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Pre-Service Primary Teachers' Knowledge and Understanding of Geography and Its Teaching: A Review*

Simon CATLING[1]

School of Education, Oxford Brookes University, Oxford, UK

Abstract

It is a decade since the last review of the geographical understandings of pre-service primary teachers. Examining the range of research about novice primary teachers' geographical and environmental knowledge and understanding, it is clear there have been limited follow up studies, and there remain important gaps in the research. Research relevant to this topic was identified through journal, research book and conference proceedings searches, where these were accessible. It is evident that more research now exists into pre-service primary teachers' senses of geography, geographical and environmental knowledge and environmental attitudes. For instance, it appears that they have an information oriented view of geography but are not clear about the meaning of the term 'environment', that there are misunderstandings in such aspects of their geographical knowledge as climate change, that they may not adapt their behaviors though they appreciate a need for care for the environment, and that they have limited experience in planning for and teaching geography in primary schools. Furthermore, studies are lacking into their understanding of such aspects of geographical learning as fieldwork, map work, geographical enquiry and a wide range of topics in physical and human geography. While there is some information, little is known really about their teaching of geography to younger children. In view of the increased focus globally on geographical knowledge in the school curriculum, this raises serious questions about geography teacher educators' understanding of their trainee primary teachers, in part because tutors seem rarely to undertake such research. This appears to be an embedded situation, resulting in negligible evidence to challenge the status quo and improve pre-service primary teachers' geographical knowledge. Is it really a concern? Four responses are presented, but the paper concludes that more needs to be known.

Keywords: Pre-service primary teachers, geographical knowledge, environmental knowledge, environmental attitudes, research review

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[1] Emeritus professor: School of Education, Oxford Brookes University, Oxford, UK. sjcatling[at]brookes.ac.uk

Introduction

To begin with two questions: What do we know about pre-service primary teachers' understanding of geography and of its teaching? To what extent does this matter that we seem to know little? This review examines the evidence for the first question, and, essentially, asks the second question – apparently rhetorical, since the response would appear to be obvious – because it is a provocative, important and serious question which depends on what is known about the first. It is rhetorical in that surely primary geography teacher educators want to understand the prior, current and developing understandings about geography which pre-service primary teachers bring to and develop during their courses. It is provocative because it challenges the global geography education community to be aware that comparatively little research is undertaken into this topic. This is a serious matter since there seems to be much that is not known, not only about trainee primary teachers' prior perceptions and knowledge but also about their geographical learning and their teaching of geography during their primary teacher education courses in those countries where geography is an evident component of the primary school curriculum. In this context, the purpose of these questions is to raise a vital concern about what is known and what needs to be studied if we are to enable pre-service primary teachers to teach geography engagingly and well with younger children as they embark on their careers.

The last review of the geographical understandings of pre-service primary teachers was presented by the author at the International Geographical Union Commission on Geographical Education symposium in Glasgow in August 2004 (Catling, 2004a, 2004b). It noted that there was limited research into trainee primary teachers' geographical knowledge and understanding, and that such key matters as their teaching of geography in primary classrooms during their courses was, essentially, unresearched. It reviewed nineteen studies published over fifteen years to mid-2004. Negligible analysis has been made since then, even in social or society and environment studies (Adler, 2008; Tambyah, 2008). The 2004 review concluded that the nature and amount of research appeared likely to remain constrained since there was little active support to undertake it. It argued, nonetheless, that the need remained to undertake further research, and that it would, partly to address this concern, be vital to develop pre-service primary teachers' understanding of themselves as learners so that they might address their needs as teachers of geography in primary classrooms appropriately throughout their careers.

A decade on is an appropriate time to consider what has been learnt between 2004 and 2014 and what need for research remains. This paper reviews pre-service primary teachers' geographical understanding and intends to give some indication of the state of current knowledge by identifying areas of research that have been reported internationally during these ten years. In doing so it notes where there seem to remain gaps in the literature. It concludes by returning to the paper's second question and by raising questions in order to promote further research, which is essential if we are serious about the capability of our future teachers of primary geography.

There are considerable variations in the provision in primary initial teacher education courses around the world. Time for geography in such programs is limited, where it exists, and geography almost always appears in the context of social studies or humanities units or modules, such as in the USA and England, though it may be linked with aspects of science, as in Finland and Greece. Gersmehl (2014) noted that in the USA as few as one in eight teachers' training courses required a geography component for graduation. For very many non-specialist primary trainees this is likely to be no more than a few taught sessions amounting to just a few hours of lecture and/or workshop time. In those countries where there is no geography in the primary school curriculum, geography does not appear in primary initial teacher education courses. Where opportunities exist for primary geography specialists, in comparatively few nations, there may be a small cohort taking a subject specialism component in their primary teaching course (alongside trainees who are taking other subject specialisms). In England, for instance, such specialisms have reduced heavily since the 1990s, which has meant a major decrease of knowledgeable geographers going into primary teaching. This is a situation into which there has been little research, in part because the strong emphasis in primary teaching programs across the globe lies in training the teachers of young children to teach their national language(s), mathematics and perhaps science and technology. The lack of research internationally into geography in primary teacher education courses means that there is no clarity about the situation globally for geography for non-specialist pre-service primary teachers, who are the very, very large majority of teachers of geography for younger children in schools around the world. This is an evident constraint, for it is not known what the geographical components are in primary initial teacher education courses and to what extent they address their trainees' understanding and learning needs to prepare them to teach geography, even within social studies or humanities, in their country's primary school curriculum.

One context: Pre-service primary teachers and geography in England

In some countries geography is a component of the national curriculum for primary children, most recently introduced in 2014 in Australia (Maude, 2014; Catling, 2014). This section considers, briefly, one country, England, as an illustration of the limitations in what is known about geography for generalist trainee primary teachers and of their geographical knowledge and understanding.

In England, one of the four countries in the United Kingdom, geography has been a required national curriculum subject for 5 to 14 year old pupils since 1988. It has had a set of subject requirements specified by the government for the primary school curriculum since 1991, which were revised for the third time for teaching from September 2014 (DfE, 2013). Inevitably the compulsory programs of study for 5-7 and 7-11 year old children have impacted on the content of the geography units in primary initial teacher education courses in England.

By the mid-2000s geography in primary initial teacher training courses was noted as having an 'average' taught contact time across courses of 10.5 hours (Catling, 2006). By 2013-14 this time allocation for teaching appeared to have declined to an average of less than 8 hours (Catling, 2013a), with considerable variations between universities of 2 to 16 hours contact teaching time for geography. On average teaching time was reduced by twenty-five percent over eight years. In some courses trainee primary teachers undertook a specific geography assignment or linked it with another humanities or social studies subject, but in other courses there was no assessment of their geographical understanding as future primary teachers. Teacher education is changing in England, with steadily increasing numbers of primary teachers being trained in school led and based courses which may or may not provide much focus on or have staff expertise in geography, since it is viewed as a lower status primary curriculum subject compared to English, mathematics and science. This has raised deep concerns about whether there is time in geography 'units' in university-based courses properly to identify and address trainees' needs in their geographical learning and understanding. Such 'units' tend only to introduce pre-service teachers to the requirements for primary geography, give them some ideas about teaching approaches and enable them to encounter some appropriate resources to use when teaching geography. These geography 'units' are likely to be part of a humanities module.

There is little knowledge of the geography backgrounds and understandings of England's future primary teachers. Research evidence is limited, though some information has emerged across the last ten years (Catling, 2004a, 2004c; Catling & Morley, 2012; Martin, 2008; Morley, 2011, 2012; Nikel, 2007; Wheatley, 2007; Witt & Clarke, 2012, 2013, 2014). This provides an interesting and concerning picture, especially when combined with evidence from earlier studies. It seems that only about half of pre-service primary teachers have a national sixteen-plus geography qualification, while the other half gave up geography at the age of fourteen. Only a high minority of trainee primary teachers appear to have clearly positive feelings for the subject. The trainees' general sense of geography is that it is about world knowledge and human and physical processes. More than half say they are informed about and have concerns related to the environment, but they do not always associate this view with geography. Trainees' locational and world map knowledge generally is not good, except where it is relevant personally. While some prefer human geography, others enjoy physical geography, though their level of understanding in both aspects is not really known. Indeed, there is a general concern about the depth of trainees' knowledge and understanding of geographical and geological concepts. It appears that many do not recognize their own misconceptions and misunderstandings in geography, and they rarely do anything about this unless they find it personally relevant. This is reinforced by evidence that many pre-service primary teachers appear not to be motivated to acquaint themselves well with the area around the schools in which they teach, often a focus for local geography studies with younger children in England (Catling & Martin, 2004). Yet some future primary teachers are engaged by the natural environment and are able to draw on their own daily geographies to enhance their teaching, though few trainees really seem to recognize their own everyday geography and how this influences their teaching (Martin, 2008).

The situation in England is a microcosm of knowledge about the geographical understanding of pre-service primary teachers. Little is known about the geography units these primary trainees take, and understanding of their geographies and geographical awareness remains very limited, while almost nothing is known about their teaching of geography with younger children. It is not a healthy picture.

Research approach

This review considers a range of research which has appeared between mid-2004 and later-2014, mostly in research journals but some presented at conferences and in proceedings or research texts. It has been developed in the context of the research approach 'disciplined noticing' (Mason, 2002). This approach requires being systematic in recognising, in this case, articles which are pertinent to understanding pre-service primary teachers' geographical knowledge and understanding and their teaching of the subject. Three key criteria were used. One was that a paper referred to research into the understanding of subject knowledge and subject teaching by pre-service primary teachers. A second referred to the focus of such a paper on generalist trainee teachers, though research into subject specialists was also noticed. Third, the focus of the research had to be on or relevant to pre-service primary teachers' geographical education. This third criterion was used because research into aspects of the geographical understanding of trainee teachers has been found by the author to appear in publications in environmental, humanities and social studies education, which overlap strongly with geographical education (Reynolds, 2014), and in science education. It can also be reported in other contexts, such as early years education. These criteria provided a filter to identify relevant research for this review.

Identifying review sources involved journal and google searches and checking conference and research book publications as far as possible. It included the serendipitous noticing of publications, for instance, via the web. The approach has been to undertake a systematic review of the research that has been identified to draw out the salient matters reported by researchers (Denscombe, 2014). This has meant being aware that a research study may focus on more than one aspects of pre-service teachers' geographical knowledge and/or its teaching. It has involved judging the quality of the research and its findings. The purpose of the review has been to provide an overview and to outline aspects of the specific research. This has led, inevitably, to noting gaps in the research literature. While every effort has been made to find studies and report their salient findings, it cannot claim to be exhaustive study (Torgerson, Hall and Light, 2012).

The review has drawn on research which responds to the question: What do we know about pre-service primary teachers' geographical knowledge and understanding and of its teaching? There have been negligible reviews with this focus (Catling, 2004a; Adler, 2008; Tambyah, 2008). To find information relevant to this question, research was considered in relation to three aspects of pre-service primary teachers' geographical knowledge and the subject's teaching:

- their awareness and knowledge of geography, which covers feelings and ideas about geography, as well as knowledge of particular aspects of geographical studies;
- their environmental knowledge and attitudes, including environmental and ecological literacy, understanding of the term 'environment', and attitudes to the environment;
- their views and knowledge about teaching geography, covering experience of and confidence in teaching geography, alongside their planning for teaching and the influences affecting this.

The differentiation between geography and environment was made in relation to literature foci and sources; it does not indicate a lack of overlap between these two areas. This was also done to clarify that much research relevant to understanding pre-service primary teachers' geographical knowledge and understanding can be accessed through environmental education studies, since in some parts of the world this is the 'subject' studied, while in others it is geography, either directly or as a subject in the context of social studies. Some environmental aspects, related to sustainability and the science of climate change for instance, also appear in science education publications. As appropriate, cross-reference is made between 'subjects' in each section. In this sense geographical knowledge encompassed what is termed environmental knowledge.

This review does not claim to cover the full sample of articles, presentations and other papers and chapters, since it considers only English language publications, but it is considered that those included here help to give a sense of the state of play; indeed, no claim is made to have identified all English language articles. A wide range of journals have been searched, principally in geographical education, environmental education and science education, which identified articles published in such journals as *International Research in Geographical and Environmental Education* (*IRGEE*), *Environmental Education Research* (*EER*), *Geojournal*, *International Journal of Science Education*, *Journal of Science Teacher Education*, and *Journal of Science and Technology Education*. Other journals consulted also provided relevant articles, including *Elementary Education Online*, *Australian Journal of Teacher Education*, and *Irish Educational Studies*. *IRGEE* and *EER* provided the largest number of articles, with eleven and six respectively. In addition a number of conference proceedings and research publications were monitored and published papers drawn on from these. Table 1 indicates the balance of subjects, the foci of the publications used, and the countries involved.

Of the thirty-six studies referred to in this review, fewer than half have been undertaken directly in geography education, with a similar number researched in environmental education contexts (Table 1). These are supported by several related studies from science and two in early years' teacher education. The research reported took place in twelve countries. More than half the studies were researched in the UK – including a cross-national study between Northern Ireland and the Republic of Ireland – and Turkey, with a quarter researched in Australia and the USA. The rest are a scattering of studies from a further seven countries (Table 1). Two studies were bi-national and one tri-national.

Table 1. *Subjects, nations and researched aspects relevant to pre-service primary teachers' knowledge of geography and its teaching*

No.	Subject areas of international journal, conference papers and edited books
14 (c.39%)	Papers in geography education publications
13 (c.36%)	Papers in environmental education publications
7 (c.19%)	Papers in science education publications
2 (c.6%)	Papers in early years education publications
No.	**Aspects covered by the research studies***
9	Research about pre-service primary teachers' ideas and feelings about geography
18	Investigation of aspects of pre-service primary teachers' environmental knowledge, including climate change and ecology
7	Explored pre-service primary teachers' environmental concerns and attitudes
10	Examined aspects of pre-service primary teachers' teaching of geography and environmental matters, almost all focused on separate aspects of teaching.
No.	**Locations of research studies**
13	UK, including 2 cross-nationally (Northern Ireland and Ireland; England, Germany and Denmark)
7	Turkey
5	Australia, including 1 cross-nationally (with Lebanon)
4	USA
2	Greece
2	Israel
1	Denmark (with Germany and England in UK)
1	Fiji
1	Finland
1	Germany (with England in the UK and Denmark)
1	Ireland (with Northern Ireland in UK)
1	Lebanon (with Australia)

*Note that several studies covered more than one aspect.

Analysis of literature is a vital precursor for future research (Newby, 2014). The intention of this review, in drawing together the range of studies covered, has been to clarify what we know in response to the research question above, but also to raise the deeper concern about the extent to which geography tutors of trainee primary teachers can act on what is identified.

Understanding pre-service primary teachers' geographical knowledge

This review focuses on pre-service teachers' knowledge of and perspectives on geography and the environment, and their teaching of geography in primary schools. Two topics are common to this review and that of 2004 (Catling, 2004a): trainee primary teachers' senses and knowledge of geography, and their environmental knowledge and attitudes. Thirty-six studies are drawn on. Initially the focus is on research into trainees' geography knowledge bases; it turns then to their environmental knowledge and attitudes; and third, to a variety of matters pertinent to their learning and teaching of geography are noted. Several studies are drawn on in two or all three of these areas.

Pre-service primary teachers' awareness and knowledge of geography

Studies of pre-service primary teachers' ideas about and feelings for geography are few. In England future primary teachers have mixed feelings about geography, expressing views across the spectrum from thorough dislike (few) to ambivalence (around half) to much enjoyment (high minority) of the subject (Catling & Morley, 2012; Wheatley, 2007). A similar range of feelings was found across The Republic of Ireland and Northern Ireland in an all-Ireland study (Waldron et al., 2007, 2009; Pike et al., 2006), with well above half the sample positive about geography. These attitudes would seem to have developed at secondary school. Those who were negative felt that the teaching of geography was boring, while for positive students their teachers had made it interesting and stimulating. However, it has been noted in studies in England and across Ireland (Catling & Morley, 2012; Morley 2012; Waldron et al., 2009) that as many as half of pre-service primary teachers have no qualification in geography, having given up the subject at the age of fourteen. In England, far fewer go on to advanced level study than have done across Ireland.

English trainee primary teachers' ideas about geography varied, with an 'information-oriented' perception of geography emerging strongly; that is, geography was viewed as knowing facts about the world, including its physical features, environments and countries (Morley, 2012). It did not seem that whether trainees gave up studying geography at fourteen or had studied geography further had any impact on their understanding of the subject. Research in Turkey found a similar perception of geography, though there was a stronger interest in people, places and cultures, and an 'interactionist' perspective was evident, focused on the interplay between people and the physical environment (Öztürk & Alkiş, 2009). The sense of geography in the all-Ireland study (Waldron et al., 2009) was more diverse and more content-topic based, though fieldwork was noted a 'quintessentially' geographical. It was noticeable in these studies that understanding geography as studying the effects of human actions on people and the natural environment did not appear in the trainees' sense of the subject. Investigating the ideas about geography of a sample of Australian pre-service primary teachers, Preston (2014) found that they held a very similar sense of the subject to Catling (2004c) and Morley (2012). For them geography was an information-based subject, with locational and world knowledge (information about countries and features) being dominant perspectives, which Preston summarised as 'a very narrow conception of geography'

(Preston, 2014, 343). His study involved two groups of trainees, some at earlier and some at later points in their course, but it was noted that for both cohorts their perceptions of geography were more similar than different, having taken course units which included geography. Earlier Australian research (Tambyah, 2006, 2008) reported that many trainee primary teachers were concerned about their limited geographical knowledge, which they see as inhibiting their teaching of key geographical concepts, such as spatial patterns and human-environment relationships. In a separate small-scale study in England, focused on pre-service postgraduate primary teachers, Martin (2008) noted that trainees may have a wider sense of geography to call upon, informed by their informal experiences of living in the world, though this was not necessarily drawn upon. These studies indicated also that a minority of trainees had misperceptions about geography, while more widely they had a limited sense of the breadth and depth of geography's disciplinary range.

There has been negligible research into prospective primary teachers' understanding of the various areas of geographical knowledge. Indeed, the limited relevant research published or presented during 2004 to 2014 has been undertaken in environmental education and science rather than in geography, though clearly it is informative for geographers! One aspect of this research can be noted here. Climate change is a key element in understanding our global natural environment, and of significance for geographical studies, including with primary age children. It encompasses such aspects as global warming, the ozone layer and the greenhouse effect. Studies in these topics have been undertaken in Turkey, Finland, Greece and the USA. They provide some insight into trainee primary teachers' knowledge of an aspect of the physical environment. One study covered a range of primary subject specialists, including geographers (Ocal et al., 2011); three worked with generalist trainees during a science unit (Hestness et al., 2011; Ikonomidis et al., 2012; Lambert et al., 2012); and two were of primary science specialists (Çokadar, 2013; Ratinen, 2013). All had medium to large samples, were questionnaire-based and used statistical analysis; one involved process drawings and journal notes.

Investigations of trainees' understanding of global warming were undertaken with prospective primary teachers in Turkey (Ocal et al., 2011) and Greece (Ikonomidis et al., 2012). Their findings indicate misunderstandings and confusion among trainees about the causes of global warming and its effects. A common misconception among Turkish trainees assumed a relationship between the hole in the ozone layer and global warming. In this study more than half the trainees thought global warming and earthquakes were connected and over 90% thought global warming caused skin cancer. The Greek research identified that more than half of trainees believed the greenhouse effect is caused by increased solar activity and/or that radioactivity is a cause, as well as that reducing unleaded petrol use would help decrease greenhouse gases. Some 62% believed that reducing nuclear bombs would help cut global warming, as would having cleaner beaches (31%) and removing litter from rivers (22%). It was clear that only a small minority of future primary teachers understand the concepts of global warming and the greenhouse effect well. Questions were raised about the general level of understanding of the

greenhouse effect in a Finnish study (Ratinen, 2013) of primary science specialists. Again, misconceptions held by many trainees emerged, largely based on erroneous information, a lack of factual knowledge and incomplete and misleading conceptual understanding. Yet trainees were aware of the consequences of global warming and of various actions which might mitigate it, though these were not always accurate. Pre-service primary teachers were generally supportive of taking positive steps, though male students were less committed to doing so. Ocal et al. (2011) found that male trainees appeared to have a better understanding of global warming than did female trainees. It seems that the dominant sources for knowledge about global warming were television and the internet. Trainees raised concerns about the lack of teaching about this topic in schools and on their courses, which they felt inhibited their learning and understanding.

In a separate Turkish study Çokadar (2013) found that while some primary trainees misunderstood the relationship between the ozone layer and global warming, the majority seemed to have a sound appreciation. Through teaching specifically about the ozone layer in their science module these trainees' understanding was improved. Research in the USA by Lambert et al.(2012) reflected a wide range of understandings and misconceptions in the pre-test to a taught course on global warming, but found that trainees' understanding improved through teaching, though for many their knowledge remained limited. The positive impact of teaching about climate change was noted in another USA-based study (Hestness et al., 2011), which discerned that a focused module helped future primary teachers to feel more confident about teaching the topic. The positive impact of teaching pre-service primary teachers was reinforced in a study of their improved knowledge and understanding of the impact of air pollution following a module on this topic (Mandrikas et al., 2013). Though their understanding could be improved further, many pre-service primary teachers appeared to have a deeper conceptual grasp, indicated through their use of terms and in giving accurate descriptions.

These studies of subject knowledge raise concerns about future primary teachers' understanding of the topics they may well teach. Helpfully, they indicate that teaching about such topics in initial teacher education courses can improve pre-service primary teachers' understanding. Yet, this is a matter which remains a challenge, given the limited time and wide range of geographical knowledge that generalist primary teachers need, just in geography. It can be all too easy to pass on to younger children the partial knowledge and those misperceptions which teachers may hold when they have not had an opportunity to improve their understanding. There is a lack of studies across the range of aspects of geography, which means that the extent and depth is not known of the accurate geographical knowledge which pre-service primary teachers have and the possible many misunderstandings and misconceptions which they may hold. The example of global warming may or may not be indicative of a much bigger issue; simply, there is a lack of research.

Pre-service primary teachers' environmental knowledge and attitudes

Teaching environmental understanding – and by implication geography – requires that trainees be 'environmentally literate' (Yavetz et al., 2009). Geographical and environmental literacies encompass such aspects as knowledge of the various aspects of

the physical and social environment, ecology, environmental concerns, approaches to tackling environmental issues, attitudes to the environment, and personal and others' environmental impacts. Studies in Israel (Yavetz et al., 2009, 2014) raised concerns about future primary teachers' conceptions of the environment, which they tend to see as a biophysical entity that does not involve people nor is affected by the complex interactions between natural processes and people's actions. The environment was seen by many trainees as an object, external to them, though about a quarter of them held a 'romantic' or naturalistic conception of the environment, and a high minority noted that people can have adverse effects on natural environments. While trainees' environmental literacy tends to improve during their primary teacher education courses, this is demonstrated weakly through their behaviours and change seems not to be deep rooted. The findings in a Turkish study of primary trainees' environmental attitudes and sense of responsibility was equivocal, though trainees accepted that greater awareness and responsibility were appropriate (Tuncer et al., 2007). Yet, these trainees were undecided about how solutions to environmental issues might be agreed and what their effects might be. This seemed to be grounded in the trainees' limited environmental knowledge. A study in Fiji found similar outcomes (Taylor et al., 2007), but while trainees were evidently positive in their environmental attitudes, they felt that modifying their lifestyles was a step more than they were willing to take. This indicated that these trainees had yet to appreciate the link between the effects of their 'consumption patterns' and their interplay with and impact on environments locally and far away.

It might seem that initial teacher education courses have only a limited impact in changing understanding and attitudes which have developed earlier in life, influenced through families, schooling and society more widely. Examining environmental attitudes and senses of responsibility among Turkish trainee primary teachers, Ő zden (2008) identified a range of factors which seemed to affect trainees' attitudes and perceptions. These included family background and position in the family, socio-economic context, place of residence and the area of the country lived in, the course of study, and the point in the initial teacher education course at which the research occurred. Pre-service primary teachers were found to hold positive environmental attitudes. In a separate Turkish study, Turan (2011) found that future primary teachers seemed to hold strong positive attitudes to the environment, and that female trainee teachers appeared more aware and to have a greater sense of environmental responsibility. These findings might reinforce the role and impact of informal learning about environments and of environmental attitudes, particularly if linked with the indications that knowledge of global warming may be more influenced by television and internet sources (Ocal et al, 2011; Çokadar, 2013). However, as indicated above, environmental attitudes may be able to be influenced positively through formal teaching about the environment and environmental science.

Researching a modest sample of trainee elementary teachers' ecological literacy in the USA, Balgopal et al. (2012) explored their knowledge about and personal perspectives on responding to and dealing with environmental issues. Using a writing-to-learn essay-based approach they examined how these trainees' knowledge of and responses to dilemmas changed over a course of study. The researchers found that ecological

knowledge increased by the end of the course but that it varied between trainees, with almost half developing an informed and analytic understanding while a sizeable minority retain a subjective perspective of the conservation issue they studied. Some two-thirds of these trainee primary teachers described the dilemmas involved effectively, but many found it more difficult to express their own views clearly since science education rarely asked this of them. It was felt that limited experience of writing in science about such matters might inhibit trainees' capacity to take on board notions of environmental stewardship. They rarely thought about it. It is not known whether this is any different for geography.

Attitudes to the environment, how it can be affected by people and what people might do are important aspects of geographical and environmental and ecological literacy, as well as key to understanding sustainability. Nikel's (2007) small-scale interview-based cross-national study of Danish, German and English primary pre-service teachers identified the importance of both 'having' and 'taking' responsibility for the environment, which needed to be informed for future teachers to make judgements and have agency. Kennelly et al. (2012) investigated the perspectives of a small sample of Australian pre-service primary teachers who identified the relevance of well-grounded content knowledge of and pedagogical strategies for teaching sustainability as underpinning their confidence to include sustainability in their teaching with young children. In an earlier study of trainee Australian primary teachers Gooch et al. (2008) found that limited factual knowledge and poorly or unarticulated beliefs about environmental concerns inhibited clear and critical thinking when planning to encourage action-oriented stances to environmental challenges in their teaching of primary-age children.

In a comparative study of Lebanese and Australian pre-service primary teachers Vlaadingerbroek & Taylor (2007) identified an evident difference between the environmental knowledge and attitudes of these two samples of trainees. While in both countries environmental education is part of the school and primary initial teacher education curricula, it was found that Australian trainees were more aware, informed and positive about environmental matters and concerns. This is not to say that Lebanese trainees were not necessarily knowledgeable or that Australian trainees did not share misunderstandings. But the Australian pre-service primary teachers seemed to have a broader understanding and 'more acute' awareness of environmental concerns facing their nation than the Lebanese trainees had of their country. The Lebanese trainees tended to attribute such issues to immediate and 'narrower' visible influences such as traffic congestion and poor waste disposal. National and social influences in daily lives affected Lebanese trainees' perceptions of the importance of environmental understanding and behaviour. Pre-service teachers in both nations who favoured positive environmental behaviours thought environmental education important, but the weakness of environmental education in Lebanese schools is likely to be a challenge for them.

It can be inferred from these studies in environmental education – and inferred too in geographical education – given the range of knowledge and attitudes different trainee primary teachers seem to bring to their initial teacher education courses, that there are similar challenges in different countries. Many trainees may not be well informed about

the meaning of a frequently used term such as 'environment', and in planning units for teaching there may be limitations to the knowledge-base on which trainees draw. While many may espouse positive environmental attitudes and values, there appear to be questions about the extent to which they put such views into practice and about the likelihood of changing their behaviours to be more 'pro-environment'. These findings raise questions about the impact of such variations in future primary teachers' knowledge and understanding, about how well they might teach younger children, and about the attitudes and values they may pass on purposefully or unintentionally.

Pre-service primary teachers' views and knowledge about teaching geography

Morley (2011) asked English pre-service primary teachers about their intentions as teachers of geography (as well as of other subjects). Trainees indicated that they saw geography as an important subject, relevant, accessible and enjoyable for children. They wanted to be inspiring and enthusiastic for the subject and to encourage outdoor learning. Prior experiences of learning geography would seem to have some impact on trainee primary teachers' sense of the subject and their valuing and liking of it. Many in the all-Ireland study (Waldron et al., 2009) felt that they had generally positive experiences, particularly where these linked with fieldwork and practical studies. Memorable geographical experiences could be recalled by almost half the large sample of trainees. However, a small minority felt negative about their experiences of being taught geography, influenced by their responses to their teachers and by tedious note taking and rote memorisation tasks. Similar concerns were noted by Catling & Morley (2012) from uninspiring and unenthusiastic teaching. What appears evident is that when taught geography in school engagingly trainees enjoyed the subject. It seems clear that where teachers are positive about their subject and teach in stimulating ways they have a positive impact on their pupils. This is an important message for non-specialists to bear in mind as future teachers of geography to younger children.

Pre-service primary teachers were asked in the all-Ireland study about their confidence in teaching geography (Waldron et al., 2009). Confidence was high among a large majority of trainees, and this reflected their perception that their confidence had increased during their four-year course. Preston (2014) found a similar sense of confidence among the large majority of his Australian sample of trainees at the end of their undergraduate course, though he reflected that confidence does not necessarily translate into competence as teachers of geography. Waldron et al. (2009) noted that Irish trainees' liking for geography increased during their courses. Their sense of the importance of geography as a school subject was very positive on entry and remained so on course completion, in comparison to Preston's (2014) finding that trainees' attitudes became more positive over their course. In contrast, in other nationally-based studies, it seems less clear-cut that pre-service primary teachers are as strongly positive about environmental education and environmental science, though this depends to an extent on context and country (Vlaadingerbroek & Taylor, 2007; Kennelly et al., 2012; Yavetz et al., 2009, 2014).

It is hard to appreciate pre-service primary teachers' views about the curriculum requirements for geography (or environmental education) in any nation, and certainly across nations, since there is very little research in this topic. In Turkey trainee primary teachers saw teaching geography with a local perspective as important, linked for about a fifth of them with place studies and developing knowledge of the wider world (Öztürk & Alkiş, 2009). This contrasted with trainee teachers' views in England, which emphasised developing younger children's information about the world with more of an emphasis on the physical environment (Morley, 2012). Martin (2008) has argued that formal notions of curriculum geography can be enhanced and developed through the use of trainees' informal senses of geography, what she terms their 'ethnogeographies' (Martin, 2005). She noted that what is important is that their training in geography teaching should encourage them to understand and appreciate their geographical experience and 'everyday' understanding of geography. This is important for them to develop and deepen their appreciation of the subject and to connect their own, and children's, daily experiences, built up over time, with the range of aspects which geography studies, and which underpin the key concepts of geography, such as place, scale, interconnections and natural environment and human processes. In this context, trainees might be encouraged to see links to their geographical understanding and teaching in their hobbies and interests (Catling, 2013b), such as their travel experiences, engagement with nature and environmental concerns, and interest in sports. However, an enquiry in Turkey revealed a limited interest by trainee primary teachers in involvement with environmental groups (Ocal et al., 2011).

To an extent the focus on learning informally or in open-ended and experiential contexts is reinforced by the emergent outcomes of studies in England by Witt & Clarke (2012, 2013, 2014). They adopted a 'community of explorers' approach to encourage pre-service primary teachers communally to encounter and think deeply about aspects of the geographic environment and raise interest in place, landscape and sustainability. What emerged was trainees' responding to the natural environment through engagement and personal relationships, developing their sense of the potential and value of being out in the environment to enable learning, as well as seeing and making connections with their prior subject learning. These researchers infer that such experiences, which can involve teaching children, help trainees to '(re)imagine' their place relationships linked with play, creativity, exploration and discovery, developing deeper, more meaningful relationships with nature. A study based in the USA (Ernst & Tornabene, 2012) found that pre-service early years teachers tended to have personal preferences for natural places containing water, though for educational learning they identified parks as most conducive. Interest in using the outdoors was linked to promoting young children's experiential learning in and about the 'natural' environment and developing environmental appreciation, though their views were tempered by concerns about access and safety, particularly supervision. While it seems that learning in and about the environment 'out there' is valued, pre-service primary teachers also recognise that there are constraints they have to overcome if they want to go beyond the nursery, kindergarten or primary school site with younger children.

What we know about trainee primary teachers' experience in teaching geography is negligible. In England Kelly (2006) surveyed both undergraduate and postgraduate pre-service teachers, finding that almost a quarter taught no geography on school placements, while between a fifth and two-fifths saw no geography taught. Those trainees who had the opportunity to teach geography tended to teach few lessons, with the majority teaching six or less, though a very few trainees taught ten or more geography lessons. Their teaching covered a variety of geography topics, particularly local and other place studies, geographical skills and aspects of physical and human geography. Most stated that they taught just one 'dimension' or aspect of geography, perhaps safety in the local area, about a village in another nation, the seaside, water or an environmental concern. This self-reported study provided some basic information but it contained no perspective on the nature and quality of the geography teaching. Investigating the planning of environmentally oriented topics by Australian pre-service primary teachers, Gooch et al. (2008) found that effective planning required a sound environmental knowledge relevant to the topic being taught. In encouraging responsible environmental actions trainees also needed to make greater use of critical thinking and democratic processes if the work the children did was to be meaningful and enhance their sense of environmental stewardship and capacity to take responsible actions. They found that in trainees' plans often there was inconsistency affecting the coherence between their beliefs and knowledge, learning intentions, classroom activities and assessment methods. The trainee primary teachers clearly needed more help in developing their understanding and skills in planning well for meaningful subject learning. Similar conclusions were identified in a study of trainees' learning in a society and environment curriculum unit, which engaged them in developing their understanding of enquiry approaches to children's learning, finding this was hindered by the trainees' limited subject knowledge (Tambyah, 2008). These studies did not investigate how and to what extent trainees put their plans into practice; they were based on researchers reviewing the planning documents. Thus, there is a lack of insight into the practices of teaching geography and about teaching the environment and environmental attitudes and values, though what has emerged is that trainees need to know the relevant subject knowledgeable to plan for what they teach.

Studying geography teaching by trainee primary teachers across Ireland, Waldron et al. (2009) identified several pertinent findings from the self-reporting of their trainees' teaching experiences. While two-thirds were positive about their teaching, only a third was positive about themselves as teachers of geography. The children's responses were an important influence on the trainees' self-perceptions, which were strongest when, they reported, the children felt actively engaged. The majority of trainees were positive about the topics they taught, their teaching methods and the resources they used. Around a fifth of trainees recognised their children found learning geography challenging, but they did not state why. It would seem that effective planning of geography teaching with good interactions with children provided the basis for positive experiences which enhanced trainees' confidence in their teaching and the subject. Nonetheless, up to a quarter of the trainees felt constrained by their class teachers, and some supervising tutors, where ideas about geography or approaches to its teaching were in conflict. At times some trainees

also felt inhibited by the curriculum requirements in Irish primary schools. In that this all-Ireland study focused on trainees' self-reported views there remains a lack of external evidence about pre-service primary teachers' teaching of geography.

A further element of the all-Ireland study of primary trainees (Waldron et al., 2009) concerned their perceptions of what makes a good teacher of geography for primary children. As Morley (2011) found with English pre-service primary teachers, the Irish trainees' views focused on teachers' professional qualities, including their knowledge of geography and global concerns and being skilled in planning and resourcing stimulating geography teaching. They also emphasised teacher interest and enthusiasm and the willingness to be a risk-taker, especially in fieldwork. Trainees felt that the use of the local area for geographical learning and undertaking geographical enquiries was also important. The emphasis on good geographical knowledge and pedagogical skills pertinent to the subject's teaching and to younger children's learning echo the capabilities outlined for high quality teachers of geography in elementary schools in the USA (GENIP Steering Committee, 2007) and in Italy (Giordia & di Palma, 2011). Tambyah (2006) notes that this is a matter of professional identity for pre-service primary teachers as curriculum decision-makers.

What emerges here from a range of national studies is the importance that trainee primary teachers give to their geographical understanding and their skills in motivating and teaching younger children. These aspects would appear to underpin their confidence in teaching geography, though not necessarily provide an identity as teachers of geography (among other subjects). However, there is a lack of corroborative evidence to support these self-perceptions. It is helpful that many trainees, though not all, feel positive about teaching geography in primary schools, but it remains essential to research the quality of their geography planning and teaching to understand better their needs and development – and, indeed, of their geographical knowledge underpinning their teaching. This would be enhanced further by investigating the nature and quality of the teaching they receive in geography in their initial teacher education courses to understand to what extent geography units and modules have an impact on the trainees' learning to teach.

Reflecting on the current state of play

This research provides evidence that there are geography teacher educators in various parts of the world who want to understand more about the pre-service primary teachers to whom they teach geography and that they wish to improve their trainees' geographical understanding. This group is small but important. They are complemented by researchers in environmental education – a parallel and overlapping curriculum area – and in science education which shares some common ground in earth sciences and sustainability with geography. This links with the interest of some early years practitioners in trainees' appreciation of nature and outdoor learning. Together they provide a fuller picture than might otherwise have been the case; they make a valuable contribution to our understanding through their research. What seems to engage them in this enterprise is their interest in understanding more clearly the perspectives of pre-service teachers of younger children in order that those teachers may be better prepared and are more positive and able teachers of geographical knowledge and understanding. Not only may these

researchers provide improved courses but the longer-term impact might be higher quality geographical learning among primary children (Gooch et al., 2008; Nikel, 2007; Tambyah, 2008; Waldron et al., 2009; Mandrikis et al., 2013; Yavetz et al., 2014). To achieve this depends clearly on being better informed about future primary teachers' knowledge and understanding of, views about and attitudes to geography and the environment, so that tutors are able to build on and develop well-grounded knowledge or challenge and change poor knowledge and misunderstandings, as well as change to positive stances ambivalent or negative attitudes to the subject, the world and global concerns.

There is an informative diversity among these thirty-six studies of pre-service primary teachers' understanding of geography and the environment and of their teaching. Yet the range of papers does not provide as much information and understanding about future primary teachers' geographical knowledge and capabilities as would be hoped. While trainees' feelings about geography and their overview of the nature of geography has been an aspect of a quarter of these studies, half the papers and conference presentations have investigated student ideas about the 'environment', using this term broadly to include quite specific areas of environmental knowledge, namely elements in climate change, air pollution and ecology. A fifth of them have involved exploring primary trainees' knowledge of environmental concerns and attitudes to the environment and environmental issues and responses. This research might imply that there is reasonable awareness of trainees' understandings, but these studies are variable in their nature and the scale of their investigations. They overlap in that several examined both knowledge and attitudes. Just under a quarter of the studies reported on the development of trainees' understanding during a taught unit or module, most in relation to scientific knowledge connected with climate change and global warming. These showed the positive effects of taught courses for pre-service primary teachers, but by no means all trainees improved their knowledge well. Many of these studies were based on questionnaires while only a few were interview-based to shed light on deeper understandings of nuanced perspectives.

There are minorities of trainees in all the studies with different views about geography, the environment and environmental attitudes and values to the main findings, indicating that there may be highly motivated and engaged trainee primary teachers learning alongside those who are misinformed and hold potentially damaging misconceptions and negative attitudes. What remains particularly weak as an area of research is the teaching of geography and environmental matters in primary initial teacher education courses. Just over a quarter of the studies cover topics ranging from trainees' self-reported experiences of teaching geography, their possible impact on children's learning, their confidence in teaching geography, their perspectives on their own experiences of learning geography in school and its effect on them, diverse views of what the geography curriculum should focus on, their planning of teaching, informal experiences that affected their views on such environmental aspects as 'nature', and what they characterise as the qualities of a good primary teacher of geography. This is a lengthy list of topics, most of which have no more than one or two studies reported world-wide.

It is evident that, in effect, nothing really is deeply understood and appreciated about trainee primary teachers' knowledge, skills, valuing, planning and teaching of geography. Indeed, it is informative to note at this point what has *not* been researched in recent years – and the list is long. It seems that, compared to the review of 2004 (Catling, 2004a), trainee primary teachers' locational and world map knowledge, their understanding of rivers and water, and their notions of local studies have not been the subject of further research. For much longer there has been a dearth of published studies about pre-service primary teachers' understanding of places and their teaching, their knowledge of landscapes and mountains, what they know of weather and climate, their awareness of many aspects of human geography from settlements to trade to energy and water use, their spatial ability and map understanding, and their knowledge of geographical enquiry, development education and fieldwork. Studies concerning geographical and spatial thinking and spatial citizenship are also missing. Alongside these, there is a lack of investigation into trainees' capabilities in teaching primary geography, including their understanding of assessment for younger children's geographical learning, their awareness of national geography curricula, and the classroom contexts in which primary trainees might find themselves teaching geography. There seem to be no studies of geography with subject specialists in primary teacher education programmes, though some exist in science primary teacher education. What has been researched has been spread thinly. There remain significant gaps indicating that much more research is required, and that some of it might thoughtfully be cross-subject.

It seems that globally we know and understand much less than we need to in order to provide effective and good teacher education in geography for pre-service primary teachers. We have a number of emerging concerns which must be noted. First, little really is known about future primary teachers' knowledge in and understanding of the range of topics within geography as a discipline and school subject. We need to understand more widely how trainees perceive and define the subject and what might be required to enhance their understanding of it. Second, a better appreciation of their attitudes to geography is needed, including about their prior experience of the subject in school and of their informal and daily experiences of geography, to understand to what extent their attitudes can be built on and/or need to be challenged, as well as used to engage them in the subject and motivate their valuing and teaching of it. Third, within geography a significant area is environmental values. This is linked with global learning and sustainability education. There is evidence that many trainees consider these important, though there are mixed views about the extent to which positive attitudes affect their behaviours and might affect their teaching. Given that there are those who challenge teaching young children to consider their personal understandings and positions about environmental issues, sustainability and global learning (Standish, 2012), these are aspects of trainees' geographical knowledge, understanding, teaching and learning which need to be better appreciated. Fourth, it seems that many may develop variable environmental knowledge and views via the media and internet and from societal sources rather than from good geography teaching, but next to nothing is understood about the effects of such informal learning and the ways in which it may support or constrain trainee primary teachers' geographical perspectives and teaching. Indeed, the extent to which

trainees engage in organisations and societies and have hobbies or interests which may influence their knowledge and views is not understood or appreciated in primary teacher education. Fifth, there is a significant lack of understanding of pre-service primary teachers' experiences of teaching geography, of the opportunities they have to do so, how they prepare and plan for this and what impact their teaching has – just as we know little of how they are prepared to be able to do all of this in their initial teacher education courses. Sixth, linked with this, is the need to examine more fully trainee primary teachers' senses of themselves as teachers of geography to younger children. This relates to their confidence to do so, how they perceive their understanding of geography and their capacity to apply it, and criteria they might be using as markers to set standards for and judge their capabilities and achievements.

Responding to the question: Does 'knowing little' matter?

Emerging from this review of papers pertinent to appreciating prospective primary teachers' understanding of geography and its teaching is that what is known can be described as modest at best. Some, but not a great deal, has been learnt since the previous review (Catling, 2004a) during the early years of the twenty-first century. For instance, we have a better sense of the variability in pre-service primary teachers' knowledge and understanding of climate change. Yet to extrapolate from this that their wider geographical and environmental knowledge is weak would be to go beyond the evidence from one area in geography. Simply, we do not know enough to make such a generalisation. The challenge in this review's initial questions was that we appear to have very limited knowledge of trainees' geographical experience and understanding of geography and of their attitudes towards the subject's teaching with younger children, let alone how they might teach it effectively. Really, we know little. The provocation in the review's second question is: to what extent does this matter? Four possible responses can be considered.

Geography units and modules for non-specialist pre-service primary teachers in their initial teacher education courses have always been limited, where provided. National and course priorities have constrained the time for the subjects outside the national language(s), mathematics and possibly science and technology, meaning that humanities and arts subjects have little time allocated to them. For instance, in an English university primary course all the seven arts and humanities subjects together are likely to have less tutor contact time than English and mathematics jointly. Tutors of primary geography have worked under such limitations for very many years. Given the need to introduce and develop their primary trainees' knowledge of geography curriculum requirements and teaching approaches appropriate for younger children, there has rarely been time to consider the trainees' prior knowledge, their perspectives about the subject, and how their learning of it and its teaching develops. Informally these aspects may be drawn upon in workshops and seminars but there is rarely time to relate these to research about trainees' perspectives, where this exists and is known to the geography tutor. Units and modules have been maintained, increasingly with reducing contact time in recent years, and pre-service primary teachers take something from them to support their teaching of

geography. So, one answer to the question is that it may not really matter what we know of primary trainees' experiences, understanding and views about geography and its teaching, since largely we have survived without this so far. Yet it can be argued that this is to avoid the issue.

Geography has a place in many national curricula and advisory school curricula around the world, at times as a distinctive subject or alternatively as a contributing subject in a social studies or an environmental education programme. At times geography may be combined with history as a humanities subject or linked to science, taking a more earth science or biophysical focus or focusing on sustainability. Distinctly or in an integrated context, geography curricula do not stand still. With recent introductions and revisions – and value – attached to geography curricula in countries such as England, Turkey and Australia, for instance, there have been serious questions raised about the knowledge and understanding of geography which pre-service primary teachers have. Research reviewed here raises questions about how well grounded many primary trainees' geographical and environmental awareness is, the extent to which they know about the aspects of geography they will teach, and how best they might teach to foster younger children's geographical learning and interest. If geography teacher education tutors know little of their trainees' backgrounds and the range of strengths and needs they may be dealing with, their role is likely to be less effective than it should be. The findings of research about the potential, needs and demands of trainees can inform tutors' thinking about how they might best approach their geography teaching. Thus, a second response to the question is that geography tutors need to know more about their trainees' experiences, senses, knowledge and understandings of and attitudes to teaching geography, and that it is important to get to grips with this. The present situation is not acceptable.

There is a third response, which is implied by this review's limited evidence – and it is not a comfortable one. This review and its predecessor have noted that there is limited research and that there are considerable gaps in what needs or ought to be researched about primary trainees' geographical knowledge and understanding. There has been over the past twenty-five years some continuity in particular areas of research, such as into trainees' ideas about geography, their environmental attitudes, and, more recently, into particular aspects of environmental knowledge such as climate change. There has been a diverse range of studies into elements of geography teaching, from whether trainees have the chance to teach geography, to how confident they feel, and on the 'notions' of geography – formal and informal – on which they draw. Occasionally trainees' world and locational knowledge, their understanding of rivers and their appreciation of local studies in geography have been investigated, though for these topics not for ten or more years. We know little else. This research has been conducted by relatively few geography educators, environmental educators and science educators. Yet, those who teach geography to pre-service primary teachers have a 'captive audience' in their primary trainees with whom to research! It seems that there is little geography education research undertaken annually with the many, many thousands of primary trainee teachers around the world. This might be because other priorities in tutors' time demand their attention; it may be that time is simply too limited in geography units or modules; it could be that such research is not encouraged or supported in universities, let alone in schools; and it might be that there is not an appreciation that such

investigations are worth doing and/or tutors have not the personal interest in, commitment to or skills for undertaking such research. This might support a third response to the question 'to what extent does it matter?', that for far too many geography education tutors it is simply not possible, not vital, nor seen as particularly useful that they make the effort to understand better the geographical interests, knowledge, dispositions and capabilities of our future primary teachers of geography. The reality is that knowing much is not going to be possible, so we should not worry.

Geography teacher educators do a challenging job supporting the development of primary trainees' awareness, understanding and knowledge of geography and approaches to its teaching. This occurs usually in constrained circumstances. Primary teachers will teach geography where and when they are required to. Pre-service primary teachers will, most likely, receive some training to do this, variously well-grounded or minimal and narrow, and they may see and even teach geography during their school placements. This appears to be an embedded situation. So, there is a fourth response to consider. This is that we are 'beating ourselves up' over the limitations of research and ought not to feel so threatened by the challenge we have. After all, the other social studies and humanities and arts subjects have the same problem, since primary teacher education courses are dominated by the subjects of national language(s), mathematics and science and technology. We ought to recognise what we do and, while not be satisfied with it, realise that research is of value and help, even where it presents us with international inconsistencies and though it may be limited. So, perhaps, our response should be 'just get on with it' and that we should value and make use of what we have learnt and continue to learn. Our understanding of students will continue to grow, if not coherently, consistently or by filling in many of the gaps. Yet as we learn more we may be able to draw succour from research into geographical understanding and learning among pre-service primary teachers (and from related studies in other subjects such as environmental education and science) and even find that elements of this research help to improve the understanding and teaching of geography tutors. It would seem that from the efforts of those researchers in and beyond geography education who have investigated primary trainees' geographical and environmental experiences, perspectives, knowledge, understanding, learning and teaching that undertaking such research is worth the effort and that it matters. Even if it remains sparse and modest, such investigations need to continue and we need to draw on them to help our teaching of pre-service primary teachers.

Conclusion

The geography education research review in the USA (Bednarz et al., 2013) provided a critical insight into research in geography education. Although it does not refer to relevant research into elementary school social studies pre-service teacher education (in which geography sits in the USA and in many other countries' primary curricula), it concluded that there are significant weaknesses in research about pre-service teachers' geographical understanding. It argued that larger-scale and more rigorous research is required, focused on teaching geography as well as about how to develop effective and good teachers of geography. This includes trainees' geographical knowledge and understanding and how they translate and make use of this to develop their teaching of the subject in the classroom.

The report noted the need to investigate the nature and teaching of geography in initial teacher education courses, as well as ways in which it can be improved. This review supports this case for primary teacher education research and, hopefully, provides more insight into the need for research.

This leads, in conclusion, to posing several questions to encourage us to move forward. Particular areas for research have been noted. We need to consider the following questions as the basis for making progress in encouraging the research that is required. They draw on the responses to the questions this paper posed at the start. They are provided to stimulate further discussion. The first question is that since there is limited research into trainee primary teachers' geographical understanding, how do we do take up the gauntlet to research this topic further in ways which are informative and helpful and which open up areas in which there is a lack of research? A second question is that since few people do such research in few countries – and only four or so countries appear to be leading it – what is required to encourage more tutor engagement with research into understanding trainees' experience and knowledge in geography? To help overcome this challenge, the third question must ask what is it that inhibits such research given that pre-service primary teachers are on our doorsteps (though for some countries geography is not a component in their teacher education courses)? The fourth question notes that since we know little about what geography tutors teach, we need to inquire how they do this and to what effect, on campus and in schools – and, indeed, ask what role schools play and how effectively. Fifth, we need to be aware that we have little information about the time given to geography as a subject, or within a subject grouping, in teacher education courses internationally and ask that if the fare of a few hours teaching geography to primary trainees provides little more than a subject introduction, and ideas about some teaching approaches and a few useful resources, what can we gain from investigating this situation and how might we apply what is learnt? Finally, we should ask what range of research approaches is needed to enable us to be better informed about the variety of topics to investigate and to give us information which will help propose more useful units and modules for primary trainees – even though it may be a challenge for these to be implemented in any national context?

If we could network those researchers who are investigating geography in primary teacher education and trainees' geographical knowledge and teaching – and if we can bring in other tutors to participate in this research and network – the mutual sharing and learning about research topics, methods and findings may help to enhance both national and cross-national research further and to enlarge the pool of researchers and what we know. If we can do this, we all gain, especially our primary children when learning geography.

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Biographical statements

Professor Simon CATLING is Emeritus Professor of Primary Education in the School of Education, Oxford Brookes University. He worked as a primary teacher from the early 1970s before moving into teacher education in the mid-1980s. He has published geography, map work and atlas materials and guidance for primary children and teachers, as well as very many professional, scholarly and research papers and book chapters about primary geography. His recent books have been Teaching Primary Geography (with Tessa Willy, 2009) and Teaching Primary Geography for Australian Schools (with Tessa Willy and John Butler, 2013). He is a Past-President of the Geographical Association in the UK, and has served as a Dean and Associate Dean of Education at Oxford Brookes University. From 2008-2012 he was Honorary Secretary of the International Geographical Union Commission on Geographical Education.