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Climate Change and Its Impacts in the Teaching of Physics and Chemistry Issues and Perspectives

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Abstract

The proposed identifies the knowledge to teach from the concept of climate change and its impacts on our environment in the official documents of the first cycle of secondary education in Côte d'Ivoire. This leads us to question how to take into account the essential concepts through the following questions: what are the concepts related to the concept of climate change that are taught? What are the different pedagogical styles used by the Ivorian education system to strengthen and apply the knowledge base resulting from climate change and its impacts? The results obtained allow us to say that the documents submitted to our analyzes contain few elements on climate change in the broad sense. These documents rarely offer the opportunity to think about choices that will enable students to build knowledge.

Key words: Climate change; Impact; Physics-chemistry; Didactics

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INTRODUCTION

Meteorological observations conducted by men for centuries, we note that it is from the 19th century that the climate becomes a scientific object. It is about building positivity by simultaneously developing experimental techniques and experimental reflections. These sciences are increasingly structured under the impetus of a political will. This structuring took place through the creation of the Intergovernmental Panel on Climate Change (IPCC). Pending its results on the synthesis of the effects of a rise of 1.5 ° Celsius in global temperature compared to the pre-industrial era to be published in 2018, on the one hand; the special report on the ocean and the cryosphere, and the report on desertification, land degradation and food security, which will also be published in September 2019; previous results mention that climate change poses a serious threat to humanity. It threatens the global agenda for sustainable development of reducing child poverty and child mortality, ensuring education. In fact, these results indicate that the activities of human societies generate large amounts of greenhouse gases (GHGs), and that these gases are the main cause of the «climate change» that we are experiencing, and whose Scale will increase with time: extreme weather events, crop production decline, melting ice, heat waves, droughts, etc. (IPCC, 2014). Beyond causing serious ecological consequences, climate change also includes a wide range of social issues, the nature and scope of which deserve special attention, particularly from an education policy for sustainable development.

Over the past twenty years, climate change education (CCE) has become an essential tool for protecting the environment. The United Nations Framework Convention (2007) on Climate Change (Article 6) and the Kyoto Protocol (2012) (Article 10) encourage governments to educate, empower and involve all stakeholders and the most important groups in policies fighting climate change. The Convention on the Rights of the Child stresses that children's development depends on a safe and healthy environment. All children should enjoy a standard of living that allows them to develop physically,

mentally, spiritually, morally and socially. The challenge is to integrate the concepts of education for sustainable development into all aspects of quality education by considering three areas: the environment, the economy and society. Learners will need to have basic knowledge in all areas of education in order to understand the causes of climate change.

With this in mind, UNESCO (2008) has contributed to the implementation of Article 6 through a number of initiatives: seminars, Sandwachs, development and dissemination of materials, tools and educational resources.

Schools need to play a major role in understanding the causes of climate change so that students can make an informed decision and take appropriate action to better manage its consequences.

Improving the quality of education requires taking a relevant and innovative approach to getting students through a refocused curriculum to acquire the values and skills needed to participate in the transition process to a more sustainable lifestyle, an economy green and a sustainable society that can withstand climate change.

Education is therefore essential to raise awareness of ecological and ethical issues, as well as values and attitudes, skills and behavior compatible with sustainable development, and to ensure effective public participation in decision-making. Climate change education must therefore focus on the dynamics of the physical / biological and socio-economic environment as well as that of human development, and be integrated into all disciplines and use conventional and unconventional methods and effective means's communication (Bertou-Gueydan, Clément, & Clément, 2008).

In this perspective, most of the countries, including Côte d'Ivoire, are committed to promoting and improving the integration of climate change education into its educational program in order to enable the future citizen to acquire a structured and reasoned culture in terms of the environment and climate change. Achieving this goal necessarily means adopting new educational and didactic approaches in schools.

The school-based approach to climate change therefore implies that curriculum developers and executive guides in the different teaching disciplines incorporate key concepts related to the concept of climate change in all aspects of educational programs. This refers to the knowledge to be taught and the teaching methodology, only to the cooperation between teachers and learners. The active participation of all stakeholders in climate change thinking and action is essential to the successful implementation of this school approach.

Our study is part of the work that aims to provide insights on the mastery of students at the end of the middle school of education, concepts related to the concept of climate change in physics-chemistry. On the one hand, it involves analyzing their knowledge of the issues related to climate change, their degree of acquisition of skills to reflect on various options for action and to possess the determination necessary to act; and on the other hand, to make a critical analysis of the educational and didactic model currently used in the teaching of this concept. Thus, in a first part, starting from some didactic and epistemological references of the theoretical framework, we will clear the problematic and we will specify the principal elements of the methodological context. In a second part, through the didactic transposition, we will present the results resulting from the analysis of the students' performance as to the mastery of the notions related to the concept of climate change and official documents (programs, educational guides, manuals in use) after the middle school of education, followed by their discussions. We will conclude on the prospects for a better integration of the concepts related to the concept of climate change into the curricula and books in use, and a proposal for more effective pedagogical and didactical interventions of teaching the concept of climate change to the hight education.

1. THEORETICAL FRAMEWORK OF RESEARCH AND PROBLEMATIC

1.1 Theoretical Framework of Research

Climate change is a real phenomenon that affects our environment and our social and economic well-being. Views differ in identifying the causes and consequences of climate change

■ The concept of climate change

According to the Environment Dictionary, climate change refers to all variations in climatic characteristics at a given location, over time: warming or cooling. Some forms of air pollution, resulting from human activities, threaten to significantly change the climate in the direction of global warming. This phenomenon can cause significant damage: rising sea levels, increased extreme weather events (droughts, floods, cyclones, ...), destabilization of forests, threats to freshwater resources, agricultural difficulties, desertification, reduction biodiversity, extension of tropical diseases, etc. The concepts associated with it are teachable in all school subjects. Thus, the scientific, economic and social needs for knowledge on climate change, explain that the concept of climate change is an important object for education.

With its cross-cutting nature, the knowledge at stake is uncertain, particularly because of the complexity of interactions within the climate system. Climate change is therefore a change in the state of the climate that can be detected by changes in the mean and / or variations in its properties and persists for long periods, usually for decades or more (IPCC, 2007). Global Climate Change (GCC) is called because its geographic extent is global and its characteristics and consequences are varied.

Climate change, or climate change, corresponds to a lasting change in the statistical parameters (average parameters, variability) of the Earth's global climate or its various regional climates. These changes may be due to processes intrinsic to the Earth, external influences or, more recently, human activities. The question of climate change, through its strong media treatment, vector of knowledge and learning factor (Chailley, 2004a), by the debates it generates in society and within groups of experts from different disciplines, is part of socially lively scientific questions or lively socio-scientific questions (Legardez & Alpe, 2001).

■ Conceptual change

Conceptual change is defined as «a process of conceptual development of students' initial ideas towards more scientific conceptions» (Duit, 1999, p.265). During this «gradual process, initial conceptual structures based on students' interpretations of everyday experiences are continually enriched and restructured» (Vosniadw and Ioannides, 1998, p.28). The cyclical process is characterized by several phases of inductive and deductive work (Hewson, Beeth and Thorlet, 1998). Thus, conceptual change involves a significant shift in students' initial ideas on climate change in this work towards conceptions more similar to those of scientists. More specifically, several transformations can take place in students' initial ideas as a result of conceptual change: notions can be added or subtracted (Nersessian, 1991), links between notions can be added or removed or the structure of ideas initials can be radically altered (di Sessa and Sherin, 1998).

■ KVP model

The didactics of a discipline are classically centered on the content of what is taught and learned in this discipline. A didactic analysis of curricula or textbooks is thus concerned with the content of these official documents, but it also seeks to account for their messages, whether explicit or implicit.

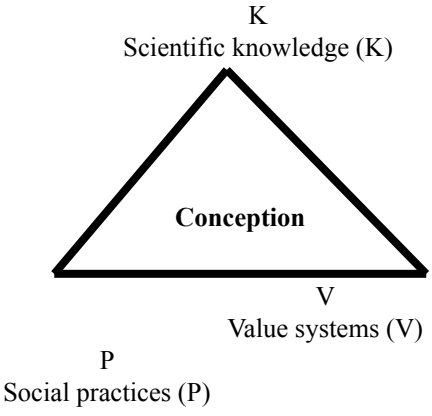

Figure 1
Triangle of Interaction Between Scientific Knowledge (K), Value Systems (V) and Social Practices (P)
Source: Clément's model 1998, 2004

The scientific and technical content is explicitly interacting with the poles: social Practices (P), Value systems (V), and scientific Knowledge (K). This model (Clément, 1998, 2004) considers the existence of an interaction between three poles, indicated according to Figure 1.

According to Bernard, Clément & Carvalho (2007), analyzing these KVP interactions based on the initial ideas of students, the contents of official documents (programs, textbooks) and the concept of climate change require:

-knowledge in the disciplinary field: in the case of climate change, they come from several disciplines (chemistry, physics, ...);

-an epistemological distance critical of these disciplinary contents;

-a historical approach helping to identify epistemological obstacles, the limits, even the errors, of our past knowledge;

-a culture in didactics (physics and chemistry);

-an anthropological analysis of the socio-economic and cultural context related to the social practices and dominant values of climate change and which interfere with this knowledge.

■ Didactic transposition

The inclusion of environmental issues by the Ivorian government in education programs poses the crucial problem of the choice of curriculum content and their translation into textbooks. To what degree do curricula and textbooks reflect the conceptualization of the concept of climate change? This question is essential in physics-chemistry, following the adoption since 2012 of a new pedagogical approach: the skills-based approach, which came into force at the start of the 2013/2014 school year. This observation raises the question of didactic treatment strategies, in the framework of the Ivorian climate change program for sustainable development.

These new programs are first transposed into textbooks; secondly, the knowledge to be taught undergoes in turn another transposition by the teacher through class activities where the learner is invited to build the knowledge. The problem of climate change affects all components of society, students and teachers.

■ Concept of representation/conception

Some understanding of the genesis and development of child thought is needed to better understand the mechanisms that govern the psycho-cognitive functioning of the child, an epistemological reflection on the origin of scientific knowledge and their mode of action. Development.

We recall the usual meaning attributed to the terms representations and conceptions we use in this work. Both terms are used by many authors (Astolfi and Develay, 1989; Giordan and de Vecchi, 1987) without distinction. When didactics became interested in student representations, this concept of representation was imported from social psychology (Durkheim, 1912) and genetic psychology (Piaget, 1965, Bruner, 1966). Representation then designates in didactics the «already-there conceptual» (Astolfi and Develay, 1989), the

«empirical knowledge already constituted» (Bachelard, 1971). The work has multiplied and some studies (Viennot, 1979) have shown the considerable gap between learners' ideas and scholarly knowledge. The work also shows the extreme strength of these ideas and their persistence despite the teaching received.

In this work, the concept of representation is used in the first sense given by social psychology. As the psychosociologist Moscovici (1976) defines it, the subject needs to imagine a phenomenon, a new scientific theory to appropriate it, for example. Representations allow individuals to control their environment or act on it. In this sense, we retain with Gauchon (2005) a definition of Abric (1997): «representation as a functional vision of the world that allows the individual or the group to give meaning to his behavior, and to understand reality. Through its own system of references, so to adapt to it, to define a place for it «. In our study, we seek to have students' perspectives on a number of notions associated with the concept of climate change. Answering the questions that are submitted to students requires the use of representations that they have notions related to the concept of climate change. These representations are based on pre-existing references: prior knowledge, knowledge acquired during their school curriculum, conceptions. The knowledge of the conceptions or representations developed by the students allows us to measure the gap between the knowledge of reference and the ideas of these last ones, to locate the representation by the pupils of the targeted knowledge.

■ Pollution

Pollution is the degradation of an ecosystem by the introduction, usually human, of substances or radiation altering to a greater or lesser extent the functioning of this ecosystem. Urban air pollution is generated by transport, industry and energy production. It is manifested by the presence of fine particles (aerosols, especially carbon) and urban smog (including tropospheric ozone) clearly visible. Appliances used for combustion in homes, motor vehicles, industrial establishments and forest fires are frequent sources of air pollution. Pollutants that are most harmful to public health include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Indoor and outdoor air pollution causes, among other things, respiratory diseases that can be life threatening.

Despite government efforts to mitigate the effects of this pollution, the results are not up to expectations: there is always an increase in pollution by the most harmful pollutants.

■ The most harmful pollutants

Current research results indicate that:

- Carbon dioxide (CO2) is responsible for about 60% of the anthropogenic greenhouse effect;
- methane (CH4) causes about 15% of the anthropogenic greenhouse effect;
- the water vapor (H2O) presents in very large quantity, it is the gas which has the most importance on the «natural» greenhouse effect;
- nitrous oxide or nitrous oxide (N2O) generates about 15% of the anthropogenic greenhouse effect;
- halocarbons, and other fluorinated artificial gases (HFCs, PFCs, SF6s) account for about 15% of the natural greenhouse effect, are synthetic and do not exist in their natural state.

These greenhouse gases (GHGs) have always existed in the atmosphere in a natural way because life is possible on earth without the greenhouse effect which ensures an average temperature of 15 ° C instead of -19 ° C (IPCC, 2007). Since the advent of the industrial revolution, the most dangerous of these gases (CO2, CH4, NO2, etc.) have experienced an exponential increase whose origin is far from natural (Cyrielle Den, 2007). CO2 alone is responsible for more than 50% of the increase in all GHGs.

Human activities remain the primary causes of global warming, particularly those related to the consumption of fossil fuels for industrial and domestic uses and to the combustion of biomass producing GHGs and aerosols that affect the composition of the atmosphere. The change in land use, due to urbanization and man's agricultural and forestry practices, affects the biological and the surface of the earth (Daouda, 2008). These anthropogenic changes are very rapid and therefore threaten the often fragile ecosystems. Indeed, continued deforestation, exacerbated by the ever-increasing exploitation of forests by rural communities (clearing and development) contributes to 20 to 25% of total CO2 emissions (UNEP, 2008).

1.2 Problematic

In the context of global warming, voices are rising to denounce the «consensus factory» in the IPCC aimed at stifling dissonant interpretations (Sietz 1996), cited by Albe (2007). Others consider that the IPCC forecasts are too moderate. While for some, the decrease in the volume of ice at the poles proves (and the images provide evidence) accelerated global warming in progress, for others (Vinnikov, Cavalieri and Parkinson 2006), cited by Albe (2007), the different observations in Arctic and Antarctic would indicate a different climate change in both hemispheres. Polyakov et al. (2003) consider that the facts would be more complex than it seems: if the surface of the pack ice tends to decrease, its thickness would increase. A number of climatologists are questioning the modeling proposed by the IPCC experts and would like other hypotheses to be considered, for example by considering, alongside CO2, the impact of water vapor, which is the main greenhouse gas. Greenhouse (accounting for 60% of the greenhouse effect). The famous Mann (1998) «hockey» curve, based on dendrochronology, which is a scientific method of dating based on counting and morphological analysis of tree rings, which indicates a significant increase in the temperature, has been very controversial. And the overlap with temperature measurements made from ice cores does not provide «tangible» evidence. Especially

since the importance of exchanges between the névé and the atmosphere in the upper layers of the ice does not allow to have measures quite reliable over the last 500 years. Some geographers, such as Leroux (2005), are skeptical about the geophysical approach. Its «geographical» approach to the climate system is based on the existence of powerful polar mobile anticyclones controlling climate change (Urgelli, 2008).

Faced with the controversy over the modalities of action to be implemented and the assessment of the scale of the phenomenon in the future, we note that climate change is already a reality. It is not a new phenomenon. Indeed, it has led, throughout history, to the collapse of entire civilizations. Climate change is a persistent problem, the effects of which are not linear (Gardiner, 2006).

The magnitude of the threat of climate change, increasingly evident, calls for immediate responses to address environmental pollution that is a global and interdisciplinary issue.

Many countries have mainstreamed climate change into pre-existing sectoral policies including those based on active, inclusive and participatory learning and learning processes. Thus, the Ivorian government, like other governments, has taken action through school curricula and textbooks to integrate education with the concept of climate change. They aim to encourage critical thinking, social criticism and analysis of local situations to adapt lives and livelihoods to the economic, social and ecological realities of climate change. Taking climate change issues into account in curricula raises the question of the effectiveness of the pedagogical and didactic model used to conceptualise the notion of climate change and the accessibility of official documents: educational programs, executive guides, manuals used in the first cycle of secondary education. This interrogation on all these elements leads us to the following questions:

-What is the degree of understanding of the concepts related to the concept of climate change by students after the end of the first cycle of secondary education?

-Are the pedagogical and didactic strategies recommended by the official documents effective in facilitating students' ownership of the concept of climate change?

The objective of this research is to deepen and expand the knowledge of students after the third class on their level of understanding of the causes of global warming, the appreciation of the consequences of climate issues, and to give them the means to apply the knowledge gained to make positive changes in their lives, in their school or in the community as a whole.

2. IMPLEMENTATION STRATEGY

2.1 Target Population

To answer these questions, this research uses qualitative and quantitative information collected from 100 students in the third class (divided into three classes) of the " Collège Expérimental Jean Piaget" of the Ecole Normale Supérieure (ENS) in Abidjan, and extracted from the various curricula, executive guides, and used books in force ranging from the seventh year to the then year of high school.

2.2 Data Collection

Two grids were built to collect data:

- The first grid is constructed from the questions selected from the list of exercises proposed at the end of each lesson related to the concept of climate change in the manuals in use. These questions were adapted and made accessible to the 100 students in our study population. After submitting the questionnaire, we conducted individual interviews to make explicit their conceptions of the phenomenon. All of the students' responses to test their level of mastery of the chosen answer were ranked according to the following three modalities: Insufficient, Satisfactory, Excellent. It is for us to check the level of scientific literacy of the students at the end of the cycle on the signs, causes, consequences and solutions of climate change. The data collected are recorded in Table 1;

- The second grid refers first to the identification of lessons related to the concept of climate change; then, to analyze the quality of the learning situations, the pedagogical styles recommended by the educational program and the executive guide of each selected lesson; and lastly, the accessibility of the knowledge to be taught and the iconographic documents of textbooks in use from the sixth to the third grade. It aims to monitor the effectiveness in building scientific literacy and skills development among students after the end of the first cycle. The data collected are recorded in Tables 2 and 3.

Arrangements have been made with the school administration to effectively engage the 100 students in the various activities.

2.3 Data Analysis Methods

The analysis of the data is based on the two grids described above. To perform this data analysis, we use qualitative and quantitative methods, where these can be combined and complement one another according to the logic of mixed methods (Creswell & Tashakkori, 2007).

The data from the questions in Table 1 are processed from the descriptive analysis of frequencies and percentages in order to clear the mode and to proceed to a hierarchical classification of the responses. In this way, the distribution of student responses helps to identify trends and identify the core of students' ideas on climate change.

As for Tables 2 and 3, the hierarchical classification is established by calculating the average of the occurrence of each occurrence. The data obtained is processed using a content analysis (Bardin, 2007).

3. RESULTS AND DISCUSSION

3.1 Repartition of Student's Responses to Signs, Causes, Consequences and Solutions of Climate Change

Using the table below, we record students' responses according to their degree of mastery of the ideas submitted to them. Table 1 presents the level of mastery of the selected ideas from the exercises of the used books in use and made accessible to the 100 students of our starget population.

Table 1
Levels of Students' Knowledge of the Signs, Causes and Consequences of Climate Change

The selected ideas of the exercises of the manuals in use and made accessible to the target population	List of acquisition level		
	Insufficient	Satisfying	Excellent
	Relative proportion in number of pupils		
Signs of climate change			
1- The frequency of lightning strikes on the ground increases	58	29	13
2- Increasing frequency of storms	51	30	19
3- Thermal expansion of the oceans	49	29	22
4-The ordinary change of the seasons	41	32	27
5- Migration of certain animal and plant species in latitude and altitude	56	24	20
6- The distribution of rainfall has changed	43	34	23
7- Heavy rains resulting in floods	50	46	34
8- Rising sea level	49	38	13
10- The melting of terrestrial glaciers	64	22	14
Causes of climate change			
1- The increasing emission of greenhouse gases	53	28	19
2- The burning of fossil fuels (coal, oil, natural gas, ...)	47	38	15
3- The sun is getting closer	54	28	18
4- Cattle breeding	61	23	16
5- The smoke of combustions	41	34	25
6- The dumps	42	41	17
7- Deforestation	39	41	20
8- Gases produced during combustion reactions	45	32	23
9- ChloroFluoroCarbures (CFC), used in refrigerators, air conditioners producing cold	48	29	23
10-Rockets	46	37	17
The consequences of climate change			
1- Intensification of floods, hurricanes, drought, forest fires	44	31	25
2- Air pollution	40	43	17
3- We will have to use more electricity	38	48	24
4- Drylands are becoming increasingly dry	45	36	19
5- high CO_2 concentration	39	35	26
6- There will be more diseases	50	34	16
7- The disappearance of certain animal species	41	41	18
8- Fewer fish	47	39	14
9- The modification of the water cycle	41	42	17
10- The increase of water vapor in the atmosphere	41	38	21
Solutions to climate change			
1- The use of renewable energies, using the force of wind, sun and tides	42	37	21
2- Walking or riding a bicycle	35	44	21
3- To plant trees	32	40	28
4- Reduce your energy consumption	42	41	17
5- Less polluting	39	44	17
6- Reinforcement of dikes to protect flood areas	38	42	20
7- The conversion of biomass into a source of energy	46	35	19
8- Raise awareness and empower everyone	38	39	23
9- Reduce greenhouse gas emissions	45	34	21
10- Put the garbage in the garbage	29	38	33

As noted in Table 1, the evaluation notes that students are more or less familiar with ideas related to climate change. Ideas from classroom concepts have acceptable explanations from students. So,

- At the level of the signs of climate change: we note that the « Satisfying + Excellent» responses of students are beyond half of the study population, for the thermal expansion of the oceans (51 students); 50 students for

heavy rains resulting in floods; 51 students for sea level rise; and 59 students for the ordinary change of seasons. In Grade 8 (fifth grade), fluid thermal expansion is a part of the program's lessons. We have therefore constructed with the pupils the factors on which this dilation depends.

- At the level of the causes of climate change, the « Satisfying + Excellent» responses recorded are 53 students for the combustion of fossil fuels, 61 students for deforestation, 59 students for fumes, 58 pupils and 55 pupils respectively for the dumps and for gases produced during combustion reactions. All these ideas from climate change are familiar to students; they have been regularly used throughout their cycle.

- At the level of the consequences of climate change: we record responses « Satisfying + Excellent» beyond the average for the intensification of floods, hurricanes, drought, forest fires with 56 students, for the pollution of the air with 60 students, for we will use more electricity with 62 students, and for the modification of the water cycle with 59 students. These ideas come from the students' environment : they were built with their teachers throughout the first cycle.

- In terms of climate change solutions: 68 students propose to plant trees, 71 students to put garbage in garbage cans, and 65 students propose to walk or ride a bicycle. The ideas adopted by these students on solutions to climate change are part of those received during the various courses in physics and chemistry.

However, we do not record adequate responses at the student level when the ideas selected for the test come from the documentary headings of the textbooks in use. This is the case of 58 students who can not explain how the frequency of lightning strikes on the Earth increases with global warming. They do not know that with global warming, there is a resurgence of lightning and therefore more fires in the forest, most of which are caused by lightning. Indeed, with the warming, thunderstorms become more explosive. This is explained by the increase of water vapor in the atmosphere that feeds the movement of hot air currents. But the rise of these hot currents towards the masses of cold air loaded with ice particles causes more electric discharges.

We also note less explicit explanations for the growing emission of greenhouse gases for 53 students, for The Sun is getting closer with 54 students, and 50 students for It will have diseases at the level of the causes of climate change. These results are mentioned both in terms of the consequences and in terms of solutions to climate change.

Finally, we consider that the level of mastery of the ideas selected and adapted to the level of the pupils in relation to the climatic change as well at the level of the beneficial effects as at the level of the harmful effects does not allow them to better understand and to explain correctly all aspects of this phenomenon. The teaching of concepts related to the concept of climate change has not had a significant contribution to the conceptualization of the notion of climate change at the student level.

3.2 Evaluation of Educational Programs, Executive Guides and Used Books in Relation to the Concept of Climate Change

Evaluation of educational programs and executive guides.

Table 2 shows the number of lessons by level of education, showing the number of learning situations proposed in the guides related to climate change. It lists as a percentage the taxonomic levels and pedagogical styles.

Table 2
Assessment of Number of Lessons, Percentage of Learning Situations and Teaching Styles Referring to Climate Change in Educational Programs and Executive Guides

Educational programs and executive guides						
			Number per level of education			
The lessons			6ème	5ème	4ème	3ème
			7	6	3	5
			Number per level of education			
Learning situations in the guides offered to teachers			6ème	5ème	4ème	3ème
			2	2	-	-
			Taxonomic Levels			
			Comprehension Percentage %			
Abilities and contents	Teaching level	Cognition		Application	Analysis	Synthesis
	6e	26	21	39	11	3
	5e	24	27	35	12	2
	4e	24	25	37	11	3
	3e	28	24	40	5	3
			Types			
			Percentage %			
Pedagogical Styles	Teaching level	Informative	Injunctive	Participative	Persuasive	
	6e	28	-	72	-	
	5e	30	-	70	-	
	4e	22	-	78	-	
	3e	20	-	80	-	

The set of lessons listed takes into account throughout the cycle the ideas needed to better control the beneficial and harmful effects of climate change. At the end of the cycle, students should have a well-structured knowledge of the signs, causes, consequences and solutions to climate change.

With the predominance of participatory pedagogical style characterized by contradictory arguments in the choice of ideas on climate change, we note that designers favor the participation of students in class activities by the use of sentences that lead them to question themselves, who seek their reflection and expression of their own ideas on climate change. We note that the will to train is found in the pedagogical approach that the teacher must follow to his students.

However, the low number of learning situations on recorded climate change and the high percentages found at the taxonomic (Knowledge, Understanding, Application) levels of Skills and Content show that in the construction of knowledge in students, designers prioritize cognitive skills. Low level, memorization and restitution. This would be a major obstacle in the construction of knowledge among students for the concept of climate change.

■ Used Books'Evaluation

Table3
Evaluation of Teaching Knowledge, Iconographic Material and Exercises Referring to the Concept of Climate Change in Used Books

			The number of text types					
	Teaching level		Narrative	Descriptive	Informative	Prescriptive	Argumentative	Explicative
know mobilized		6e	-	23	19	9	16	33
		5e	-	27	23	7	15	28
		4e	-	25	16	6	14	39
		3e	-	28	17	3	18	34
			The number of documents types					
	Teaching level		Photos	Drawings	Tables	Schemas	Croquis	Graphics
		6e	26	9	-	2	-	-
		5e	20	9	-	-	-	-
		4e	12	3	-	-	-	-
The iconographic documents		3e	18	9	-	5	-	-
			Their functions in relation to the text					
	Teaching level		Complementary		Additional		Included	
		6e	23		14		-	
		5e	22		7		-	
		4e	5		10		-	
		3e	24		8		-	
			Number by type of exercise					
	First and second year of middle school		Check your achievements			Reinvest your achievements		
		6e	11			12		
		5e	3			10		
The exercises			Check your knowledge			Apply knowledge		
	Third and fourth year of middle school	4e	-			-		
		3e	2			1		

Table 3 shows that the knowledge to be taught is easy to access, and the complementary functions of iconographic documents (photographs and drawings) predominate. The exercises found in the used books of both cycles are very small compared to the average of 125 exercises per level of education.

The will to inform is found in the contents especially in the knowledge to be taught that the used book publishers make available to the readers, and also to the functions in relation to the text that they give to the iconographic documents. Although the knowledge to be taught is easy to access, we note that this knowledge does not refer directly to the iconographic documents. The different sentences in the textbooks do not express important values in climate change education, namely protection, individual or collective responsibility, solidarity. The most common sentences are those that provide only information or that concern questions limited to knowledge.

The student does not know when to use them. The text relating to these documents serves only to make a brief description to sensitize. These descriptions ignore the different effects of climate change. Thus, the impression left by the editors of these used tbooks is the lack of rigor in the selected examples: lack of references to laws to make better known the effects of climate change. In the various textbooks, there is little evidence of epistemological reflection to further enlighten readers on the signs, cuses, consequences and solutions to climate

change. Thus, in these used books, the issue of climate change is discussed without much explanation on what this concept covers.

We deplore the fact that the chosen iconographic documents do not give enough information about the dangers or even they must give examples of the everyday life likely to help this fight.

In the end, although publishers favor a constructivist model of climate change education, the results show that this model has a less significant impact on students' ideas.

CONCLUSION AND PERSPECTIVES

The results obtained allow us to say that their documents contain few elements on climate change in the broad sense.

Educational programs, executive guides, and textbooks used in the first grade of secondary education rarely provide the opportunity to think about choices that can enable students to build knowledge.

In the light of these results, how do we judge the quality of the documents submitted to our analysis and the effectiveness of the competency-based approach currently used? We believe that by analyzing these results and interviews with students in the target population that this constructivist model is to be improved.

We believe that some important elements in iconographic documents and learning situations were adding if we aim at building scientific conceptions on all aspects of climate change.

Teacher training on climate change is another element that was adding to a climate education program.

The evolution in educational programs, executive guides and textbooks of the concept of climate change associated with the clearly expressed will of an educational component related to protection, individual or collective responsibility, solidarity, are all premises possible of a truly educational dimension in the formation of all to the problems of this phenomenon that is a reality of our time.

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