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# Developing Pedagogies for Teaching about Climate Change

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*Abstract: One of most pressing social and scientific problems of our times is maintaining climate stability in the face of growing evidence of dramatic climate change. Understanding climate change is a challenge for most citizens and it follows that teaching about climate change is equally challenging. In order to suggest new pedagogical strategies for teaching about climate change, this paper resists the deficit model of teacher education by suggesting a more organic approach in developing climate change pedagogies. This suggestion emerges from research which examines how prospective teachers understand climate change as both a scientific and social issue. Preliminary results suggest a socialized understanding of climate change as the consensual paradigm for dealing with the complex challenges presented by climate change. This paradigm affirms research that contest the anchoring of understanding of climate change on scientific concepts. The paper discusses and explores alternative pedagogies aiming to exploit student-teachers' developed dialogic interactions and socialized scientific knowledge, as foundational in teaching about climate change and enhancing socio-scientific student engagement.*

Keywords: Sociology of Learning, Pedagogies, Sustainability

## Introduction

**T**HE TENSIONS AROUND teaching values and science continue to fuel interest in locating socio-scientific teaching and learning (Blum, 2009). Socio-scientific research aims to investigate the way that scientific propositions are incorporated into opinion making about a particular social problem which has a scientific dilemma at its core (Sadler, 2005). Climate change is an example of such a dilemma because there is much political rhetoric about climate change, the solutions are vast and varied and the scientific facts around climate change are highly contested and complex. In education, the focus on climate change has been to present and transmit a 'catalogue of facts' (Polanyi, 2009) and use these as a basis for understanding and underpinning the need for action and social change. The educational rationale makes sense in terms of learning theory, which presumes content knowledge influences the quality of opinion making. However, investigations into socio-scientific reasoning, which examine the reasoning patterns of students as they grapple with complex scientific problems have centered on how much students know about the science and then how they use this knowledge to make sense of the issue. These investigations show that teaching and learning about socio-scientific issues requires more than the catalogue of facts.

Socio-scientific issues are varied and one prescriptive methodology may not be the best way to deal with all issues. Sadler (2003) concluded that scientific learning is "infrequently applied in all but the most similar circumstances" (Sadler, 2003, p.528.) Fleming(1986) concluded that students mostly draw on experiential knowledge in forming opinions about

complex scientific issues. Fleming reported that when asked a technical question, 91 percent of students were able to incorporate scientific terminology into their responses. However, when asked to assert their position in regards to a scientific issue, very few students drew on their scientific knowledge as a way to justify and articulate their opinions. In addition, other studies have identified obstacles to in socio scientific reasoning include inability to distinguish and evaluate evidence, and the lack of maturity of students (Levisinson, 2006).

As socio-scientific issues are varied and require specificity, in terms of knowledge and pedagogy, so teaching about climate change may require equally specific pedagogy. Traditionally teaching about climate change has rested in science or geography disciplines. Within these distinct discipline areas, the teaching methodologies contextualize science but also have the tendency to 'distill' (Sadler and Fowler, 2005) the science and compartmentalize scientific issues. But a few distinct qualities about climate change necessitate a re-think about traditional pedagogies. Firstly, when we think about educational outcomes, the educative outcome for climate change is not so much an accurate understanding of scientific principles, but that there is an awareness of climate change as phenomena impacting on all humanity and impacting on the quality of life. It is a great public health, well-being and safety issue. In this case, it is on par with other public campaigns that desire healthy lifestyles, inform people about their quality of life and promote a participative citizenship. Ultimately, with such areas of learning, the outcomes of achievement are not only in the specific understanding of the scientific and technical information, but also that the person is able to actively participate, make decisions and engage in public debates, that is, "can be part of wider struggles over the control of processes of local development and environmental management" (Blum, 2009, p.715).

Teaching about climate change is also an interdisciplinary endeavour as it is a socio-scientific issue rather than a scientific or geographic topic. In previous research, Vongalis and Kurup (2008) found that most pre-service teachers thought that teaching about climate change was the responsibility of all teachers. The prospective teachers were emphatic in identifying their strong level of responsibility in teaching about climate change, and that part of their educative purpose was to 'make a difference'. It would appear that to confine the teaching of climate change to specific teachers, of specific disciplines runs contrary to the cosmopolitan desire of new teachers to create social change through education.

Addressing the different levels of public and student understanding Pruneau et al (2001) suggest that a critical socio-constructivism should underpin climate change pedagogy. Their research suggests that while people may not understand the science, they are interested in voicing opinions about climate change. In other words, through opinion making they are engaged and interested. This is an important pedagogical consideration because one of the educative purposes of tackling climate change is to engage people in the complexity of socio-scientific issues. By implication, a great challenge for teachers is to integrate the complexity of scientific understanding with the complexity of social responses to climate change.

Goldkuhl (2002) argues that using scientific reasoning is "talking about the world"(p.1), and the reflective conceptualization is based on a socio-scientific pragmatism in which people use scientific understanding to clarify their views of the world. The issue under question is whether talking about the world, that is, a form of situated learning in which scientific information is introduced when necessary to clarify understanding, is a useful pedagogy when teaching about climate change. Research by Hwang (2009) argued that using a narrative inquiry methodology to interrogate the traditional notion of science was a way to disrupt tra-

ditional practices in science as a way to make better sense of experiences around environmental education. Sense-making and communication are two practices that create avenues for better understanding of socio scientific information.

When writing about climate change, Giddens (2009) emphasizes the unique problematic associated with climate change. He considers it a collective problem, which presents humanity with a paradox. Because climate change is intangible, not immediate and not visible to everyday life, the very real threat is pushed to the back on people's mind. The paradox is that the nature of the threat of climate change is also the thing that makes it so difficult to confront. But, by not confronting it, we create greater problems. For these reasons the issue of climate change is a specific socio-scientific issue that requires a re-think about how to teach about it.

In order to address the paradox of climate change and suggest different ways of addressing pedagogical issues, the research examines the way that prospective teachers incorporate scientific and social knowledge when forming opinions about climate change. This research partly responds to Stevenson (2007) who calls for "constructing discourses of professional learning that reflexively build, sustain and develop such spaces and opportunities for enacting meaningful environmental education in schools" (p. 265). The research will show how pre-service teachers deal with the paradox of climate change and by assessing how prospective teachers understand, form opinions and talk about climate change the aim is to incorporate this reflexivity as pedagogical potential. The socio-scientific reasoning patterns will be analysed to suggest the development of an organic pedagogy in which the pragmatic reasoning processes of student teachers can be enhanced to underpin the socialized and scientific teaching of climate change.

## **Research Results**

In 2008 the author conducted research around how prospective teachers understood notions around sustainability and their teaching practice. An interesting finding from this research of 191 student-teachers from various disciplines was that over 90 percent of the student teachers believed that it was the responsibility of all teachers to teach about climate change issues (Vongalis-Macrow and Kurup, 2008). Unpacking this notion that all teachers were responsible for teaching about climate change issues, we asked the group to elaborate further. In order to understand how student teachers talk about climate change, they were given a list of statements about climate change and global warming and asked to respond in terms of agreement and disagreement on a 5 point Likert scale. The percentage agreement in the table is inclusive of both agreement and strong agreement with a particular statement.

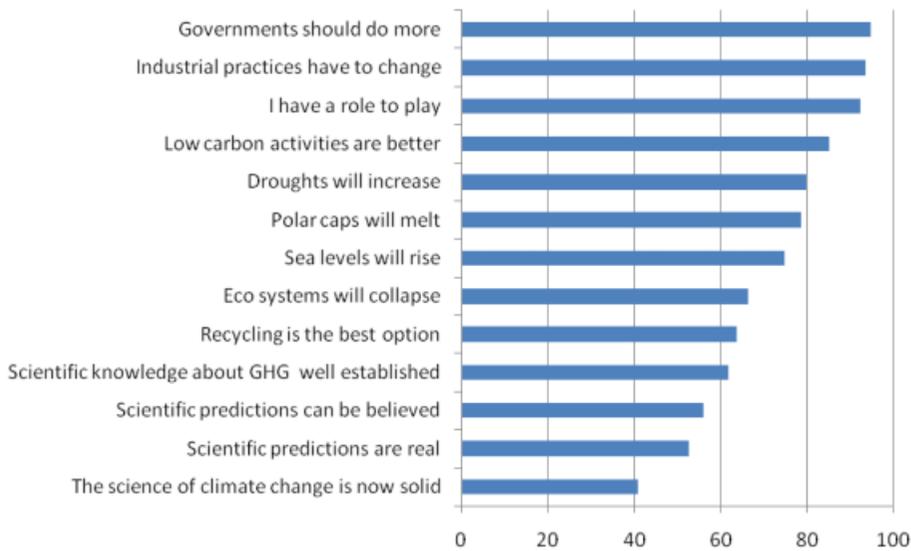


Table 3: Pre-service Teachers Opinions about Issues Related to Climate Change

When examining the opinions of prospective teachers, the table shows that the cohort has very strong views about the role of government as the focal point for addressing climate change issues. In addition, the strongest held beliefs that governments should do more and that industry should be more regulated achieved almost consensus amongst the students. These items suggest the firmly held beliefs critical of both government and industry. The only other item which achieved a very strong consensus referred to the personal resolve of the group when over 90 percent were of the opinion that they have a role to play in addressing climate change. The beliefs around the science of climate change are not as strong as the social beliefs. When students were asked their opinion about the rigour of science of climate change, just on 40 percent agreed that the science of climate change was well established. The table shows that the students are less assured about the science as a whole, even though they could identify examples of climate change phenomena.

The trend in such responses shows that student-teachers draw on their social knowledge in forming opinions and affirms other research which has suggested that the social aspects of scientific issues are the most dominant domain in reasoning processes (Fleming, 1986). Part of the strongly held views by student teachers is to also question or at least have some reservation about the scientific evidence that purports to explain climate change as a certain phenomenon. This poses questions about how the participants can hold very strong view about climate change and the role of industry, government and the economy while casting greater doubt on the science and beliefs about climate change.

To examine this point further, the reasoned opinions of student-teachers provide another data source from which to speculate about the reasoning processes of the cohort. Of interest in this investigation is how the students reasoned their opinions.

The second stage of this research focuses on the opinions of five focus groups from the same cohort of student teachers. Using Zing software, which is able to collect and collate group opinions, the five focus groups were made up of student teachers in groups of 5-6 students. A total of 24 student teachers participated in the second stage of the research. The

focus groups were presented with four issue based questions around climate change and sustainability. The group was required to discuss their various opinions and then present a representative group explanation of their answer. The aim of the group activity was to encourage students to reason their answers to one-another so that the final group answer was a reasoned response. The four questions aimed to capture a range of issues around climate change and education and how student teachers made sense of these. The questions were:

1. Science of CC and GW are solid and the trends are well mapped by the IPCC report. We can believe the predictions by the scientists regarding sea level rise and climate change.
2. Climate change (CC) and global warming (GW) are more important than economic and social considerations.
3. CC and GW are the most important issue of our times hence we and governments should act effectively to solve this issue.
4. There is no need for carbon intensive economy, people should be educated and living practices need to change.

The paper discusses the implications of the student teachers' opinions and reasoning around socio-scientific understandings and the implications for teaching.

### **Reasoning Patterns in Forming Opinions: Responding to Scenarios**

Students were asked to respond to four scenarios designed to elicit opinions about climate change. The responses are the considered opinion of the group and attempts to capture the agreed upon argumentation.

Question: Science of CC and GW are solid and the trends are well mapped by the IPCC report. We can believe the predictions by the scientists regarding sea level rise and climate change.

All five groups expressed an agreement that the science in the Intergovernmental Panel of Climate Change (IPCC) report is well founded. The rationalization for the agreement refers to the credibility of science as in *"Yes, we agree with the scientific methods they used to study climate change"*, and the authority of scientists, *"we believe the scientist's because they hold positions of authority and [we] don't know better"*, and *"You tend to believe a lot of what scientists say especially when you can see effects happening in front of you"*. The reference to authority is a critical point in the reasoning process, especially as the students questioned the accuracy of scientific knowledge and the expected changes resulting from climate change are not fully understood. Referring to the first table, what will happen to eco systems, polar ice caps and sea levels is contentious and there is skepticism amongst student teachers.

For those who were unsure, they pointed to the uncertainty of science, "that it is only theory", the 'hidden agenda' scientific research. One group states, *"Scientists have identified that it is a problem however they can only estimate what is going to happen and these estimations may be an over-reaction and only time will tell!"* Overall, scientific information needs to be construed as authoritative, credible and relate to experiential evidence in order

to resonate with the participants. Therefore, in assessing the credibility of socio-scientific issues, the question of who is talking, that is who is suggesting the evidence and theory is critical in the way the issue is perceived and judged and rationalized.

A pedagogical strategy drawing upon teachers' need for authoritative knowledge in complex scientific issues represents the work of teachers not so much as those imparting information and knowledge, but those able to direct and guide towards accurate and authoritative information sources. Teachers can integrate their own identified need for solid knowledge of climate change to create learning opportunities that identify, access and direct students to authoritative information about climate change. In terms of pedagogy, the capacity to guide students to authoritative sources and promote the know-how of getting information, as a component of learning, provides a long term, sustainable method of on going learning. As socio-scientific issues, are specific (Sadler, 2003 and Blum, 2009) and require particular understandings, being able to identify those with authority and the views of those in authority is a critical educative tool for future citizens. The teachers' role models the skills for knowing where and how to seek credible information. Inquiry based teaching methods which promote the active learner seeking and making inquiries about information would be a typical strategy that would enhance knowledge making about the credibility of scientific concepts. The discernment of the information requires further pedagogical skill in the way that information is socialized within the experiences and understandings of the learner.

Question: Climate change (CC) and global waring (GW) are more important than economic and social considerations.

This question asked the student teachers to assess the relative importance of CC and GW against the importance of the economy and social issues. There is a moral element in the reasoning pattern in this kind of question because it assesses the relative risk in prioritizing one element at the expense of the other. It addresses the common concern with climate change that it is an intangible concern and thus other more visible social issues are generally seen as more important and relevant (Pruneau et al, 2001). Reviewing the opinions of the twenty groups, it becomes clear that the majority of the groups reasoned that a collapse in the economy would be more risky than climate change.

For example,

Economy is more important because without a good economy we wouldn't be able to change or help our ways to deal with climate change and global warming.

Social Issues and economic issues are more important in the now whereas climate change and global warming are more important in the future.

The majority of the groups understood the systemic interrelatedness of climate change and the economy and explaining the systemic connections was key in the reasoning showing that both social and economic conditions and climate change are inexorably linked and thus of equal importance. However, in assessing the relative risk, the concept of time was critical. The immediacy of economic collapse, "*We can't lose sight of all the issues in the world, just to fight climate change and global warming*", and the scale of impending threat was a factor in the reasoning about importance. The arguments propose that the economy is a more short term risk, thus, can impact on everyone quickly, while climate change requires a sys-

tematic and behavioural change over time. The students stated that “*We think of social and economical considerations as a short term issue whereas climate change and global warming are long term changes that cannot be fixed now.*” Another groups reasoned,

*Climate change and Global warming are things that happened over time and need to be dealt with through change in behavior; however society needs to deal with the ongoing economic and social issues effecting us now, for example rising interest rates and housing, racial discrimination and resulting poverty etc.*

Overall, in demonstrating their reasoning about the relative risk posed by climate change, one factor key in the understanding and reasoning process of climate change is the factor of time. Whether an issue has a short-term or long-term change impact, and how this is perceived by students, will influence the assessment of risk and the relative importance of the scientific evidence. In his response to climate change, Giddens (2009) considers it a collective problem which presents humanity with a paradox. Because climate change is intangible, not immediate and not visible to everyday life, the very real threat is pushed to the back on people’s mind. The paradox is that the nature of the threat of climate change is also the thing that makes it so difficult to confront and by not confronting it, we create greater problems.

Futures education specifically focuses on immanent perspectives and problematizing about the future. Pedagogy, which helps students reflect on their possible futures and hypothesize happenings in distinct situations, is of particular value in dealing with the ‘intangibility’ of climate change. Since the notion of time is a critical factor in moral reasoning and decision-making, inviting students to predict and imagine, thus confronting the notion of time as a variable in different situations, helps to bring future reflections into the everyday. Futures pedagogies dealing with the notion of time and its relativity in inciting concern and action, builds on the systemic understandings of student teachers. They have an understanding of the systemic interrelatedness of social and economic systems, and how these intersect with climate change. Pedagogy which promotes systemic awareness and systemic change helps to construct more tangible ideas about the future as a continuum of the present and past. The continuum of human change and system change is not only a concern for history disciplines, but very real phenomena of humanity.

CC and GW are the most important issue of our times hence we and governments should act effectively to solve this issue.

What governments should do also requires a moral judgment about the social justice role of government. For most groups the reasoning around this question begins with a phrase indicating the importance of climate change and global warming. This phrase is followed by a conditional qualifier such as ‘but’ or ‘however’, followed by statements identifying other crucial social issues. These issues ranged from global problems such as poverty, the proliferation of nuclear weapons, terrorism, famine, war and disease. For example, “*To some this may be true other may have other thoughts on things that are more important or pressing issues that are ongoing. Some may also feel that they are the most important issue of our time but they do not override the increase poverty in third world countries and equal right of peoples*”. Other more local issues were also identified by some groups as equally or more

important. These include including public transport, addressing drought, euthanasia and capital punishment.

The localized experiences of the participants are critical qualifiers in determining the role of government. Even though the student-teachers have expressed strong views about the leadership of government in dealing with climate change, when reasoning about the role of government and what is important, the notion of importance is qualified against the immediate needs of local issues that impact on quality of life.

Community level education can be a focal point of teaching about climate change. By focussing on local happenings, climate change is made more tangible as it is part of the local experience and climate change becomes part of the local government and public discourse. The concern about the local, expressed by the student-teachers actually reflects the established link between community efforts at sustainability and addressing climate change (Pruneau et al, 2001 and Blum, 2009). A pedagogy which highlights community based actions on climate change, inclusive of field work and community engagement, would help to consolidate the presence of climate change issue in the everyday.

Addressing climate change is a community issue and cannot be tackled in isolation from the wider public views. Polanyi (2009) points out that the power of science is not as a result of presenting facts, but from how society uses or legitimizes those facts. In other words, he states that what we regard as scientific evidence and how climate change is conceptualized is grounded in democracy and how that evidence is appropriated and used by the public. Smyth (2005) states that “Environmental education has grown through the promotion of innovative educational approaches and the increasing attention given to human aspects of the system”(p.3). The results show that the student teachers are searching for ways to make connections and humanize climate change learning. Climate change pedagogy is about public and education interactions to foster a critical level of public awareness in all levels of citizenry. As education looks towards its communities for educative experiences, a virtuous circle develops in which younger learners are enriched and enrich community.

*Question: There is no need for carbon intensive economy, people should be educated and living practices need to change.*

This question asked the groups to respond to the value of education in changing awareness and behavior. As expected many of the groups stressed the importance of education to change lifestyle and practices within a carbon intensive economy. The sentiments are expressed in one of the groups which states, “*People should be aware of their own individual carbon footprint. Further education is required so that people become more knowledgeable and reduce their impact on the environment. Businesses should also take this preventative step*”. Another group reasoned that, “*We believe education is very important to help create a body of understanding how to look after our environment. Life style changes are part of creating a better environment for people to live in therefore will lead to long term impact on the earth’s environment*”. There is a reasoning pattern in which education is regarded as a key component of behavioural change and that as prospective educators are aware of their capacity to influence students.

The pedagogical implications of education specifically targeting behavioural change necessitates that prospective teachers develop a repertoire of understandings of behavioural change theories which they are able to scaffold in the learning processes. In relation to climate

change, the work of Fishbein (1993), specifically reasoned action, may form a theoretical underpinning for teachers' pedagogical development. Fishbein contends that people adopt new behaviours based on their own values and attitudes towards the new behaviours and also taking into account the social expectations around the new behavior. As suggested by Pruneau et al (2001) pedagogical strategies drawing on the theory of reasoned action may involve analyzing media reports and representations of those who demonstrate the desired behavior publically. The incorporation of media and personal narratives helps to make concrete new behaviours and how they are linked to action around climate change.

In addition, theories based on agency and social action focus on the individual within a social context and theorise how individuals and groups interact. Social action theories focus on strategies aimed at specific actions for improving our world. Agency refers to students' responsibilities to initiate and negotiate relationships and actions (Jennings and Mills, 2009). Empowering students through positive actions and positive examples of change alleviates the tendency to draw on nightmarish scenarios of what may happen if action is not taken. While the attempt at shock tactics may be a reaction to inertia around climate change, this can also foster a nihilistic vision of the future and fuel cynicism and futility often felt by young people with respect to climate change and actions (Patchen, 2006). Giddens (2009) sums up the need for positive action thus,

“In combating climate change, we should look to make a Gestalt switch from negative to positive, creating a vision for the future that has a compelling appeal...the focus should be on goals, and the means of reaching them, that citizens can readily understand and accept” (p.2).

## Conclusion

By asking student-teachers a range of questions about climate change, what became evident is the predominant socialized understanding of climate change as the prevalent way that student-teachers reflect and talk about climate change. However, rather than concluding that socialized understanding of climate change shows a deficit in scientific knowledge, it does affirm the contentious and political nature of a socio-scientific issue such as climate change. The complex nature of this issue compels educators to innovate pedagogies create new possibilities for learning about scientific issues. Polanyi (2009, p.2) insists that “science's greatest gift to civilization is its acknowledgement of fallibility” and this is most relevant to climate change claims. Therefore a rigid adherence to all climate change propositions denies, “the paradox [that] lies at the base of the gleaming edifice of science” (Polanyi, 2009:2).

The unique issues presented by climate change, not only affirm the socio-scientific contextualization but also necessitate that since each socio-scientific issue is singular and specific, then each needs different ways to address the learning associated with the issue. Based on this premise, and incorporating the data from the student-teacher research, new teaching strategies have been suggested. These strategies resist the deficit model of teacher training which insists that knowledge content forms the basis of quality teaching, rather the suggested pedagogical strategies embrace the student-teachers' strengths and attitudes as a basis for teaching about climate change.

Student-teachers strongly agreed with the authority of scientists to represent fonts of accurate scientific information. In this case, while they may not be able to show their own

scientific knowledge, they have capacity to source and teach about how to discriminate about the value of information. This necessary 21<sup>st</sup> century skill can compensate for the teachers' own shortcomings. There is a pragmatic knowledge making at work in which information is not only that which is used to create knowledge but also information is a form of know-how in which students are able to identify those who represent the source of knowledge as anchors for their understanding and opinions.

By assessing how prospective teachers talk about climate change, the study emphasized the dialogic interactions and identified these as important considerations in creating teaching and learning around climate change. Incorporating elements of future education, social action and agency theories as well as inquiry based learning are strategies compatible with enhancing social and political literacy of student-teachers so they are able to organically build pedagogies that express the complexity and uncertainty around climate change. The data shows that student teachers are firm believers in the power of education and in critiquing social and political decisions around climate change. The positivity demonstrated by student teachers to question government and economic policy, to show some skepticism about scientific evidence, to understand the systemic relatedness of climate change and other socio-economic issues and to see education and their teaching as a positive source of empowerment and change are important teacher attributes to build upon. Rather than focusing on what student-teachers don't know, by focusing on what they bring to teaching about climate change, the aim is to harness their attitudes and desires as a way to draw attention and address the paradox of climate change. Finally, the emphasis on social actions presents a way for educators to deal with the paradox of climate change.

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