Global Climate Change and the Need for Relevant Curriculum

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Abstract. With the rising importance of preparing students in the fields of science, technology, engineering and mathematics (STEM), the establishment of the Next Generation Science Standards (NGSS) is critical to the development of disciplinary core ideas in the study of Weather and Climate. With the recent debate over the issue of global climate change, mostly instigated by the media, and its implications on human activities, economy and international policies, the insertion of this matter as a disciplinary core idea, both for middle and high school, is of great importance. Another factor contributing to the integration of this need is related to research findings about students' misconceptions about climate change and its direct correlation with media influences (Rajeev Gowda et al., 1997) and the lack of information about climate change inside curricular materials such as current science textbooks (Choi et al., 2010).

Keywords: global climate change; curriculum; educational standards; science education

Introduction

In the 21st century, several reports demonstrate evidence regarding the intensification of climate change and poverty due to the inadequate and increasing capitalist tendencies of natural resources manipulation, especially associated with globalization processes. For example, negative predictions associated with unsustainable economic growth in China have been reported associated with new coal power plants that have been built, leading experts to predict increased carbon dioxide emissions that could double by the year 2030 Jones, LaFleur and Purvis (2009). In this case, there seems to be a correlation between what some authors designate as "Empire" (Korten, 2006) and its hegemonic values of competition, power control and economic greed with an increase of disproportionate levels of global poverty and overexploitation of natural resources. The main economic sectors that are potentially most affected by unsustainable economic and political

practices have been identified as agriculture, water resources, natural ecosystems, biodiversity, coastal areas, and human health (Nyong (2009, p.47-55). Additionally, another prediction that relates to the negative outcomes of anthropogenic-induced climate change is the increase of people displacement (Piguet, Pécoud, & De Guchteneire, 2011), usually affecting inhabitants of areas of the highest levels of poverty, social inequalities and vulnerability, such as the recent example of Hurricane Katrina (Leichenko, Thomas & Barnes, 2010).

In this regard, it seems evident that, even though capitalism and the technological advances are fostering what we call globalization by providing the possibility of connecting diverse groups from across the globe and by facilitating access to knowledge. There is still a significant portion of individuals who are not only being denied the same opportunities to participate in this technological revolution, but also are suffering the negative consequences of unsustainable forms of natural resources management. This scenario may indicate that what is termed "global citizenship" may not only be restricted for those who are able to consume the technological products but this concept may also have its meaning limited to interactivity in a global scale without integrating a sense of belonging to an Earth Community. For educators and researchers, the efforts should focus on trying to expand the idea of "global citizenship" as a condition that can only be defined through digital democracy and environmental responsibility and participation. In this sense, there is an urgency for more research in the education field that aims at discussing how to overcome the digital divide between students' from different socio-economic (SES) conditions while also promoting a broadening of the construct "global citizenship" to also include environmental and technological knowledge, skills and ecological responsibility. To this extent, this paper presents arguments that demonstrate how the use of technology inside climate change related curriculum may contribute not only to reducing the digital divide that exists between rich and poor students. Additionally, it will also explore topics aimed to reduce students' misconceptions about climate change, increase low-income students' interest in STEM related areas, promote student agency and community empowerment, and help students' develop a sense of belonging to an Earth Community, an essential requirement for global citizenship.

This paper is put forth as a structured argument in order to primarily present a position that educational curriculum efforts towards expanding the notion of global citizenship should have as one of its goals the dissemination of the idea of social alliance, which should be based on two main values: the principle of universal justice and empathy towards others. Additionally, such educational efforts should be based on the following constructs: 1) consciousness awareness (Korten, 2006); and, 2) the development of cross-cultural competencies (Banks, 2006). Second, the use of technology in presenting climate change related curriculum may help facilitate students' development of scientific knowledge (such as biological, ecological, physical) about this matter and also aid their development of empathy towards others and concern about social justice through discussions that focus on

the social repercussions of climate change. In this regard, the need for modern curriculum that integrates the use of technology inside climate change studies could contribute to improving students' consciousness and global awareness, in other words, the ecological and sociological responsibility that define their role as active global citizens.

The Need for Expanding the Notion of Global Citizenship
The idea of a world or global citizen can be defined either through nationalist or cosmopolitan lenses, and it certainly implies the need to have concern for climate issues that impact cultures worldwide (Gibson, Rimmington and Landwehr-Brown, 2008). Another perspective on this issue can be seen by contrasting the ideas of Empire and Earth Community, which puts forward a diametrically opposed set of actors that permeates all levels of society and hierarchies of power, which in turn leads to conflict and compromise (Korten (2006). The counterpoint to the idea of Empire is described as the notion of Earth Community (Korten, 2006). In this sense, an Earth Community should be characterized by the following values: mutual trust, respect, accountability, compassion, cooperation, and environmental stewardship (Korten, 2006, p.37). In this case, a definition of global citizenship that embraces values such as "respect and honor for other cultures, and a concern for global issues" (Gibson, Rimmington and Landwehr-Brown, 2008, p.12) would be closer to the development of an Earth Community, than the nationalistic perspective. In the same way, Korten's (2006) idea of Earth Community would correlate with Cortina's (2008) understanding of social alliance, as the idea of "Empire" could also imply the existence of an unfair contract between those who are oppressed and their oppressors. Pursuing this further, Cortina (2008) not only identifies mutual recognition and compassion as basic core values associated with the notion of an alliance, but also differentiates between the ideas of contract, which is seen as something for economic gain, and alliance, which has social awareness as a core property. Therefore, educational curriculum efforts towards a broader notion of global citizenship should have as one of its goals the internalization of the notion of social alliance, which should be based on two main values: the principle of universal justice and empathy towards others (Thompson & Bendik-Keymer, 2012). However, while the principle of social justice may be perceived as an essential pre-requisite for the establishment of mutual cooperation among individuals in a complex society, our present modern and liberal paradigm stresses power and privilege, in that those with the power often compromise the well being of the masses of society (Korten, 2006, p.34).

Furthermore, such educational learning opportunities that seek to contest and to modify the core values of the Empire will have to be based on the idea that by helping individuals, societies transcend from a lower to a higher stage of consciousness or global awareness by providing individuals with the necessary knowledge and skills in order to reduce the digital divide between hegemonic and economically privileged individuals and socio-economic marginalized groups, this may facilitate the internalization of essential moral values such as empathy,

tolerance and universal justice. In this sense, the concept of global awareness can be viewed as ways in which all the world in interconnected and interdependent, where problems and issues have an impact of the lives of individuals worldwide (Gibson, Rimmington and Landwehr-Brown, 2008). Hence, once these variables are in place this can contribute to the development of an individual's sense of belonging to a plural global community, which is necessary for his/her choice of adhering and actively participating in that community (Cortina, 2005). Following this further, another important component of educational efforts towards a broader concept of global citizenship should be the development of cross-cultural competencies (Banks (2006). As such, there is a need for a literate citizenry that have commitments of global equity, which reflect the skills, attitudes, and knowledge of settings of diversity (Banks, 2006). While other types of knowledge and skills may fall into the category of cross-cultural competencies (such as linguistics and ethics), for the purpose of this paper, the focus will center on the importance of ecological, technological and sociological types of knowledge and skills associated with climate change as essential cross-cultural competencies for the development of scientific literacy and a broaden concept of global citizenship.

Technology, ESD and the Digital Divide

According to Ahmed (2010), the articulation between actions against global poverty and environmental responsibility might significantly increase the chances of educators to reduce the performance gap that exists between high- and low-income students. In this regard, the author considers education for sustainable development (ESD) as the key educational mediator that may fight poverty at the same time that it might develop lifelong learning among students. Ahmed (2010) describes three key elements in the attempt to integrate marginalized groups with sustainable development measures:

> the empowerment of people at the local level in designing and achieving poverty reduction; access to productive assets, capital and technology for the poor, microfinance being a widely used instrument; and extending a social safety net economic support to the ultra-poor, those who are ineligible even for microfinance, in order to enhance their capabilities to access capital and technology. (p. 241).

Technological Inequalities and Low-Income Students

Since the end of the 20th century and the beginning of the 21st century, several generations of students have had the opportunity to engage in scientifically related activities inside the classroom through virtual laboratories and simulation software. In fact, recent studies suggest that the use of such pedagogical tools in science education can be beneficial for student learning in grades 6-12 (Scalise et al., 2011); for the development of new learning strategies among students and teachers, in secondary schools (Jimenez, Gyette, Platteaux, 2007; Edelson, 2001; Goyette, Platteaux, and Jimenez, 2007), at university levels (Williams, Lansey & Washburne,

2009; Winn et a., 2006), as well as in the improvement of overall student technology skills.

Other variables, such as reduced budgets and decreased funding sources in schools, may also act as significant factors in favor of the use of virtual labs and simulations for science lessons. However, the use of technology-rich science inquiry differs between high- and low-income areas, since the former seemed to focus on high-order thinking and problem solving while the latter are prone to lower-order activities (Scalise et al., 2011). In this case, it seems urgent that both scholars and policy makers take into consideration the need for the development of curriculum and pedagogical materials that not only focus on reducing the digital divide by providing students with real-life skills and competence but also aim at improving their sense of responsibility towards Earth Community, particularly regarding the use of natural resources that contribute to technological improvements and globalization processes (Dodds, Strauss & Strong, 2012).

Students' Misconceptions about Climate Change

The identification of students' misconceptions about climate change processes is of significant importance in order for educators and scientists to develop pedagogical materials as well as teacher education programs that aim at addressing this scientific illiteracy (Rajeev Gowda et al., 1997) The authors conducted a survey with high school students and were able to identify five recurrent misconceptions about climate change: 1) Inflated estimates of temperature change; 2) Confusion between CFCs, the ozone hole, and climate change; 3) Perceived evidence – warmer weather focus; 4) All environmental harms cause climate change; and, 5) Confusing weather and climate (Rajeev Gowda et al., 1997, pp.2233-2235). Also, the students who believed in the existence of evidence associated with climate changes identified news and television as their main source of information.

In this sense, the same authors identified four possible sources that might contribute to this idea of scientific illiteracy: 1) Information availability; 2) News media as a source of information; 3) Judgmental heuristics; and, 4) Fuzzy environmentalism (Rajeev Gowda et al., 1997, pp. 2236-2237). Interestingly, the authors point out the fact that students identified teachers as informational sources about climate change much less frequently than news media. The authors then attribute this to the fact that traditional school curriculum may act against the in depth coverage of climate change related issues, especially because of its lack of multidisciplinary organization.

Other researchers have developed positions about the influence that science textbooks may have on students' misconceptions about climate change and verified that some of the scientific concepts related to the students' misconceptions about climate change were not even mentioned in most of the analyzed books. The main scientific concepts that were not approached or inefficiently approached by the analyzed books were: 1) Distinction between pollution and greenhouse effects or

climate change; 2) Distribution of greenhouse gases in the atmosphere; 3) Solar irradiation change and its possible impacts on current climate change; 4) Projections of future climate changes according to emission scenarios; 5) Climate change is already under way; and, 6) The dependency of human society on fossil fuel and barriers to reducing emission of greenhouse gases (Choi et al., 2010, p.893). Additionally, it might be unpractical to believe that books could be updated as fast as new knowledge becomes available which means that educators should try to rely more on Internet resources, digital materials and increased training opportunities for teachers (Choi et al. 2010). Finally, the authors argue in favor of scientists and science educators to collaborate in the development of pedagogical materials related to climate change that take into consideration students' common misconceptions about this matter.

Sociological Aspects of Climate Change
It is important that educators take into consideration some essential aspects associated with sociological aspects of climate change that justify the need for an urgent integration inside the educational field. For example, the use of environmental arguments to justify the displacement of people can be viewed as a mechanism of better understanding human migration patterns (Piguet, Pecoud and De Guchteneire, 2011). Accordingly, there are some theories that may explain this absence: that the notion of environmental-related migration may be perceived as a "primitive' form of migration" (Piguet, Pecoud and De Guchteneire, 2011, p.3).

Another argument that might serve to justify the incorporation of environmental related issues inside environmental education field is the fact that the impact of major climate change phenomenon, such as drought, floods, and sea level rise (is likely to differ between regions with different levels of vulnerability (Piguet, Pécoud and De Guchteneire, 2011). Moreover, if a society is greatly dependent on its environment for its economics, there may be an increased level of vulnerably as compared to other more industrialized communities. In this case, an understanding climate change is unlikely to affect all humans the same way, since its impact may also depend upon the individuals' access to resources (financial, political, infrastructure) that might be required in order to facilitate an effective response to environmental changes (Piguet, Pécoud and De Guchteneire, 2011). Therefore, discussions about the sociological aspects of climate change should also include a collective reflection upon the correlation between socio-economic class and resources accessibility by the population affected. A particular case that can exemplify this issue is the illegal migration that happens between Mexico and the U.S. While it is widely accepted the influence that violence influences the political and economic instability inside Mexico, which in turn has displaced people across the border, little has been discussed about the influence that economics may have on this matter (Brochin, 2012). The effects of climate change can already be perceived inside Mexico, where overpopulation has negatively impacted land traditionally used for agriculture, rendering it unfit to support crop development and cultivation Johnson (2011). In this regard, the author points out that this

problem may be aggravated by the reduction of annual precipitation, which is expected to drop in 12% in central Mexico by 2020. In some ways, this need for survival tied to the environment can be seen as contributing to Mexican citizens migrating to the United States (Johnson, 2011).

Another recent demonstration of the correlation between sociological and climate change related analysis was the devastation caused by Hurricane Katrina in 2005. Furthermore, Leichenko, Thomas and Barnes (2010) describe poverty, limited resources, poor education, high levels of unemployment and racism as the main variables that have contributed to increase New Orleans' degree of vulnerability. In the same way, groups of African-American and the elderly were more greatly impacted by the conditions brought on by Hurricane Katrina. Researchers cited the inability of these groups to evacuate tied primarily to issues of health and economics left these marginalized populations most affected (Leichenko, Thomas and Barnes, 2010).

Climate Simulation Software as a Way for Reducing Scientific Illiteracy
Researchers such as Scalise et al. (2011) have pointed out that virtual laboraoty experiences and simulations in science are just beginning to be disseminated as curriculum. At the same time, other researchers have demonstrated that the use of simulation software can be used as an efficient methodology in ESD (Shapka, Law and VanWynsberghe, 2008) and in science education (Luo and Kemp, 2008) for elementary (Lim, Nonis and Hedberg, 2006), middle school (Shin, 2002) and undergraduate students (Williams, Lansey and Washburne, 2009; Winn et. al., 2006).

In addition, the use of computer simulations that focus on issues of global climate change, including models of the interactions of the atmosphere, land masses, and oceans can most help students understand the ways in which human behaviors impact global populations Sheppard, 2005). Moreover, the author identifies topics and methods that can provide students with methods for demonstrating and understanding both positive and negative outcomes associated with global or local impacts through the use of climate change simulation software in order for the landscape visualization to be able to positively affect and motivate individuals to engage in sustainable actions.

Some of the main reasons associated with the uneven access by poor students to STEM resources results from the costs of assistive technology, the lack of training for faculty and the problems associated with wide scale distribution of such resources, and as such these inequities can be tied to the socioeconomic status (SES) of the local community and the schools which serve these students (Hagedorn and Purnamasari, 2012). As such, the ideas of a digital divide tied to economics in real, especially where topics and concepts of global climate change are tied to access and usage of computer technology (Bruno, Esposito and Genovese, 2011). This idea can be expanded to equate educational inequalities associated with the level of access to

quality education and technological tools as another main reason for lower socioeconomic status students to be excluded from STEM related areas.

Conclusion

This paper intended to contribute to the discussion in favor of a broader concept of global citizenship, which takes into consideration the notion of social alliance and the importance of digital democracy towards both social and environmental justice. In this regard, it was related that an educational effort towards this direction may be the integration of technology tools inside the teaching about climate change, both its ecological and sociological aspects. To this extent, the use of technology in presenting climate change related information is critical, as it is associated with an emphasis about the importance of social alliance and sustainable values, such as cooperation and respect, for the development of an Earth Community, may contribute to the following factors: 1) to facilitate students' development of scientific knowledge about this matter; 2) to help students develop empathy towards others and concern about social justice through discussions that focus on both the ecological and the social repercussions of climate change; and, 3) to contribute to the reduction of the digital divide between different SES groups. This paper, however, did not intend to exhaust the discussion about the ecological, sociological and educational aspects associated with climate change. In this sense, while there are also issues concerning the social-political causes of environmental disasters, this paper intended to highlight a few arguments about some of the variables that may potentiate the impact of climate change in a global scale, such as global poverty and resources accessibility.

In this case, the purpose of this discussion is to highlight the role that poverty may have both as a variable that inflate negative outcomes associated with climate change, due to vulnerability and lack of resources, and as a barrier against the dissemination of knowledge and skills about climate change phenomenon and its repercussions around the globe, particularly though digital divide. Finally, more research is needed about the educational efforts that aim at articulating the need for digital democracy with an emphasis on the development of an Earth Community should be conducted in order to help educators and police-makers define what cross-cultural competencies should be a part of the 21st century global citizenship curriculum.

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