadly conceptualised as being based on a social constructivist approach, not only directed the nature of the activities and the professional development programme, but, as outlined above, it also inevitably contributed to the ontology and epistemology of this research, and to the construction and interpretation of the research questions.

Directed by the core approaches of Cognitive Acceleration and Assessment for Learning, following discussions with colleagues and participating teachers, I identified four underlying pedagogical principles over the course of the initial year of the professional development programme. These principles were *observing the local; collaborative group work; challenging thinking and learning through questioning*. Table 1 summarises the practices considered characteristic for the pedagogic principles. See Glackin and Serret (2011) for a full account of each outdoor principle. The principles were used to structure the 10 outdoor science activities and became the foci for the six professional development sessions. The activities were initially developed by the professional development programme team and adapted following feedback from the participating teachers. The programme team consisted of myself and four colleagues from King's College London, experts in science education and two staff representatives from the Field Studies Council, an environmental education charity.

Table 1. Practices characteristic for pedagogic principles.

Pedagogical framework principle	Examples of teaching practices characteristic of programme enactment
Observing the local	Teaching occurs outside for an extended period
	Students encouraged to explore the everyday in a variety of ways
	Students challenged to go beyond one-word descriptions
	Students encouraged to look at the broader context for explanations
Collaborative group work	Pre-planned groups
	Students encouraged to write group working rules
	Students encouraged to evaluate and adapt working rules
	Sets and assesses group work
Challenging thinking	Students are presented with a puzzling event or situation
	The challenge is set up in a 'familiar' context—so the focus is on the challenge rather the equipment, new language or new environment
	Questions, and prompts, are used to guide students
	Student response informs further questions and prompts
Learning through questioning	'Open questions' are asked which facilitate discussion
	'Wait time' is used to enable students to think and discuss ideas
	Class talk encourages student listening
	Talk pattern used: initiate (t)—response (s)—prompt (t)—response (s2)—etc.

Participants

Eighteen secondary science teachers from 10 secondary schools across Greater London enrolled onto the 'Thinking Beyond the Classroom' programme. During the first year of the programme, research data were collected with 12 of the 18 participating teachers. Five of the 12 participants withdrew from the programme and as such were not included in the study. Furthermore, data from one participant were excluded from the study because the participant had not participated in the Year 1 observations or interviews.

The resulting participants, Cara, Charlie, Claire, Megan, Michael and Tom, became the six case study teachers (all names are pseudonyms). Table 2 summarises the case study teachers' specialist science subject, general teaching experience, school type, accessibility to outdoor space and previous outdoor teaching experience. All the teachers were early-mid career professionals—their experience ranged between two and eight years, and all had taught in only one or two schools. Four of the teachers had additional responsibility in their department, enabling them to develop the department's teaching schedules. The majority of the participants reported that they had limited experience of teaching science outside. Their science specialisms included biology, chemistry and physics. All the case study teachers taught Key Stage 3 general science (students between 11 and 14 years).

School contexts

Located across London, the teachers' school grounds were wide ranging—from small concrete areas with decorative planters to acres of land including woodlands and ponds. Whilst I acknowledge that contexts influence teachers' decisions (Munby, Cunningham, & Lock, 2000; Tobin & McRobbie, 1996), I was not seeking to recruit a 'type' of school, but rather to focus on the extent to which the six teachers made different pedagogical decisions related to their belief systems. That said, the six teachers worked in five schools: four schools were girls' only state (public) faith schools and the fifth was a co-educational state school.

Table 2. Case study teachers' background information and school contexts.

Teacher name[a] (Science subject taught at A-level (16–19 years))	School name[a] and type	Access to outdoor space	Teaching experience[b] and additional roles	Previous outdoor science experience
Michael (Physics)	Saviour's Girls' Girls' only Comp. Faith-based	Large school site: including lawn, pond and orchard Local park (2 min walk)	3 years	Taught Y9 (13–14 years) Speed distance practicals Taught Y7 (11–12 years) ponds (adaption) investigation
Cara (Biology)	Nearside College Co-educational Comp. Secular	Small concrete playground, with several planted borders. Local park (20 min walk)	7 years i/c KS3 Science	Escorted A-level biology students on a residential visit Participated in an outdoor science programme
Charlie (Biology)	St. Hilda's School Girls' only Comp. Faith-based	School on split site: Small school lawn at one site Local park (10 min walk)	3 years	Escorted A-level class to day-only field centre Taught Y8 (12–13 years) ecology sampling methods outside
Tom (Chemistry)	Lady Veronica School Girls' only Comp. Faith-based	Small concrete playground, with several planted borders. Local park (10 min walk)	6 years i/c KS3 Science	'Very little'
Megan (Biology)	St Patricia's School Girls' only Comp. Faith-based	Large school site including lawn and small woodland	5 years i/c KS3 Science i/c student leadership	Escorted A-level biology students on a residential visit. Ecology work with all year groups outside. Use outdoors often as an extension of the classroom, for example, model of the digestive system. Breeding trout in classroom and releasing them in local river
Claire (Chemistry)	St. Hilda's School Girls' only Comp. Faith-based	School on split site: Small school lawn at one site Local park (10 min walk)	8 years i/c KS4 Science	'Virtually none' Placing UV beads outside

[a]Pseudonym.
[b]Number of years of experience as of July 2009; Comp = comprehensive (state school); KS = Key Stage 3 (11–14 years), Key Stage 4 (14–16 years).

Data sources and collections

Quantitative instruments such as questionnaires have dominated research into teacher beliefs and self-efficacy (Wheatley, 2005). Responding to Klassen, Tze, Betts, and Gordon's (2011) call for an increased use of qualitative approaches to enable a deeper understanding of how beliefs and self-efficacy operate, I mainly accessed multiple qualitative data sources for all six teachers over the two-year duration of the programme.

Employing an iterative approach, the findings I generated from the data collected during Year 1 were used to inform the refinement of the research instruments for Year 2. The data sources included (1) teacher written reflections and session questionnaires; (2) field notes from lesson observations; (3) semi-structured interviews and (4) an internal evaluator's programme session field notes and lesson observations.

Participants completed the session questionnaires at the end of each of the six professional development sessions. The purpose of the questionnaire was twofold. First, I wanted to ascertain for all participants their main outcomes from the sessions. To this end, I used the teacher's reflections of the sessions and their comments on what was useful, what was new and what ideas they would develop in school. When new activities were introduced, participants were invited to rate their confidence to subsequently trial the activity in school (on a 0–9 scale on the questionnaires). A space was provided for an explanation of their rating. I acknowledge that 'confidence' is a 'non-descript term that refers to strength of belief but does not necessarily specify what the certainty is about' (Bandura, 1997, p. 382). However, other studies use 'confidence' asserting that compared to self-efficacy the word is more widely understood among teachers (Palmer, 2011).

The second purpose of the session questionnaire was to invite teachers to identify aspects of pedagogical practice that they would like to develop for future teaching sessions. This provided information on the pedagogical practice they believed to be important for successful outdoor teaching. In addition to the session questionnaires, during the third programme session teachers completed a reflection sheet inviting their perspectives on their enactment of the programme ideas in their schools.

To investigate pedagogical practice and teachers' interpretations of the programme messages, I observed teachers trial the programme lessons in school. I conducted at least one lesson observation for each teacher over the programme's duration. Furthermore, the lesson observations were used to substantiate what teachers reported during interviews. Informed by the four principles underpinning the programme, the professional development team developed an observation framework to sharpen the observation focus.

The third way in which data were generated was through semi-structured interviews. The interviews were an opportunity for the teachers to discuss their interpretations of science, and more specifically, their interpretations about teaching science outdoors. For pragmatic reasons, when possible, interviews immediately followed observations or were conducted on the same day. A minimum of two interviews were conducted with each teacher over the programme's duration. On average, interviews lasted 30 minutes; they were audio-recorded and transcribed.

Finally during Year 1, the programme funding permitted an internal evaluator. Through programme session and school observations, alongside teacher participant interviews, the evaluator reported on the outcomes of the programme from the perspective of the teachers and their students. The evaluator used the programme's pedagogical framework, as well as the observation support sheet. I was able to use these evaluation data that offered an additional perspective on the data already generated and an opportunity for increased trustworthiness in the research.

Data analysis

Reflecting my epistemology for this study, constructivist grounded theory methods were used in the data analysis (see Charmaz, 2010). Drawing on Lincoln and Guba's (1985) approach, following an initial coding of each individual case study participant's data for a particular research area—for example, teacher beliefs—I grouped the codes into categories based on similarities. This process was iterative, that is, as new codes and categorises emerged, I returned and re-examined previous data and case studies. I set out briefly

below the analytical process used for the three research areas: beliefs, self-efficacy and pedagogical practice.

Data analysis: teacher beliefs. Due to the diffuse nature of beliefs (Kagan, 1992), I analysed, for each teacher, the data sources: session questionnaires and written reflections, lesson observations and interviews. At the broadest level, I identified four categories of beliefs: beliefs related to learning and teaching—for example, how students learn; beliefs related to pedagogical practice—for example, the purpose of questioning and collaborative group work; beliefs related to science and school science—for example, what should be taught about science and beliefs related to outdoor learning—for example, the teacher's role outside and how learning should be managed. These categories were identified as overlapping. In the Findings section I elaborate on my categorisations of teacher beliefs.

Data analysis: teacher self-efficacy. Like teacher beliefs, the construct self-efficacy is not easily identifiable to researchers (Wyatt, 2014). Hence, I analysed self-efficacy in two forms, which are referred to as explicit teacher self-efficacy and inferred self-efficacy or the Researcher's Perception of Teacher's Self-Efficacy (RPTSE).

Explicit teacher self-efficacy was informed by two sources. The first was the teachers' own confidence ratings to teach programme activities extracted from the session questionnaires. The teachers' confidence ratings were compiled and average ratings were calculated for individual teachers and for individual activities. The second source was the interviews from which I identified explicit statements concerning the teachers' future ability to enact ideas from the professional development programme. Examples included: 'I felt very wary about going from inside to outside' (Cara, Interview) and 'You feel that much more confidence—oh that's what you do, oh that's easy I can do that—and then you start and get better and better' (Megan, Interview).

The second form of self-efficacy, referred to as inferred RPTSE, required the development of an analytical framework informed by previous research study's descriptions of practice of teachers identified as having high or low self-efficacy (e.g. Allinder, 1994; Muijs & Reynolds, 2001). The analytical framework created consisted of four dimensions indicating teachers' levels of self-efficacy. These were subject knowledge, flexibility/disposition, teacher/learner focus and behaviour management. See Glackin and Hohenstein (2016) for an extended discussion of the RPTSE and the framework.

Data analysis: pedagogical practice. To analyse pedagogical practice, the lesson observations provided the main data source. Table 1 lists the characteristics for the four principles underpinning the 'Thinking Beyond the Classroom' programme that guided the analysis, whilst being open to other emerging codes/categories (e.g. management of student outdoor learning). To enable simple cross-year and cross-case comparison, I judged case study teachers' practice principally on the teaching of the programme activities and their engagement with the principles of the pedagogical framework. Hence, I categorised teachers as achieving *very successful* programme enactment to *less successful* programme enactment. From these categorisations I crudely grouped the case study teachers as either *more* or *less successful* in programme enactment.

For example, one principle of the pedagogical framework was collaborative group work, which provoked a range of responses from the teachers. Those teachers whom I considered to be engaging successfully with the principle of collaborative group work offered evidence that they had pre-planned group work (e.g. a teacher reporting how they planned the students' groups), encouraged students to take ownership of work (e.g. students asked to write

group rules; students given time to evaluate rules) and included the assessment of group work (e.g. teachers asked students to self-assess their group work skills). Conversely, teachers whom I considered to be engaging less successfully with the principle of collaborative group work encouraged students to work in pairs or alone and taught students as a whole class (e.g. a teacher acting like a tour guide leading passive students around the school grounds).

I acknowledge that the framework used to categorise teachers' practices was subjective. Hence, my claims were substantiated or challenged using the internal evaluator's session notes and lesson observations. The categorisations are holistic and are considered broad generalisations. So, the teachers who enacted one or two principles, or were only observed on one rather than numerous occasions doing so, were categorised as less successful. The judgement was a collective assessment over the duration of the programme.

Findings

The six case study teachers supported the assumption discussed earlier that science teachers' beliefs were more fundamental than contextual factors (e.g. school grounds and student attainment) or professional characteristics (e.g. years of service and subject specialism) in influencing pedagogical practice outside the classroom. For example, no association was found between case study teachers' science subject specialism and their level of programme enactment. That is, biology teachers were no more effective than chemistry or physics teachers. Whilst accepting that this finding is based on only six science teachers, the finding is worthy of further research, as it is contrary to popular perception that biology teachers will be more able and willing to teach outside given that their subject matter is associated with the outdoor environment in the form of the subdisciplines of ecology and natural history (Barker et al., 2002).

Rather, I found the range and type of teachers' beliefs were an important factor differentiating 'successful' and 'less successful' programme enactment. As detailed in Table 3,

Table 3. Beliefs of teachers compared to programme enactment.

	Belief type	*More successful* enactment of programme pedagogical practice	*Less successful* enactment of programme pedagogical practice
Epistemological/general beliefs about science education	Beliefs of learning Science epistemology	Social constructivist Relativist position	Traditional Realist position
	Belief about the purpose of science education	Skills application Knowledge of scientific method	Content knowledge Future scientist
Beliefs about the outside	Beliefs about learning outside	Offers learners authentic opportunities to develop generic skills Offers learners opportunities to develop multidimensional relationship with outside environment	Offers learners 'fun' opportunities It is a treat
	Beliefs about teaching outside	Detailed planning with built-in flexibility is essential	Limited planning required as the context's 'novelty' will hold learners' attention
	Beliefs about managing students outside	Pedagogical choice dictates management strategies	Management strategies dictate pedagogical choice

these beliefs can be clustered into two groups: 'epistemological and general beliefs about science education' and 'beliefs about the outside'. The former group consisted of beliefs concerning how children learn, science epistemology and the purpose of science education. The latter group addressed beliefs related to the outside, directly concerning learning, teaching and managing behaviour, as well as teachers' beliefs concerning the alignment of particular subjects with outdoor teaching.

Below, I discuss each group of beliefs in turn; first, the influence of epistemological and general beliefs about science education and, second, the influence of beliefs about the outside. Then I consider the influence of teachers' beliefs on managing learning outside before exploring the role of self-efficacy on related pedagogical decisions.

Epistemological and general beliefs about science education: more successful enactment

Findings indicate that teachers judged as successful in programme enactment were more likely to have beliefs aligned with social constructivism, hold a relativist science position and more likely to consider the purpose of science education as the application and understanding of the scientific method.

Table 4 summarises the case study teachers' epistemological and general beliefs about science education. Teachers, Claire, Megan and Charlie, judged as successful programme enactors, were identified with largely social constructivist beliefs. For example, Claire, a chemistry specialist, stated that, 'Children mainly learn by constructing their own understanding based on their experiences and observations, and by discussing their ideas, and questioning [them]' (Claire, interview).

Claire's beliefs about how children learn were also evident in her support of learning: in the classroom observations, her teaching was identified as being frequently dialogic and student-centred. Similarly Megan, a biology specialist, expressed that children learned 'By experiencing many varieties of activities that are challenging and engaging thus enabling them to find out information for themselves' (Megan, reflection sheet).

Whilst Megan's response focused on the role of teaching strategies, her emphasis on students being able 'to find out the information for themselves' suggested a constructivist

Table 4. Case study teachers' science epistemologies, beliefs concerning the purpose of science education and teaching approach.

		More successful programme enactment			*Less successful* programme enactment		
Case study teacher (Science specialism)		Megan (Bio.)	Claire (Chem.)	Charlie (Bio.)	Cara (Bio.)	Michael (Phy.)	Tom (Chem.)
Science epistemology	Relativist	x	x	x	x		
	Realist					x	x
Purpose of science education	Skills Application	x	x	x	x		
	Knowledge of scientific method						
	Content knowledge/ future scientists			x		x	x
Dominant teaching approach in the classroom	Social constructivist	x	x	x	x		
	Traditional/didactic					x	x

Note: 'x' indicates belief identified.

belief concerning learning, and her teaching approaches reflected a social constructivist position. For example, she promoted group work and consistently supported and encouraged students through her questioning, rather than giving up and telling them the answer.

With regard to science epistemology and the purpose of science education, Claire not only considered learning science as a means to make sense of the world, but also reasoned that this could be achieved via other methods. She thought school science should prioritise the development of all students' scientific skills and their awareness of the applications of science and 'not just those who choose to pursue a career in science or engineering'. The learning objectives she presented to students reflected these beliefs. Comparably, Megan felt that school science served two roles: first, 'to provide pupils with essential skills needed throughout life for example, analytical, evaluative, investigative' skills; second, 'to give them an understanding of the way they and the things around them function and interact' (Megan, reflective sheet). Hence, Megan considered science as more than an accumulation of subject knowledge, indicating a belief that understanding the nature and processes of science constituted essential life skills.

Epistemological and general beliefs about science education: less successful enactment

In contrast teachers judged to be less successful in programme enactment were more likely to have beliefs aligned with traditional theories of learning, hold a realist science position and see the purpose of science education as imparting subject knowledge and ensuring the supply of future scientists. Table 4 presents case study teachers Michael and Tom, judged as less successful in enacting the programme, having principally traditional teaching positions and transmission teaching approaches. Michael, a physics specialist, responding to the question concerning how children learn wrote, 'Different children learn in different ways, some learn through doing practical activities others through study, others presenting ideas. I am sure there are many books that go into a lot of detail about this point' (Michael, reflection sheet).

This pragmatic response was concerned with teaching methods rather than student cognition or social relationships; indeed, the latter part of the response might suggest either an indifference to research about learning or a lack of related knowledge. Michael consistently referred to teaching methods needing to offer variety, believing that if 'kids can be interested in it—a certain topic—then they may want to learn about it'. However, the observed lessons, regardless of the teaching method used, were consistently teacher-led and didactic. Hence, I argue Michael presented learning from an authoritative rather than a dialogic position (Scott & Mortimer, 2004). The same can be said for Tom, a chemistry specialist. Although his approach was interactive, in that he asked lots of questions, his teaching was often authoritative in that he expected the students to find and offer 'correct' answers.

For both Michael and Tom, their epistemology of science was predominantly realist. That is, although there was evidence that theory was to be investigated, neither discussed the idea of rejecting hypotheses. Rather, existing theories were to be understood and then observed through investigation. Hence, to this end, Michael believed school science should prioritise the teaching of science theory. Tom had slightly broader beliefs, in that he felt the

purpose of science education was 'to help develop enquiry skills, investigative approaches, to develop the scientists of the future'.

Beliefs about outdoor teaching and learning: more successful enactment

As identified in Table 3, the second group of beliefs concerned teachers' constructions of outdoor teaching and learning. In general, the teachers categorised as successfully engaging with the programme highly valued teaching outside for the potential opportunities to learn 'authentic' science, as well as the chance to develop scientific skills, for example, scientific observation and generic skills such as risk assessment. These teachers stressed the requirement for comprehensive lesson planning with built-in flexibility and whilst some attention when planning was given to managing student behaviour, the type of activity and learning objectives eventually dictated the management strategies used.

For the more successful teachers, the word 'authentic' held several meanings. First, teachers used the word 'authentic' to express a belief that students were more familiar with the schools' grounds than the school laboratory and, therefore, were more likely to see the value of the science learned outside. For example, learning about forces whilst observing a netball match or a tree swaying in the wind was considered an authentic context for learning compared to a textbook or white board presenting a 2D picture of a parachutist.

Second, the teachers considered science learning as 'authentic' when students had autonomy over the examples they chose to explore outside. For example, when exploring light and filters students could report on anything that had surprised them whilst attempting to explain the science. The teachers reported that this was in contrast to the narrow or controlled range of examples students were given to explore in the classroom, which often resulted in the exact answer being presented at the end. The issue here is that for some students, knowing that they will be told the correct answer eventually, alongside having no control over the examples to be explored, can generate a feeling of despondency towards practical work.

Third, teachers saw 'authentic' science learning as the opportunity for students to collect 'real data' from which they constructed their own explanations. Teachers felt that the outdoors offered students a greater insight into the messiness of science and scientific enquiry than the 'fair test' that often dominated their classroom practice. Teachers who were more successful programme enactors reported that due to the vast choices for potential study, alongside the ever-changing environment outside, students were offered a greater sense of control over their own learning.

Teachers successfully engaging with the programme demonstrated a shift in their beliefs concerning teaching outdoors. This shift contrasted with their beliefs concerning how children learn that remained relatively consistent over the two-year programme. For example, in Year 1 Charlie recognised that the outdoors offered opportunities for data collection, pedagogical variety, and novelty and excitement. At the end of Year 2, however, his response was more encompassing, emphasising the multiple benefits offered to students' learning including memorable, unique and challenging contexts to apply science understanding; opportunities to 'observe' science in the 'familiar', making it less abstract; and opening students up to understanding more of their natural world.

The shift in successful teachers' beliefs concerning teaching outside also related to their perception of the type of subject that could be taught, as well as the type of pedagogy

required. This was observed for Claire, who at the start of the programme believed learning outside enabled students to become more aware of their surroundings which was restricted to biology-related subjects:

> Question: Reflect on one idea that you have been struck by today. How can you implement this in your 'classroom'?
> Response: Thinking about outdoors activities that aren't just biology based. (Claire, session questionnaire)

At the end of the programme, Claire felt that many topics could be taught outside, including concepts from chemistry and physics, going as far as saying that the outdoors was more conducive than the classroom for extended student discussions. This, she suggested, was due to students being faced with real-life examples, which inspired discussion. Furthermore, Claire also noted that whilst the outdoors offered a challenge for the high attaining students, the outdoor context enabled the lower attaining students to engage to a greater extent than when inside, 'as they were free from the constraints (of the classroom)' (Clarie, interview).

Chiming with her belief that the outdoors was for biology learning only, Claire initially reported the belief that biology teachers had special training to teach outside: 'I am not a biologist, I've never been trained, if you like, in how to use an outdoor space, it's never been something that has been expected of me, to use an outdoor space' (Claire, interview).

Possibly, Claire's belief that biology only could be taught outside and that biology specialists had special training undermined her self-efficacy during Year 1 of the programme, resulting in her hesitance to teach outside. During Year 2 Claire's beliefs altered and she saw the outdoors as a useful context to teach any science subject (including chemistry and physics). As a consequence, her self-efficacy increased. I return to the influence of self-efficacy at the end of the Findings section.

Beliefs about outdoor teaching and learning: less successful enactment

Teachers judged as less successful in programme enactment valued teaching outside for the novelty and for the opportunity for the students to have 'fun'. When the outdoors was viewed as a treat, extensive lesson planning was considered unnecessary, as the action of going outside was deemed sufficiently novel to hold student attention. However, for this group of teachers, managing student behaviour outside was a concern and indeed was found to influence activity choice and the learning objectives pursued.

Over the programme's duration, the teachers judged to be less successful in the programme held beliefs about teaching and learning outdoors that were less flexible compared with that of the successful teachers. For example, Tom maintained the belief that teaching outside increased his teaching repertoire, offering something novel and a 'treat':

> I think it's really useful because it gives you different ideas, different ways to teach. Even if you don't do it exactly as it's shown when you go on the course it can give you—ooh, actually I can modify that a little bit, and I can do that in the classroom, I could do it in the playground, I could do it a little bit like this, you could merge two together. It gives you more ideas. When you are a new teacher you don't know first of all, you are clueless—oh I don't know how to do this. And then once you are a little bit older, once you've got a year or two's experience then you are like—yeah, I know how to do this. When there's plenty

> of other ways to do it, or new ideas that somebody else has come up with, so it expands your teaching choices. (Tom, interview)

It is interesting to note that although Tom stressed during the interviews that learning outside would be more engaging for his students, he did not seem committed to his articulated beliefs—that is, during Year 2 he did not teach outside. It is noteworthy that Tom did have several negative experiences outside during the first year of the programme; for example, equipment did not work and there was a change in school policy concerning administrative requirements to take students outside. That said, other participants faced with similar challenges did continue teaching outside.

Beliefs about the outside: managing learning

The teachers' beliefs concerning how learning should be managed influenced programme enactment. Furthermore, as Table 3 shows, a pattern was identified between beliefs concerning how children learn and how learning should be managed. For teachers identified as having social constructivist beliefs and approaches (generally more successful programme enactment), their pedagogical choices were considered to dictate the management strategy used. Conversely, amongst teachers who I identified as having traditional beliefs and approaches about learning (and generally less successful programme enactment), their management strategies dictated their pedagogical decisions.

For example, Megan, who frequently used social constructivist approaches, speculated that the inclusion of group work skills led to a reduced need for her to manage students as they became more able to self-manage. Megan noted that students needed to become confident in working outside prior to learning taking place. For this to happen, she explained, students needed to develop the necessary skills, such as collaborative learning and scientific observation, whilst spending time outdoors so that familiarity with the skills and the context could occur. These patterns are summarised in Table 5, which shows that teachers

Table 5. Beliefs concerning teaching and learning outside for teachers holding social constructivist or traditional beliefs.

Teachers' beliefs concerning learning	Beliefs about **student learning** outside *Students will …*	Beliefs about **teaching** outside
Social constructivist (Generally more successful programme enactment)	… develop generic skills e.g. group work, discussion. … have increased ownership of tasks. … increase their awareness of the surrounding environment. … develop the ability to transfer **science** knowledge to different contexts. … have greater understanding of the natural environment.	Students need to be taught explicitly how to work outside. Planning is essential; so is flexibility.
Traditional (Generally less successful programme enactment)	… have fun and be more engaged. … transfer classroom taught science outdoors.	Teaching outside is novel and a treat; it offers variety. Behavioural issues will result. Support staff are essential; often difficult to get. Limited 'good' science examples are found in school grounds. Increased planning and administration; time is a factor. Things can go wrong and 'back up' is not at hand.

with primarily social constructivist beliefs recognised that dedicated time was required for students to develop skills to work outside so that they were eventually able to learn independent of the teacher.

In contrast, this belief, and affiliated practice, was not evident in teachers whom I identified as traditional in their beliefs. That is, whilst less successful teachers noted that extra time generally was required for outdoor teaching to be incorporated into lessons, rather than it being required for lesson planning as more successful teachers reported, the extra time was required for the increased administrative duties (such as risk assessment, finding extra support staff and liaising with colleagues), which were considered a burden and a barrier.

It is worth noting here that the transference of teaching approaches identified as aligned with social constructivist beliefs from the inside context to the outside context was not automatic for all teachers and moreover took time. For example, Claire, who in Year 1 was identified as having a social constructivist approach which included a distinct focus on collaborative learning, initially exhibited strategies more in line with 'traditional approaches' when teaching outside. Claire's practice outside during Year 2 eventually came to reflect her constructivist beliefs as she transferred strategies from inside to outside (e.g. students' seating organised outside enabling whole class discussions).

What, then, might explain the teachers' initial use of teaching strategies more aligned with traditional approaches? One possible explanation as suggested above is the teachers' judgement of their ability, or their self-efficacy, to manage learning and enact the pedagogical practices outside. Below, I explore the influence of teachers' self-efficacy on decisions concerning programme enactment.

Self-efficacy to manage student learning outside

Teachers' self-efficacy, or their judgement concerning their ability to manage student learning when outside, affected all teachers involved in the programme and influenced the majority of teachers' pedagogical practice (apart from Megan). However, teachers responded to this belief concerning their ability to manage behaviour in different ways. Successful teachers were seen to persist in trialling activities outside, even though initially they reported feeling uncomfortable.

For example, as discussed earlier, Claire believed that students would become distracted outdoors and that poor behaviour would follow. She also believed that biology teachers had special training to teach outside. As a result Claire was unsure if she would be able to manage potential misbehaviour, which initially altered her teaching practices to those more aligned with traditional approaches. However, when her judgement about her ability to manage students was not justified, and she realised that teaching strategies were transferable to different contexts, her self-efficacy increased. She was observed to increasingly employ social constructivist teaching approaches outside.

Charlie, like Claire, was judged as having successfully engaged in the programme; he too had low self-efficacy with regard to managing student behaviour outside. However, his lowered self-efficacy persisted for the programme duration. During Year 1 Charlie attempted to justify his hesitance to teach outside, believing it to be the result of the lack of familiar resources he used in the classroom:

> I'm more comfortable inside but it would help if we did do it outside I think as the examples are around us easily and we can look at them again etc. I use the board a lot to focus their ideas, and that isn't there. I think it is more me, and trusting them. Trying to gather their ideas might be difficult, they might be difficult; there might be too many distractions. But saying that they might get over this with practice. […]. (Charlie, interview)

Charlie's lowered self-efficacy was contrary to the good student behaviour consistently observed both inside and outside the classroom and with his gradual development of effective strategies and alternative 'props' for use outside.

Both Claire and Charlie held social constructivist beliefs about learning that aligned with the professional development programme framework. This, it could be argued, might have aided their determination and persistence to continue with trialling outdoor activities even when they had self-doubt and were concerned about the outcome. However, this relationship does not explain the case of Cara whose beliefs and programme enactment presented an exception to the identified pattern.

Cara was identified with social constructivist beliefs and relativist science epistemology. However, her enactment of the programme was considered less successful. I suggest that Cara's lowered self-efficacy to manage student learning outside overshadowed her social constructivist beliefs concerning learning, resulting in her framing her role as a 'policewoman' rather than a teacher when outside and using techniques more aligned with traditional teaching approaches.

Cara, unlike Claire, who was also identified as using traditional teaching approaches initially outside, did not transfer her social constructivist approaches from the classroom to the outdoors. It would appear that Cara's low self-efficacy relating to her ability to manage learning outside contributed to her giving up teaching the activities during Year 2.

Like Charlie, Cara's low self-efficacy contrasted with her positive experiences and her students' positive experiences outside. However, unlike Charlie, the frequency of Cara's practice was limited in terms of the number of lessons and the amount of time she spent outside. Possibly, Charlie and Cara's different responses to their low self-efficacy were due to their contextual circumstances. That is, whereas Charlie and Claire worked in the same department and attended the professional development programme together, Cara's colleague left the school and therefore the programme during Year 1 and was not replaced. Furthermore, Cara commented that she did not feel supported by the school to be involved in the programme and senior staff were reluctant to permit her to attend the training sessions.

Discussion

From a perspective of teachers' beliefs and teacher self-efficacy, in this paper I have sought to contribute to the existing debate, recently highlighted by Kisiel (2014), as to why some science teachers teach successfully and frequently outside the classroom whilst other teachers do not. During a two-year professional development programme, I have explored the interactions between teachers' epistemological and general beliefs about science education and their beliefs about teaching, learning and managing behaviour outside, and identified patterns relating to the successful engagement with the programme.

Aligned with Tsai's (2002) nested epistemology model, I identified a congruence between teachers' espoused beliefs about teaching, learning and science epistemology. Hence, I identified a nested epistemology grouping in Charlie, Claire and Megan, in that they held social constructivist beliefs about learning, held relativist science epistemologies and believed the purpose of teaching science was for students to learn and apply knowledge and skills. Conversely, I identified a second nested epistemology grouping in Michael and Tom, in that they held traditional beliefs about learning, held realist/positivist science epistemologies and believed the purpose of teaching science was for students to possess scientific knowledge and to create future scientists. Further, and extending Tsai's findings, the case study teachers' pedagogical practice was frequently identified as being aligned eventually with their espoused beliefs.

Whist substantiating Tsai's (2002) findings, my analysis here goes further by identifying an alignment between nested beliefs concerning epistemological and general beliefs about science education and beliefs concerning teaching and learning outside. That is, generally speaking teachers identified as predominantly social constructivist were more likely to have beliefs aligned with notions of the outdoors as an 'authentic' teaching environment; they considered the outside environment as offering opportunities for science and generic skill development, and also identified the requirement for extensive and flexible lesson planning. These beliefs generally translated to a teacher being more successful in engaging with the professional development programme. That is to say, in general a teacher identified with social constructivist beliefs, and the associated related beliefs about learning outdoors, was likely to successfully practise science teaching outside.

Conversely, my analysis suggests that teachers identified with predominantly traditional approaches were more likely to have beliefs aligned with ideas that the outdoors provided a fun experience, and whilst considered as more engaging than the classroom, the outdoors was a place for knowledge transference rather than the construction of new conceptual understandings. Viewing the outdoors as novel and a treat, this group of teachers, with nested epistemologies aligned with traditional approaches, was more likely to be concerned that things would go wrong, presenting barriers such as the need for, and difficulty in, obtaining support staff alongside the time required for related administrative duties. The manifestation of such beliefs resulted in a teacher being judged as less successful in the programme. Hence, my findings indicate that a teacher identified as holding traditional beliefs and related beliefs about teaching and learning outdoors was less likely to successfully teach the professional development activities, often giving up teaching lessons outside (see Table 5 for a summary of beliefs and successful programme enactment).

Using and extending Tsai's model of nested beliefs, I suggest several reasons to explain why the two groups of nested epistemologies identified across the case study teachers might have resulted in different pedagogical practices. First, the professional development programme was informed by a social constructivist framework; therefore, the strategies such as students asking questions and learning through discussion were more akin to teachers holding similar beliefs and working successfully with related approaches in the classroom, than those with traditional learning beliefs. Mansour (2010) similarly reported the importance of the congruence required between science teachers' epistemological beliefs and the underlying philosophy of the curriculum for successful implementation.

Second, the teachers who were less successful, who used approaches aligned with traditional beliefs concerning learning, had little experience of learning or teaching outside. However, as students themselves the case study teachers had experienced academic success in traditional-oriented education environments with few 'formal' opportunities to learn science outdoors. Hence, chiming with Trumbull and Slack's (1991) findings, these teachers' academic successes, which were achieved without opportunities to learn outside, shaped their subsequent beliefs and resulting pedagogical decisions, leading them to dismiss many ideas introduced during the professional development programme. In so doing, the teachers who were less open to pedagogical change might, as Mansour (2013) suggests, have also believed that their students' learning preferences mirrored their own, prompting a further barrier to teaching outside and ultimately for belief change. Indeed, for these teachers the effort to maintain strategies that were in opposition to their 'core' beliefs, for an extended period of time, was extremely challenging, if not impossible.

This realisation leads to the third reason concerning the teachers' successful programme enactment. Extending the nested epistemologies model, and by considering Rokeach's (1968) concept of core and peripheral beliefs, I propose that the beliefs discussed above might be ordered by their strength of connectedness. That is, I postulate that core beliefs relate to how children learn and how they should be taught, whereas peripheral beliefs are those concerning the outdoors as a context to teach science. Hence, whilst the majority of teachers were inexperienced at using the outdoors at the start of the programme, teachers who held social constructivist beliefs (core) were more likely to demonstrate a positive change in their beliefs about teaching and learning outside (peripheral). For these teachers, the professional development programme mirrored their core beliefs about what constituted effective teaching and learning, and thus the outdoor context offered an opportunity for authenticity in, and of, learning, which the social constructivist teachers valued.

Conversely, no long-term belief change occurred in those teachers who held traditional beliefs at the start of the programme. Belief change was not observed in their core beliefs concerning how children learn, or in peripheral beliefs concerning the outdoor context. Rokeach (1968) postulated that core beliefs were more difficult to change than those considered peripheral and due to the strength of connectedness, core beliefs impact a substantial number of other beliefs. Hence, during the professional development programme, teachers with traditional beliefs about learning were required to alter not only their beliefs about learning outside, but also their fundamental beliefs concerning learning and teaching. I propose that for teachers' perception of the outdoors to change from one of offering 'risky fun' or 'novelty' to one offering 'authentic learning opportunities', in whatever form, the prerequisite is that their core beliefs about science learning and teaching are explicitly articulated, and that a climate is established where teachers are open to challenge and the potential for change.

This paper has demonstrated how teacher beliefs concerning learning and teaching influence the interpretation and enactment of a professional development programme to teach science outdoors. However, one teacher, Cara, did not fit the pattern or analysis described above. Instead, Cara's persistent low self-efficacy to manage student learning outside prevented her from fulfilling her social constructivist beliefs about learning

outside. I propose that self-efficacy affects the extent to which core educational beliefs can be enacted, which in turn shapes the extent of enactment of the peripheral beliefs.

It was noteworthy that low self-efficacy related to the management of student learning outside was identified across all the case study teachers, resulting in differing pedagogical outcomes. As I have reported elsewhere (Glackin, 2007), teachers' confidence in managing learning outside is an underreported factor, often masked by the research methods employed, such as questionnaires and structured interviews. Due perhaps to professional pride or fear of adverse judgement about their performance, often referred to as 'social desirability bias' (Maccoby & Maccoby, 1954), teachers are understandably less inclined to explicitly reveal their apprehension concerning a particular teaching strategy or reform. However, this study identifies teachers' concerns that are both explicit and implicit in their comments and their behaviours, underscoring the importance of teachers' self-efficacy to teach outside.

To reiterate, teacher self-efficacy is a judgement of one's ability 'to organise and execute the courses of action required to successfully accomplish a specific teaching task in a particular context' (Tschannen-Moran et al., 1998, p. 233) and it is this issue, I suggest, of accomplishment in a particular context wherein the unique problem lies. That is, whilst teachers *might* be able to prepare for most eventualities (and more successful teachers do), predicting and planning for learning opportunities and potential behavioural problems when outside are very challenging. Not only is the space constantly changing in terms of the seasons and the weather, the 'science' examples alongside the wide range of possible distractions are also changing.

It is this unpredictability of the outdoor context for teaching which sets it apart from other science education reforms or initiatives such as classroom-bound inquiry or student presentations. That is, whilst the unforeseen and fortuitous learning opportunities outside provide the much-coveted 'authentic science' experience and impromptu fun, it is this same unpredictability that induces the lowered self-efficacy and the belief that chaos will result without the safe predictable enclosure of the classroom.

In response to Thomson and Gregory's (2013) call for a better understanding of the relationship between teachers' beliefs and their practice for the successful implementation of education reforms, I would argue that if outdoor learning is to become more ubiquitous across secondary science lessons, reforms must take into account both the teachers' beliefs concerning the teaching strategy, be it, for example, collaborative learning, learning through questioning or inquiry, and their beliefs about teaching science outside.

Finally, reflecting on the different pedagogical outcomes for Cara and Charlie who commenced the programme with similar levels of self-efficacy, the findings highlight that whilst beliefs and self-efficacy are fundamental to decision-making, and, in an agreement with Lumpe et al. (2012) and McKinnon and Lamberts (2014), teachers' self-efficacy to teach science can be positively influenced when participating in extended professional development programmes, contextual factors act as enablers to their enactment. In explaining the different outcomes between Cara and Charlie, the contextual factors can be considered as sources of self-efficacy (Bandura, 1997). Whereas Charlie experienced social and verbal support when working alongside a colleague in a school with supportive senior staff, Cara did not. This shared judgement that the combined efforts of colleagues can enable the required action for a positive accomplishment is

referred to as collective efficacy (Goddard, Hoy, & Woolfolk Hoy, 2004). As yet no research has explored collective efficacy in terms of how colleagues', senior staffs' or students' self-efficacy supports outdoor professional development programme for science teachers.

Limitations

Whilst this study provides potentially valuable insights into the complexities of teacher self-efficacy, beliefs and pedagogical practice, several limitations are evident, encouraging caution in the interpretation of the findings. First, the data sets on which the findings are based are small. Six teachers were studied in depth, of which five worked in girls-only schools. However, rather than being representative of all secondary science teachers, my study presents findings for teachers who engaged in outdoor science professional development over an extended period. Of the teachers studied, there is nothing to suggest that they were either atypical or exceptional. Rather, all the case study teachers reported 'normal' constraints on practice—similar to those reported in the literature (e.g. Lock, 2010).

Second, the duality of my role as researcher and programme tutor was potentially problematic, as was the analytical frameworks developed and used in this study, specifically the RPTSE framework and the categorisation of teachers' practice. I undertook a number of preventative measures towards impartiality and to engender trustworthiness in the findings. These included member checks, that is, several teachers were invited to read and comment on their written case studies; external checks, that is, on several occasions colleagues discussed and offered alternative insights into the research themes emerging from the data; and intra-data checks achieved through the interval evaluator's independent observations and interviews (Denzin & Lincoln, 2008).

Finally, in agreement with Hagiwara, Maulucci, and Ramos (2011), this study, as with the majority of studies concerning teacher self-efficacy, was limited due to the lack of knowledge of the context's collective efficacy. As Hagiwara et al. (2011) note, there is 'immense complexity' in collecting data to attempt to understand the multiple social dynamics, including student attitudes, beliefs, self-efficacy and behaviours of the headteacher, sense of school community and decision-making. Although the comparison between Cara and Charlie offered some insight into the influence from collective efficacy, what were omitted from this analysis were in-depth students' and school efficacy levels (collective efficacy) and the influence they might have had on the case study teachers' responses to the professional development programme. Hence, although a potential 'next' step to a deeper understanding of how 'factors' of professional development can influence practice, due to the current lack of literature concerning teacher self-efficacy related to professional development and the outdoors, I felt justified in this study's focus and choice of data sources.

Implications

Accepting that teachers' beliefs about how children learn will influence the success of an outdoor professional programme, the implications of this study are important for both pre-service and in-service professional development. As Rokeach (1968) notes, core

beliefs are more challenging to change over time. It is, therefore, imperative not only that pre-service science teachers are exposed to outdoor pedagogical practice, but also that the practice is underpinned by social constructivist theory and that the outdoors is presented as offering 'authentic' learning experiences rather than a novel teaching strategy.

The study's findings suggest two prerequisites for professional development to have a significant influence. First, teacher educators and programme designers must articulate the programme's underpinning theoretical framework, and second, teachers should be given time to explore their beliefs about teaching and learning. An emphasis is required on both beliefs concerning teaching and learning and the related pedagogical strategies, and beliefs related to the unique context of teaching outdoors. Articulating beliefs would offer programme tutors and teachers a shared understanding of the professional development's philosophy, whilst enabling personal analysis of the divergence of individual perspectives and experiences. As Mansour (2013) suggests,

> teacher educators need to allow teachers to explore and express their existing beliefs and try to assimilate new ideas by reforming their beliefs or construct new ones. Teachers must be helped to make their own construction of the world explicit. (p. 1268)

Furthermore, if teachers' perspectives and experiences are collected, programmes might be adjusted and differentiated. For example, in this research study in grouping teachers based on their experience of CASE teaching, the sessions might be varied to ensure an appropriate balance between theory—such as cognitive challenge and metacognition—and practice.

Teachers' better understanding of pedagogical concepts also serves to deepen mastery experiences (Palmer, 2011), which Bandura (1997) notes is the most important source for raised self-efficacy. Hence, the findings support Palmer's concept that to fully enhance self-efficacy, mastery experiences are accessed not only through teaching the activities (enactive mastery), but also through understanding the theories of the pedagogical strategy chosen (cognitive mastery). Only through eventual and consistent 'enactive' and 'cognitive' mastery experiences will self-efficacy to teach outside develop.

Finally, as highlighted previously, individual teacher professional development does not occur in a vacuum—students', colleagues' and senior staffs' beliefs and self-efficacy all influence a programme's outcome. As Hagiwara et al. (2011) acknowledged, the majority of studies concerning teacher self-efficacy are limited due to the lack of knowledge of the context's collective efficacy. To develop a greater understanding of the complexity in achieving effective outdoor science professional development, research studying how a school's collective efficacy influences the response of an individual teacher is necessary.

For outdoor science teaching to be understood as an authentic opportunity for science learning rather than a risky but fun treat, it is critical that professional development programmes are developed that respond directly to these issues. This programme development will require a greater understanding of the strategies influencing teachers' beliefs and their related practice. Although a challenge, if these factors are left under-explored, government policies and manifestos will continue to have limited influence on the quality and quantity of student science learning outside.

Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor

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