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“There is no easy solution:”
Singapore Teachers’ Perspectives and Practice of Climate Change Education

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Abstract

This qualitative study examines what six geography teachers in Singapore schools believe to be the purpose of climate change education, and how this influences their practice. A key finding of this study indicates that teachers oriented their practice around their belief that the aim of climate change education was to instil environmental values or critical thinking in their students. The belief in the purpose of climate change education was more influential compared to other factors such as the national curriculum, the school context, or their knowledge of climate change.

Keywords: climate change education, teacher education, teacher beliefs

Introduction

The overwhelming majority of scientists agree that warming in the climate system was “unequivocal” and that changes observed throughout the climate system were “unprecedented” (IPCC Press Release, September 27, 2013). In spite of the general scientific consensus on the issue of global warming and climate change, a significant amount of controversy over the relevance, purpose, and nature of climate change education exists. This is particularly important given the need to help young people acquire an understanding of the science of climate change, its impact, and potential solutions. The United Nations Educational, Scientific and Cultural Organization, for instance, has stressed the need for climate change education in order to help a broad audience

... understand, address, mitigate, and adapt to the impacts of climate change, encourage the changes in attitudes and behaviors needed to put our world on a more sustainable development path, and build a new generation of climate change-aware citizens. (UNESCO, 2010).

Research on education and the environment and/or sustainable development has grown as a field of inquiry. The literature on teachers' knowledge and practice tends to focus on environmental education as a broad category. These include analyses of teachers' conceptions of environmental education (Ballantyne, 1999; Corney & Reid, 2007; Cotton, 2006; Cross, 1998; Gooch, Rigano, Hickey & Fien, 2008), as well as the factors that influence their practice (Grace & Sharp, 2000; Lee, 1993; McNaughton, 2012; Stevenson, 2007). Few studies, however, have focused specifically on teachers' beliefs and knowledge of *climate change* education, and those that do focus primarily on teachers' misconceptions about the science of climate change (Dove, 1996; Groves & Pugh, 2002; Papadimitriou, 2004; Summers, Kruger, Childs and Mant, 2000). In this paper, we contend that it is important for researchers to pay particular attention to climate change education because this issue of climate change is unique in many ways. For instance, its high profile, as well as its politicized and controversial nature in some segments of society has resulted in teachers and schools facing significant pressure to avoid controversy by self-censoring what they teach (Meehan, 2012).

This paper seeks to understand what six geography teachers teaching about climate change in Singapore schools believe to be the purpose of climate change education and its impact on their practice. It further analyzes the nature of the relationship between teachers' beliefs and practice within the socio-political milieu of the Singapore national education and school contexts. The research questions addressed in this study are:

- What do geography teachers in Singapore believe to be the purpose of climate change education? What is the relationship between their beliefs and practice of climate change education?
- What other factors influence teachers' practice of climate change education in Singapore?

Singapore's case is compelling because of the state's explicit and unambiguous support for values-based advocacy in climate change education. The highly centralized nature of its national education system also provides a relatively homogenous backdrop against which to examine teachers' own beliefs about climate change education, and how they choose to teach it in their classrooms. Our data suggests that the importance of respondents' beliefs in the purpose of climate change education played a more significant role in shaping teachers' pedagogical decisions and classroom practice compared to the school context or their content knowledge.

The next sections provide a description of the relevant literature and the pertinent features of the Singapore context. This is followed by an outline of the research design and an analysis of the main findings of the study. We then conclude with a discussion of the implications of this study and suggestions for future lines of research.

Influences on teachers' understanding of climate change education

As discussed above, relatively few studies have focused specifically on climate change education. While scholars such as Chang (2014) have explored students' and teachers' misconceptions about climate change, most studies on teachers' understandings and perspectives focus on environmental education in general. We draw on this broad literature in order to frame our analysis of teachers' understandings of climate change education itself.

Purpose of environmental education

Within the literature, there is debate about the role of environmental education. For instance, researchers like Fien (1993), Huckle (1985) and Morgan (2011) have argued that the purpose of environmental education was to advocate for values education and social change for the environment. In the United Kingdom, Lambert and Balderstone (2000) suggested that the teacher's role was a moral one and teachers could not claim to teach without considering what was right and wrong. This emphasis on values-based "education for the environment" is evident in much of the environmental education literature (Cotton, 2006). In contrast, other researchers have pointed to the opportunities provided by the complexities of environmental issues for developing independent and critical thinking in students (Aldrich-Moodie & Kwong, 1997; Jickling, 1992, Ernst & Monroe, 2004). This position draws on Dewey's assertion that both students and teachers should be free "to explore the forces at work in society and the means by which they may be directed" in order to develop more equitable relations between citizens (1936, p. 377). In the contrasting positions on the purpose of environmental education outlined above is the implication that teachers make value judgments when teaching about climate change. Halstead and Taylor (1996) suggest that values are deep or fundamental convictions, which influence behavior, and are used as reference points in evaluating particular issues. For instance, research has shown that teachers' beliefs about their subject matter are important influences on their practice in subject areas like science education (Gess-Newsome 1999; Tsai, 2002) and geography education (Brooks, 2006, 2010; Seow, 2014).

Within environmental education, Sund and Wickman's (2008) research on secondary school teachers in Sweden suggested that the same scientific knowledge could be used for different purposes in education depending on teachers' personal beliefs. For example, large scale quantitative surveys of geography teachers from 18 different countries (Ballantyne, 1999), from the United Kingdom (Grace & Sharp, 2000; Tomlins & Froud, 1994), and across the United Kingdom and Hong Kong (Lee, 1993) indicate that teachers feel responsible for the promotion of positive environmental attitudes and behaviors. Conversely, a number of studies have also noted that teachers were reluctant to

explicitly advocate for the environment in their lessons (Cross, 1998; Gooch *et al.*, 2008). For example, in the United Kingdom, Cotton (2006) found that teachers preferred to adopt a neutral stance while presenting a range of different viewpoints about environmental issues. This reflects Stenhouse's (1975) position that the teacher's role is one of "procedural neutrality" and that his/her own value position should not be revealed to the class so that students would be able to work out their own value positions.

Subject matter knowledge

Research has also shown that teachers' subject matter knowledge of environmental issues was important to their classroom practice. For instance, Summers *et al.* (2000, p. 294) suggested, "secure teacher knowledge is the prerequisite for the most effective teaching" about environmental issues. Studies on teachers' knowledge, however, suggested that many student teachers had misconceptions about the science of climate change (Dove, 1996; Groves & Pugh, 2002; Papadimitriou, 2004; Summers *et al.*, 2000). These misconceptions included the belief that air pollution or ozone depletion caused global warming. Teachers were also confused about the gases involved in the greenhouse effect. As a result, respondents also tended to wrongly assume that reducing pollution or taking part in recycling efforts would help mitigate global warming. In their study of student teachers in the United Kingdom, Corney and Reid (2007) found that school and higher education were the main sources of respondents' knowledge of environmental issues. This suggests that whether climate change was taught, and how it was taught, might affect teachers' knowledge of the issue. Cross (1998) also noted that teachers' lack of knowledge of the complexities of environmental issues inhibited their ability to teach about it beyond face value acceptance of concepts and issues. This suggestion that teachers' knowledge of environmental issues matters to their practice has implications for our study on climate change. Although not the focus of our research, we examine teachers' knowledge as part of our research methodology in order to understand its influence on teachers' practice vis-à-vis teachers' beliefs.

School and political contexts

Climate change education does not occur in a vacuum. Studies have shown that contextual influences at various scales can affect teachers' beliefs about and practice of environmental education. For instance, Meehan (2012) found that teachers in US high schools did not necessarily advocate for the environment despite holding strong beliefs about it largely because of the contentious nature of climate change in the communities where they worked. Studies have also shown that factors like school structures and how subjects are organized have great influence on classroom practice. There is, for example, a lack of congruence between the inter-disciplinary approach that supports the

teaching of environmental issues and discipline-based school curricula in many places (Corney & Reid, 2007; Gayford & Dillon, 1995; Stevenson, 2007). Tensions also exist between the relatively inflexible school and national assessment policies and the adoption of open-ended approaches in the teaching of environmental issues (McNaughton, 2012). Other problems include a lack of time and resources (Grace & Sharp, 2000; Lee, 1993) and support from other staff members (Walker, 1997).

The Singapore Context

Countries with a strong environmental movement or those that are facing environmental threats tend to support environmental education to a larger extent than others (Stevenson, 2007). Climate change is widely accepted in Singapore because of the perception that Singapore is indeed threatened by climate change. Consequently, the Singapore government has been particularly active in promoting and supporting climate change policies and it has established a National Climate Change Secretariat (NCCS). In its National Climate Change Strategy, the NCCS stated that “average global temperatures and sea levels are expected to rise if carbon emissions from human activities continue to grow unchecked, and extreme weather conditions are likely to become more intense and frequent” (2012, p. 4). The Singapore state’s actions have received strong support from the public. Nearly 86% of the respondents of a public perception survey commissioned by NCCS felt that they should play a part in taking action on climate change and 58% of the respondents believed that Singapore should take steps to address climate change in spite of the potential costs involved (Teo, 2012).

Climate change education has also been explicitly incorporated into the national geography curriculum for secondary schools. The national geography curriculum and prescribed textbooks specifically link current global warming to human causes, discuss the impacts of climate change on people, and offer possible mitigation measures. The curriculum also highlights the negative impact of climate change to humans such as sea level rise, and lists international strategies to reduce greenhouse gas emissions like the Kyoto Protocol. They further suggest that extreme weather conditions like high intensity tropical storms are related to climate change. The weather and climate topic in the geography curriculum poses questions such as, “What is happening to the Earth’s climate? Is the weather becoming more extreme?” (Singapore Ministry of Education, 2013, n.p.). The curriculum, in addition, gives greater prominence to anthropogenic factors, including human activities such as deforestation and the burning of fossil fuels. The NCCS has worked closely with the Ministry of Education to develop climate change awareness in youths in a number of ways. For example, it developed an educational drama on climate change for primary school students to encourage individual action on climate change among youths (National Climate Change Secretariat, 2012). It

has also held national competitions for schools at all levels to take part in producing short videos on climate change as well as in offering technological solutions to address the issue (National Climate Change Secretariat, 2012).

Research Design

This research aims to gain an in-depth understanding of teachers' knowledge and its relationship to their practice of climate change education. The literature review above suggests teachers' personal understandings of environmental education and the context in which they work are important. This necessitates a research design that seeks "to understand situations in their uniqueness as part of a particular context" (Patton, 1985, p. 1). A positivist approach towards this study would not do justice to the complex and multi-faceted nature of teachers' knowledge and its relationship to their practice. Merriam (1998) suggested that while quantitative research took apart a phenomenon to examine its component parts, a strength of interpretive research is its ability to reveal how "all the parts work together to form a whole" (p. 6). In this study, each teacher is considered a case, and the analyses of each teacher's knowledge bases and practice is the scale of study. The data consisted of semi-structured individual interviews of six Singapore geography teachers as well as relevant curricular and political documents such as the national geography curriculum, textbook, political speeches and official government publications.

The two female teachers had more than fifteen years of teaching experience while the four male teachers were relatively inexperienced. All the participants majored in geography and all obtained their teaching certification from the National Institute of Education (see Table 1). Of the six participants, four taught in government schools (Westside Secondary and Northland Secondary) while two taught at a prestigious and highly selective state school (Southlink High). Southlink High is one of the few schools in Singapore that is allowed to develop its own curriculum as it has been accorded independent status by the Ministry of Education. Its students are part of the elite Integrated Programme and are exempted from taking the Singapore-Cambridge "O" Level national examinations. We purposefully selected teachers from both regular government schools and independent schools largely because these schools offer slightly different Geography curricula. Elite independent schools, while still largely funded by the state, tend to have more freedom to design their own academically demanding curricula albeit within certain parameters established by the Ministry of Education (Ho, 2012).

Table 1. Respondent Profile

Name	Gender	Years of Teaching Experience	Subject Major	Name of School	Type of School	Student Academic Profile
Andrew	M	4	Geography	Southlink High	Independent	Above Average
Brandon	M	5	Geography	Soutlink High	Independent	Above Average
Francis	M	1	Geography	Westside Sec.	Government	Average
Sharon	F	25	Geography	Westside Sec.	Government	Average
Melissa	F	16	Geography	Northland Sec.	Government	Average
Zachary	M	4	Geography	Northland Sec.	Government	Average

The interview protocol comprised a concept mapping exercise, an elicitation task and semi-structured interview questions (refer to Appendix 1 for interview protocol). Respondents were asked to develop a concept map of climate change, as concept maps are an established means to probe respondents' perceptions of the structures within an area of study and the links between topics (Novak & Gowin, 1984; White & Gunstone, 1992). The tacit meanings that were attributed to content already acquired and held by respondents could also be indicated through concept maps (Brooks, 2007; Ghaye & Robinson, 1989; Martin, 2005; Seow, 2014). In this study, respondents were asked to use these maps to explain their understandings of the causes and consequences of, and solutions to climate change. The second part of the interview included questions that asked the participants to explain how they approached the teaching of climate change in their classroom. In this part of the interview, respondents were also asked to respond to a series of quotes from climate change sceptics and whether they included such perspectives in their classroom teaching. This type of elicitation technique was used to produce rich data by Driver, Leach, Millar and Scott (1996) and Hopwood (2006) in science and geography subject conceptions research respectively. We were particularly interested in finding out what the teachers thought were the main purposes of teaching about climate change, whether or not they were advocates for environmental change or action, and the extent to which they encouraged students to engage with controversy within climate change education.

Our analysis was data-driven and inductive (Miles & Huberman, 1994). During the analysis process, the raw data, including researcher notes as well as transcriptions of the interviews, were jointly classified and coded. We then collaboratively reviewed the interview transcripts to identify similarly coded texts and eliminate redundancies. The data was analyzed and coded according to what they revealed about teachers' beliefs about the purpose of climate change education vis-à-vis the national and school contexts that teachers worked in and teachers' knowledge of and beliefs about climate change, and their classroom practice.

Findings

Purpose of climate change education

One of the main findings of this study is that despite working within a highly centralized and prescriptive national context that explicitly advocated for human action in response to climate change, participants still held contrasting beliefs about the purpose of climate change education. Three of the six respondents, Francis, Melissa, and Sharon, strongly believed that as teachers, they should explicitly promote and develop environmental values in their students. For instance, they all stressed the importance of instilling both awareness about climate change and a sense of responsibility in their students to make an effort to address it. Sharon, for example, argued that climate change was inevitable and therefore students needed to both be aware of, and play a part in, limiting the effect of climate change. Similarly, Melissa felt that it was important for the students to realize that as individuals, they could do something about climate change:

"I bring in the importance of awareness that we are contributing to greenhouse gas, and then if nothing is being done... look at all the concerted efforts by- done by different governments... Yeah so I bring in things like that to show them that "Hey, don't think that you are only a small speck and then whatever you do can't contribute."

Francis, in addition, emphasized the severity and urgency of the problem of climate change in his classroom:

"...the next generation needs to grow up with the mind-set that this is a big problem that needs to be tackled. There is no easy solution (and) there are things that they might have to sacrifice. And what are some of the different ways that ... they can come up with to deal with this."

In contrast, Brandon, Andrew and Zachary were of the opinion that the purpose of climate change education was to instil critical thinking skills in their students. For instance, Brandon suggested that climate change was the perfect vehicle for developing and applying critical thinking skills.

“I do give them the policy maker executive summary [of the IPCC report]... to highlight certain bits in it like the projected scenarios, the historical increase in temperatures...they’re very juicy, they’re very good to work with so that.”

Andrew and Zachary made similar arguments:

“Thinking of being an active citizen, it has to go beyond these fads right... Because ultimately, am I doing it just because the curriculum wants me to talk about it? Or do I teach it because I want them to be informed and make their own choices, and decide whether they want to do something about climate change? ... So then I’m going to give them that, the kind of understanding of the complexity we can find in climate change, rather than just, oh we go do that, then they all going to die because sea level (is) going to rise.” [Andrew]

“I hope to get them to ask more questions and have more questions to ask... the whole idea of global climate change is change, it is still changing, so definitely... that’s why I say to ask more questions and to continue to read up more ... To be more reflective when making a comment, that there are things that we don’t know and we don’t jump to conclusions very soon.” [Zachary]

Relationship Between Beliefs and Practice

The respondents’ descriptions of their classroom practice were clearly aligned to their beliefs about the purpose of climate change education. Notably, Sharon, Melissa and Francis felt so strongly about advocating for the environment that they were willing to manipulate classroom discussions through the judicious use of statistics and information. For instance, Sharon insisted on the primacy of advocating for the environment to engender an environmental ethic in her students over developing thinking skills:

“I think I have mentioned before that, you know, of course that other, there are other scientists who think that we are exaggerating but I’m not going to show too much of it ... [the students] will just continue

doing what they are doing then that defeats the purpose of the study so I will just show them some alternative but not too much."

Melissa also stated that she tried not to encourage prolonged discussions of the contentious issues surrounding climate change in her classes. Like Sharon and Francis, she reported largely using the material in the school textbook because those were more clearly in support of climate change as a serious issue.

"...one of the things we ask was, do you think it's a myth? And my conclusion is that uh, probably even if it is a myth, the very fact that temperature has been rising is true. That means the numbers cannot be wrong. The statistics cannot be wrong ... See, I can't promise the student that it is real, because these are issues that is very abstract you know, some of them are very abstract. But we can link. We can try to make intelligent guesses, of course with a little bit of manipulation on my side. So for example, I want to show Industrial Revolution has some part. So what I do is that I show them the dates, the years and everything... So certain things are manipulated".

Francis also reported deliberately manipulating his lessons to convince his students of the seriousness of climate change:

"What I would do is I would get the negative examples. So we'll get, purposely, get those that shows that people who are saying that it is not real are those that you can poke a lot of holes in the argument, because they are not substantiated, then the claims sometimes are exaggerated and stuff like that. I guess the eventual goal is to make sure that the kids do believe that climate change has a large impact."

To Francis, critical thinking about climate change data and claims were secondary to this larger purpose. He argued that the acquisition of such critical thinking skills was less important compared to conveying the magnitude of the impact of climate change to the students:

"Whether they develop the skill in discerning between good statistics, bad statistics, or evaluating whether the arguments are, which ones are founded, which ones are true, which one is more believable, I think that particular skill is not as important, or can be achieved in other means, as compared to, as compared to the importance of climate change, like the possible ramifications."

This is in contrast to Brandon, for instance, who based his classroom practice on providing multiple perspectives on the issue using different sources of information:

“I try to get as much primary material as possible. Well, primary in the sense that when it comes to global warming, the IPCC report. Because that pretty much provides the bulk of what the world knows and then various other papers ... journal articles or prefer magazine articles, you know, those we find, you know, Times, Newsweek because it’s a lot more accessible. So various perspectives, but the core bit will be the IPCC. I mean, and of course, the school textbook, those pretty pictures, but I try to bring in a variety of sources.”

He therefore focused on getting his students to understand different ways of interpreting climate change data, even if the discussions diluted the arguments of those advocating for the environment.

“I mean what we did was we took Al Gore’s “Inconvenient Truth” and his presentation of data and looked at alternative interpretations of the same set of data by other climate change experts who aren’t necessarily deniers but, you know, who point out that the way the data is presented, you know, can sensationalize the issue ... So it’s a very useful...well, it’s very useful to examine like data and the biases inherent in how it’s presented, in how it’s analyzed.”

Andrew and Zachary similarly reported going beyond the materials in the nationally prescribed textbooks because they wanted to expose students to alternative perspectives and claims about climate change.

Discussion

A key finding of this study is the importance of teachers’ beliefs of the purpose of climate change education on their classroom practice. Notably, this seemed to play a more significant role compared to their subject matter knowledge and their school and political contexts. Research points to the resilience of teachers’ belief systems that bias interpretations of subsequent and often contradictory information (Nisbett & Ross, 1980). They also have strong affective components that are separate from knowledge and remain immutable even in the face of new information (Nespor, 1987). This is supported by

research on Singapore teachers' perceptions of geography and its impact on their classroom practice (Seow, 2014). Other scholars, such as Cotton (2006) and Meehan (2012), in contrast, suggest that for environmental education, teachers are largely influenced by their beliefs about the role of teachers and school context respectively.

Francis and Brandon chose to approach the teaching of climate change very differently even though they both demonstrated a high level of knowledge about climate change. Both respondents could clearly reference the development of the scientific consensus on climate change over time, and could largely evaluate statements about climate change in terms of whether these were claims or fact. Francis however chose to present data and information from only one perspective, as he strongly believed in climate change advocacy. Brandon, on the other hand, was willing to introduce contradictory perspectives, as he believed that the purpose of climate change education was to teach students how to think critically.

Interestingly, Sharon and Melissa both believed that the purpose of climate change education was to strongly advocate for the environment even though they harbored some doubts about the scientific consensus on, and the nature of the controversy surrounding, climate change compared to Francis. For instance, Sharon suggested that while she was unsure about the debates over climate change, she felt that she was also duty-bound to stick to the national discourses on climate change and advocate for the environment.

“...somehow I feel like a bit disturbed because a lot of contradictory reports and then like when I teach my students I need to be like, okay I must really tell them that it's still very debatable, you know? And my conscience is like, I can't tell them... Yeah, so most of the time I'll just follow the textbook then I can't be wrong, right?”

In contrast, Brandon, Andrew, and Zachary believed that the purpose of climate change education was to develop critical thinking skills in their students. Consequently, they chose to present multiple perspectives in their classroom and emphasize the practice and acquisition of analytical and critical thinking skills.

Our data also suggests that a secondary influence on practice is teachers' knowledge of climate change issues. This supports Cross (1998) who observed the relationship between teachers' knowledge about environmental issues and their classroom approach. For instance, although Brandon believed that the purpose of climate change education was to develop critical thinking skills in his students, his knowledge of climate change as a field caused him to aim for the inculcation of pro-environmental values through critical inquiry. This was in contrast to Zachary and Andrew who provided perspectives beyond

the curriculum without being able to help students properly assess the validity of these alternative views.

Notably, the three teachers made similar pedagogical decisions in spite of the significant differences in their depth of knowledge of climate change science. Unlike Brandon who was knowledgeable about climate change science and the current consensus on the issue, neither Zachary nor Andrew appeared to have that same depth of knowledge. For example, Zachary characterized his view of climate change as surrounded by “question marks” and stated that he

“...realised that there is a lot of two sides, whether it’s this or that... whether it’s natural or human, there are so many documentaries online and all that, and I don’t know whether it’s reliable.”

Andrew appeared similarly unsure about climate change. For example, he confused global warming with ozone depletion. He also had less experience of teaching and/ or learning about climate change compared to all the other respondents. These relatively lower levels of knowledge of the climate change scientific consensus perhaps made it harder for both Andrew and Zachary to confidently advocate for the environment in their practice. However, because they prioritized critical thinking over advocating for the environment, Andrew and Zachary did not fall back on solely the national curriculum and present only one point of view in the same way as Melissa and Sharon did.

Conclusion

Climate change is contentious in the political and social realms in some parts of the world, despite the broad consensus within the scientific community (Anderegg, Prall, Harold & Schneider, 2010). For instance, Smith and Leiserowitz (2012) conducted four national representative surveys of perceptions of risk associated with global warming in the United States, and highlighted five reasons for climate change denial articulated by the respondents: (1) conspiracy theories; (2) flat denials of the existence of global warming; (3) belief that global warming is a naturally occurring phenomenon; (4) media hype; and (5) doubts of the reliability of climate science. These complexities surrounding climate change therefore provide rich opportunities for dealing with controversy and conflict in the classroom.

The findings in this study suggest that the teachers responded to the contentious nature of climate change education in various ways. A key determinant was Singapore teachers’ beliefs about the purpose of climate change education. Some of the teachers felt that the purpose of climate change education was to promote pro-environmental values and consequently, adopted a

values-based advocacy teaching approach in their classrooms. The other respondents, in contrast, felt that climate change education was supposed to promote critical thinking. They therefore prioritized providing multiple perspectives on climate change to their students. The difference between Brandon's teaching approach and that of Zachary and Andrew was further related to differences in their knowledge about climate change issues. The diversity noted here is particularly surprising because of the unambiguously supportive stance adopted by the Singapore state towards climate change, the dominant role of the Singapore government in shaping and influencing national curricula and assessments, and the numerous institutional and curricular constraints imposed on Singapore teachers (Ho, Alviar-Martin, Sim & Yap, 2011; Ho, 2010).

To conclude, this study provides insight into what drives teachers' classroom practice of climate change education. It suggests that the inclusion of climate change education in national and school curricula is not a sufficient condition to ensure the development of the type of climate-change aware activist citizen envisioned by UNESCO (2010), even in a context as supportive of this end as Singapore. In addition, ensuring teacher knowledge about climate change as advocated by Chang (2014), though important, may not necessarily lead to the realization of this end either. Instead, teacher education programmes should provide opportunities for teachers to critically examine and clarify their beliefs about the purpose of climate change education.

References

- Aldrich-Moodie, B. & Kwong, J. (1997). *Environmental education*. London: Institute of Economic Affairs.
- Anderegg, W., Prall, J., Harold, J. & Schneider, S. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences of the US of America*, 107(27), 12107–12109.
- Ballantyne, R. (1999). Teaching environmental concepts, attitudes and behaviour through geography education: Findings of an international survey. *International Research in Geographical and Environmental Education*, 8(1), 40-58.
- Brooks, C. (2006). Geographical knowledge and teaching geography. *International Research in Geographical and Environmental Education*, 15(4), 353-369.

- Brooks, C. (2007). *Towards Understanding the Influence of Subject Knowledge in the Practice of "Expert" geography Teachers* (Unpublished doctoral dissertation). Institute of Education, London.
- Brooks, C. (2010). Why geography teachers' subject expertise matter. *Geography* 95(3), 143-148.
- Chang, C. H. (2014). *Climate change education: Knowing, doing and being*. New York: Routledge.
- Corney, G. & Reid, A. (2007). Student teachers' learning about subject matter and pedagogy in education for sustainable development. *Environmental Education Research*, 13(1), 33-54.
- Cotton, D. (2006). Implementing curriculum guidance on environmental education: the importance of teachers' beliefs. *Journal of Curriculum Studies*, 38(1), 67-83.
- Cross, R. (1998). Teachers' views about what to do about sustainable development. *Environmental Education Research*, 4(1), 41-52.
- Dewey, J. (1936). The social significance of academic freedom. *The Social Frontier*, 2, 376-379.
- Dove, J. (1996). Student teacher understanding of the greenhouse effect, ozone layer depletion and acid rain. *Environmental education research*, 2(1), 89-100.
- Driver, R., Leach, J., Millar, R. & Scott, P. (1996). *Young People's Images of Science*. Buckingham: Open University Press.
- Ernst, J., & Monroe, M. (2004). The effects of environment-based education on students' critical thinking skills and disposition toward critical thinking. *Environmental Education Research*, 10(4), 507-522.
- Fien, J. (1993). *Education for the environment: critical curriculum theorising and environmental education*. Geelong: Deakin University Press.
- Gayford, C. & Dillon, P. (1995). Policy and the practice of environmental education in England: A dilemma for teachers. *Environmental Education Research*, 1(2), 173-183.

- Gess-Newsome, J. (1999). Pedagogical content knowledge: an introduction and orientation. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining Pedagogical Content Knowledge: The Construct and its Implications for Science Education* (pp. 3-17). The Netherlands: Kluwer Academic Publishers.
- Ghaye, A. L & Robinson, E. G. (1989). Concept Maps and Children's Thinking: a Constructivist Approach. In F. Slater (Ed.), *Language and Learning in the Teaching of Geography* (pp. 115-130). London: Routledge.
- Grace, M. & Sharp, J. (2000). Exploring the actual and potential rhetoric-reality gaps in environmental education and their implications for pre-service teacher training. *Environmental Education Research*, 6(4), 331-345.
- Groves, F. H., & Pugh, A. F. (2002). Cognitive illusions as hindrances to learning complex environmental issues. *Journal of Science Education and Technology*, 11(4), 381-390.
- Gooch, M., Rigano, D., Hickey, R., & Fien, J. (2008). How do primary pre-service teachers in a regional Australian university plan for teaching, learning and acting in environmentally responsible ways? *Environmental Education Research*, 14(2), 175-186.
- Halstead, J. M & Taylor, M. J. (1996). *Values in Education and Education in Values*. London: Falmer Press
- Ho, L. C. (2010). "Don't worry, I'm not going to report you": Education for citizenship in Singapore. *Theory and Research in Social Education*, 38(2), 217-247.
- Ho, L. C. (2012). Sorting citizens: Differentiated citizenship education in Singapore. *Journal of Curriculum Studies*, 44(3), 403-428.
- Ho, L. C., Alviar-Martin, T., Sim, J. B.-Y., & Yap, P. S. (2011). Civic disparities: Exploring students' perceptions of citizenship within Singapore's academic tracks. *Theory and Research in Social Education*, 39(1), 298-316.
- Hopwood, N. (2006). *Pupils' Conceptions of School Geography: A Classroom Based Investigation* (Unpublished doctoral dissertation). University of Oxford, England.

- Huckle, J. (1985). Values education through geography: a radical critique. In D. Boardman (Ed.), *New directions in geographical education* (pp. 1-13). London: Falmer Press.
- Intergovernmental Panel on Climate Change Press Release (2013). *Human Influence on climate clear*. Stockholm.
- Jickling, B. (1992). Why I don't want my children to be educated for sustainable development. *Journal of Environmental Education*, 23(4), 5-8.
- Lambert, D. & Balderstone, D (2000). *Learning to teach geography in the secondary school*. London: Routledge Falmer.
- Lee, J. (1993). Geography teaching in England and Hong Kong: Contributions towards environmental education. *International Research in Geographical and Environmental Education*, 2(1), 25-40.
- Martin, F. (2005). *An Analysis of PGCE Primary Students' Conceptions of Geography, Education and Knowledge and the Relationship between these and their Development as Teachers of Primary Geography*. (Unpublished doctoral dissertation). University of Coventry, England.
- McNaughton, M. (2012). Implementing education for sustainable development in schools: learning from teachers' reflections. *Environmental Education Research*, 18(6), 765-782.
- Meehan, C. (2012). *Global warming in schools: an inquiry about the competing conceptions of high school social sciences and science curricula and teachers*. (Unpublished doctoral dissertation). University of Wisconsin-Madison, Madison.
- Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education*. San Francisco: Jossey-Bass Publishers
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Beverly Hills: Sage Publications
- Morgan, J. (2011). *Teaching secondary geography as if the planet matters*. Oxon, Routledge.

National Climate Change Secretariat (2012). *National Climate Change Strategy 2012*. Singapore.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, 19(4), 317-328.

Nisbett, R. & Ross, L. (1980). *Human Inference: Strategies and Shortcomings of Social Judgements*. New Jersey: Prentice-Hall.

Novak, J. D. & Gowin, D. B. (1984). *Learning how to learn*. Cambridge: Cambridge University Press.

Papadimitriou, V. (2004). Prospective primary teachers' understanding of climate change, greenhouse effect, and ozone layer depletion. *Journal of Science Education and Technology*, 13(2), 299-307.

Patton, M.Q. (1985). *Quality in Qualitative Research: Methodological Principles and Recent Developments*. Invited Address to Division J of the American Educational Research Association, Chicago, April 1985.

Seow, T. (2014). *The Subject Conceptions and Practice of Pre-service Geography Teachers in Singapore*. (Unpublished doctoral dissertation). Institute of Education, London.

Singapore Ministry of Education (2013). *Geography GCE O-Level Syllabus*. Singapore: Curriculum Planning and Development Division.

Smith, N. & Leiserowitz, A. (2012). The rise of global warming skepticism: exploring affective images in the United States over time. *Risk Analysis*, 32(6), 1021-1032.

Stenhouse, L. (1975). *An introduction to curriculum research and development* (Vol. 46). London: Heinemann.

Stevenson, R. (2007). Schooling and environmental education: contradictions in purpose and practice. *Environmental Education Research*, 13(2), 139-153.

Summers, M., Kruger, C., Childs, A., and Mant, J. (2000). Primary school teachers' understanding of environmental issues: An interview study. *Environmental Education Research*, 6(4), 293-312.

- Sund, P., & Wickman, P. O. (2008). Teachers' objects of responsibility: something to care about in education for sustainable development? *Environmental Education Research, 14*(2), 145-163.
- Teo, C. H. (2012). Speech on Climate Change by Mr Teo Chee Hean, Deputy Prime Minister, Coordinating Minister for National Security and Minister for Home Affairs, at the Committee of Supply Debate, 1 March 2012. Retrieved from http://app.nccs.gov.sg/news_details.aspx?nid=642&pageid=97
- Tomlins, B. & Froud, K. (1994). *Environmental education teaching approaches and students' attitudes*. Slough: National Foundation for Educational Research.
- Tsai, C. C. (2002). Nested epistemologies: science teachers' beliefs of teaching, learning and science. *International Journal of Science Education, 24*(8), 771-783.
- United Nations Educational, Scientific and Cultural Organisation (2010). *The UNESCO Climate Change Initiative: Climate Change Education for Sustainable Development*. Retrieved from www.unesco.org/en/climatechange
- Walker, K. (1997). Challenging critical theory in environmental education. *Environmental Education Research, 3*(2), 155-162.
- White, R. & Gunstone, R. (1992). *Probing Understanding*, New York: Falmer.

Appendix 1: Interview Protocol

A. On climate change and climate change education

1. Let's discuss your concept map. Could you walk me through the various components and linkages in this diagram?
 - Where would you place the causes/ impacts/ solutions to climate change in this diagram? (as required)
2. Do you think it is important to teach this topic? Why?
 - What types of attitudes or values do you focus on in this topic? Why?
 - What type of skills do you focus on in this topic? Why?

3. Which parts of the diagram do you incorporate in your teaching, and which parts do you not teach? Why?
4. Which parts of the diagram do you emphasize in your teaching? Why?
5. Please read the abstracts provided. What are your reactions to what you have just read?
6. Would you introduce these perspectives to your students in the classroom? Why?

B. Personal Context

1. Can you recall what you learnt about climate change when you were at school/ university/ PD courses?
2. Does your school have any curricular or co-curricular programmes/ activities focused on climate change issues?
3. Do you actively look for information about climate change? Why? What sources of information do you refer to?
4. How has climate change issues affected you in your personal life?

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