Challenges and possibilities in climate change education

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Abstract: Educating and communicating about climate change is challenging. Researchers reported that climate change concepts are often misunderstood. Some people do not believe that climate change will have impacts on their own life. Other challenges may include people's difficulty in perceiving small or gradual environmental changes, the fact that overconsumption brings people power and recognition, people's weak connection to nature, and people's tendency to make emotional decisions and quickly solve environmental problems. Drawn from research, some climate change communication and education strategies are presented. Well designed environmental messages could convince people that they can still reduce the scale of the phenomenon and could link mitigation actions to people's positive desires or aspirations, while providing local examples of climate change impacts and illustrated information. In mitigation education, some strategies (future education, reflective, experiential, socio-constructivist approaches and the community of change), jointly used, could correct the learners' misconceptions and lead them to action. In adaptation education, scientists and citizens could get together to choose a specific problem that may worsen with climate change, analyze it, and propose and implement adaptations. In the meantime, pedagogical strategies inspired by cognitive science could strengthen the citizens' skills: posing and solving problems, decision-making, scenario building and sustainable planning.

Key words: environmental education; climate change; mitigation; adaptation; communication

1. Introduction

The study of climate change is now a productive science that is in full expansion. Researchers in this field study local and international realities, create scenarios, forecast impacts, invent concepts to designate their discoveries: vulnerability (the degree to which a community has been weakened due to the harmful effects of climate change) (Smit & Wandel, 2006), risk management, carbon sequestration, and so on, and think about solutions. Many researchers have recognized the importance of communicating their results to citizens to help them become aware of the urgency to act, and to enable them to carry out mitigation and adaptation actions. However, this is one of the trickiest or most sensitive educational projects that the fields of education and communication have ever faced. The population that must be educated includes people of all ages, with varying levels of scientific literacy and interacting in multiple social, economic and political spheres. The educational objectives are as equally ambitious: helping citizens understand complex environmental and meteorological concepts, changing their daily

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lifestyles and adapting to a phenomenon that harbors several yet unpredictable impacts.

How can people reach these difficult educational objectives that are so essential in a day to day reality in which there are already several very tangible climate change impacts, like torrential rains, intense coastal erosion, decreasing levels of the water tables in developing countries, and so on? In this article, the authors summarize the research that has dealt with people's ideas concerning climate change. Next, the authors will tackle the cognitive, social, psychological and behavioral challenges that may restrict awareness, education and communication efforts regarding climate change. Finally, the authors draw from environmental communication and education in order to suggest promising avenues to improve citizens' training and involve them in mitigation and adaptation actions.

2. Challenges in climate change education and communication

2.1 Cognitive challenges

Since the beginning of the 21st century, several researchers have interviewed citizens in order to identify their ideas or concepts regarding climate change. According to Owen (2005) and Papadimitriou (2004), people were generally aware of the presence of changes in the climate. They knew that this problem could eventually worsen (Patchen, 2006; Bord, O'Connor & Fisher, 2000) and they were interested in it in a non-alarmist fashion (Pruneau, et al., 2001). This problem is not part of their everyday priorities, to the contrary of personal difficulties and problems linked to the economy, health, abortion, and so on (Eisenack, Tekken & Kropp, 2007; Lorenzoni & Pidgeon, 2006). Since the last decade, people have built conceptions that allow them to understand and talk about climate change in their own way. However, several conceptions that are widespread throughout the population distance themselves from scientific explanations and are not very efficient in promoting taking charge of the global problem. Thus, several citizens explained the greenhouse effect as a hole in the ozone layer or as a wall of dust, located in the atmosphere, which contributes to heat retention (Pruneau, et al., 2001; Andersson & Wallin, 2000; Kempton, 1997). Many citizens did not know the connections between some human behaviors (i.e., electricity consumption) and greenhouse-gas emission (Patchen, 2006) or confuse a number of environmental problems. For example, some people believed that nuclear energy, aerosols, insecticides, war or the presence of solid waste have an impact on climate (O'Connor, Bord & Fisher, 1999; Pruneau, et al., 2001). Numerous people claimed that climate change impacts will be felt after their lifetime and that, if they lived in a city or a developed country, the phenomenon would have little effect on them (Lorenzoni & Pidgeon, 2006; Owen, 2005; Pruneau, et al., 2001).

When researchers asked people to identify climate change impacts, most of them said that they had noticed higher temperatures, a passage from four to two seasons, unstable meteorological conditions, as well as the unusual presence or absence of certain animal species (Andersson & Wallin, 2000; Kempton, 1997; Papadimitriou, 2004; Pruneau, Liboiron, Vrain, Gravel, Bourque & Langis, 2001). Thus, people's conceptions were close to scientists' conceptions, because they seemed to already have noticed signs of this problem in their environment.

As for mitigating and adaptation actions toward climate change, some individuals thought that this problem must be resolved as quickly as possible (Owen, 2005; Patchen, 2006). They claimed that actions should already have been carried out. Some think that the government and industries are first and foremost responsible in the struggle against climate change. The perception of the human capacity to solve the climate change problem varies from person to person. Some people believed that climate change is a natural phenomenon and that humans cannot control it (Patchen, 2006; Pruneau, et al., 2001). Others were convinced that their actions could make a

difference yet, perceiving a resistance against action by their fellow citizens, they fear ending up alone in their endeavor (Patchen, 2006).

Since people knew little about the causes of climate change, they sometimes found it difficult to identify efficient solutions to decrease the number of changes (Owen, 2005; Patchen, 2006). Among many, the notions of mitigation and adaptation are often confused (Eisenack, Tekken & Kropp, 2007). In terms of solutions, numerous individuals suggested reducing the use of aerosols or collecting waste to lower CO_2 emissions (Lorenzoni & Pidgeon, 2006; Patchen, 2006; Pruneau, et al., 2001). In the studies by Bord, O'Connor and Fisher (2000) as well as Owen (2005), approximately 80% of the participants said they carried out small actions to reduce their CO_2 emissions, like turning off lights, boiling only the amount of water required or turning down the thermostat in their house. A great majority of people interviewed claimed that they were ready to use electric light bulbs or domestic appliances that consume less energy. However, these same people were less inclined to carpool or use their bicycles or public transportation.

How does one explain these conceptions that are sometimes appropriate, sometimes different from scientific ones, and that do not necessarily lead to environmental action? First, the environmental and climatic notions necessary to properly grasp climate change are numerous and complex. Certain concepts are difficult to understand (i.e., clean development mechanism, sea current conveyors, and so on), because they necessitate knowledge in several scientific fields. For the layperson, it can also prove difficult to recall the exact wording for each concept. In fact, according to Seider (1998), the human brain can only deal with a limited number of elements at a time when processing information. It can be difficult for non-specialists to form a mental picture of all the connections amongst the environmental elements that are involved in climate change. Indeed, these connections are similar to complex systems: An immense web of causal links between interdependent components that mutually affect each other in several ways (Homer-Dixon, 2000). For example, in the field of mitigation, it can be a challenge for people to understand the relationship between eating meat that comes from faraway countries and climate change. Seeing climate change as a very complex set of problems could also keep certain citizens from wanting to learn.

In addition, some present day impacts from climate change are difficult to perceive with the senses, either because they are hidden (decrease in the levels of aquifer water), invisible to the naked eye (accumulation of pollutants in water tables and in coastal areas) or because they take place in remote areas of which people know little about concerning the living conditions (melting of the permafrost in the Arctic). Not being able to perceive problems directly through one's senses curtails awareness and thus the experiential learning of climate change. Access to these realities is indirect and is attained through the academic discourse held by scientists and via satellite numbers or images that are not easily decoded by the general population. Capturing this information calls on abstract thought and transpositions that are weaker than signals emitted by the senses. Seider (1998) explained that, when an intense and immediate change is perceived in the environment, people's hypothalamus responds by increasing their level of adrenaline and pushing them to react to the danger. However, if the changes around people are gradual, as it is the case with climate change, they are less aware of them, forgetting how things were before. People forget to react in order to solve the problem or prepare themselves against eventual dangers. Finally, the mental representation of climate change impacts can be harder to achieve since these impacts, particularly extreme events, do not really resemble events experienced by most people.

2.2 Social and psychological challenges

Other challenges linked to the habits of contemporary life and people's reactions when facing stressful

problems could limit citizens' desire to participate in the struggle against climate change. Today, people live in an environment that is cut off from nature and at an excessive rhythm, which does little to promote awareness and reflection. People, overcome with daily tasks and seeking to satisfy their immediate needs, have little time and energy leftover to think about the future and prepare themselves for events that may eventually occur. The disconnection from nature limits awareness of events linked to climate change that are already taking place in ecosystems. One must spend time in nature in order to notice the loss of species, different behaviors exhibited by birds, variations in the freeze-thaw cycle, changes in the size of sea ice, and so on. Nowadays, contact with physical realities is mostly attained through technological tools: maps mainly representing political and economic elements, television coverage and computer documents.

An accelerated rhythm of life also generates rapid decision-making, in such a way that decision-makers (individuals or politicians) do not take the time to use a structured and thought-out decisional process. For example, determining their goals, listing several alternatives, evaluating the consequences (on nature and human health), using rigorous strategies to choose an action and monitoring their decisional process (Welch, 2002; Pruneau & Utzschneider, 2008). The elements that guide decisions are often the desire for power, wealth or the need to belong (please others). The information gathered to facilitate decision-making is often partial, biased or limited due to an insufficient prediction of risks (Seider, 1998). In the same way, environmental problems just last for some time and again quickly solved, with people and even scientists being little inclined toward analyzing the social causes and founding their work on historical facts (Pruneau, et al., 2007).

Finally, Seider (1998) explained that, when faced with problems that cause anxiety, such as climate change, people react in several ways: they exclude the information received; they go back to their personal tasks and in time forget the problems; they pretend that there is too much to do to solve these problems; they accuse authorities or certain targeted groups or claim that they will take care of it later.

2.3 Behavioral challenges

The optimal objectives of education and communication about climate change are to involve people in mitigating and adaptation actions. Major challenges arise from these objectives, because they involve changing individual and collective behaviors regarding pollution and overconsumption, which often satisfy people's instinctive needs to have fun, gain power, receive exciting stimuli and be loved (Seider, 1998). Thus, buying too many household or beauty products corresponds to the need for having fun, for showing that one is in a position of power or for being loved. The behaviors associated to instinctual needs are difficult and take a long time to change. Moreover, these needs distract people from environmental dangers that they should be confronting. They are expressed through vanity, jealousy and excessive ambition, which are emotions that decrease the necessary will to collaborate in order to work towards solving environmental problems.

2.4 Summary of challenges

Thus, in communities where the authors wish to educate and communicate about climate change, the obstacles working against the adoption of mitigating and adaptation behaviors could be cognitive, for example, a low level of scientific and mathematical literacy, the presence of erroneous ways of thinking about the issue, a lack of information and understanding, as well as weak problem resolution and decision-making competences. The challenges could also be situational, for example, a lack in material resources, money and time; political pressure exerted by an entourage that is not bent on conserving resources; the absence of collaboration and cohesion within the community; and so on. They could also be social, psychological or behavioral, for example, a weak connection

to nature; limited awareness concerning the realities of climate change and its impacts; values and behaviors in general poorly favorable to the environment; the impression that one has little acting power; and challenges related to behavior modification (Pruneau, et al., 2006; Maiteny, 2002).

3. Communication about climate change

Some communication specialists have thought about the way to write and deliver messages on climate change. Hassol (2008) assessed that the most important messages to transmit are the followings: (1) Climate change is really happening and is getting worse; (2) Scientists are certain of this fact; (3) Humans are responsible for these changes; and (4) Citizens must act and are capable of reducing the extent of the phenomenon if they immediately get involved. Messages can benefit from certain rules inspired from research in environmental communication (Angus Reid Group, 1992). They can be focused on the need for self-protection and the importance and efficiency of individual initiatives. They can encourage people to look at the environment around them. They can clearly show the actions to take and report that other people have begun to act (people like to feel that they are part of a larger movement).

Messages must also be educational. The basic concepts of climate change (greenhouse effect, links to human actions, and so on) must repeatedly be explained and summarized in the media. Pictures that are simple to understand and memorize (Pruneau, et al., 2001) can be used, such as the CO_2 layer that covers the earth and that retains heat (Hassol, 2008). In addition, a timeline could be used to illustrate specific changes, starting in the past, then in the present, which would encourage people to act in order to influence the future (Schneider, 2008). Stories of current local impacts that affect not only nature but also humans could be told in order to build awareness about the reality of these changes.

Solutions (mitigation and adaptation) must hold an important place in climate change messages to stimulate hope. According to Futerra Sustainability Communication (2007), fear must be used with caution if one does not wish to provoke denial. It is also important to avoid criticizing or attacking families for their bad behaviors, because of the loyalty between family members. Messages must encourage the population to demonstrate their ingenuity and their pride in addressing the problem (Hassol, 2008). They must mention the opportunity of building a promising future in terms of security, prosperity and health. They must also progressively build an engaging and morally appealing vision (Moser, 2007).

Exemplary stories showing people in their home who have begun to adopt behaviors concerned with the climate can be exhibited in order to gradually create social values that encourage these behaviors. Behaviors that are easy to develop (stop idling, turn off electric appliances, use fluorescent lights, lower the thermostat, and so on) should initially be privileged in these stories. Benefits other then environmental stemming from the desired behaviors could be communicated. Thus, it is worth testing the improvement of residential neighborhoods by implanting green zones or reinforcing national pride after the early implantation of adaptations (Futerra Sustainability Communication, 2007). Similarly, the story of adaptation actions successfully carried out in various regions of the world could be told in order to encourage hope among citizens all the while informing them.

According to Moser (2007), communication functions better if a relationship is established between the ones bearing the message and the ones receiving it. Communication will not be very successful if the messenger bores, confuses or scares the audience by using a language or information that is too complex. Climate change messengers must be chosen according to their credibility among the target social groups, like decision-makers,

politicians, teachers, and so on. They must adapt their language to their clientele and direct their discourse in accordance with their needs and interests, be it security, economy, health, or whatnot (Hassol, 2008). Moser (2007), based on Gladwell's (2000) theories, added that the first types of people to convince in the field of climate change are the connectors (individuals who possess a vast network of social contacts in all levels of society), the geniuses (learned individuals who are skilled at quickly finding answers to questions) and the salespeople (individuals who know how to make things appealing and relevant). In communities where one wishes to start an environmental action movement, it is important to identify these types of people who, once they are committed, will be more susceptible to initiate a social movement.

4. The relations between education and climate change

4.1 Education about climate change and mitigation

In EE (environmental education), when tackling the creation or the choice of pedagogical strategies, one is rarely limited to the methods that will be used thereafter to transmit knowledge. In fact, in EE, it is well known that transmitting knowledge alone cannot convince people to start making environmental actions (Heimlich & Ardoin, 2008). Rather, one tackles an educational project keeping in mind the five EE objectives: awareness, knowledge, state of mind, competences and participation (environmental action). One usually thinks in terms of developing capacities among learners, like building the desire, the power and the knowledge to act.

The action research on climate change education carried out by Pruneau, Langis, Richard, Albert and Cormier (2005), as well as by Pruneau, Doyon, Langis, Martin, Ouellet and Boudreau (2006), was accomplished in this perspective. In one of the first experiments with three groups of Canadian pupils, ages 11 and 12, Pruneau, Langis, Richard, Albert and Cormier (2005) reached their goal of seeing an evolution in the pupils' way of thinking about climate change, thanks to carefully chosen pedagogical strategies. Education through pictures was used to better explain the greenhouse effect to young people. Experiential pedagogy in nature (solo observation activity in a location of their choice) enabled pupils to re-establish links with that environment and encouraged them to want to protect local ecosystems from climate change. In addition, educational activities concerning the future encouraged pupils to specifically predict how climate change could affect their environment (people, ecosystems, infrastructures, and so on). A socioconstructivist approach (knowledge building) guided the pedagogical process, which lasted 8 months, with 60 minutes of activity per week. In this socioconstructivist approach, pupils were encouraged to play the role of scientists (doctors, ecologists, meteorologists, chemists and urban planners), to predict the impacts of climate change in their community and share their results with local decision-makers. This project stimulated much motivation and earned a high level of participation with 98% of pupils who improved their way of thinking about climate change. Most pupils however thought that there was little chance that the general population would mobilize itself in order to carry out mitigating actions.

Then, Pruneau, Doyon, Langis, Martin, Ouellet and Boudreau (2006) carried out the project entitled *The Circle of Ecological Wisdom*. They wanted to encourage 25 teachers and their pupils to adopt mitigating behaviors. The goal was to form a big circle of people who are helping each other find different lifestyles. This collaborative action research sought to identify the social and pedagogical factors that reinforce and limit the adoption of mitigating behaviors among adults (teachers) and young people (ages 8-16). After participating in training activities on climate change and certain pedagogical strategies, the teachers were encouraged to choose and try 1 or 2 mitigating behaviors in their personal lives. After analyzing their experience, the teachers created their own

model of climate change education that they experimented with in their classroom. The researchers analyzed the process of behavior modification among 25 teachers and 75 of their pupils. All of the teachers and pupils adopted from 1 to 2 new environmental behaviors. The motivation factors were a deep attachment to the nature and a desire to help the earth, which are both feelings provoked by emotional and cognitive training activities. The factors facilitating action were, among others, the participation in a community of change (support group for adopting new behaviors), how easy the chosen actions were, and family support. The limitation factors were a lack of time, poor awareness in entourage, forgetfulness and fatigue. The feelings experienced while trying new behaviors were mostly positive: pride, feeling of being a hero, impression of making a difference, and so on. The researchers concluded that the following are all promising avenues for encouraging people to adopt mitigating behaviors: experiential approach (being alone in nature, observing local problems in the field, putting on plays, trying out a personally chosen behavior, and so on), reflective approach (recording personal reflections in a journal, and so on), future education (predicting impacts on local ecosystems, knowing that climate change has consequences on their life), disseminating knowledge (illustrated through pictures and local examples), and finally the community of change. If used together, these strategies bring people closer to nature, encouraging them to notice recent changes and want to get involved in the fight against climate change. These strategies allow them to make a first environmental action, note that they can carry it out with success, want to encourage their relatives to imitate them and defeat the feeling of isolation thanks to a support group.

4.2 Education about climate change and adaptation

In the body of research, there exist some answers concerning how to educate and communicate about climate change and mitigation. Research needs to be furthered in education about climate change and adaptation. This type of education is more difficult to succeed, because, if the researchers want to prepare people to implant local adaptation measures, they must necessarily do the same work in information, motivation and behavior modification, than in education about mitigation. In addition, for education about climate change and adaptation, one must put into place a community process. It is the members of the community who must analyze together the present environmental problems, predict the possible impacts of climate change (drought, floods, and so on) on their territory, evaluate their community's degree of vulnerability, and solve potential problems that could stem from it. In education about climate change and adaptation, the knowledge to be transmitted or built by citizens is even vaster. The authors add to the concepts strictly related to climate change, the scientific knowledge that is endogenous to local ecological and social problems, knowledge of community resources that can facilitate adaptation, as well as the knowing adaptation means. In addition, if citizens are to succeed in implanting efficient adaptation measures, it is insufficient to only reinforce their knowledge. The researchers must also think about developing certain sustainable competences among citizens. According to Magill (2000), in a changing and unpredictable environment, individuals must acquire flexible competences, which is to say useful in reacting to present and eventual events. In the field of climate change, the authors have identified the following flexible competences that are necessary to create, implant, monitor and manage efficient adaptation measures: technical (biochemical analysis, scenario construction, and so on) and mathematical skills (making a quantitative representation of a problem, building and analyzing models, communicating mathematically, and so on), problem-solving, forecasting the future and risks, vulnerability analysis, and sustainable decision-making and planning. Heimlich and Ardoin (2008) claimed that environmental competences can be learned and improved through practice. The competences mentioned above could be developed and reinforced among citizens within the

framework of a coaching process by facilitators and scientists from various fields. These coaches could help citizens throughout the process of analyzing a local problem all the way through proposing and implanting adaptation measures. Citizens would supply their endogenous knowledge of the environment, whereas scientists would bring their technical knowledge, while acting as a model in their way of solving problems, deciding, planning, and so on. The approach could be participatory (using activities, such as World Café, Appreciative Inquiry, Participatory Rural Appraisal, Visioning, Scenario Planning), unilateral and multilateral (a mix of top down and bottom up approaches), and centered on dialogue. Scientists and citizens could work together on the present: describing the current situation of the environment in their areas, choosing a specific problem for which they concern, analyzing the problem and discussing the current consequences on the citizens' life. They could then work on the past, looking at the behaviors, actions and policies that have worsened the problem. They would then work on the future: writing scenarios of what could happen and sharing these scenarios with the community. They would finally build the future: deciding on what they want in relation to the studied problem and listing possible active or proactive adaptation actions.

Throughout the process, specific pedagogical strategies would facilitate learning the targeted competences. For example, citizens could learn how to improve posing local environmental problems that may worsen with climate change. Posing an environmental problem consists in determining each of the problem's traits (causes, location, actors, local vulnerability, impacts, and so on) as well as stating the problem many times, in order to properly define the initial situation and the goals to be reached. Freiman, Pruneau, Barbier, Ouellet, Langis, Liboiron and Baribeau (2008) found that peer exchanges concerning the problem and the visual representation tools (drawing of the problem, scale reproduction, 3D mapping, mind mapping, and so on) can help citizens improve to formulate a local environmental problem. In fields other than the environment, Cox and Brna (in press) also discovered the advantages of visual representations, as much for defining as for formulating solutions. In addition, when choosing between formulated adaptation measures, citizens could benefit from being trained to use a more environmental and reflective decisional mode. That is to say, they would be encouraged to properly define their goals, list numerous alternatives, predict human and environmental consequences for each alternative, and choose and monitor the decisional process (Pruneau & Utzschneider, 2008). By practicing with scientists, citizens could also learn to evaluate their community's vulnerability by observing the frequency and the severity of climatic events and by determining the most fragile locations, the social limits and strengths that influence their adaptation capacities, etc.. Predicting the future and the risks is an essential skill to be acquired to adapt oneself to climate change and presuppose the use of hypothetical and predictive thought. Citizens could learn to build scenarios describing probable and preferable future events, by properly analyzing current social, economic, environmental and political situations and trends. These scenarios would help them collectively choose and plan actions to access a desired future.

Thus, this is how, through practice, within the framework of coaching by scientists and with the help of pedagogical strategies to reinforce competences, citizens would progressively acquire habits of thinking and doing, while expanding their knowledge of climate and environmental notions that are necessary to the implantation of adaptations. Cohen, Neilsen, Smith, Neale, Taylor, Barton, et al. (2006) and Eakin, Magava, Smith, Moreno, Martinez and Landavazo (2007) successfully carried out coaching trials on citizens with scientists while formulating adaptation measures. The researchers, however, did not use any pedagogical strategies to reinforce competences.

5. Conclusion

In this article, the authors do not claim to offer every solution to the challenges posed by communicating and educating about climate change. Given the multiplicity and difficulty of the notions related to climate change, the type of education to promote is similar to a pedagogy of complexity. Fraser and Greehalgh (2001) maintained that in this type of pedagogy, learners must develop their capacities to adapt themselves to change, generate new information, and continually improve their performance. In the authors' opinion, it is in the local environment and with coaching by specialists that climate change education can be achieved, that is to say, getting out in the field, observing current changes in the human and natural ecosystems, both choosing and analyzing a problem collectively (with the help of the senses and visual representation tools), predicting impacts, finding solutions (mitigation and/or adaptation), acting, evaluating the actions in order to improve them, etc. This type of learning, called experiential, promotes awareness among citizens, builds their competences and facilitates the teaching of complex concepts (the concepts take on a real meaning and become easier to memorize when in the field). During this process, a well orchestrated communication campaign would complete the pedagogical work by conveying messages, such as the urgency of acting and people's capacity to find solutions, while illustrating and repeating the necessary scientific explanations. Thus, citizens must fully understand the issue of local climate change, investigate the changes, and develop their ingenuity to solve the problems.

Research in education and communication about climate change must become a priority. Diverse avenues deserve to be explored, for example: testing various types of messages (notably in the communication of risks); furthering research concerning behavior modification (relative to climate change); studying throughout history the factors that facilitated citizens' adaptation capacities regarding perilous environmental situations; creating and evaluating pedagogical strategies capable of reinforcing competences, such as risk prediction, vulnerability analysis, climate sensitive decision-making, and so on. It is by observing scientists and citizens in action in the field that these new competences, closely related to the field of climate change, will be understood and conceptualized, and that the means will be created to reinforce them.

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