



## Climate Change Education: A proposal of a Category-Based Tool for Curriculum Analysis to Achieve the Climate Competence

### Educación sobre el Cambio Climático: una propuesta de una herramienta basada en categorías para analizar la idoneidad de un currículum para alcanzar la competencia climática

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#### ABSTRACT

Climate Change is the most important threat to our planet. The Paris Agreement of 2015 provides a strategy to reduce its impacts through decarbonization, but this pathway requires a deep change in the society.

Education has been identified as a major tool for adaptation and mitigation in many international treaties, but a general framework or strategy to implement Climate Change Education is yet to be defined. To provide this framework we propose the introduction of a Climate Change competence. This concept will help to organize many of the attributes needed by society to produce a coherent response, around a well-known concept in Education such as the competence, which could be easily introduced in the national legislations and scholar systems.

For this competence to be implemented, we need to assess how fit the current curriculum is or how it could be used to achieve the Climate Competence. For this we propose to develop an evaluation tool of the educational system, to assess the fitness or capabilities of a given curriculum to understand Climate Change.

We propose a category-based analysis to describe the strengths and weaknesses of a given curriculum, based on the Intergovernmental Panel for Climate Change (IPCC) reports and related documents, which are the largest scientific compilations on the problem.

The categories provide a simple and powerful tool to analyse to what extent a given curriculum could be useful to describe Climate Change and its consequences. This tool could be used to analyse different curriculums across different regions, educational levels or even different education systems and provide an accurate diagnostic of how useful a curriculum is to address this problem.

*Palabras clave:*

Cambio Climático

Competencia

Evaluación del currículo

Investigación sobre el currículum

R E S U M E N

El Cambio Climático es la principal amenaza a la que se enfrenta nuestro planeta. El Acuerdo de París de 2015 proporciona una estrategia para reducir su impacto mediante la descarbonización, pero este camino requiere un cambio profundo en la sociedad.

La Educación ha sido identificada como una importante herramienta para conseguir la adaptación y mitigación en muchos tratados internacionales, pero aún no se ha definido un marco o estrategia general para implementar la educación sobre el Cambio Climático. Para proporcionar este marco proponemos la introducción de una competencia en Cambio Climático, ya que este concepto ayudaría a organizar muchos de los atributos que necesita la sociedad para producir una respuesta coherente, alrededor de un concepto bien establecido en la Educación como es la competencia, que podría ser fácilmente introducida en legislaciones nacionales y sistemas escolares.

Para implementar esta competencia necesitamos evaluar cómo se ajusta el currículum actual, o cómo podría ser usado para conseguir la competencia en Cambio Climático. Para ello se propone el desarrollo de una herramienta de evaluación de un sistema educativo, capaz de señalar el grado de ajuste y las capacidades de un currículum dado para entender el Cambio Climático.

Proponemos un análisis basado en categorías para describir las fortalezas y debilidades de un currículum determinado, a partir de informes y documentos del Panel Intergubernamental Para el Cambio Climático, que son las mayores compilaciones de información científica sobre el tema. Las categorías proporcionan una herramienta simple y poderosa para analizar hasta qué punto un determinado currículum puede ser útil para describir el Cambio Climático y sus consecuencias. Esta herramienta podría ser utilizada para analizar currículos de diferentes regiones, niveles educativos o incluso diferentes sistemas, dando un diagnóstico preciso de cómo de útil es un currículum para enfrentarse a este problema.

## 1. Climate Change and Education

Global Climate Change is now considered the greatest threat that humanity is facing, and collective action is crucial to avoid catastrophic impacts. The United Nations Intergovernmental Panel on Climate Change (IPCC) has affirmed that Climate Change is the defining issue of our time and that we have reached a crucial moment where action must be taken as suggested in the Paris Agreement of 2015 on Climate Change.

In their reports, the IPCC confirms the certainty of Climate Change and describes the current evidence available. The magnitude and extent of the observed and future impacts will shape the present and the near future of the planet. Negative impacts include, but are not limited to, sea level rise, loss of agricultural lands, severe droughts and increased storm frequency (IPCC, 2014).

A large group of observations provide strong evidence that warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The increase of the global mean surface temperature, the rise of sea level due to polar ice melting, the thermal expansion of the oceans and the retreat of large portions of glaciers, among many other evidences, show a clear trend of the global changes of the climate.

This change can be unequivocally attributed to human activity, mainly through the emissions of greenhouse gases from industrial activity (IPCC, 2014). These gases increase the reflectivity of the atmosphere to the infrared light emitted by the earth amplifying the greenhouse effect in the atmosphere. While the natural greenhouse effect is essential to support life on the planet, increasing concentrations of CO<sub>2</sub>, methane and other greenhouse gases enhance the effect increasing the mean temperature on land and in the ocean.

The international scientific consensus among the IPCC is unanimous on the diagnostic that the climate is changing dramatically, that the origin of this change is anthropogenic and that a reduction in the emissions of greenhouse gases is the only strategy that can minimize the effects of these changes.

Although the observations of Climate Change are now 30 years old, the international consensus identifying this as a major problem is very recent and it is only until the Paris agreement in 2015 that this was considered as a major threat to humanity and all the countries.

At the Paris climate conference, held in December 2015, 195 countries signed an agreement and established the following goals (UNFCCC, 2015):

- To keep global temperature rise below 2 degrees Celsius above pre-industrial levels and attempt to limit the temperature increase even more, below 1.5 degrees Celsius.
- An aggressive reduction of greenhouse gas emissions to decarbonize the economy by the year 2050.
- Confirm the importance of education, training, public awareness, public participation and access to information and cooperation at all levels.

Although this represents a major advance in political consensus around this problem, the treaty is imperfect and many questions on the adoption of the plan remain unanswered. Recently the US government announced its withdrawal from the agreement (Zhang, Chao, Zheng & Huang, 2017), showing the fragile nature of the consensus and the dangers of not following coordinated strategies for a common problem.

In the treaty the actions for mitigation and adaptation are described including a wide array of policies and strategies to be implemented by governments. Among these actions education is included, reflecting the well-established fact in the literature that successful climate change adaptation and mitigation requires specific knowledge, skills and behavior change that only appropriate and strategic educational policies can provide (Anderson, 2010; Mochizuk & Bryan, 2015). This is part of a general consensus, for example Sharma (2012) indicates that Science education, mainly public education, has usually been considered an important tool to face world challenges and respond to them because it could influence the habits of the society and in their social, cultural and economic relationships.

The United Nation Framework for Climate Change, in its article 6 recognizes the importance of education in climate change mitigation, as it creates awareness of the problem and encourages behavioural changes which are crucial for successful adaptation and mitigation strategies (UNFCCC, 1992). This, is a reflection of the literature where authors have claimed that Climate Change Education should focus on the kind of learning, critical and creative thinking and capacity building that will engage youth with the information so that they can take appropriate actions to respond to Climate Change (Stevenson, Nicholls & Whitehouse, 2017).

A concept related to Climate Change Education is Education for Sustainable Development (EDS) that has a mission to change citizens' attitudes and values toward the natural environment (Arbuthnott, 2009). Similarly, UNESCO has described the role of Education for Sustainable Development as an essential element of the global response to Climate Change, helping young people to understand and address the issue of global warming and encouraging changes in their attitudes and behaviours (UNESCO, 2010). Also, other authors have suggested that Climate Change Education can be a strategic and meaningful way for promoting the principles and practice of sustainable development through education (Mochizuk & Bryan, 2015).

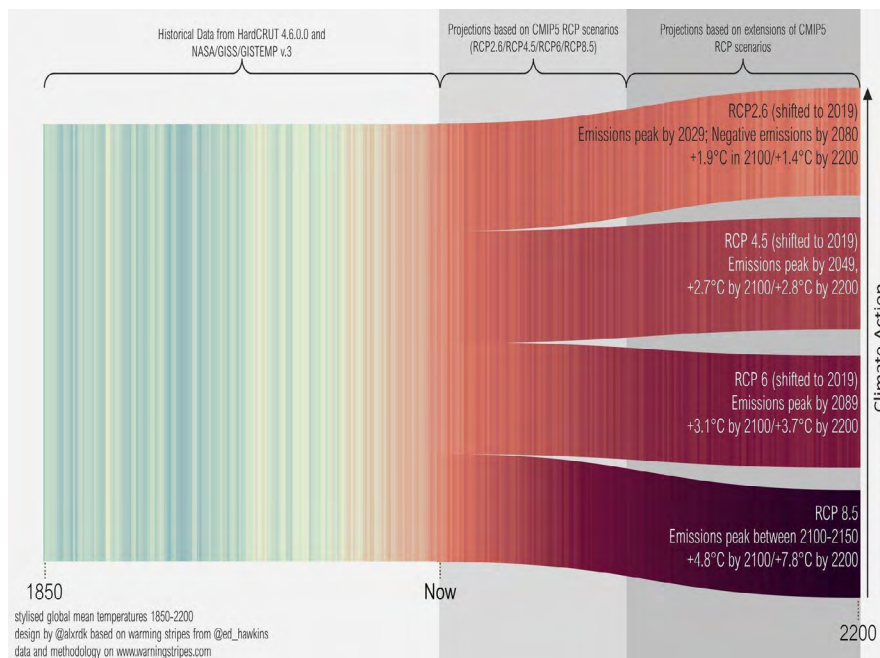


Figure 1. Increase of average land temperatures since 1880 and their projections for different Representative Concentration Pathways (RCP) of the AR5 report of the IPCC. Taken from warningstrips.com

At present there exist many organizations that help to include Climate Change in the educational system, such as UN CC: Learn (The One UN Climate Change Learning Partnership) (United Nations, 1994), with more than 30 multilateral organizations supporting countries to implement training on climate change, education and public awareness.

The Climate Change office in Spain has called for an Emergency Curriculum on Climate Change and there is an ongoing search for a common educational document that can be used in schools to teach Climate Change.

All of these initiatives support the broad consensus that exists on the central role of education to achieve the ambitious goals set by the Paris Agreement. However, a clear strategy on how to implement this task in each state or legislation has not been provided.

As a first step towards a strategy to transform education as a major tool to mobilize society we need to assess the capabilities of the current educational system to educate on Climate Change, create awareness and promote action.

In the following section, we describe the Concept of Climate Competence which provides a framework for an efficient inclusion of Climate Change in Education.

## 2. The concept of Climate Competence

Education should be the starting point to create basic environmental awareness. It is easier to have responsible citizens if they have received a good education in this matter, including scientific skills, futures thinking and critical analysis to understand the impacts of climate change (Fahey, 2012). A solid education in Climate Change will make citizens good defenders of the natural environment and the planet in general. However, public in general have a partial, incomplete and often poorly formed understanding of Climate Change (Gonzalez-Gaudio & Meira-Carrea, 2010). Many people including environmental activist or university students don't understand the science of climate change and it could be due to the lack of quality of educational system (Sharma, 2012). Climate change is a social issue and for these reasons should be necessary to involve society. Education should play the role to motivate people to be active citizens combating climate change (Sharma, 2012). Also, as the public debate on this issue is gaining power around the world, social movements such as "Fridays for Climate", "Teachers for future" or "Extinction rebellion" are also calling for reforms in education to mobilize society.

Climate Change Education should pursue to encourage a range of transversal skills and capabilities that cut across the cognitive and affective domains (Mochizuk & Bryan, 2015). Additionally, it should be an inter-disciplinary task due to it is not only necessary to know the scientific aspects but also the socio-economic impacts and provide solutions to it (Fahey, 2012). Climate change is a global socio-ecological issue and for this reason education cannot present natural ecosystems independent from societies, it should integrate school science with social studies in sustainability science (Sharma, 2012).

The public system of education should play a fundamental role in this transformation, but, while this role is identified in the international treaties and in the social debate there is no clear strategy on how to articulate this role in practice. The strategy and how it should be included in the educational systems are still under debate. In order to shed some light into this debate, we introduce the concept of Climate Competence. This concept is pertinent as it joins two major branches of research:

- In the literature on Climate Change response, a description of attributes needed by society is presented. As the problem is pressing and complex, awareness is key to mobilize society around this problem. Scientific Evidence based knowledge is essential to understand the magnitude and complexity of the problem. Finally, a new skill set is needed to improve adaptation and to create new organizational and technological solutions for mitigation.
- In the field of Education, competence has been a central concept to define educational objectives. Although a large debate on the future of competences exists, it will remain as a central part of the national legislations. The concept is familiar to the educational communities, and therefore, the creation of a new competence could be easily assimilated.

Since the publication of the Delors Report (Delors et al., 1996), where the four pillars of learning were defined, competences have been used to organize the educational system around the world. One pillar is related to knowledge, other one to skills and the two remaining ones are related to attitudes and social behaviour.

To create a Climate Competence, we adapt the attributes, identified in Climate Change literature, needed to trigger a coherent response in society to fit the structure of a competence. For this we consider the four pillars common for all competences:

- Learning to know. Scientific knowledge is central in this definition and includes all relevant knowledge that is needed to understand the nature of Climate Change, the magnitude of its impact and the complexity of the multidimensional challenge.
- Learning to do. Adaptation and mitigation skills need critical thinking to respond to fast and changing conditions that Climate Change will present.
- Learning to be. This part contains the creation of awareness and all the necessary skills to be able to act with growing autonomy, judgment and personal responsibility.
- Learning to live together. The most important part of this definition is the notion of the planetary dimension of the problem. Only informed and coordinated action around the world will create an impact in the design of solutions for this urgent problem.

The concept of Climate Competence provides a framework to develop understanding, awareness and abilities related to Climate Change through Education. A study on students' conceptions of global warming and Climate Change confirms the need for a better understanding of basic concepts related to Climate Change as these ground the conceptions of the impact of Climate Change on the Earth's systems and allows students to connect natural systems to economic, social-political and technical systems (Shepardson, Niyogi, Choi, & Charusombat, 2009).

This concept collects a large body of work on Climate Change literature, environmental education, and education research. Joining two different research areas can provide a solid structure on how to organize Climate Change Education and produce a practical implementation guide.

As it appears in the Spanish legislation (BOE), the concept of competence is established as «the ability to respond to complex demands and carry out various tasks in an appropriate manner». The competence «involves a combination of practical skills, knowledge, motivation, ethical values, attitudes, emotions, and other social and behavioural components that are mobilized together to achieve effective action». Therefore, the proposed Climate Competence agrees with this definition, as well as the fact that the competence knowledge integrates a knowledge of conceptual base: concepts, principles, theories, data and facts, as well as knowledge related to skills, referred to both observable physical action and mental action; and a component that has a great social and cultural influence, and that implies a set of attitudes and values.

Therefore, the evaluation of a curriculum from the point of view of Climate Competence must be approached from these three areas: conceptual, skills and attitudes. Within the proposed categories, table I shows the categories related to the concepts, and the skills and attitudes would be included in tables II and III, referring to adaptation and mitigation.

### *2.1. Assessment of the curriculum on Climate Change*

The need to create an Emergency Curriculum on Climate Change is pressing and should be addressed by the corresponding policy makers. However, it is also necessary to understand what the challenges and opportunities of current curriculums around the world are with respect to the issue of Climate Change in order to identify possible improvements.

The curriculum of any subject, including science ones, results from the compromise with several factors as science for the industry, democracy, scientific community and the development of the students which fragment the curriculum (Kliebard, 2004; Sharma, 2012). Sharma (2012) indicates that this fragmentation could hinder the education of climate change due to it implies several disciplines and suggests that education should look for few core ideas to explain climate change integrating natural and social sciences. Fahey (2012) studied the curriculum of the first postgraduate programme in Australia about climate change adaptation using two methods, one based on evaluation of the objectives of the programme (Tyler 1949) and the second of the educative process (Stenhouse 1975 & Mckernan 2007). Fahey (2012) suggested that the evaluation of the objectives of the programme is a good method to evaluate the curriculum, but it should be flexible and incorporate also the methodology used and the collaboration between institutions and stakeholders. He also found that if academics of higher education are climate change researchers, they could easily integrate their knowledge in their lessons. Chew-Hung and Pascua (2017) studied the policy curriculum of Singapore and stated that although Climate Change is present in several school subjects, there is a notable absence of explicit mention of how this topic should be learned. In their study of higher education institutions of the United States and Canada, Cooper, Keeley and Merelender (2019) found that undergraduate college-level courses on Climate Change offered in



these countries commonly miss key aspects of climate literacy, which in turn result critical to bridge the gap between climate science, literacy, and action.

It should be also noted that since Climate Change Education seeks to encourage the development of transversal skills and capabilities, specific teaching and learning methods based on participation, experience, critical-thinking and solving of open-ended problems are needed to promote an efficient learning that changes attitudes and behaviours (Mochizuk & Bryan, 2015). A review of the published literature supports active learning methods, e.g., (Pruneau, Grave, Bourque, & Langis, 2003; Stevenson, Nicholls, & Whitehouse, 2017).

The concept of Climate Competence could also be used to perform an assessment of a curriculum highlighting its strengths and weaknesses, to identify opportunities and challenges. In this paper we will focus on the first of the four pillars of competences: Learning to know, which is focussed on knowledge and contents. Ferrari et al. (2019) recently demonstrated that knowledge-based learning could improve the social representation of Climate Change and thus, can promote the Climate action and response.

In particular, in this paper we will develop a framework to assess and measure the different characteristics of a given curriculum with respect to Climate Change. It could be used as an evaluation tool of the educational system in many different curricula across regions, countries, levels of formation, etc. It is designed to be used as a tool to define the degree of alignment of a curriculum with contents related to Climate Change.

These tools aim to solve a very important and difficult problem: What contents are the most appropriate and necessary to understand Climate Change and how fit is a given curriculum to explain this problem.

The main objective of a Climate Change curriculum is to provide enough contents and concepts to understand its magnitude, causes and consequences. This knowledge will allow the construction of a realistic picture of how Climate Change threatens many aspects of our daily life.

The construction of this picture should be based on rigorous scientific knowledge and it should help students to understand:

- The importance and impact of climate on the lives of societies around the world.
- The role of science to create a rigorous diagnostic of the state of the climate.
- How science studies the planet and how climate works.
- The observed rapid changes in the climate in this century and how they represent a major threat to our civilization.
- The impact of human activity on the local and global climate. The anthropogenic origin of the problem is a key factor to understand possible solutions for the problem.

Moreover, the construction of this image should lead to the identification of the potential impacts of Climate Change in the near future, both on a local and global scale. The students should be aware of the cost of no action and the importance of informed coordinated action to reduce the impacts of Climate Change.

Climate Change is a complex issue and cannot be understood completely without the use of technical and scientific information, but the message for action should be simple and people should be able to act immediately on it.

From the previous descriptions it is easy to understand two of the major problems that arise when creating a tool to assess a curriculum. The first one is the need to accurately describe a complex problem such as the Climate Change in simple and rigorous terms. The Science of Climate Change is a very large and active field of research and different connections are made constantly, therefore it is hard to establish a coherent and well accepted set of concepts which can describe the topic. The second issue is that, once this set of concepts, considered ideal to explain Climate Change, has been identified, we need to analyse whether they are present in the curriculum.

To measure the fitness of a curriculum we also need to consider the main objectives of Climate Change Education.

To analyse how fit a given curriculum is to this task we need to analyse several aspects. We have listed the main aspects proposed for the analysis:

- Conceptual contents: The collection of concepts needed to explain the physical mechanisms of Climate Change.
- Construction of a narrative: A collection of concepts is not enough. A narrative which goes from causes to effects needs to be established and therefore includes connections between concepts.
- The interdisciplinary perspective: As the problem reaches different aspects, the curriculum needs to establish links between different disciplines, such as Social and Natural Sciences or Technology.

- Construction of attitudes and habits: Although this is connected with the third pillar of the Climate Competence, again, a link between concepts and skills is needed.

These are some of the most important issues to consider when designing a tool for curriculum assessment. In our proposal of Category-based analysis we include these issues while providing a simple but robust method to perform the analysis.

### 3. Construction of the categories for the analysis

The main idea is to analyse if a given curriculum covers the most important aspects of Climate Change Education. To do this properly, it is necessary to build a bridge that covers the gap between the scientific literature on Climate Change and the current curriculum taught in classrooms.

Following previous approaches to document analysis (Massot, Dorio, & Sabariego, 2004; Gallardo, Vergel, & Villamizar, 2017; Bowen, 2019) we construct a series of categories to analyse the fitness of a curriculum to education on Climate Change. The categories proposed in this study are based on the reports of the IPCC for several reasons.

The Intergovernmental Panel on Climate Change (IPCC) is a scientific body of the United Nations that was established in 1988 (IPCC, 1988). First, the main role of the IPCC is «to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation» (IPCC, 1998). The IPCC governing panel is made up of government members representing 195 countries; that is, intergovernmentalism is a key characteristic of this institution. This synthesizes all the available scientific literature on Climate Change into major assessment reports every 5-7 years. More than 60% enlisted references are from peer-reviewed journals; the remaining 38% referred to books, conference proceedings, reports from governments and industry and other literature (Bjurström & Polk, 2011).

Moreover, the reports are drafted, and peer reviewed in several stages, thus guaranteeing neutrality, objectivity and transparency. The IPCC identifies where there is agreement in the scientific community on topics related to Climate Change, and where further research is needed. IPCC assessments provide a scientific basis for governments to formulate climate-related policies. The assessment reports support the international negotiations of the United Nations Conference and Convention on Climate. Therefore, it could be concluded that the IPCC's influence on the construction, mobilization and consumption of climate change knowledge is considerable (Hulme & Mahony, 2010).

Lastly, the IPCC assessments are produced in three volumes, each of which is prepared by a working group. Working Group I deals with «The Physical Science Basis of Climate Change». Working Group II assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change and options for adapting to it. Finally, Working Group III deals with «Mitigation of Climate Change». All these groups have two co-chairs, one from a developed country and one from a developing country. The research, writing and reviewing involved in each IPCC assessment report is made by volunteer scientists, it takes over two years to produce and include the assessment of thousands of scientific studies.

Therefore, the IPCC reports are a good basis for the construction of these categories. Still, we have also used some other documents such as the «Essential Principles of Climate Literacy» by the NOAA which have a closer connection with the curriculum (NOAA, 2019).

These categories are divided into three sections: 1) scientific aspects, 2) adaptation and 3) mitigation. To establish the categories for scientific aspects of Climate Change we use the Technical Summary of the Working Group I of the IPCC and the Technical summary from the WGAR5. These reports are the basis of the categories, but we have slightly modified some of them to make them useful as categories (see Table 1).

No	Contents
1	Scientific method and scientific communication
	Treatment of uncertainty
2	The Climate system and its subsystems: atmosphere, hydrosphere, cryosphere, biosphere and lithosphere
	Interaction between climate subsystems
	Observed changes in the temperature

	Definition of atmosphere and observed changes
	Definition of water cycle, the hydrosphere, the cryosphere and observed changes
	Definition of the lithosphere and observed changes
	Definition of the biosphere
3	The energy budget of the earth
	Natural processes that determine the climate
	The greenhouse effect
	Natural radiative forcing: Solar radiation, aerosols, contrails, changes in land use
	Anthropogenic processes that influence the climate: Pollution, atmospheric chemistry and GHG
	Spatial and temporal effects and climate feedbacks
	The carbon and nitrogen cycles: CO <sub>2</sub> and NO <sub>2</sub> in the atmosphere
4	Observed changes in the Climate systems
	The influence of human activities in climate.
	The atmosphere: Its importance for the global climate and the Climate Change
	The hydrosphere: Its importance for the global climate and the Climate Change
	The cryosphere: Its importance for the global climate and the Climate Change
	The lithosphere: Its importance for the global climate and the Climate Change
	The biosphere: Its importance for the global climate and the Climate Change
5	Predictions of the global and regional Climate Change
	The future of Climate
	How we predict the future climate
	Changes in the climate in the short term
	Changes in climate in the long term

Table 1. Categories created by our research group.

The second section related to adaptation to Climate Change will be constructed using the most important concepts from the Technical Summary of the working group II of IPCC (Field et al., 2014). In this document, the authors propose some concepts to understand the impacts of Climate Change, the vulnerability of societies and how to adapt to these changes. The selected categories are in Table 2.

No	Contents
1	Observed impacts, vulnerability and adaptation in a complex changing world
	Climate change: changes in the properties of the climate that persist for an extended period.
	Hazard: potential occurrence of a physical event which can cause death, diseases or other impacts.
	Exposure: the presence of living beings and/or their assets in places that could be affected by climate change.
	Vulnerability: The propensity to be adversely affected.
	Impacts or effects of climate events on natural and human systems.
	Risk: probability of occurrence of hazardous events.
2	Future Risks and opportunity for adaptation
	Adaptation: Processes of adjustment to the effects of the expected climate.
	Incremental adaptation: actions to maintain current attributes of the systems.
	Transformational adaptation: actions to change current attributes of the systems...



3	Managing future risk and building resilience
	Transformation in the attributes of natural and human systems.
	Resilience: Capacity of response of human or environmental systems to maintain their function or structure.

Table 2. Categories created by our research group about adaptation.

The third and last section is dedicated to mitigation. According to Edenhofer et al. (2014) mitigation is the intervention of society to reduce the concentration of greenhouse gases. Categories for this section were extracted for the Technical Summary of the working group III of the IPCC (Edenhofer et al., 2014). They include several aspects that need to be taken into account before acting against climate change: the activity sectors that contribute the most to climate change and the main measures proposed to be implemented. The selected categories are in Table 3.

No	Contents
1	Creation dedicated policy on these levels: international, national, regional or local, and the cooperation between them.
	Inclusion of ethical considerations including equitable effort-sharing on relevant policies.
	Interests, perspectives and challenges between and within societies.
	Economic evaluation to design appropriate policies.
	Intersection between climate policies and other social goals.
	Perception of society of risks and opportunities of climate change.
	Necessity to create institutions and capacity for governance.
	Consideration of uncertainties of physical impacts and social responses
	Main activity sectors: energy, transport, buildings, industry, human settlements and agriculture, forestry and other land uses.
2	Mitigation policies and institutions
	Reduction of emissions of greenhouse gases.
	Reduction of energy intensity by improving technical efficiency.
	Production and resource efficiency improvement.
	Structural and systems efficiency improvement.
	Activity indicator change.

Table 3. Categories created by our research group about mitigation.

#### 4. Analysis with the categories

The idea of these category-based analysis is to compare a given curriculum with these categories in order to understand how fit it is for Climate Change Education. A perfect curriculum would contain all of these topics and the necessary connections to provide a clear understanding of Climate Change and its consequences. An inappropriate curriculum may lack most of the central contents needed to understand the topic. Most of the curriculums may have some degree of fitness as many of these contents are usually contained in many of the Natural and Social Science curriculums, but the connections are seldom described.

For this analysis, qualitative and interpretative methodology of document analysis is desirable (Massot, Dorio, & Sabariego, 2014; Gallardo, Vergel, & Villamizar, 2017). This method of induction of thematic categories has been used before in documents of the education laws as curricular contents (Gallardo, Vergel, & Villamizar, 2017).

The comparative analysis could be developed from two perspectives. Firstly, it should be found the correspondences between the variables of different selected categories and the official curriculum, both in the content section, evaluation criteria and procedures, establishing a percentage of present versus absent categories. In the second part, it should be taken into account the optional nature of some curriculums. In most of the educational

levels there are compulsory and optional topics. It is necessary to distinguish what percentage is compulsory. For example, in secondary education some large percentage of the curriculum depends on the choice of the students and may simply opt out a good set of contents.

Our proposal of analysis includes the coherence and sequence of the topics in the curriculum. We distinguish vertical and horizontal coherence. The vertical coherence is defined as the fact that there is the right sequence and depth of contents related to Climate Change between the different courses. As described before, Climate Change needs a narrative structure from causes to effects which can mobilize to action. If the contents are present in a curriculum but they are disconnected or worked in different years with different depth each time, the vertical coherence of the curriculum decreases. On the other hand, horizontal coherence represents a positive or negative relationship between contents treated in the different subjects of the same course. It would be more appropriate, therefore, a curriculum that develops climate competence in a coherent way between subjects and between successive courses.

The analysis then produces a series of metrics that describe the fitness of a given curriculum for Climate Change Education. The tool has an important purpose: to describe the strengths and weaknesses of a given curriculum with respect to the Climate Competence.

This will provide important information for policy makers about what changes are needed to implement the Climate Competence.

In this analysis, we cannot forget about the ethical and social dimensions which are essential to the development of the Climate Competence. Although this paper is dedicated to the knowledge dimension of the curriculum, we can outline the procedure to assess the curriculum to contemplate these dimensions. For this, we would need to analyze not the contents which are the main source of our analysis but to locate the items related to attitudes, ethical and social issues. These issues are normally described in the prologue of the courses or subjects which always make a justification of the ethical reasons why these subjects need to be included in the curriculum. For example, the prologue is the place where the importance of preserving nature as a foundation of our survival is found. Another way to locate these issues into the standards of the curriculum is by looking into the specific verbs which describe actions or with words related to attitudes or ethical discussions. These are the elements of the curriculum which should be investigated as the ethical or social dimension of the intended learning.

In order to tell whether a Curriculum is complete or not in these dimensions we could look into the documents that served to the foundation of the United Nations Framework for Climate Change (UNFCCC). These documents describe the ethical, social considerations behind the creation of the IPCC and the UNFCCC treaty that describe the actions for the Climate that the world must follow.

The Table 4 describes just some examples of the ethical considerations included in the UNFCCC treaty which are a global consensus and that should be included in the curriculum.

Extracted elements for the analysis	UNFCC Treaty
Ethical issue: Climate is a common concern for humankind	Acknowledging that change in the Earth's climate and its adverse effects are a common concern of humankind
Attitude: Concern on the impact of human activity on humans	Concerned that human activities have been substantially increasing the atmospheric concentrations of greenhouse gases, that these increases enhance the natural greenhouse effect, and that this will result on average in an additional warming of the Earth's surface and atmosphere and may adversely affect natural ecosystems and humankind,
Ethical issue: The origin of emissions is mainly developed countries but developing countries will grow their needs to meet their social needs	Noting that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries, that per capita emissions in developing countries are still relatively low and that the share of global emissions originating in developing countries will grow to meet their social and development needs
Attitude: Awareness of the importance of ecosystems	Aware of the role and importance in terrestrial and marine ecosystems of sinks and reservoirs of greenhouse gases,

Ethical issue: Widest cooperation is needed in accordance with their common but differentiated responsibility	Noting that there are many uncertainties in predictions of climate change, particularly with regard to the timing, magnitude and regional patterns thereof, Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions,
Ethical issue: The need to protect the climate for future generations	Determined to protect the climate system for present and future generations,

Table 4. Examples of the Ethical Considerations included in the UNFCCC Treaty which are a global consensus.

This is just a brief outline of how these dimensions could be analysed to assess whether the Curriculum contemplates these issues or how to include them.

## 5. Conclusions

In this paper we have described the importance of the threat that Climate Change pose over society and the need to act now with decisive actions and policy. We have described the general consensus about the central role that education must play to create a new generation of responsible and aware citizens. This consensus is in contrast with the lack of a clear strategy to implement Climate Education in schools.

To address this problem, we propose the concept of Climate Competence. We describe the convenience of this concept to join the research on attributes that society must have for a coherent response to Climate Change with the language of Education.

As a necessary step to this goal we need to analyse the fitness of current curriculums for Climate Change Education. For this we have developed a category-based analysis which provides a tool to describe the weakness and strengths of current curriculum to understand how much is needed to achieve the goals of the Climate competence.

The category-based analysis looks to narrow the gap between the existing science on Climate Change and the contents in the schools. As the Climate Change science is a very complex field of study, we make use of the reports of the Intergovernmental Panel on Climate Change (IPCC) of the UN as a framework to build the categories needed for this analysis. Finally, we describe how the analysis should be performed. In the future, we will use this tool as an evaluation tool of the educational system to describe the opportunities and challenges for current curriculum to achieve the Climate Competence, which is fundamental to mobilize the society in front of this complex and urgent problem.

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