Chapter 19

Educating and Communicating about Climate Change – Challenges and Possibilities[1]

Diane Pruneau, Abdellatif Khattabi, Joanne Langis, Charline Vautour

Abstract

Educating and communicating about climate change is challenging. Researchers report that climate change concepts are often misunderstood. Sometimes people do not believe that climate change will have impacts on their life. Other challenges include people's difficulty in perceiving gradual environmental changes, the fact that overconsumption gives people power, people's weak connection to nature, and people's tendency to quickly solve environmental problems. Well designed environmental messages could convince people that they can reduce the scale of the phenomenon and could link mitigation actions to people's positive aspirations, while providing local examples of climate change impacts and illustrated information. Climate change education and communication strategies were experimented by Université de Moncton's (Canada) and ENFI's (Morocco) researchers to educate students and citizens to mitigation and adaptation. In mitigation, future education strategies, reflective, experiential, and socioconstructivist approaches, and the building of a support group, jointly used, proved to be useful in leading students to environmental behaviors. In adaptation, Moroccan and Canadian citizens were invited to choose a local problem related to climate change, to analyze it, and to propose adaptations. In the meantime, educational strategies were used to strengthen the participants' problem solving and futures thinking skills. The experiments resulted in the listing of efficient adaptation ideas.

The study of climate change is now a productive science. Researchers in this field study local and international realities, create scenarios, forecast impacts, invent concepts to designate their discoveries (vulnerability[2], risk management, carbon sequestration, and so on), and think about solutions. Many scientists recognize 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 the fields of education and communication have ever faced. The popula-

1 This research was funded by the International Development Research Center (IDRC, Canada).

2 Vulnerability is the degree to which a community has been weakened due to the harmful effects of climate change (Smit & Wandel 2006).

tion 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 equally as ambitious: help citizens understand complex environmental and meteorological concepts, change their daily lifestyles, and adapt to a phenomenon that harbors several yet unpredictable impacts.

How can we 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, we summarize the research that has dealt with people's ideas concerning climate change. Next, we tackle the cognitive, social, psychological, and behavioral challenges that may restrict awareness, education efforts regarding climate change. Finally, we report some promising avenues that were used at the Université de Moncton (Canada) and the École Nationale Forestière d'Ingénieurs (ENFI, Morocco) to improve students' and citizens' knowledge and to involve them in successful mitigation and adaptation actions.

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 are generally aware of the presence of changes in the climate. They know that this problem could eventually worsen (Patchen 2006; Bord, O'Connor & Fisher 2000) and they are interested in it in a non alarmist fashion (Pruneau, Liboiron, Vrain, Gravel, Bourque & Langis 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 to 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 taking charge of the global problem. Thus, several citizens explain 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 do not know the connections between some human behaviours (i.e. electricity consumption) and greenhouse gas emissions (Patchen 2006) or confuse a number of environmental problems. For example, some people believe that nuclear energy, aerosols, insecticides, war or the presence of solid waste have an impact on the climate (O'Connor, Bord & Fisher 1999; Pruneau et al. 2001). Numerous people claim that climate change impacts will be felt after their lifetime and that, if they live in a city or a developed

gence activity (evaluation of ideas stated) then allowed them to eliminate less pertinent ideas. They again found adaptation ideas using the *Upside Down Problem* strategy (Michalko). We asked them to answer the following question: *What could we do to make more damage in agriculture during heavy rains?* Participants wrote down many eccentric ideas and then took advantage of those ideas to find realistic adaptation measures. They finally chose to make an informative pamphlet illustrating the good practices in agriculture with climate change. This pamphlet was distributed to local farmers.

In spite of the adult participants' low level of schooling, the solutions that they found proved to be effective, adapted to the community and sometimes original. Table 1 presents participants' solutions along with their type and their degree of effectiveness (as evaluated by scientists).

Tab. 1: Adaptation measures to heavy rains in agriculture, proposed by Canadian participants

Adaptation measures	**Effectiveness**	**Types of adaptations**
Sand bags to control the water	Effective	Proactive and active
Pipes on each side of the road	Effective	Proactive
Ditches on each side of the road	Really effective	Proactive
Pump to take out water	Effective	Proactive
Add rocks to raise the land	Not effective	
Dams, dikes	Really effective	Proactive
Environmental committee	Effective	Active and proactive
Write a song to make people aware	Effective	Proactive
Contact areas that have lived through a similar problem	Effective	Active and proactive
Greenhouses to protect crops from heavy rains	Really effective	Proactive
Higher ground	Effective	Proactive
Plant grain and leave it in the ground all winter	Really effective	Proactive
Draining where the hill comes down	Really effective	Proactive
Ditches around buildings	Really effective	Proactive
Add clay (retains water)	Effective	Proactive
Collect insects with hands	Not effective	
Put a plastic on the vegetables	Effective	Proactive
Transplanting bigger plants (more resistant to heavy rains)	Effective	Proactive
Add hay between rows to absorb the water	Effective	Proactive
Less polluting equipment	Not effective	

A similar experience was organized with Moroccan farmers. The *Futures Wheel* was again used to help participants list the many risks of a flood and a drought. The adaptation measures proposed by the Moroccan farmers also turned out to

be original and potentially effective. For example, a group of beekeepers proposed the following adaptation measures to overcome the alternating floods and droughts in their region: grow, at the same time, plants resistant to drought and plants resistant to floods (assuring the availability of plant nectar for the bees, in anticipation of these two events), plan for big water reservoirs (to hydrate the bees that flap their wings intensively during a drought to cool the beehive), build the beehives at the bottom of hills and a little distance away to protect them from both the rise in water levels and wind, etc.

8. Conclusion

In this article, the authors do not claim to offer every solution to the challenges posed by 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 Greenhalgh (2001) maintain that in this type of pedagogy learners must develop capacities to adapt themselves to change, generate new information, and continually improve their performance. In our opinion, it is in the local environment 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, 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 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.

References

Andersson, B. and Wallin, A. (2000), "Students' understanding of the greenhouse effect, the societal consequences of reducing CO_2 emissions and the problem of ozone layer depletion." Journal of Research in Science Teaching 37 (10), pp. 1096-1111.

Angus Reid Group (1992), Canadians and the environment. Report to Environment Canada. Angus Reid Group, Toronto.

Bord, R.J., O'Connor, R.E. and Fisher, A. (2000), "In what sense does the public need to understand global climate change?" Public Understanding of Science 9, pp. 205-218.

Eisenack, K., Tekken, V. and Kropp, J. (2007), "Stakeholders' perceptions of climate change in the Baltic Sea Region." In Schernewski, B. et al. (Eds.), Coastal development: The Oder/Odra estuary and beyond. Coastline Report No. 8. Potsdam Institute for Climate Impact Research, Postdam, Germany.

Environmental Protection Agency (1992), Framework for Ecological Risk Assessment. Risk Assessment Forum. EPA, Washington.

Fraser, S.W. and Greenhalgh, T. (2001), "Coping with complexity: Educating for capability." British Medical Journal 323 (7316), pp. 799-803.

Freiman, V., Pruneau, D., Barbier, P.-Y., Ouellet, E., Langis, J., Liboiron, L. and Baribeau, T. (2008), How students pose an environmental problem: Case of Grade 3 students trying to reduce sedimentation in a river. Paper presented at the Annual Conference of the American Education Research Association, New York, 17-20 March 2008.

Futerra Sustainability Communication (2007), The rules of the game. Evidence bas for the climate change communications strategy. Online: www.futerra.co.uk

Hassol, S.J. (2008), Communicating climate change and solutions. Paper presented at the National Council for Science and the Environment Conference: Climate Change: Science and Solutions, Washington, 12-16 January 2008.

Hicks, D. (2007), "Remembering the future: What do children think?" Environmental Education Research 23 (4), pp. 501-512.

Homer-Dixon, T. (2000), The ingenuity gap. Alfred A. Knopf, New York.

Joannert, P., Barrette, J., Boufrahi, S. and Masciotra, D. (2004), "Contribution critique au développement des programmes d'études : compétences, constructivisme et interdisciplinarité." Revue des sciences de l'éducation 30 (3), pp. 667-696.

Kempton, W. (1997), "How the public views climate change." Environment 39 (9), pp. 12-21.

Lorenzoni, I. and Pidgeon, N.F. (2006), "Public views on climate change: European and USA perspectives." Climatic Change 77, pp. 73-95.

Magill, R.A. (2000), Motor Learning: Concepts and applications. William C. Brown, Dubuque, Iowa.

Michalko, M. (1991), Thinkertoys. A Handbook for Business Creativity for the 90s. Ten Speed Press, Berkeley, CA.

Moser, S. (2007), "Communication strategies." In Isham, J. and Waage, S. (Eds.), Ignition. What you can do to fight global warming and spark a movement, Island Press, Washington, pp. 73-94.

Niss, M. (1996), "Goals of Mathematics Teaching." In "International Handbook of Mathematics Education", sous la direction de A. Bishop, Dordrecht: Kluwer, pp. 11-48.

O'Connor, R.E., Bord, R.J. and Fisher, A. (1999), "Risk perceptions, general environmental beliefs, and willingness to address climate change." Risk Analysis 19 (3), pp. 461-471.

Owen, S. (2005), Public attitudes to climate change, motivators and barriers to action: Newcastle and the North East. Brand Strategy & Research, New York.

Papadimitriou, V. (2004), "Prospective primary teacher's understanding of climate change, greenhouse effect, and ozone layer depletion." Journal of Science Education and Technology 13 (2), pp. 229-307.

Patchen, M. (2006), Public attitudes and behavior about climate change: What shapes them and how to influence them. Purdue Climate Change Research Center, West Lafayette.

Pruneau, D., Doyon, A., Langis, J., Martin, L., Ouellet, E. and Boudreau, G. (2006), "The process of change experimented by teachers and students when voluntarily trying environmental behaviours." Applied Environmental Education and Communication 5 (1), pp. 33-40.

Pruneau, D., Freiman, V., Barbier, P.Y., Utzschneider, A. Iancu, P. and Langis, J. (2008), "Vers l'apprentissage de compétences environnementales souples. » Spectre 38 (1), pp. 30-33.

Pruneau, D., Freiman, V., Langis, J., Baribeau, T., Liboiron, L. and Champoux, A. (2007), "How scientists and students pose an environmental problem." In Guzovic, Z., Duie N. and Ban M. (Eds.), Proceedings of the Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, Dubrovnik, Croatie, 10-12 June 2007 CD-Rom, ISBN: 978-953-6313-87-1.

Pruneau, D., Langis, J., Richard, J.-F., Albert, G. and Cormier, M. (2005), "The evolution of children's ideas on pollution in the framework of experiential and socioconstructivist activities." Environment and Sustainable Development 4 (1), pp. 17-34.

Pruneau, D., Liboiron, L., Vrain, E., Gravel, H., Bourque, W. and Langis, J. (2001), "People's ideas about climate change. A source of inspiration for the creation of educational programs." Canadian Journal of Environmental Education 6, pp. 121-138.

Pruneau, D. and Utzschneider, A. (2008), "Students' decision-making process while involved in sustainable development projects." In "Proceedings of the 2007 North American Association for Environmental Education Research Symposium", Virginia Beach, VA, 12-16 November 2007. Online: naaee.org

Pruneau, D., Vautour, C., Prévost, N., Comeau, N. and Langis, J. (submitted). Construire des compétences d'adaptation aux changements climatiques, grâce à l'éducation relative à l'environnement. Éducation et francophonie.

Schneider, S. (2008), Communicating climate change and solutions. Paper presented at the National Council for Science and the Environment Conference: Climate Change: Science and Solutions, Washington, 12-16 January 2008.

Seider, P. (1998), Invisible walls. Why we ignore the damage we inflict on the Planet … and ourselves. Prometheus Books, Amherst, NY.

Slaughter, R.A. (2005), Futures thinking for social foresight. Tamkang University Press, Tamsui, Taiwan.

Smit, B. and Wandel, J. (2006), "Adaptation, adaptative capacity and vulnerability." Global Environmental Change 16, pp. 282-292.

Welch, D.A. (2002), Decisions, decisions. The art of effective decision making. Prometheus Books, Amherst, NY.

country, the phenomenon will have little effect on them (Lorenzoni & Pidgeon 2006; Owen 2005; Pruneau et al. 2001).

When researchers ask people to identify climate change impacts, most say they have 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 et al. 2001). Thus, people's conceptions are close to scientists' conceptions, because they seem to already have noticed signs of this problem in their environment.

As for mitigating and adaptation actions toward climate change, some individuals think that this problem must be resolved as quickly as possible (Owen 2005; Patchen 2006). They claim 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 believe that climate change is a natural phenomenon and that humans cannot control it (Patchen 2006; Pruneau et al. 2001). Others are convinced that their actions can make a difference yet, perceiving a resistance against action by their fellow citizens, they fear of ending up alone in their endeavor (Patchen 2006).

Since people know little about the causes of climate change, they sometimes find 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 suggest 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 they were ready to use light bulbs or domestic appliances that consume less energy. However, these same people were less inclined to carpool or use their bicycle 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 lay person, 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 between 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, in coastal areas) or because they take place in remote areas of which we 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) explains that, when an intense and immediate change is perceived in the environment, our hypothalamus responds by increasing our level of adrenaline and pushing us to react to the danger. However, if the changes around us are gradual, as it is the case with climate change, we are less aware of them, forgetting how things were before. We forget to react in order to solve the problem or to prepare ourselves 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. Social and psychological challenges

Other challenges linked to the habits of contemporary life and to people's reactions when facing stressful problems could limit citizens' desire to participate in the struggle against climate change. Today, we 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 to 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 reali-

ties 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, for 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 are 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, Freiman, Langis, Baribeau, Liboiron & Champoux 2007).

Finally, Seider (1998) explains 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.

3. Behavioral challenges

The optimal objectives of education and communication about climate change are to involve people in mitigation and adaptation actions. Major challenges arise from these objectives because they involve changing individual and collective behavior 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.

4. Summary of challenges

Thus, in communities where we wish to educate and communicate about climate change, the obstacles working against the adoption of mitigation 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-solving and decision-making competences. The challenges could also be situational. For example, a lack of 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).

5. Communicating about climate change

Some communication specialists thought about ways to design messages about climate change, in order to lessen some of the challenges presented above. Hassol (2008) assesses that the most important messages to transmit are the following: climate change is really happening and is getting worse; scientists are certain of this fact; humans are responsible for these changes; 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 on 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 greenhouse gas 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, and 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 (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).

Success stories of people who have begun to adopt climate-related behaviors in their home can be exhibited in order to gradually create social values that encourage these behaviors. Behaviors that are easy to develop (stop idling, turn off electrical appliances, use fluorescent light bulbs, lower the thermostat, and so on) should initially be given greater importance in these stories. Benefits other than environmental stemming from the desired behaviors could be communicated. Thus it is worth testing the improvement of residential neighborhoods by implementing green zones or by reinforcing national pride after the early implementation of adaptations (Futerra 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.

6. Experiments on educating and communicating about mitigation carried out at the Université de Moncton

At the Université de Moncton, the action research projects carried out by Pruneau, Langis, Richard, Albert and Cormier (2005) as well as by Pruneau, Doyon, Langis, Martin, Ouellet and Boudreau (2006), were accomplished in the perspective of meeting the cognitive, social, psychological, and behavioral challenges presented above and of using the types of messages suggested by researchers in the communication field. In the first experiment, with three groups of Canadian students, ages 11 and 12, Pruneau et al. (2005) reached their goal of seeing an evolution in the students' 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 students to re-establish links with their environment and encouraged them to want to protect local ecosystems from climate change. In addition, futures education activities encouraged students to specifically predict how climate change could affect their environment (ecosystems, infrastructures, and so on). A socioconstructivist approach guided the pedagogical process, which lasted 8 months, with 60 minutes of activity per week. In this socioconstructivist approach, students 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 to share their results with local decision-makers. This project stimulated much motivation and earned a high level of participation with 98% of students who improved their way of thinking about climate change. Most students however thought that there was little chance that the general population would mobilize itself in order to carry out mitigation actions.

Then, Pruneau, Doyon, Langis, Martin, Ouellet, and Boudreau (2006) carried out the project entitled *The Ecosage Circle*. They wanted to encourage 25 teachers and their students to adopt mitigation 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 mitigation behaviors among adults (teachers) and young people (ages 8 to 16). After participating in training activities on climate change, the teachers were encouraged to choose and try one or two mitigation behaviors in their personal lives. After analyzing their experience, the teachers created their own climate change education model that they experimented with in their classroom. The researchers analyzed the process of behavior change among 25 teachers and 75 of their students. All of the teachers and students adopted from one to two new environmental behaviors. The motivation factors reported by the teachers and students were a deep attachment to 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 support group (during the adoption of new behaviors), the easiness of the chosen actions, and family support. The limiting factors were a lack of time, poor awareness of one's 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 mitigation 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), futures education (predicting impacts on local ecosystems, knowing that climate change has consequences on their life), disseminating knowledge (illustrated through pictures and through local examples), and finally the support group. If used together, these strategies bring people closer to nature, encouraging them to notice recent changes and to want to get involved in the fight against climate change. These strategies allow them to adopt a first environmental behavior, to note that they can carry it out with success, to want to encourage their relatives to imitate them, and to defeat the feeling of isolation thanks to a support group.

7. Experiments on educating and communicating about adaptation carried out at the Université de Moncton and ENFI

In research, there exist some answers on how to educate people about *mitigation*. However, research needs to be furthered in educating about *adaptation*. This type of education is more difficult to succeed, because, if we want to prepare people to implement local adaptations, we must necessarily do the same work in information, motivation, and behavior modification, than in education about miti-

gation. In addition, to educate about *adaptation*, one must put into place a community process. It is the members of the community who must analyze together the actual 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 *adaptation*, the knowledge to be transmitted is larger than in education about *mitigation*. Knowledge of local ecological and social problems, knowledge of community resources that can facilitate adaptation, as well as knowledge of adaptation means must be added.

In addition, if citizens are to succeed in implementing efficient adaptations, it is insufficient to only reinforce their knowledge. We must also develop certain 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. Université de Moncton's and ENFI's researchers thought that some *competences* could be usefully strengthened in citizens in order to help them create, implement, monitor, and manage efficient adaptations. The concept of *competences* broadly defined here is composed of a set of cognitive and metacognitive resources (knowledge, skills, attitudes; knowing how to observe, control and improve one's cognitive strategies), conative (motivation to take action), physical, social (appealing to an expert), spatial (efficient use of space), temporal (good organization of time), material (using a book, a tool) and affective (Joannert, Barrette, Boufrahi & Masciotra 2004). The competences that could make an adaptation approach by citizens progress and work could include the analysis of the community and of its vulnerability, creative problem-solving, futures thinking, risk management, technical and mathematical skills and sustainable decision-making and planning. Citizens able to analyze their environment with the help of scientific indicators could better find problems that are at risk of getting worse with climate change. As for the vulnerability analysis (degree at which a community is weakened by the negative impacts of climate change; Smith & Wandel 2006), some citizens could have developed the habit of observing the frequency and severity of meteorological events and could be able to determine the most fragile aspects of their community. Other citizens could demonstrate futures thinking which is the ability to imagine and evaluate several probable and desirable scenarios for the future of local situations (Slaughter 2005). They would, for example, try to answer the following question: *What would happen in our area with heavy rains?* The competence of risk prediction, a skill linked to futures thinking, consists of an evaluative process in which we measure the probability of harmful environmental effects following exposure to stress factors (Environmental Protection Agency, 1992). The competence of environmental problem-solving, which includes the abilities to adequately pose and represent a problem, to list many original and effective solutions, to take thought out and structured decisions, to plan and act,

also appears as a competence likely to encourage a successful adaptation process (Pruneau, Freiman et al. 2008). In decision-making, ecosystem health and human security must also be well considered as well as the long term future (Pruneau & Utzschneider 2008). Finally, many mathematical abilities could be demonstrated by participants working at proposing adaptations: thinking mathematically (asking questions that are typical to mathematics), posing and solving mathematical problems in different ways, making models, reasoning mathematically (following and evaluating a chain of arguments, validating the proof ...), representing mathematically (choosing and making good use of many forms of mathematical representation: tables, equations ...), handling symbols, formulas and mathematics sentences, communicating mathematically ... (Niss 1996).

It is with the goal of initiating the research on the competences that need to be reinforced to facilitate the adaptation process that this first research-intervention was done with Canadian citizens by Université de Moncton researchers in collaboration with ENFI researchers (Pruneau, Vautour, Prévost, Comeau & Langis, submitted). In a rural community, adults without a diploma (that have spent little time in high school) were observed while they progressed towards proposing adaptations to the impacts of heavy rains in agriculture brought about by climate change. Throughout the process, specific pedagogical strategies were used to strengthen the participants' problem solving and futures thinking skills. The goal of the activities was to help participants consider and visually represent all aspects and risks of the chosen problem, think of the links between the problem's impacts and to find creative and locally effective solutions. Participants were first invited to share the signs of climate change observed in their community and then to discuss their impacts on their personal life. They then attended a videoconference to become familiar with climate change: nature, causes and impacts on precipitation patterns. Using the activity *The Futures Wheel* (which consists in visually representing the consecutive impacts of a problem); Hicks 2007), they then predicted many possible consequences of a drought and of heavy rains in their community. This activity was meant to reinforce their ability to think about the future and to predict many risks brought about by these extreme events. Three experts then came to share their concerns with the participants on droughts and heavy rains in the community. The participants finally chose to work on the problem of heavy rains in agriculture. They drew up a plan to gather more information on the problem and they visited vegetable growers. They questioned the farmers to foresee the difficulties that would be created by a flood in agriculture. Thanks to the *Fishbone Diagram* activity (which consists in visually representing a problem with its causes; Michalko 1991), participants were invited to better pose their problem and then to propose measures to reduce the impacts of a flood in agriculture. The facilitator then read a story relating to a farmer's experience with a downpour and participants identified impacts of the problem, shared their feelings and made a list of new adaptation ideas. A conver-