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The Efficiency of a Basic Science MOOC in Spanish to Improve the Social Representation of Climate Change

La eficiencia de un MOOC de Ciencia básica en español para mejorar la representación social del Cambio Climático

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Abstract:

Climate Change (CC) is the greatest threat to our society, but although science presents evidence of the magnitude of the problem and accurately describes the consequences, people are not acting enough. The reason behind this paradox could be the inappropriate Social Representation (SR) on CC in society and may explain why there are still skeptical and denialist beliefs, as well as their inadequate communication. A quasi-experimental design with pre-test and post-test verified whether well-designed MOOCs based on scientific evidence can improve SR on CC, generating awareness and effective mobilization to address this important issue.

Keywords:
Education; Environmental Education; Climate Change Education; massive online open courses (MOOCs); Social Representation (SR)

Resumen:
El Cambio Climático (CC) es la mayor amenaza para nuestra sociedad, pero, aunque la ciencia presenta evidencias claras sobre la magnitud del problema y describe con precisión las consecuencias, las personas no están actuando lo suficiente. La razón detrás de esta paradoja podría ser la no apropiada Representación Social (RS) sobre el CC en la sociedad y puede explicar por qué todavía existen creencias escépticas y negacionistas, así como su no adecuada comunicación. Mediante un diseño cuasi experimental con pretest y postest se verifica si los MOOC´s bien diseñados y basados en evidencia científica pueden mejorar la RS del CC, generando conciencia y una movilización efectiva para abordar este importante tema.

Palabras clave:
Educación; Educación Ambiental; Educación del Cambio Climático; Cursos Masivos en Línea y Abiertos (MOOCs); Representación Social (RS)

1. Introduction

Climate Change (CC) is the greatest threat to humans and all species on earth (Ruiz & Ferrari, 2019). Anthropogenic greenhouse gas emissions have fundamentally altered the earth's climate (IPCC, 2014). The balance of the climate over the last 10,000 years has allowed civilizations to be created and this fundamental change in the climate is already altering our life on the planet (IPCC, 2013). This global challenge must be addressed from many perspectives and requires active local and international policies as well as coordinated strategies for mitigation and adaptation. The huge transformation required by society to face this problem and mitigate the effects of CC can only happen if Education takes an active role (Ferrari-Lagos et al., 2019). In this paper we study the effects of Education, in particular the impact of a Massive Online Open Course on the science of CC on the Social Representation (SR) of CC which is essential for the mobilisation of citizens in the face of this planetary challenge.

1.1. Social representation and education

The Social Representation (SR) of the CC is our subjective perception of reality and, to a large extent, it conditions our response (Jodelet, 1986) to some phenomenon. SR helps individuals and groups to anchor their position in situations and events relevant to their immediate concerns (Abric, 1994) and serves to determine whether the object of this representation is a threat or not. A misalignment between SR and reality - based on scientific evidence - will result in a response that is inconsistent with the urgency of the problem.

The scientific representation of CC, based on the enormous amount of evidence, is in stark contrast to the actual SR of society which is often inconsistent and imprecise. This distorted representation of reality may explain why there are still skeptics and deniers of CC even when they have no scientific basis to distort the political agenda around CC..

The SR has three main components (Figure 1) that constitute the way reality is perceived by people: information, structure and attitudes.

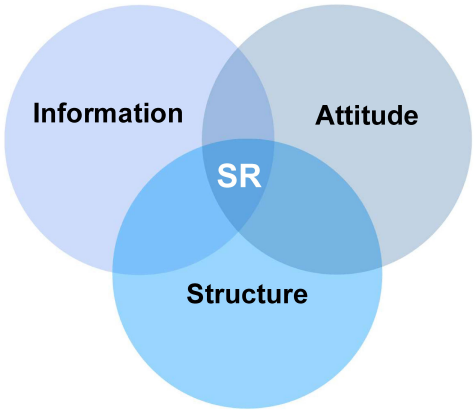
Information is the set of concepts, false and true, that feed SR. The origin of this information can vary, some elements may come from scientific sources and are objective facts, while others may come from a common culture, pseudoscientific facts or inaccurate information and are not always true or contain distorted elements of a scientific truth.

The structure of SR refers to the order and hierarchy of this information where beliefs, values and ideology condition how this information is articulated and give meaning to the subject of representation.

The final element is the attitude, which provides the positive or negative predisposition to the corresponding action (Bello Benavides et al., 2017). This element is important because it determines whether the representation justifies an active attitude in the face of a threat or whether, on the contrary, the representation justifies a distant and passive attitude.

Figure 1

Elements of Social Representation (SR)



Throughout this article we will analyse how the SR on Climate Change looks like in a group of users of a MOOC of the basic science of Climate Change and how the course can modify this representation by bringing it closer to the scientific diagnosis that describes Climate Change as a great threat that requires the rapid mobilisation of society as a whole.

Education is widely recognized as the main tool for improving the SR and adjusting it to the reality described by science in the IPCC reports (United Nations, 2016). Education is essential to trigger a better response to mitigation and adaptation to climate change. It is therefore important to investigate in detail the mechanisms by which the SR can be transformed. To investigate these mechanisms, we propose an experiment in which we

evaluate the SR of a group of students before and after a MOOC (Massive Online Open Course) on CC to explore how this representation is modified and whether the information contained in the MOOC brings their SR closer to the reality described by the scientific evidence.

1.2. MOOCs as an information alternative

For several years, social and political scientists have been discussing why society does not identify CC as one of the major problems facing human beings. This failure in the SR of CC reduces the time remaining to design and establish solutions to CC, weakens mitigation and adaptation efforts and undermines support for public policies that implement solutions to the global challenge.

On the other hand, we could hope that a SR of CC that is more in line with scientific representation will allow for the implementation of appropriate policies at the different levels of administration and will mobilise society in the face of an increasingly urgent and important problem. According to the results of a survey applied to members of the Spanish Network of Cities for Climate, the lack of information is the fourth difficulty in the adoption of measures to combat climate change (Barroso et al., 2016).

In this article we explore the effect of a MOOC as a useful tool for improving SR of CC, that includes the three parts we have mentioned above, information, hierarchy of structures and attitudes. We can say that, due to the nature of the course, it is to be expected that the impact will be greater on the information that forms the SR of CC. It is very important to investigate whether information with scientific rigour presented in an orderly manner and with accessible language can serve to improve the SR of CC. This improvement in SR can produce a substantial change in society's attitudes and promote effective mobilisation against SR.

The research questions in this article are as follows:

- Does a MOOC based on CC science produce an improvement in the SR of CC?
- Does a MOOC based on climate change science produce an improvement in knowledge about adaptation and mitigation?
- Is there an association between age and fear of the consequences of climate change?

2. Methods

To test whether there are changes in the SR of CC after taking a MOOC in the science of CC, we applied a pre-experimental design, with pre-test and post-test measurements (Stanley & Campbell, 1973), to the participants of the second edition of the MOOC "Climate Change Awareness and Training for Primary and Secondary School Teachers", hosted by the MiriadaX portal[1] that we have developed in our research group.

1 https://miriadax.net

The main research instrument in this article is a questionnaire that is answered by MOOC participants on the MOOC´s electronic platform. The questionnaire used in this study is made up of three parts: in the first part we investigate knowledge, in the second section we investigate the feelings of the students around the CC and in the third part we explore the reasons why there is no action against Climate Change.

2.1. Participants

In the edition of the MOOC to which we refer in this article we had five hundred and thirty (530) participants doing the pre-test and two hundred and fifty-five the post-test. Due to the nature of the MOOC there were students from all over the world, from 24 countries, mainly from Latin America and Spain, and to a lesser extent from Italy, Portugal and Africa. As a first observation, these participants were 51% female and 49% male. The ages of the participants ranged from 14 to 72 years (M = 36.6, SD = 13.3).

By country of origin we have 38% Spain, 9% Mexico and 8.5% Argentina. The participants have a professional profile dominated by Education professionals. In the MOOC, 45.6% of the participants were teachers, 26% were non-teaching professionals and 28.3 were students. Interestingly, all the participants from Africa were teachers and 76% had completed university education.

2.2. Instrument

In order to explore the student's understanding of CC, we focused on the first two sections of the questionnaire. The first section is dedicated to the socio-demographic data we have collected, reflecting their age, gender, educational level, country of origin among other important data. The second section consists of 32 items (García-Vinuesa et al., 2019) designed to explore the interactions between scientific culture and common culture. The questionnaire measures the competence of the student to identify the scientific truth or falsehood of a series of statements, which are in fact true or false.

These statements are classified into four knowledge areas related to the first two principles of climate literacy according to the United States Global Change Research Program (USGCRP, 2009):

- Area 1. Physical processes related to CC (8 statements).
- Area 2. Causes of CC (10 statements)
- Area 3. Consequences of CC (10 statements)
- Area 4. Responses to CC (4 statements).

The questionnaire has logical statements containing scientific and objective facts, as well as common phrases about CC that could be found both in popular science literature and in the media.

The student has to decide between the degree of truthfulness of the statements using a 4-element Likert scale to evaluate the degree of students' knowledge and their SR of CC in general. Each statement has boxes where students evaluate the truthfulness of the

statement with the following options: “Totally True” (TT), “Probably True” (PC), “Probably False” (PF) and “Totally False” (TF). This scale allows us to measure the students' perception of the MOOC on a scale of 1 to 4, 4 being the maximum value of agreement between the scientific culture and the common culture.

The scientifically correct statements are taken from the 2013 and 2015 reports of the Intergovernmental Panel on Climate Change (IPCC). The ability of students to identify the validity of these statements is related to the ability to read, interpret and evaluate scientific texts properly and to an SR close to the scientific description of CC. In this section the answer "don't know / don't respond" has not been chosen to avoid a non-reflective or evasive answer. We hope that an individual's SR will be more scientific and closer to objective truth to the extent that it can correctly identify scientific statements and identify as false those statements that have no scientific validity or basis. Similarly, someone with a distorted SR of CC will fail to identify different statements as true or false.

2.3. Data analysis

The questionnaire is answered by MOOC students just before and after completion. Our analysis focuses on finding out how the students' ability to identify the truth or falsity of the statements presented and ultimately the SR of the CC varies between students.

We analyse the evolution of the sample between the pre-test and the post-test, looking for improvements in the area of knowledge and information about CC. We also analysed the difference in different subgroups of the sampled group, which indicates a variable level of adaptation to the course format.

Finally, we analyzed the part of the questionnaire dedicated to the feelings produced by the CC and the reasons why people do not mobilize against this phenomenon. For this particular section we applied a chi-square analysis to the items of categorical variables (feelings produced by CC and reasons for not acting against CC, associated with age and region respectively), to determine whether or not there is a relationship between the two variables. The Chi-square is a statistic of significance and must be accompanied by a statistic that determines the strength of association between the two variables. When both variables are dichotomous, the Odds Ratio (OR), is an excellent statistic to determine the size of the association. It can take values from 0 to positive infinity. When this is greater than 1, it is interpreted as the number of times something can happen over something that cannot happen. An OR of 1.5 to 2.4 indicates a weak association, 2.5 to 3.9 a moderate association, and greater than 4.0 a strong association (Rosenthal, 2012). When one or both variables are polytomous, the most commonly used measure is Cramer's V. This test is a form of correlation and is interpreted in exactly the same way. It can acquire values from 0 to 1. Values close to zero indicate no association, and values close to one indicate a perfect association. For a more precise interpretation of Cramer's V, the associations are considered to be weak (.10 and .19), moderate (.20 and .39), relatively strong (.40 and .59), strong (.60 and .79) and very strong (.80 and 1.00), (Rea & Parker, 2014). To determine which variable categories are significantly related, standardized residues (rh) were used. Their sign indicates the direction of the association and their values follow a normal distribution, so if they

acquire values ± 1.96, they are statistically significant. The level of significance used in all the contrasts is analysed under 5%.

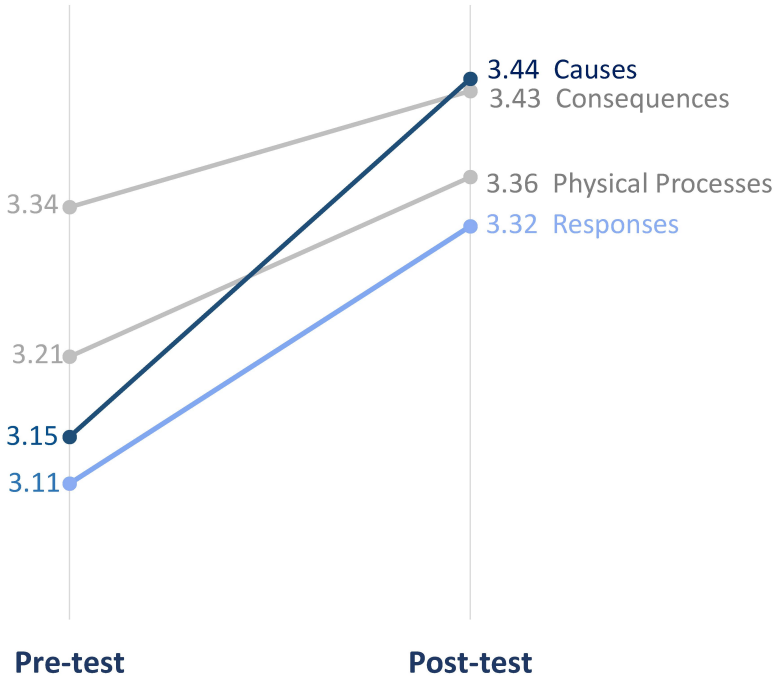
3. Results

As a first result we show the comparisons between the pre and post-test. One of the main objectives of this study was to investigate whether MOOC participants improved their knowledge of climate change related concepts given the characteristics of the sample.

Significant progress was observed in all areas of knowledge. Comparing the four different areas (Figure 2), we observe that Areas 3 (Causes) and 4 (Responses) show relatively greater improvement compared to Areas 1 (Definitions) and 2 (Consequences).

Figure 2

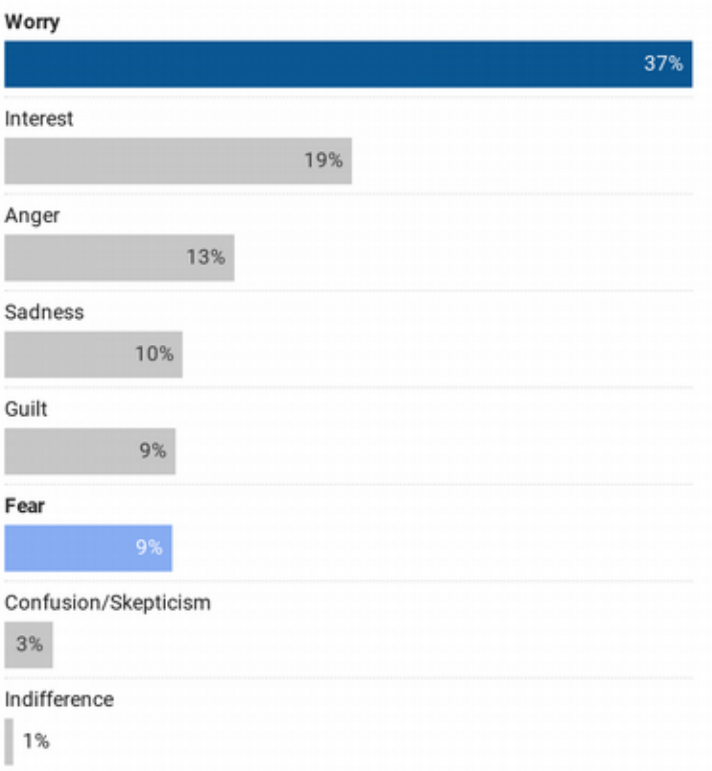
Average scores by area of study



Our analysis of the feelings section gives the following results. The three feelings that most participants have when they hear about climate change are worry, interest and anger with 37%, 19% and 13% respectively (Figure 3). The lowest feeling was indifference, with 1%. Sadness, guilt and fear are found with very similar percentages, between 9 and 10%.

Figure 3

Feelings towards Climate Change



Of all the feelings analysed for CC, fear is the only one that has a statistically significant association with age (χ^2 (2) = 13,860, p<.001). This relationship was found to be low and directly proportional (Cramer's V = .162, p < .001), which explains that 25% of young people (14 - 35 years) identify themselves twice as fearful or afraid of CC compared to individuals over 36 years of age (odds ratio = 2.1). This value increases to 6 if compared to people over 55 years (odds ratio = 5.89), where only 6 % of this group (Table 1), expressed fear of the consequences of CC (Figure 4).

Figure 4

Fear of Climate Change by age

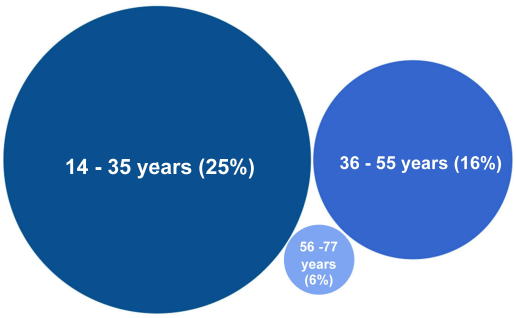


Table 1

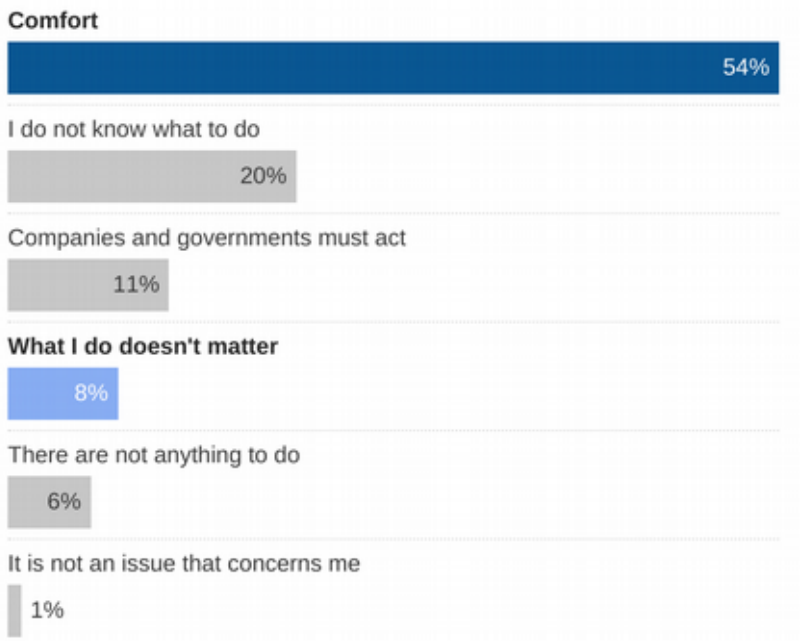
Contingency table of the age and fear variables for CC

	Fear				Total	
	Yes		No			
Age group (years)	n	%	n	%	n	%
17 – 35 (young)	74	25.3	218	74.7	292	100
36 – 55 (adult)	30	16.4	153	83.6	183	100
56 – 77 (senior)	3	5.5	52	94.5	55	100
Total	107	20.2	423	79.8	530	100

The main reason why participants do not act against Climate Change is "comfort", with more than half of the results (54%), followed by the option "they do not know what to do" with 20%. Only 1% identified themselves with the option "it is not an issue for me" (Figure 5).

Figure 5

Reason for not mobilising against CC

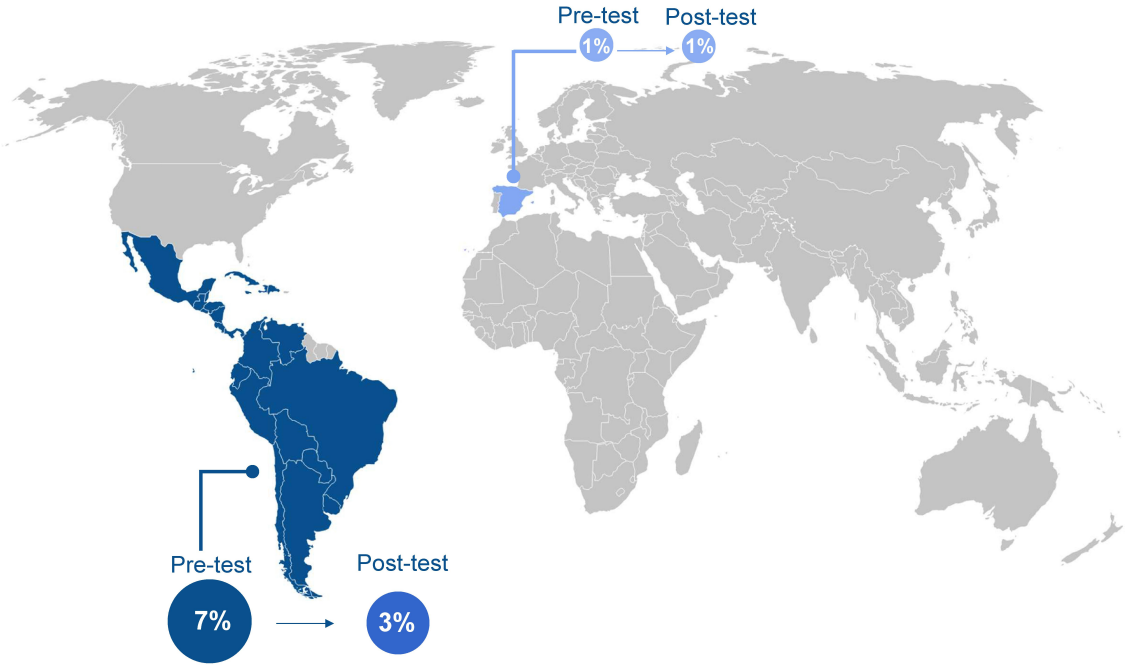


Of all the reasons for not mobilizing against the CC, the only one that presents a statistically significant association with the region (Spain and Latin America) is "what I do doesn't matter" (χ^2 (2) = 20,931, $p < .001$). This relationship was found to be moderately and directly proportional (Cramer's V = .202, $p < .001$), which explains why Latin Americans (rh = 2.4), at 7%, feel that it does not matter what they do to fight against CC, while Spaniards (rh = - 3.0), at 1%, do not feel identified with this category.

However, in the post-test no significant relationship was found between the two variables, (χ^2 (2) = 3,398, p .6.39), which means that the course positively changes the opinion that individual actions do matter, reducing the percentage to 3% in Latin Americans and remaining unchanged in Spaniards (Figure 6).

Figure 6

What I do against the CC does not matter, by region (Spain and Latin America)



4. Discussion or Conclusions

The initial results (pretest) of the four areas of scientific knowledge of the CC (physical processes, consequences, causes and responses) of our sample are similar to other previous studies (Meira-Cartea et al., 2018).

Participants improve significantly in all areas of scientific knowledge of CC after having taken the MOOC, proving our hypothesis that these courses are an alternative to improve the SR of CC, results that are shared with previous research (Bradley et al., 1999; Chawla & Cushing, 2007).

The results support the idea that a course that is largely based on scientific knowledge has the power to indirectly improve the understanding of non-scientific aspects of the issue, e.g. mitigation and adaptation, which have been included in the area of answers during the questionnaire. These results provide further support for the hypothesis that education is one of the main tools for mitigation and adaptation to CC, as suggested by the United Nations Framework Convention on Climate Change (Whitmarsh et al., 2011).

It was also observed that for those citizens who are more distrustful about the relevance of the impact of their actions against climate change, there is a positive change after the course has ended, which reinforces the idea that these courses are useful to change the predisposition in those who feel that individual actions are not significant in the fight against CC (Chengjie, 2015).

Of all the feelings analysed, the fear or dread of CC stands out, which, if compared with age, explains that it is young people between 17 and 35 who are most afraid of the consequences of this phenomenon. This explains events that have occurred in recent years, such as the creation at the end of 2018 of the youth movement called Friday For Future, promoted by Greta Thumberg, where young people went out to demonstrate every Friday of the week demanding stronger measures from their political leaders with more immediate results in the fight against the CC, which has had a great impact on a global level (Ruiz & Ferrari, 2019). Another example of a movement formed mostly by young people is the movement called Extinction Rebellion, formed in the UK and considered more radical than Friday For Future because it features civil disobedience (Aron, 2019).

In conclusion, education has an enormous power that can be channelled through new online training tools, such as the MOOCs, which improve the SR on CC, encouraging people who until then were incredulous and indifferent to act against this phenomenon, adopting adaptation and mitigation measures that will help save the planet.

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