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Environmental education and climate change in a high school in the State of Mexico

Educación ambiental y cambio climático en un bachillerato del Estado de México

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Abstract

The article aims to characterize the social representations of climate change of high school students in the State of Mexico, Mexico; a qualitative methodology is developed through the analysis of five techniques: questionnaire with evocative words, associative letter, drawing, attitude scale and interviews. The results detect confusion about the causes and consequences of climate change, as well as the predominance of naturalistic social representations and favorable attitudes towards responsible action in climate change. These findings allow us to revalue the importance of knowledge of social representations, since among their functions is the disposition towards practice and when these representations are confusing, superficial practices can be generated, in which senseless activism prevails over conscious acting; therefore, the need for environmental education for climate change in high school becomes visible. This component is crucial in the article and it is organized according to the topic discussed in the research.

Keywords: Climate change; Alternative conceptions; Environmental education; Social representations

Resumen

El artículo tiene el objetivo de caracterizar las representaciones sociales del cambio climático de los estudiantes de un bachillerato del Estado de México, México; se desarrolla una metodología cualitativa a través del análisis de cinco técnicas: cuestionario con palabras evocadoras, carta asociativa, dibujo, escala de actitudes y entrevistas. En los resultados se detectan confusiones sobre las causas y consecuencias del cambio climático, así como el predominio de las representaciones sociales naturalistas y de actitudes favorables hacia una actuación responsable ante el cambio climático. Estos hallazgos permiten revalorar la importancia del conocimiento de las representaciones sociales, ya que entre sus funciones se encuentra la disposición hacia la práctica y cuando estas representaciones son confusas, se pueden generar prácticas superficiales, en el que el activismo sin sentido prevalece sobre al actuar consciente; por ello, se hace visible la necesidad de una educación ambiental para el cambio climático en el bachillerato. Este componente resulta crucial en el artículo y se organiza de acuerdo al tema tratado en la investigación.

Palabras clave: Cambio climático; Concepciones alternativas; Educación ambiental; Representaciones sociales

INTRODUCTION

Environmental education is a pedagogical field aimed at fostering a critical awareness of the causes and consequences of environmental problems, such as climate change. It seeks viable alternatives to prevent risks (both natural and anthropocentric), promote adaptation, mitigation, and encourage resilient action in communities exposed to these risks.

Currently, climate change constitutes one of the major socio-environmental problems facing humanity, primarily caused by anthropogenic factors. In response, various international agreements have been developed to reduce greenhouse gas emissions and achieve greater social participation. Some of these agreements are listed in the following table:

Table 1. *Meetings and agreements to mitigate the effects of climate change*

Summits/Meetings	**Main Agreements**
1972 Stockholm, Sweden.	Member countries decided to meet every ten years to monitor the situation of the environment.
1979 Geneva, Switzerland. First World Climate Conference.	For the first time, climate change was considered a real threat to the planet.
1988 The Intergovernmental Panel on Climate Change (IPCC) is established.	This group presents assessment reports on climate change, including its possible impacts and solutions.
1992 Rio de Janeiro, Brazil. United Nations Conference on Environment and Development (Earth Summit).	Actions were proposed against climate change, the protection of biodiversity, and the elimination of emitted toxic substances.
1995 Berlin, Germany. First World Conference on Climate Change.	Monitoring of actions taken to reduce climate change.
1997 Kyoto, Japan. Third World Conference on Climate Change.	The Kyoto Protocol begins its functions as the UN Framework Convention on Climate Change.
2002 Johannesburg, South Africa.	Civil society appears participating in the issue.
2007 Bali, Indonesia. XIII World Climate Change Conference.	The negotiation process began for the second compliance period of the Kyoto Protocol.
2009 Copenhagen, Denmark. XV World Climate Change Conference.	The goal was set to limit the increase in global average temperature to 2°C.
2010 Cancun, Mexico. XVI World Climate Change Conference.	The Green Climate Fund is established for Climate.
2011 Durban, South Africa. XVII World Climate Change Conference.	The commitment to achieve a legally binding climate protection agreement is recognized.
2014 Lima, Peru. XX World Climate Change Conference.	The reduction of greenhouse gas emissions is proposed not to exceed the 2°C threshold.
2015 Paris, France. XXI World Climate Change Conference.	A new international climate agreement applicable to all countries is established to limit the temperature increase to 1.5 degrees Celsius.

In the brief overview of some major agreements regarding the need to coordinate international actions to reduce the effects of climate change, the United Nations Framework Convention on Climate Change (UNFCCC) entered into force in 1994, approved at the Earth Summit in Rio de Janeiro (Brazil) in 1992. Every year, the Conference of the Parties (COP) is held, known as the world climate summits in Dubai, United Arab Emirates. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988, and the Kyoto Protocol was adopted in 1997 and entered into force in 2005, aimed at reducing greenhouse gas emissions by 5.2 percent from 1990 levels for the period 2008-2012.

In Mexico, the Intersecretarial Commission on Climate Change was created in 2005, with various purposes aim to prevent and mitigate greenhouse gas emissions, as well as fulfilling commitments made under the UN Framework Convention on Climate Change, resulting in the formulation of the National Climate Change Strategy in 2007. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) confirms the primary causes of climate change. The situation for Latin America is alarming:

- Reduction or disappearance of tropical glaciers affecting water availability and hydropower generation in Bolivia, Colombia, and Ecuador.
- Decrease in precipitation in the arid and semi-arid regions of Argentina, Chile, and Brazil associated with severe water scarcity.
- Gradual replacement of tropical forests by savannas in Eastern Amazonia and in the tropical forests of central and southern Mexico due to an increase in temperature of 2 degrees Celsius and decreased soil moisture, along with the replacement of semi-arid vegetation by arid vegetation in regions of northwest Brazil and much of central and southern Mexico.
- Increase in the number of people at risk of famine, projected at 5 million, 26 million, and 85 million in the years 2020, 2050, and 2080, respectively.

Among other effects that require the attention of public policies from Latin American states, with the aim of reducing greenhouse gas emissions.

It is important to note that the United Nations Framework Convention on Climate Change (1992) establishes in Article 6 the promotion and support of education, training, and awareness regarding climate change, as well as promoting public participation. The 2022 IPCC report estimates that the impacts of climate change on ecosystems, biodiversity, and human systems will increase. Although climate change continues to be a peripheral issue in the educational field, both in educational research and in daily school practice, there are various perspectives internationally regarding the incorporation or improvement of climate change education at different educational levels. Monroe (2007) recognizes two perspectives: climate literacy and the development of critical thinking skills. In the Latin American context, Cruz and Páramo (2020) describe several perspectives: education for an environmental culture, a multidimensional approach, and community participation. González-Gaudiano and Meira (2020) emphasize the need to educate about climate and to educate for change. However, one limiting factor for implementing these perspectives at the high school level is the inadequate training of teachers to address environmental issues.

Efforts in education to raise awareness of the effects of climate change are still emerging, leading to indifference or denial of the existence of this socio-environmental problem. This lack of education makes the phenomenon incomprehensible for many students and not taken into account in their personal decisions. Climate change is socially perceived as a global issue, displaced in time and space, and too abstract (Meira, 2009).

Mexico is a country sensitive to the effects of climate change due to its own edaphological, physiographic, and hydrographic characteristics, as a large part of the territory is semi-arid (with low precipitation for most of the year). Changes in the rainy season are a threat of drought, as do the development of large population centers on the coasts or near riverbanks; these are risks for the population residing in these areas. According to this situation, the importance of environmental education for climate change is evident. "Education for climate change is an urgent necessity not only because of the magnitude and complexity of the problem, but also because of the pace at which the indicators being monitored are evolving" (González-Gaudiano and Meira, 2020, p. 161).

This education is necessary at all educational levels; in the case of high school, it is included in the curricula of some subjects. Additionally, young people at this educational level have studied environmental education and climate change topics in secondary school and are constantly exposed to information related to these issues in their daily lives. Therefore, it is assumed that they hold social representations concerning climate change. The results obtained in the current study confirm this assumption but also reflect the prevalence of alternative conceptions in the social thinking of students, reinforced by the daily interactions occurring in school institut ions. This paper presents

a synthesis of results from a broader investigation focusing on the upper secondary level and the environmental issue of climate change.

METHOD

Procedure

Research related to social representations has increased in recent years (González-Gaudiano and Aparicio, 2024). From 2012 to 2021, a total of 176 published studies were identified, of which 16 correspond to high school students (published in indexed journals). Notable works at the upper secondary level include those by Espejel and Flores (2015), Bello, Meira, and González-Gaudiano (2017), Calixto-Flores (2020), and Bello, Cruz, Meira, and González-Gaudiano (2021). From these investigations, a line of research in environmental education concerning social representations of climate change can be identified.

The theoretical approach of social representations supporting this research is the processual approach, proposed and developed by Moscovici (1979) and Jodelet (1986). This approach advocates a multi-methodological procedure, which translates into the combination of various research techniques, including "word evocation," "associative card," "drawing-narrative," "attitude scale," and "interview."

The research comprises several stages: exploration, categorization, and deepening. Prior to the development of these stages, a pilot test of the instruments is conducted (with a small sample of high school students), allowing for adjustments, primarily in writing and length.

In this research, the analysis of students' language is prioritized based on the proposals by Bardin (1991), Singéry (2001), and Quiroz (2004), which involves recovering and organizing the information, identifying the frequency of words (nouns and adjectives), and classifying the information based on theoretical categories. Content analysis is conducted for each category, followed by qualitative analysis of the information grouped into categories and triangulation, ultimately synthesizing the information. The analysis takes into account the types of representations and the presence of alternative conceptions. Initially, the information is processed through a content analysis, followed by qualitative analysis by category, and then triangulation to synthesize the characteristics expressed in the representations. This process is suggested by Singéry (2001) in which, based on the information collected through different techniques, the data is organized into categories according to a reference criterion using linguistic referents associated with social representations, both naturalistic and anthropocentric. The content analysis based on Bardin (1991) allows for the identification of typical phrases and keywords, which then leads to category analysis according to the frequency of the identified elements. To complement this with triangulation, relationships and coincidences (Singéry (2001) are identified.

Tabla 2. *Study population*

Semester/Gender	**Women**	**Men**	**Total**
Second	27	17	44
Fourth	23	14	37
Sixth	18	11	29
Total	68	42	110

Source: Own elaboration

The first stage essentially involves identifying the existence of the representation object using free association techniques such as "word evocation" with an evocative term and the "associative card" based on the elucidated words. Once the representation object is identified, the second stage involves presenting a hypothetical situation related to climate change for students to resolve through a drawing, complemented by a written explanation, analyzing the dimensions of information and the field of representation, considering the types of representations proposed by Reigota (1990). The attitude scale related to the representation object outlines the components of the dimension related to attitude. In the third stage, based on the obtained results, a semi-structured interview is developed to deepen the interpretation.

Study population

The research was conducted in a high school in the municipality of Tlalnepantla de Baz, State of Mexico. The institution was selected based on accessibility, having received the authorization and support of a teacher for the development of the research techniques in one group from each semester. The sample is intentional, focused on the willingness of the students to participate in the study.

Sixty-six percent of the second semester students are 15 years old, 25 percent are 16 years old, and nine (9) percent are 17 years old. In the case of fourth semester students, 54 percent are 16 years old, 38 percent are 17 years old, and 8 percent are 18 years old. Among sixth semester students, 52 percent are 17 years old, and 48 percent are 18 years old. The majority of students are in the semester of study that corresponds to their age.

Based on the developed methodology, the sources of information about climate change known to the students are identified, and the social representations they hold regarding climate change are characterized, highlighting the use of alternative conceptions.

RESULTS

Social representations in the school context

Moscovici (1979) uses social representations to refer to a sociocognitive structure that has, among other functions, the role of giving meaning to the environment and serving as a guide or plan for behavior by describing, classifying, and explaining reality. Through these representations, a social group constructs a functional perspective of the world, understanding a series of notions and conceptions that provide individuals with a viewpoint about a certain object, such as climate change. Members of a society share a series of common references, which constitute social representations and can be considered categorical references from which information is obtained to make decisions. Representations are constructed and reconstructed, and education plays an important role in this reconstruction.

The high school curriculum includes content related to environmental care, including topics related to climate change. The subjects in which climate change content is addressed are identified by students, among the main ones are: the subject of Chemistry, identified by seventy-five percent of second-semester students; the "cross-cutting project," which influences all subjects, recognized by fifty-four percent of fourth-semester students; and the subject of Geography, mentioned by sixty-eight percent of sixth-semester students. However, as observed, few subjects are identified by students as having significant content on climate change, as they do not reference the subjects from earlier semesters. Similar results have been obtained by Espejel and Flores (2015).

When asked whether climate change is present in their everyday conversations with others, students from all three semesters mention their teachers (twenty-five percent from second semester, forty percent from fourth semester, and fifty-two percent from sixth semester). Students discuss these topics with family members (thirty-four percent from second semester, twenty-two percent from fourth semester, ten percent from sixth semester) and friends (twelve percent from second semester, twenty-four percent from both fourth and sixth semesters).

Students recognize climate change as a current environmental problem. In the students' textual expressions, two numbers are noted. The first corresponds to their study semester and the second to the identification number.

This is how climate change is seen: Full of trash, smoke, factories, cars that cause changes in the climate, many floods, and it destroys nature (2.3).

The planet is already suffering a lot due to human experiments; it could disappear, all because of humans (2.10).

The world is dying due to climate change caused by ourselves; it is like an hourglass, first the animals are going extinct (4.3).

The world is the one suffering all the climate changes, and this is thanks to human activities and pollution (4.9).

The planet is deteriorating because of climate change and is the cause of abrupt temperature changes and natural disasters (6.7).

Does climate change cause rain, extreme heat, landslides, deforestation, destruction, and what happens to the animals and plants? (6.17).

Climate change is a topic of conversation not only in school but also in other areas. However, as observed in the previous expressions of the students, alternative conceptions predominate, and they are unable to achieve a clear conceptualization of climate change. A catastrophic vision is also noticeable, comparable to the idea of planetary collapse, where two ideas coexist: one of environmental catastrophe and the other of managing socioclimatic risk (Ruda y Peña, 2019).

This type of representation has also been identified by Bello, Alatorre, and González-Gaudiano (2016), who refer to them as environmentalist social representations.

When analyzing the words that constitute social representation, the importance of school knowledge becomes evident, as it can help make scientific concepts more accessible to students.

Confusions between causes and consequences

In this research, some alternative conceptions that are part of students' social representations are defined. This term refers to the knowledge held by individuals that differs from scientific concepts (Huerta 2027). Among the students in the study sample, a common language is identified through which they appropriate, organize, and prioritize their knowledge about climate change. In this knowledge, an informational content can be recognized (information dimension), an organization of these contents that conveys structure to the relationships (field of representation dimension), and the valuation made of the contents and relationships that comprise it (attitude dimension). These dimensions constitute the social representation. According to Moscovici (1979), the information dimension refers to the organization of the knowledge that a group possesses concerning a social object.

Students identify multiple consequences of climate change for humans, living beings, ecosystems, and the planet. The consequences identified by students reveal elements of naturalistic and anthropocentric social representations, with a catastrophic bias, similar results have been found by Meira (2005), González-Galdiano and Maldonado (2013) and Baquiano and Méndez (2016).

In the case of students in the second and fourth semesters, the main consequence identified is the increase in pollution (40 percent and 30 percent respectively), while for sixth-semester students; it is the melting of the poles (34 percent). Second and fourth-semester students also mention the emergence of new diseases as one of the main consequences (15 percent and 12 percent respectively). For sixth-semester students, the melting of the poles is again noted (17 percent). These results are consistent with those found in other research by González-Gaudiano and Maldonado (2014), where young people recognize various consequences of climate change, primarily related to environmental alterations. Additionally, responses from students more frequently include terms related to naturalistic social representations. However, in other studies concerned with social representations of climate change, the emergence of new diseases had not been reported.

In the present sample, confusions between the causes and consequences of climate change are identified, indicating that alternative conceptions are present in their social representations. These results are similar to those found in Meira, Gutiérrez, and Escoz (2018), as well as Lee and Barnett. For example, pollution is simultaneously identified as both a consequence and a cause.

Environmental pollution is considered the main cause of climate change by fourth-semester (40 percent) and sixth-semester (35 percent) students, while for second-semester students, global warming is identified as the cause (25 percent). As observed, this is not the only confusion, as global warming is not a cause; finding this alternative conception is quite common. Similar results have been found in other studies (Boyes, Stanisstreet y Yongling, 2008; Chang y Pascua, 2015).

In students' textual expressions concerning climate change, they utilize alternative conceptions, leading to confused responses. In the following statements, alternative conceptions are italicized.

The sun takes advantage of the Earth and causes its temperature to rise, leading to disasters. (2.2)

The climate is modified due to global warming; the atmosphere of our planet becomes more sensitive and receives solar radiation directly, which is more harmful to living beings, as there are fires, rivers and lakes dry up, and there are dust storms. (2.15).

Climate change starts to affect the Earth, causing pollution and the disappearance of the places where animals live. (4.11).

Climate change causes areas where there should be cold to experience excessive heat, and where there should be heat to become very cold. For this reason, the poles melt, and there is pollution; animals and plants die because of this. (4.37)

Due to climate change, the atmosphere is slowly being destroyed, the temperature is changing more and more, and there are countless negative effects on the environment due to extreme heat caused by the destruction of the ozone layer. (6. 8)

The climate is changing and appears very aggressive due to the increase in pollution from trash and some cars that emit a lot of smoke. (6.10)

Table 3. *Most frequent words used in each semester*

Representations	**Second**	**Fourth**	**Sixth**
Naturalists	global warming (14),	animals (9), death of living beings (7), water (6), rain (5), plants (5)	extinction of plants and animals (12), animals (6), temperature (6), heat (6), trees (6)
Anthropocentric	not identified	recycling (8), reusing (6), fabrics (5)	innovation (18), tree cutting (9), fabrics (6)
Globalizers	pollution (15), garbage (9), greenhouse effect (5)	pollution (15), garbage (12)	pollution (21), greenhouse effect (5)

Source: Own elaboration

In the students' responses, it is observed that alternative conceptions predominate in social representations, and the practical knowledge of climate change diverges from scientific knowledge; similar results have been found in other studies. (Espejel and Flores, 2015; Bello, Alatorre and González- Gaudiano, 2016). In this sense, it is worth questioning whether educational practices in high school are influencing the transformation of these conceptions.

The words used in the associative chains created by the students make it possible to identify the types of predominant social representation (naturalistic, globalizing, and anthropocentric). The naturalistic representation is directed toward geophysical-chemical and biological components; the globalizing one refers to interactions between social and natural components; while the anthropocentric one focuses on benefits for human societies. Studying these types of representations helps to delineate the meaning of social thinking about different phenomena related to the environment Reigota (1990).

In the following list of the most commonly used words, frequencies are included in parentheses.

In the students' expressions, the predominance of naturalistic social representations is noted, as words related to the natural environment are more commonly employed. This type of representation has also been identified by Bello, Alatorre and González-Gaudiano (2016), who refer to them as environmentalist social representations. From these results, the challenge arises: how to educate for change? How can we educate young people to face the risks of climate change?

DISCUSSION

In this research, the results show that social representations are constructed gradually in different contexts, not only in school. Students, as noted by Ledezma (2016), contribute to establishing a preliminary understanding in their communities about what this climatic phenomenon means by sharing what they have learned with family and friends. Similar to the results from other studies, such as those by Shepardson et al. and Bello, Meira, and González-Gaudiano (2017) and Meira, Gutiérrez y Escoz (2018), the representations identified in high school students exhibit multiple alternative conceptions, which, when spread to communities, limit the social understanding of this phenomenon. What happens in educational institutions greatly influences the representations formed in the communities. Therefore, education for climate change in schools is essential to foster critical awareness of the origins of this environmental problem. Like Moscovici (1979), this research acknowledges the significant influence of the media in shaping social representations.

In the identified representations, it is observed that Mexican students possess alternative conceptions about the causes and consequences of climate change similar to those held by students from other countries, such as Spanish students Meira, Gutiérrez y Escoz (2018), English students Lee, K., & Barnett, J. (2022) and French and German students (Caillaud &y Uwe, 2023).

On another note, the expressions of the students reveal the predominance of naturalistic social representations, just as found in the research by Bello, Meira, and González-Gaudiano (2017) an d by Vinuesa, Campos, and Meira (2023).

This constitutes a challenge for teaching since there persists a tradition of linking environmental problems only with natural sciences, ignoring the social dimension. In various Latin American countries such as Brazil, Bolivia, and Mexico, unlike several countries in the Northern Hemisphere, the critical pedagogy of Paulo Freire is known and applied, which constitutes an educational alternative to incorporate the social dimension into climate change education.

CONCLUSIONS

In the identified social representations, naturalistic ones predominate, but there are also multiple alternative conceptions that can bias students' perspectives by prioritizing certain ecological dimensions over other dimensions (economic, political, cultural, and social) of climate change. Limiting the causes and consequences of climate change simply to natural factors means recognizing only one part of the problem. The discourse that is generally disseminated in the media can partially misrepresent or confuse information about climate change, failing to acknowledge the role of the media itself or of the media campaigns that place the responsibility for greenhouse gas increases on citizens. Alternative conceptions predominate, some of which are valid for everyday communication but simplify the problem of climate change. In high school, young people need to have a better understanding of the phenomenon. Multiple confusions about causes and consequences are observed; in attempting certain topics, alternative conceptions prevail over scientific knowledge. Within this framework, environmental education has numerous opportunities to contribute to raising awareness about the nature of climate change and to initiate climate literacy to better understand the causes and consequences of this climatic phenomenon, moving toward environmental education for climate change, thereby starting a process of environmental awareness in society.

The incorporation of environmental content in the generic and disciplinary competencies of the high school curriculum, along with content related to climate change, constitutes a significant step toward achieving the goals of environmental education for climate change. However, it also requires updating teachers, which is still very incipient regarding environmental issues; disciplinary knowledge is generally prioritized over transversal knowledge and cognitive components over attitudinal ones.

The configuration of social representations is a lengthy process that exceeds the boundaries of educational institutions; thus, it is desirable for environmental education for climate change not to be restricted to the school context but also to be considered within non-formal education. To understand the implications of social representations in environmental education, broader studies are needed; this is the main limitation of the present study, as larger samples from different sectors of the population are required. To strengthen the line of research on environmental education for climate change in Latin American countries, it is advisable to review the various proceedings of the National Congresses on Environmental Education in Mexico and the Mexican Council for Educational Research in the thematic area of environmental education for sustainability.

Environmental education for climate change is an alternative for high school students to transition from naturalistic social representations to globalizing social representations, from alternative conceptions to scientific concepts, and to foster favorable attitudes characteristic of a resilient community. In high school, education for climate change should be presented as a complex system of different dimensions (environmental, social, and economic), considering the importance of influencing the transformation of simplified social representations.

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