

# **SUBJECTS THAT ADDRESS CLIMATE CHANGE AND STUDENTS' KNOWLEDGE: MAPPING PORTUGUESE MIDDLE AND HIGH SCHOOLERS' PERCEPTIONS**

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## **Abstract**

Studies have focused on students' perceptions of the importance of school for their climate change (CC) learning, but there are still gaps concerning students' perceptions of which subjects address CC. This is particularly relevant in countries where the approach to including this topic is cross-curricular, as in Portugal. Therefore, this study aims to map the subject areas where Portuguese students have learned about CC. Additionally, it intends to analyze the relationship between the reported frequency of classes addressing CC and perceived CC knowledge. The potential differences between school levels are also analyzed. A questionnaire was administered to 582 Portuguese middle and high schoolers, comprising one open-ended question regarding students' subject areas and a four-item Likert scale on CC subjective knowledge. Frequency analysis, Mann-Whitney U tests for paired samples, and Spearman correlation tests were used to analyze the observed outcome variables. Across middle and high school, students consistently reported Citizenship, Sciences, Physical and Chemical Sciences, and Geography as the main subjects of CC learning. During high school years, students additionally reported Biology and Geology, English, and Portuguese classes. Students reported a similar average knowledge of CC across all school grades. A correlation analysis revealed a positive association between the perceived frequency of classes addressing CC and subjective knowledge of CC. Despite the cross-sectional nature of the current study, the cumulative opportunities to learn CC throughout schooling seem not to impact students' perceived knowledge as it remains average from Grades 7 to 12. This raises a reflection on how CC is being integrated into the school curriculum and its impact on students' knowledge.

**Keywords:** *Climate change, formal education, school curriculum, student's perceptions, subjective knowledge.*

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## **1. Introduction**

The United Nations (2015) has increasingly emphasized the role of schools in promoting knowledge to address climate change (CC). National school curricula have included CC content through two approaches: a) cross-curriculum inclusion, resulting in CC being taught under various subjects; and b) a non-disciplinary or interdisciplinary space within the curriculum that facilitates the integration of CC education (Eilam, 2022).

In Portugal, as outlined in the Essential Learning Guidelines (Direção-geral da Educação, 2018), CC content can be covered in various subjects (e.g., Citizenship, Science, Geography, English). For instance, in the context of Citizenship, this topic is optional, and in certain subjects, the teaching guidelines provided are not objective, granting teachers the autonomy to determine strategies and depth to address CC. This subjectivity may result in variations in the curriculum at teacher and school levels. Hence, it is important to have a clearer understanding of the implementation of CC in Portuguese formal education. In light of this, students' perceptions are relevant to map the subject areas where CC has been addressed and their own perceived knowledge of the topic.

## **2. Objectives**

This study aims to: a) map the subject areas where the topic of CC has been addressed, from the perspective of Portuguese students; b) analyze the relationship between the perceived frequency of classes addressing CC and students' subjective CC knowledge; and c) analyze the potential differences between school levels in the study's variables.

### 3. Methods

Participants were 582 Portuguese students from 7<sup>th</sup> to 12<sup>th</sup> grades (see Table 1). The questionnaire comprised one open-ended question regarding subject areas where the topic of CC had been taught and the frequency with which it had been addressed (i.e., 1 - Once in a while; 2 - Sometimes; 3 - Many times). Additionally, a four-item Likert scale on CC subjective knowledge was used. Each item of the scale refers to a knowledge domain covered by Hoppe, Taddicken, and Reif (2018): CC in general, its causes, consequences, and mitigation actions. The response options ranged from low (1) to high (5). The scale showed a high level of internal consistency, with an  $\alpha = 0.864$  in the present study. The questionnaire was administered by the research team in the classroom context.

Table 1. Means and frequency distribution of the sociodemographic characteristics of the sample.

	Middle school	High school	Total
N=	300 (51.5%)	282 (48.5%)	582
Sex			
Female	144 (48.0%)	174 (61.7%)	318 (54.6%)
Male	156 (52.0%)	108 (38.3%)	264 (45.4%)
Age: <i>M</i> ( <i>SD</i> )	13.1 (1.1)	15.9 (1.0)	14.5 (1.8)

The software SPSS, version 25.0 was used for statistical analysis. Descriptive statistics were conducted to assess differences in socio-demographic characteristics. The data collected on subject areas where the topic of CC had been addressed was subjected to frequency analysis. Subject areas mentioned by fewer than 10% of all participants were excluded from the analysis. Since the outcome variables did not fit the normal distribution, Mann-Whitey U nonparametric tests for paired samples were selected to compare the two school levels. A Spearman correlation test was used to verify the association between the frequency with which participants perceived CC being addressed in classes and their CC subjective knowledge.

### 4. Results

The preliminary results offered no statistically significant differences in terms of participants' demographic characteristics. Across both studied school levels, participants consistently identified Sciences, Geography, Citizenship, Physical and Chemical Sciences, and as the main school subjects of prior or current CC learning (see Table 2). In addition, during high school years, participants also reported Biology and Geology, and more frequently, English and Portuguese classes, as contexts of CC learning. Students in high school reported a statistically significant higher number of subject areas where CC is addressed than students in middle school (see Table 3).

Table 2. Subject areas where each school level addresses CC, per frequency, and percentage of students.

Subject areas	Middle school	High school	Total
Biology and Geology		81 (28.72%)	81 (13.92%)
Citizenship	109 (36.33%)	98 (34.75%)	207 (35.57%)
English as Foreign Language	15 (5.00%)	71 (25.18%)	86 (14.78%)
Geography	132 (44.00%)	120 (42.55%)	252 (43.30%)
Physical and Chemical Sciences	58 (19.33%)	46 (16.31%)	104 (17.87%)
Portuguese as Mother Tongue	26 (8.67%)	59 (20.92%)	85 (14.60%)
Sciences	226 (75.33%)	86 (30.50%)	312 (53.61%)

Table 3. Means and differences between middle and high school on Mann-Whitney U tests for the study's measures.

Variables	Middle school <i>M</i> ( <i>SD</i> )	High school <i>M</i> ( <i>SD</i> )	<i>Z</i>
Reported disciplines	2.16 (1.14)	2.44 (1.05)	-3.18**
Perceived frequency of CC being addressed in classes	1.80 (0.69)	1.85 (0.64)	-0.83
Subjective knowledge	3.40 (0.77)	3.46 (0.71)	-1.13

Notes. \*\*  $p < .01$ .

Regarding the perceived frequency of CC classes and participants' CC subjective knowledge, results did not significantly differ between school levels (see Table 3). A Spearman's correlation showed a statistically significant positive relationship between the average frequency with which participants perceive CC being addressed in classes and subjective CC knowledge in middle school ( $r_s = 0.34$ ,  $p < .001$ ) and high school ( $r_s = 0.12$ ,  $p = .039$ ).

## 5. Discussion

The current study's findings offer relevant insights for educational practice, despite the limitations associated with its cross-sectional nature. Firstly, this data may encourage a reflection on the integration of CC into the Portuguese school curriculum. It is noteworthy that approximately one-third of the high schoolers in the present study continue to report classes more typically taught in middle school, such as Citizenship or Sciences, as the primary sources of CC formal learning. In line with the cross-curricular approach outlined in the Essential Learning guidelines (DGE, 2018), the study found that high schoolers associate a greater number of subject areas with which CC is taught. Although a complex issue such as CC is indeed difficult to encompass within a single subject area, the current study may highlight certain limitations of the cross-curriculum approach.

Data suggests that the cumulative opportunities to learn CC throughout schooling seem not to improve students' perceived knowledge as it remains average from middle to high school. This is consistent with the results of a systematic review by Bhattacharya, Carroll Steward, and Forbes (2021) that reported that prominent CC conceptions among middle school students were also present among high school students. The nature of the cross-curricular approach may contribute to this result, as students struggle to form the necessary connections between the fragments of knowledge covered in different subjects (Eilam, 2022). Consequently, it might become too challenging for students to understand the problem as a whole (Hoppe et al., 2018). Furthermore, the variations within the curriculum resulting from the teachers' autonomy to determine strategies and depth to address CC or other contents proposed in Essential Learning guidelines (DGE, 2018) may prevent students from correcting possible misconceptions over the years. That may lead students to perceive CC instruction at school as incomplete and meaningless (Pickering, Schoen, Botta, & Fazio, 2020; Baldwin, Pickering, & Dale, 2022).

All considered, future research could further explore students' perceptions of the adequacy of CC education in school, as well as their CC declarative, instead of subjective, knowledge. It would also be relevant to examine at a national level how CC is embedded in the school curriculum and, at a school level, which specific strategies are adopted by teachers when addressing CC.

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