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Preparing students for a changing world: how geography curricula in Europe are tackling climate change

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Climate change education has gained attention in recent years, with curriculum analyses conducted primarily at the national level. However, a comparative analysis of implementation in different European countries is still lacking. This study aims to address this research gap by comparatively examining the geography curricula of France, Spain, Germany, and Italy. The analysis reveals differences in the inclusion of physical-geographical content related to climate change. Likewise, the emphasis on either the natural or the socio-economic effects of climate change varies across the countries. All curricula include concrete competencies and learning objectives for climate education, but a gap is visible in social learning objectives. The analysis highlights the importance of exchanging best practices and experiences among European countries.

KEYWORDS

climate change education, education for sustainable development, curriculum analysis, Europe, geography curricula

1. Introduction

Thousands of demonstrating students at the Fridays for Future climate strikes show: The climate crisis is a relevant issue in the lives of many young people. They are concerned about their future in view of the effects of climate change (Hickman et al., 2021). Even from a society-wide perspective, anthropogenic climate change is currently one of the biggest global issues – action is needed immediately. Therefore, governments are concerned with raising both climate change awareness and sustainable action. One possible response on the part of the United Nations (UN) is Climate Change Education (CCE), framed within the concept of Education for Sustainable Development (ESD) (UNESCO, 2020). This concept is linked to the mandate for member states to implement ESD and climate change in national curricula. In this way, in addition to political action and technological progress, a societal transformation is to be achieved. But what does the transfer into curricula look like in Europe? This article examines the national curricula of France, Italy, Germany and Spain for the subject geography with a comparative curriculum analysis. The following questions will be answered:

- Are references to climate change included in European geography curricula?
- Which competencies and learning objectives on CCE are formulated in the curricula?
- To what extent do differences and similarities exist between countries with regard to teaching climate change?

The focus on geography is based on the relevance of this subject for ESD and climate change due to its special function as a bridging subject between natural and social sciences. The aim of the article is to derive implications for climate change education from the curricula and also to provide a basis for developing an escape game on climate change as part of the Erasmus+ project “ECCI”¹. After an overview of the theoretical background of ESD and CCE, the methodology of the systematic curriculum comparison developed as part of the curriculum analysis is presented. Subsequently, the study presents the results of the curriculum comparison, followed by a discussion.

Legal as well as policy guidance frameworks exist at various levels for teaching climate issues. Two educational policy approaches that address these issues are ESD and CCE. The former gets its political legitimacy, definition as well as topics and tasks from the global policy concepts on sustainable development of the UN as well as UNESCO, but also the EU, which has published a European Competence Framework for Sustainability (Bianchi et al., 2022 “GreenComp”). The first approaches of ESD, but also of CCE, stem from the 1992 UN Conference on the Environment in Rio de Janeiro. Here, the guiding principle of sustainable development was adopted globally and education about climate change and its impacts was anchored in Article 6 of the United Nations Framework on Climate Change (UNFCCC, 1992). Over time, ESD has been mainstreamed into the education systems of member states through numerous national and international programs. The title of the current international program (ongoing since 2020) is “Education for Sustainable Development: Toward achieving the SDGs,” or “ESD for 2030” for short. An educational goal behind CCE is to provide knowledge, skills, and behaviors on climate change, adaptation and mitigation, climate resilience, and climate justice to reduce vulnerability and prepare citizens for climate change and its consequences (Anderson, 2012). As a holistic framework, ESD can embed and advance CCE. This is demonstrated in part by the fact that climate change education is included in ESD as Sustainable Development Goal (SDG) 13 “climate action,” more specifically in Goal 13.3 “improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning” (United Nations General Assembly (UNGA), 2015). Although climate change education is theoretically included in ESD, it is still only one of a total of 17 SDGs in ESD (UNESCO, 2017). Unlike ESD, which is driven globally in a top-down process, CCE is more established as an academic research field and seldom as a fixed concept anchored via guidelines. Therefore, there is no uniform implementation of CCE (Læssøe and Mochizuki, 2015; Mulvik et al., 2022).

The 2018 PISA survey also asked students’ assessments of global issues, including climate change. The OECD average knowledge of the concept of climate change is 78% (Germany 83%, France 81%, Spain 81%, Italy 78%; OECD, 2020: 270). The percentages of students who are confident in explaining the effects of CO₂ emissions on climate change are lower: The OECD average is 63% (France 67%, Germany 61%, Italy and Spain 58%; OECD, 2020: 276). On the one hand, students – but also teachers – have misconceptions about the causes of climate change that become entrenched and persistent unless they are resolved, for example overestimating carbon flows from fossil fuels

or conflating ozone depletion and climate change (Schuler, 2011; Jarrett and Takacs, 2020). Second, students often lack the necessary background knowledge to understand climate change scientifically (Lombardi and Sinatra, 2012; Monroe et al., 2019). Furthermore, the topic is both scientifically and ethically complex, and modeling climate scenarios is still fraught with uncertainty (Chang and Pascua, 2017; Monroe et al., 2019). Environmental psychology studies show that belief in, as well as knowledge about, climate change exerts only a small influence on a person’s actual climate-smart actions as well as behavior (Dijkstra and Goedhart, 2012; Hornsey et al., 2016). A disconnect between climate change knowledge and action is also noticeable in schools (Reid, 2019). In the 2018 PISA study, German students performed the worst of all countries in terms of readiness for sustainable action, Italian students the third worst, and French students the fourth worst. Spanish students are also below the OECD average, although they are above the OECD average in climate change awareness. On average, 88% of school principals surveyed report having climate change embedded in their school curriculum, compared to less than 60% in Italy (OECD, 2020). Despite the curricular and educational legitimacy of the topic, the concrete implementation of CCE in the classroom is a challenge. As a result, some teachers are not confident in teaching climate change; in a UNESCO (2021a) study, less than 40% of respondents said they were confident enough to do so, and only 1/3 felt able to explain the effects of climate change on their own region. Monroe et al. (2019) examine what effective CCE strategies exist as a systematic review of 49 empirical studies that address climate change education. Overall, they identify several strategies, such as creating personal relevance for students, activating teaching methods, contact with scientists and inquiry learning, addressing misconceptions, and school or community projects. They see a gap in their analysis in educational programs that address climate change from both a science and a social science perspective.

Internationally, the subject of geography is considered one of a few “core” subjects of ESD (Yli-Panula et al., 2020). This originates in the thematic proximity between ESD, sustainable development, and geography, which, as a link between natural and social sciences, facilitates an integration of ESD into curricula (Granados-Sánchez, 2022). Since 2007, a positioning of the International Geographical Union on the contribution of geographic education for ESD exists with the Lucerne Declaration on Geographical Education for Sustainable Development. In addition to criteria for curricula in geography, the declaration also mentions geographic competencies and subject knowledge that can be promoted through sustainable development and ESD in the subject (Haubrich et al., 2007). A proximity between subject and content can also be postulated for climate change, especially because climate change as a complex natural science process takes place on different spatial scale levels as well as on temporal scales, and anthropogenic influences cause consequences that require adaptations or changes on different levels (Thieroff et al., 2021). In addition, the subject’s future-orientation, topicality-orientation, and multi-perspectivity result in further correspondences with the educational goals of ESD and CCE (Deutsche Gesellschaft für Geographie e.V., 2020). References to ESD are also evident in geography textbooks. However, Lindau and Kuckuck (2022) identify that only small proportions of questions in the Bavarian and North Rhine-Westphalian textbooks deal with the competence area of action in the context of an ESD. Instead of illustrating complex options for

¹ ecciproject.eu.

action and related conflicts, the tasks rather show individual recommendations for action for students, which resemble an instructional approach. Chang and Pascua (2017) examine the influence of geographic thinking on CCE among Singaporean students. They find that geographical concepts of place and scale, especially global scale, are insufficiently developed and instead students have a strong sense of place in Singapore. Climate change is therefore understood as an issue that does not affect Singapore due to the physical environment and thus appears to be of little interest. However, promoting geographic thinking can lead to correcting misconceptions and understanding climate change as a global, holistic problem.

Both the UN and UNESCO have conducted studies in the past that address the incorporation of ESD or climate change topics in policy documents of their member states. For example, the UNESCO (2021a,b), which commissioned the overarching study “Learn for our planet” to examine national framework curricula as well as education sector plans for references to climate change. Currently, almost half (47%) of the 100 national curricula examined do not contain any references to climate change; in addition, the mentions – when present – tend to be superficial. More climate change content is found in the vulnerable regions of Oceania (26%) and Sub-Saharan Africa (31%) than in Europe and North America (9%) (UNESCO, 2021a). Moreover, analyses exist that examine the integration of CCE into curricula at the (sub) national level, such as Wynes and Nicholas (2019) for Canadian science curricula for secondary schools. They find that learning objectives predominantly refer to cognitive knowledge about the climate system, global warming, and anthropogenic influence, while consequences of climate change or measures against climate change are neglected. In this context, the Canadian interpretation of CCE in some curricula is not consistent with the scientific consensus on climate change. In Germany, the first references to climate education can be found in the curricula since the 1990s. Overall, the consideration of anthropogenic causes of climate change dominates, with other categories (impacts, climate protection) sometimes reduced and subsequently added over the years after holistic introduction. In 2020, however, 15 of 16 states include causes as well as impacts and climate protection (Klüsener and Wittlich, 2023). The current state of embedding climate education in Germany shows that basic concepts of climate change and the climate system dominate the education plans. Climate change impacts are mostly related to the environment, while socio-economic impacts are less often included. The most diverse and strongest implementation of the topic is in the subject of geography (Siegmond Space & Education gGmbH & Research Group for Earth Observation, 2021). Studies that examine references to ESD or even CCE in the curriculum internationally are rarer for the subject of geography. One example is a study by Bagoly-Simó (2014), which analyzes ESD references in middle school geography curricula in Bavaria, Mexico, and Romania. The extent to which climate change is addressed in geography and science curricula at the middle school level is analyzed by Dawson et al. (2022) for Australia, Canada, Finland, Indonesia, Israel, and England. They conclude that countries vary widely, but all integrate the topic into curricula (geography and/or science). Also predominant is the teaching of knowledge about the causes of climate change. Concrete measures for action are mentioned less frequently.

2. Methods

2.1. Sample

To gain insight into the competencies and content embedded in European geography curricula, nationally valid curricula (France $n=3$, Italy $n=2$, Spain $n=2$, Germany $n=2$) for middle and high school education were selected as the tertium comparationis ($n=9$) with the help of native speakers. These countries, being among the most populous in Europe (total population of 257.4 million people of 446.8 million people in EU-27), were deemed suitable for this study as they represent a significant number of European pupils and have an important role in European education policy. In addition, these are the participating countries in the ECCI project. However, challenges in comparison arose from the fact that the countries have different types of schools, and that geography is sometimes taught in conjunction with history (France, Spain, and Italy). In addition, timetables for geography and the grade levels vary. To cover these differences, curricula for both Lower Secondary Level and Upper Secondary Level were analyzed for the type of school that leads to the university entrance qualification. Furthermore, geography-related subjects like “biology and geology” in Spain or “life and earth sciences” in France were also analyzed ($n=4$). In Spain and Germany, the educational systems are federally organized, meaning that the autonomous provinces or the Länder develop their own curricula. In Spain, the central government has issued an overarching decree in the Official Gazette (Boletín Oficial del Estado, BOE) that includes knowledge, competencies, and skills that Spanish students should acquire regardless of the autonomous region in which they attend school, and this decree will be analyzed. For Germany, the curricula of North Rhine-Westphalia (NRW), the most populous state, are selected.

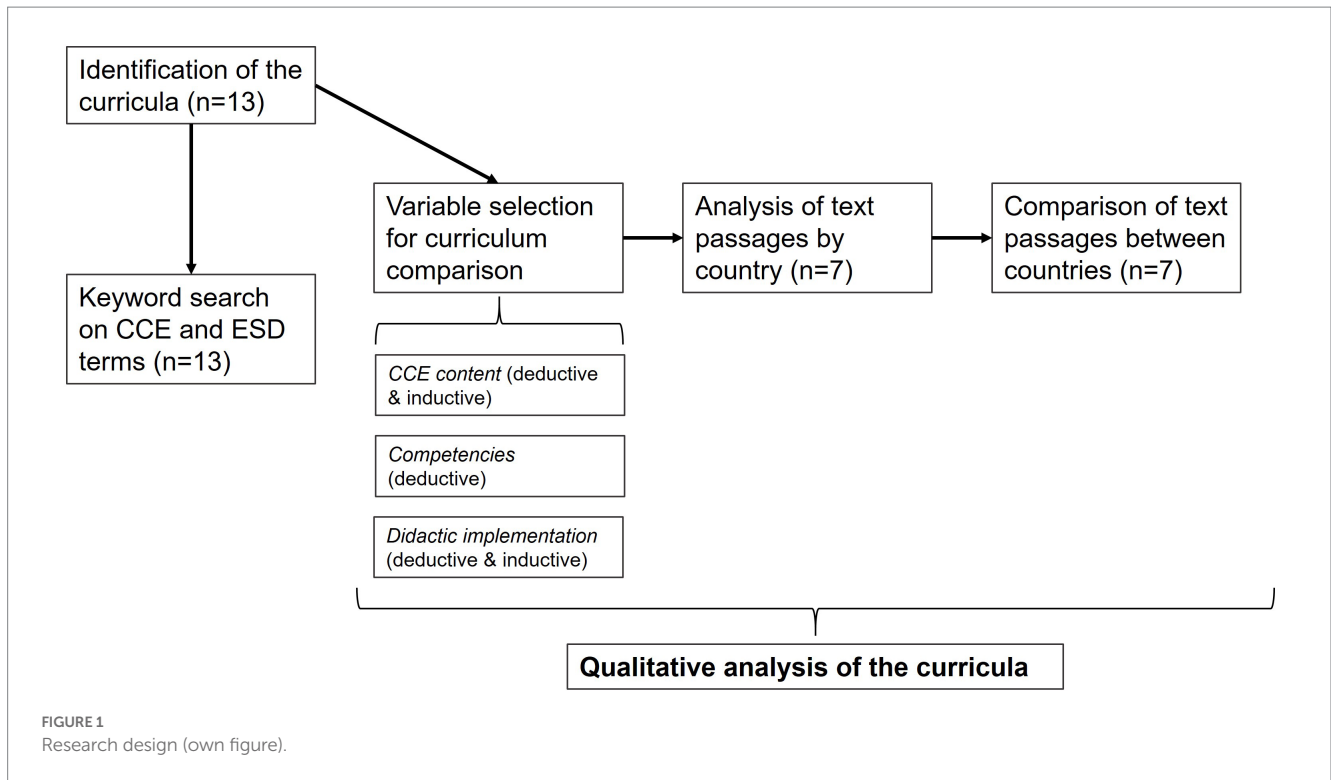
2.2. Research design

The research design is a mixed methods design. First, a keyword search is used to identify relevant text passages on ESD and CCE in all curricula. Additionally, a qualitative comparison of the curricula, which is divided into a country-specific and a country-comparative approach (see Figure 1).

2.3. Keyword search

After identifying the sample ($n=13$), a keyword search is conducted using MAXQDA software (see Supplementary Table S1) to identify mentions related to CCE and ESD in the selected curricula, based on keywords of the UNESCO (2021b) study “Learn for our planet”.

2 One German core curriculum covers both the Upper Secondary Level and the advanced course.



2.4. Qualitative analysis of the curricula

The curriculum analysis methodology used in this study combines the perspective of educational science and the structure for comparative studies according to Phillips and Schweisfurth (2008) with the geographical approach of systematic comparison according to Wilcke and Budke (2019). The methodology is based on the method of systematic comparison. The relevant variables for comparison are determined using qualitative content analysis (Mayring, 2022) and the comparison units (curricula) are compared to identify differences and similarities between the countries.

2.4.1. Variable selection for curriculum comparison

Central comparison parameters for the qualitative curriculum comparison are determined deductively from the literature and inductively supplemented during the analysis using qualitative content analysis. These parameters relate to (a) *CCE content*, (b) *competencies*, and (c) *didactic implementation* (see Supplementary Table S2).

The comparison parameters on CCE content are derived from the components of CCE, including causes (C.1), consequences (C.2), and actions (C.3) of climate change (Anderson, 2012), and guided by existing coding guides on curriculum analyses (Siegmond Space & Education GmbH & Research Group for Earth Observation, 2021; Klüsener and Wittlich, 2023). An inductive category development is evident in the upper category C.5 (implicit references to climate change), as well as in the differentiation of the subcategories. The resulting six upper categories and their subcategories are presented in Table 1.

In analyzing the competencies listed in the curricula, a deductive approach is taken, using the competency framework

TABLE 1 Coding guide for climate change content.

Category	Sub category
C.1 causes of climate change	C1.1 natural causes
	C1.2 anthropogenic causes
C.2 consequences of climate change	C2.1 climate system/extreme weather events
	C2.2 ecosystems
	C2.3 socioeconomic consequences (vulnerability)
C.3 measures	C3.1 adaptation
	C3.2 mitigation
C.4 climate system	
C.5 implicit connections to climate change	
C.6 climate politics & climate justice	

“ESD Learning Objectives” of UNESCO (2017) for classification and comparison. It breaks down separate learning objectives in more detail for each of the 17 SDGs, divided into cognitive, social, and behavioral domains. Learning objectives for SDG 13 “Climate Action” (UNESCO, 2017: 36) are included in the qualitative analysis to address specific references to climate change (see Supplementary Table S3). Due to its global policy impact, the competency framework provides guidance for all countries under study.

The proposed didactic implementation is understood as the information given in the curricula regarding the practical

implementation on the topic of climate change, whereby guiding perspectives of the subject of geography are also taken into account (see [Supplementary Table S3](#)). The curricula are analyzed both deductively and inductively. Aspects of geography that are considered core components of the subject are included deductively. The deductive analysis includes aspects of geography that are considered core components of the subject, such as different spatial scales, multi-perspectivity ([Vasiljuk and Budke, 2021](#)), and the proportions of physical and human geography. Additionally, intracurricular connections identified by [Monroe et al. \(2019\)](#) are included deductively.

2.4.2. Procedure of the curriculum comparison

When comparing curricula, the initial step involves verifying the presence of previously constructed variables (refer to Section 2.4.1) within the curricula of the selected sample countries. In this case, only the curricula pertaining to the subject of geography ($n = 7$) are included and analyzed using MAXQDA software, as the research questions relate to the subject of geography. The subsequent qualitative comparison involves contrasting text passages assigned to the variables across the countries. Since the text length of the curricula addressing each variable varies significantly among the countries, as the overall length and level of detail of the curricula varies greatly from one another, a quantitative analysis is not conducted. Instead, the focus lies on examining qualitatively whether and how precisely the variables (CCE content, competencies, and didactic implications) are described and embedded within the curricula.

3. Results

The results of the curriculum analysis are divided into results of the keyword search and a qualitative analysis, with the qualitative analysis first focusing on the results of the individual countries and then presenting them comparatively.

3.1. Keyword search

In all the documents examined, there are mentions in the upper category CCE. The vast majority of mentions (64.1%) are for the words “climate change” or “change in climate.” The second most frequently mentioned words are “climate crisis” or “climate emergency” (14.1%). Overall, the upper category ESD ($n = 135$) predominates over the upper category CCE ($n = 64$). The most mentions of all curricula for the upper category CCE are found in the curriculum of the French subject earth and life sciences for Lower Secondary Level ($n = 15$). In France, there seems to be a stronger focus on the topic area in this subject in the lower grades than in geography ($n = 10$). In the Upper Secondary Level, however, the mentions on sustainability and climate change are almost identical in both subjects. In the Spanish Lower Secondary Level, the subject geography contains more mentions on climate change ($n = 5$) than biology-geology ($n = 2$). In all countries, the subject geography shows slightly more mentions of climate change in the Lower Secondary Level than in the Upper Secondary Level (see [Figure 2](#)).

3.2. Qualitative analysis of the curricula by country

3.2.1. Germany/North Rhine-Westphalia (NRW)

3.2.1.1. CCE content

The topic of climate change is taught in Lower Secondary Level from grade 7 in content area 5 “Weather and climate.” The students should first gain an understanding of the geophysical and climatological basics (C.4) (e.g., illumination and temperature zones, climate elements, water cycle) in order to understand climate change. Both natural and anthropogenic causes and regional consequences are mentioned. Climate change measures, such as adaptation and mitigation, are considered from different perspectives at the local level. In the curriculum for the Upper Secondary Level, references to climate change can be found in content area 1 “Habitats and their natural and anthropogenic threats.” Not only climate change, but also natural geographic phenomena and landscape zones are considered. The causes of climate change include both anthropogenic (C1.2) and natural (C1.1) factors. Regarding anthropogenic causes, possible impacts are addressed. However, the examples all refer to the climate system [C2.1; [Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen \(MSB\), 2014](#)], not to impacts that only affect society (e.g., health problems, migration). Measures to address climate change (mitigation as well as adaptation) are mentioned but not elaborated. Implicit references to climate change are also found in content area 1. Students should explain the effects of human interventions that affect the vulnerability of people, the environment and the climate system using the example of droughts, desertification and floods. Further references to climate change arise from the content area “Spatial effectiveness of energy sources and energy use,” where the effects on climate change, but especially mitigation measures (C3.2), are addressed on the basis of fossil and renewable energies.

3.2.1.2. Competencies through CCE

For each content area, the curriculum of Lower and Upper Secondary Level specify concrete competency requirements for factual and judgmental competencies. In the Upper Secondary Level (content area 1), students should be able to explain anthropogenic influences and effects on the climate, which is congruent with the cognitive learning objectives (knowledge of the consequences of climate change at different spatial levels) of [UNESCO \(2017\)](#). Also indicated are competencies that can be attributed to behavioral learning objectives on climate change. Three relate more implicitly to climate change (measures for droughts, flood prevention, overcoming natural limits of use), while one competency deals with the assessment of “Ways to limit the global temperature increase” ([Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen \(MSB\), 2014](#): 23). Further competencies are listed in content area 2 “Spatial effectiveness of energy sources and energy use”: As a factual competence, it is stated that students can explain the “influence of fossil energy sources on climate change as well as the importance of renewable energies for sustainable resource and environmental protection” ([Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen \(MSB\), 2014](#): 24), which is in congruence with the cognitive learning objectives of [UNESCO \(2017\)](#) (understanding climate change as anthropogenic and caused by greenhouse gases). In the curriculum for Lower Secondary Level, seven cognitive learning goals and one behavioral learning goal can be found on

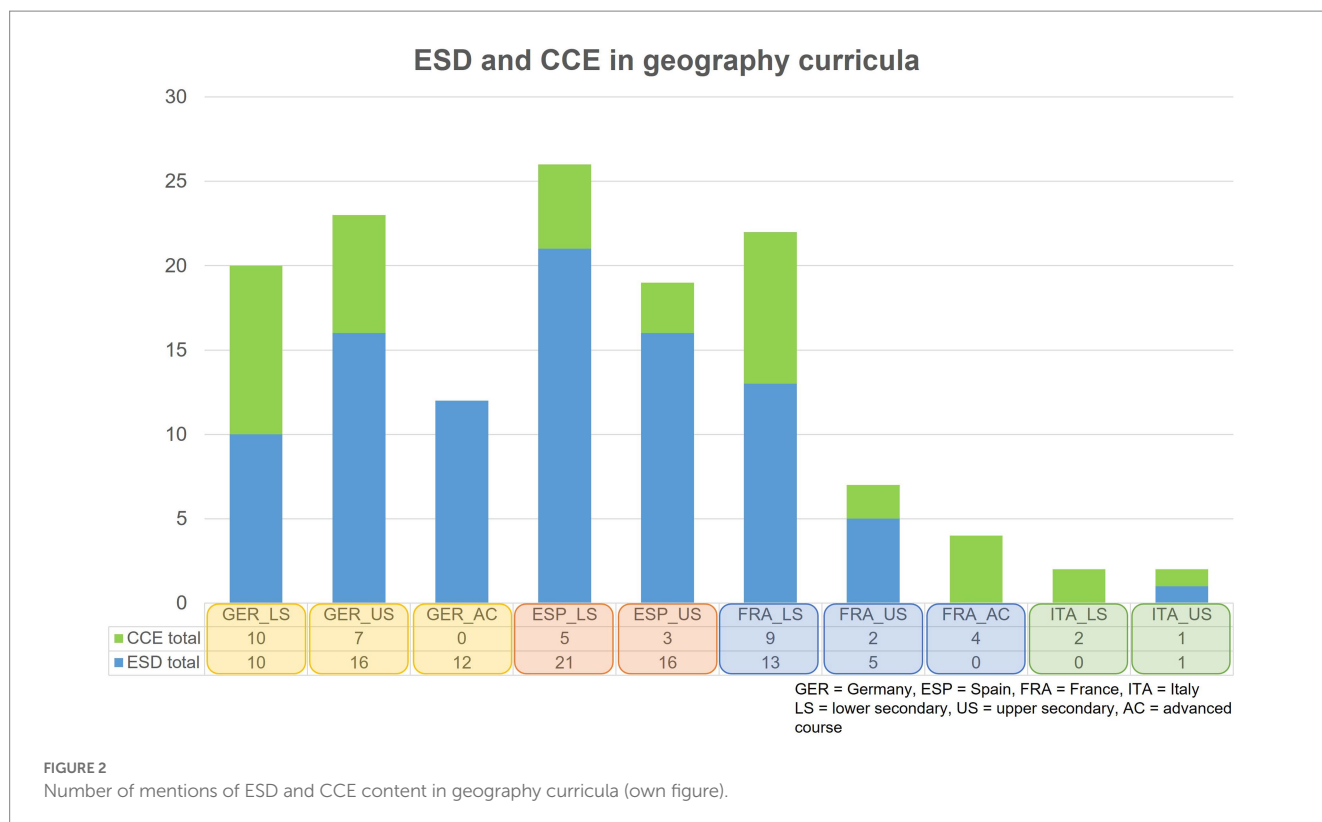


FIGURE 2
 Number of mentions of ESD and CCE content in geography curricula (own figure).

climate change according to UNESCO. The cognitive learning objectives refer to causes of climate change, mentioning the greenhouse effect, which according to UNESCO as a cognitive learning objective should be understood by the students as a natural phenomenon. Further cognitive learning objectives (3 and 5, see [Supplementary Table S2](#)) are also reflected in the description of the competencies. Likewise, students should be able to assess mitigation and adaptation measures (cognitive learning goal 5; UNESCO, 2017). The judgment competence, to discuss “Approaches to avoid climate-damaging behavior in everyday life” [Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (MSB), 2019: 27], can be assigned to a behavioral learning goal of UNESCO – assessing whether activities are climate-friendly or not. Social and emotional learning objectives cannot be identified in either curriculum.

3.2.2. France

3.2.2.1. CCE content

In the French curriculum, topic 3 “The environment, from local to global” in the second grade of Lower Secondary Level deals with the topic of global climate change and its regional effects. The effects or risks of climate change and measures to counteract them are the focus of this topic area. Risks mentioned in the curriculum – including industrial, health and technological risks – refer to category C2.3 humans (vulnerability). Causes of climate change are not mentioned in the description, but measures (adaptation as well as mitigation) in connection with SDG 13 are. Implicit references to climate change (C.5) arise from topic area 2, which also deals with migration due to climate change (Ministère de l’Education nationale, de la jeunesse et des sports, 2015). In the first year of Upper Secondary Level, teachers have the opportunity to integrate climate change as a case study in

Theme 1 “Societies and environments: fragile balances” in 12 to 14 lessons. Here, the effects of climate change on a densely populated area are to be addressed (C2.3). However, the reference to the topic of climate change remains optional. In the advanced course of the subject “History, Geography, Geopolitics and Political Science,” students work for 26–28 h on topic 5 “The environment, between exploitation and protection: a global issue,” in which climate change is integrated as one of two focal points. In addition to climate changes from the Middle Ages to the 19th century, the main focus is on the effects of climate change on society, which are addressed from an international perspective under consideration of international cooperation and climate policy (C.6) (Ministère de l’Education nationale, de la jeunesse et des sports, 2019c: n. pag.).

3.2.2.2. Competencies through CCE

In the French curriculum for Lower secondary education, competencies are not identified separately. There is only a description of the teaching approaches and contents for the respective topics, so that possible addressed competencies are derived from the contents by the authors. In topic area 3 on climate change, policies for adaptation, prevention and mitigation of climate change as well as regional impacts of climate change should be addressed, which corresponds to cognitive learning objectives of UNESCO (2017). The Upper Secondary Level curriculum does address some goals of geography instruction that are intended to promote methodological competencies, such as the ability to read or create maps. Explicitly mentioned in connection with climate change is the ability to explain the term “climate change.” From the contents of the content field itself, it can only be deduced that the students learn about the effects of climate change (UNESCO cognitive learning goal 4). In the curriculum for the advanced course, no direct climate change competencies are listed, only skills that relate to the general subject

(e.g., working independently or being able to express oneself orally). Therefore, possible competencies are again derived from the content by the authors. As in the other French curricula for Lower Secondary Level and Upper Secondary Level, effects of climate change are addressed. Also considered is international climate policy, which will promote behavioral learning goal 4 “The learner is able to promote climate-protecting public policies.” (UNESCO, 2017: 36). Social and emotional learning goals or competencies cannot be identified in any of the French curricula.

3.2.3. Spain

3.2.3.1. CCE content

In the Spanish decree, basic knowledge is divided into three blocks. Climate change is mainly addressed in block A “Challenges of today’s world” in the first two grades of Lower Secondary Level. One knowledge area relates to “Climate emergency” [Boletín oficial del Estado (BOE), 2022a: 41683]. Climate elements and factors (C.4) are addressed, as is human activity as a cause of climate change (C1.2). The impacts (C.2), or “climate risks and disasters” (Boletín oficial del Estado (BOE), 2022a), of climate change are considered from different temporal perspectives (present, past, future). Particular mention is made of impacts of climate change on humans in terms of vulnerability (C2.3), as well as opportunities for adaptation (C3.1) and mitigation (C3.2). An implicit reference to climate change (C.5) is recognizable in the same block in sustainable urban development as well as in block C, “Civic engagement,” on sustainable mobility (Boletín oficial del Estado (BOE), 2022a: 41685). In the third and fourth grades of Lower Secondary Level, “Climate emergency and sustainability” (Boletín oficial del Estado (BOE), 2022a: 41688) is mentioned in block A as a key point related to the SDGs as well as the relationship between natural and anthropogenic factors on Earth, technological progress, and conflicts (ideological, ethno-cultural), but is not elaborated. Implicit references to climate change can be identified in the keyword “Information Society” under problems of disinformation (Boletín oficial del Estado (BOE), 2022a). Block C also includes the item “Action and position on climate emergency” in these grades (Boletín oficial del Estado (BOE), 2022a: 41689). In the decree for the Upper Secondary Level, the subject geography is illustrated separately from the subject history; geography can optionally be taken by the students in the humanities and social sciences in the second year [Boletín oficial del Estado (BOE), 2022b]. Climate change, referred to as “climate emergency,” is given as an example of an eco-social problem in Spanish society (Boletín oficial del Estado (BOE), 2022b: 153). Content on climate change refers exclusively to block B of the basic knowledge: “The sustainability of Spain’s physical environment.” The diversity of the Spanish climate is addressed (C.4), in connection with the climate emergency and changes in temperature and precipitation (C2.1). Causes and consequences of climate change are also mentioned, but not broken down. Measures are differentiated between mitigation and adaptation (C3.1 & C3.2).

3.2.3.2. Competencies through CCE

Extensive descriptions of competencies are formulated in the decree. A total of nine competencies are described for the Lower Secondary Level, and their evaluation options are presented. References to climate change can be found in the competency descriptions as well as in all three thematic blocks. As a competence, students should analyze the environment and the complex systems in which it is embedded. In the

description, the climate crisis is specifically addressed, and students are expected to both understand the consequences and learn to behave in a way that respects other living beings in the spirit of sustainable development. In the description of the basic knowledge for block A (first and second grade of Lower Secondary Level), cognitive learning objectives regarding climate change can be identified on climate elements, the influence of human activities on the climate, present, past and future effects of climate change, and vulnerability and prevention. For third and fourth grade, the decree mentions a commitment to environmental protection and action in light of climate change in block C (Boletín oficial del Estado (BOE), 2022a). In the Upper Secondary Level decree, two climate change learning objectives can be identified. Students should become aware of their individual and their collective responsibility in the face of the climate crisis (Boletín oficial del Estado (BOE), 2022b: 153), which can be assigned to the social learning goals of UNESCO (2017). Derived from the contents of block B (knowledge about the causes, consequences and measures regarding climate change), all cognitive learning objectives can also be addressed in this area – even if not explicitly named.

3.2.4. Italy

The subject of geography has a low status in Italy (Morri, 2022). In certain areas of the school system (Istituti Tecnici), for example, the subject is not taught. Moreover, the national curricula (Indicazioni nazionali) serve only as guidelines and do not include compulsory content – each school autonomously creates its own educational plans. The curriculum for the Lower Secondary Level is rather superficial. In addition to a presentation of the subject’s mission statement, which also mentions climate change as a topic area of particular relevance to geography education [Ministero dell’Istruzione, dell’Università e della Ricerca (MIUR), 2012], the curriculum contains broadly defined competencies under the headings of orientation, geographical language, landscape, and region and territorial system. Mandatory content fields or competencies – specifically related to climate change – cannot be identified, which is why a qualitative evaluation is omitted. For the Upper Secondary Level, the curriculum for the Liceo Classico is analyzed (Ministero dell’Istruzione, dell’Università e della Ricerca (MIUR), 2010). Geography is taught there together with history; geography lessons take place in the first two years. The description of the contents and competencies of the subject is kept short with half a page (388 words). Sustainable development is understood here as a focus topic, with climate change given as an example. Specific competencies or contents on climate change are not given either, which is why a qualitative evaluation is omitted.

3.3. Comparison of text passages assigned to the variables between the countries

3.3.1. CCE content

The Table 2 shows which specific contents on climate change are included in which curriculum. It can be seen that climate change is integrated into the analyzed curricula (France, Germany, and Spain) with important components of CCE (including causes, measures and consequences, Anderson, 2012). In the curricula in Germany, climate change impacts mentioned by way of example refer exclusively to the climate system (C2.1); impacts on humans are mentioned implicitly only in the upper grades in connection with droughts. The impacts

TABLE 2 Content analysis of the curricula in relation to CCE (own illustration).

	C.1 causes		C.2 consequences			C.3 measures		C.4 climate system	C.5 implicit connections	C.6 climate politics & climate justice
	C1.1 natural causes	C1.2 anthropogenic causes	C2.1 climate system/ extreme weather events	C2.2 ecosystems	C2.3 socioeconomic	C3.1 mitigation	C3.2 adaptation			
ESP_LS										
ESP_US										
FRA_LS										
FRA_US										
FRA_AC										
GER_LS										
GER_US										
GER_AC										

Legend: Only category is named, no subcategories: ESP, Spain; FRA, France; GER, Germany; LS, Lower Secondary; US, Upper Secondary; AC, Advanced Course.

mentioned in the French curricula for lower and upper secondary level only refer to society (C2.3). Both Spanish decrees take up impacts as an upper-level category. In the upper secondary level decree there is a reference to the subcategory climate system/extreme weather (C2.1), in the lower level there are mentions of socio-economic impacts and impacts on ecosystems. Overall, socioeconomic impacts are mentioned more often than climate system or ecosystem impacts in all curricula (C2.2). Climate change mitigation measures are addressed in all curricula. The terms “mitigation” and “adaptation” are usually mentioned simultaneously as different solutions. Nevertheless, mitigation measures outweigh adaptation measures overall in the explanations of these measures. With regard to the causes of climate change, natural causes are only mentioned in the curricula of Germany in a joint context with anthropogenic causes (“Causes and consequences of natural and anthropogenic climate change,” [Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen \(MSB\), 2019: 15](#)). In the Spanish decree for the upper secondary level only “causes” are given without further explanation, while the category is completely missing in the French curricula.

Further differences can be seen with regard to the consideration of geophysical or climatological basics. While the students in Germany and Spain are supposed to develop an understanding of these physical geographic basics in both lower and upper secondary level, this is missing in the French curricula for geography.

3.3.1.1. Competencies through CCE

Because the level of detail of the competency descriptions of the curricula varies widely (from not explicitly stated in France, to extremely detailed in Spain), it is difficult to make comparisons. It is worth noting that all curricula, except for the French advanced course curriculum, list competencies or content that are intended to promote the specific learning goals of UNESCO’s SDG 13 (see [Table 3](#)). There are also gaps in the curricula regarding the greenhouse effect or greenhouse gases as a cause of climate change, which are listed twice in the UNESCO cognitive learning objectives. However, they are only mentioned in two curricula: the curriculum for Upper Secondary Level in Germany and Lower Secondary Level in France. Additionally, social learning goals, such as encouraging others to take action on climate, collaboration to develop strategies to address climate change, and understanding one’s own impact on climate ([UNESCO, 2017](#)), are left out. Another learning goal not addressed in the curricula relates to behavioral learning goal 2, advocacy for people affected by climate change ([UNESCO, 2017](#)). Some competencies in the curricula expand on the [UNESCO \(2017\)](#) competencies and learning objectives. For example, the Spanish decrees mention meteorological data collection methods and diagram interpretation on the topic of climate change ([Boletín oficial del Estado \(BOE\), 2022a: 41683](#)), as well as weather interpretation strategies and the use of mobile apps and websites for high school ([Boletín oficial del Estado \(BOE\), 2022b: 157](#)).

3.3.1.2. Proposed didactic implementation of CCE in the curricula

Common to all curricula is the geographical consideration of content from different, changing spatial perspectives (local, regional, global). This is also defined as a core component of geographical thinking in the introduction to the subject of geography and history for Lower Secondary Level in the Spanish curriculum ([Boletín oficial del Estado \(BOE\), 2022a: 41675](#)). In describing general objectives of the subject of geography in the

TABLE 3 Climate change learning objectives in the curricula (own illustration).

Countries	Cognitive learning objectives	Social and emotional learning objectives	Behavioral learning objectives
ESP_LS			
ESP_US			
FRA_LS			
FRA_US			
FRA_AC			
GER_LS			
GER_US			
GER_AC			

ESP, Spain; FRA, France; GER, Germany; LS, Lower Secondary; US, Upper Secondary; AC, Advanced Course.

French higher secondary level, a multiscale approach is also emphasized, promoting the alternation of different spatial perspectives as well as complex interactions between different actors on the one hand and their environment on the other (Ministère de l'Éducation nationale, de la jeunesse et des sports, 2019a: n. pag.). However, specifically related to climate change content, the linking of different spatial perspectives can only be seen in the French and German curricula: In the curricula for Lower Secondary Level, climate change impacts are to be analyzed on a regional level and climate protection measures are to be dealt with on a local, and in France additionally on a regional or national, level. There is a clear difference in the way the topic of climate change is approached geographically: In France, the physical-geographical basics of how climate change works (including the influence of humans through the emission of greenhouse gasses or the difference between weather and climate) are dealt with in the subject life and earth sciences and not in geography lessons (Ministère de l'Éducation nationale, de la jeunesse et des sports 2019b). In Germany and Spain, on the other hand, the geophysical background is taught as a component of geography; in the Spanish curriculum for the upper secondary level this is already made clear by the description of the subject block: "The sustainability of Spain's physical environment." The interdisciplinary approach in France (history and geography, and in the advanced course even four different subjects in the interdisciplinary system) and Spain is different from that in Germany. Thus, the temporal approach is also part of geography, which is expressed in the French advanced course, in which the students look at past climate changes: "Climate fluctuations and their effects: climate change in Europe from the Middle Ages to the 19th century." The Spanish curriculum for Lower Secondary Level also notes that the aim of the lesson is to develop and interpret dimensions of time and space (Boletín oficial del Estado (BOE), 2022a: 41675). Similar temporal references to past or future cannot be identified in the German curricula. In addition, the curriculum for the Lower Secondary Level in France emphasizes that the content on climate change can also be linked to the subjects of life and earth sciences, chemistry and physics, and technology. However, these cross-curricular references are missing in the curricula of Germany and Spain. Further differences arise in the naming of concrete actor perspectives on climate change. In the curricula for Germany, the actors remain unnamed and thus abstract, whereas in Spain, as the only country, the individual and his actions as well as his responsibility in connection with sustainability and climate change are also included in the curriculum. However, the

curriculum does not remain at the individual level, but additionally includes Spanish society: "Students' recognition of the eco-social problems facing Spanish society" (Boletín oficial del Estado (BOE), 2022b: 153). This collective level, or society's role in addressing the environment and the effects of climate change on society, is also integrated in the French curriculum for the advanced course (Ministère de l'Éducation nationale, de la jeunesse et des sports, 2019c: n. pag.). Furthermore, both the German and Spanish curricula explicitly address conflicts that may arise in the course of climate protection and sustainability (Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (MSB), 2019: 15; Boletín oficial del Estado (BOE), 2022b: 118).

4. Discussion

In the comparative analysis, certain variables and domains emerged as significant, exhibiting contrasting weights across different countries. Notably, there was a marked emphasis on cognitive learning objectives, with a concomitant lack of focus on social learning objectives, and a pronounced emphasis on action competencies pertaining to individual behavior. Regarding content, the scientific component of climate change was accorded differing degrees of importance across countries. In terms of didactic implementation, differences in actor perspectives and geographic orientation were apparent.

4.1. Integration of ESD and CCE

Both the quantitative and the qualitative evaluation demonstrate that the UN's mandate to anchor ESD and the SDGs in the curricula is implemented for the Lower and Upper Secondary Levels in the countries studied, as shown by mentions across all curricula. However, it becomes clear that in the subject of geography, sustainable development is treated more strongly than the topic of climate change. Qualitatively, it is noticeable that elements of CCE and climate change are often mentioned in connection with ESD and sustainability in all countries, but are subordinated to ESD. CCE as an independent term does not appear in the curricula. This subsumption of CCE under ESD in the analyzed countries can be seen as positive insofar as the thematic breadth of ESD does not decrease in favor of CCE as observed by Læssøe and Mochizuki (2015: 39), and the political and ethical dimensions of the topic of climate change can be considered in connection with other SDGs and sustainable development. It is also striking that in both Spanish decrees, there is less talk of climate change and more of a climate crisis: "This competence also implies awareness of the seriousness of the consequences of the climate crisis and the need to adopt behavior that respects the dignity of all living beings, with a view to ensuring sustainable development" (Boletín oficial del Estado (BOE), 2022a: 108). Thus, there is a linguistic focus on both the negative consequences of climate change and the urgency of timely action.

4.2. Importance of a scientific understanding of climate change

Competences that correspond to the UNESCO (2017) learning objectives for SDG 13 are integrated into the curricula as cross-disciplinary competences. This is less the case in France, as the curriculum

is less competence-oriented than in Germany or Spain. Cognitive competences on climate change are mentioned in almost all curricula and are the most common finding, similar to the studies by Dawson et al. (2022) and Wynes and Nicholas (2019). However, the greenhouse effect or the effect of greenhouse gasses is only mentioned in two (Germany and France) of the seven curricula in terms of cognitive competences. This could be due to the fact that it is implicitly assumed when “causes of climate change” are mentioned in the curricula. Nevertheless, given existing misconceptions about the greenhouse effect (Monroe et al., 2019) and a self-assessment by students of just over 60% who can explain the effects of CO₂ on the climate (OECD, 2020: 276), it would be advisable to explicitly address the greenhouse effect in the curricula in order to address these misconceptions.

4.3. Action competencies and individual versus collective action

In terms of action-related learning objectives, if a level is specified at all, the individual level is usually chosen: students are to act sustainably and pursue an environmentally friendly lifestyle (Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (MSB), 2019: 15; Boletín oficial del Estado (BOE), 2022b: 152). The special consideration of the individual, which Lindau and Kuckuck (2022) have also identified in German schoolbooks with action-related ESD tasks, obscures the fact that collective and international actions are necessary in the context of climate change, especially with regard to climate justice (Trott et al., 2023). However, international cooperation and policy on climate change are only addressed in French curricula. Although the introduction of the UNESCO (2017) Competency Framework mentions that it does not include a complete representation of all possible competencies, the question of expansion can be asked. An example of this is a judgment competency, as in the German core curricula, which deals with the evaluation of spatial structures and processes based on technical criteria, the discussion of possible spatial conflicts, and the assessment of solutions. One’s own and others’ positions, as well as underlying values and interests, should also be questioned and reflected upon (Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (MSB), 2019: 13). Thus, the judgment competence represents a link between factual analysis and action.

4.4. Focus on scientific versus social perspectives

In general, the content on climate change is similar in countries, but the technical focus from which these contents are viewed differs. This is particularly evident in France, where the scientific component of climate change (e.g., climate factors and elements, natural effects of climate change) is not addressed in the history-geography subject and instead ESD, especially human action, is at the forefront. For NRW, but also other German states (Siegmond Space & Education gGmbH & Research Group for Earth Observation, 2021), the opposite emphasis on scientific foundations and natural effects of climate change can be attested. However, to fully understand the causes of climate change,

sustainable development, and geography as a human-environment discipline, a scientific understanding is essential (Yli-Panula et al., 2020), and the synthesis between natural and social science perspectives is a desideratum of CCE (Monroe et al., 2019: 17).

4.5. Multiscale and multiperspectivity approaches

A multiscale approach as a basic concept of geography is common to all curricula, even for content related to climate change. This approach could prevent students, like those in the study by Chang and Pascua (2017) from Singapore, from showing a poorly developed sense of “space” and the global nature of climate change. Moreover, the curricula highlight multiperspectivity as an important way of looking at the topic. Climate change is a topic where a multitude of actors from politics, economics, ecology, and society bring their own, diverging perspectives on possible solutions, causing conflicts of interest. These conflicts are addressed in the Spanish decree and German curriculum. However, in Germany, it is not answered which actors are affected (“conflicts between climate protection goals on the one hand and the goal of a secure and affordable energy supply on the other,” Ministerium für Schule und Bildung des Landes Nordrhein-Westfalen (MSB), 2019: 23). Evaluating conflicts of land use is part of the judgment competency in the German curriculum (Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen (MSB), 2014: 16), while they are also mentioned in connection with sustainability in the subject competence (Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen (MSB), 2014: 20) and action competence (Ministerium für Schule und Weiterbildung des Landes Nordrhein-Westfalen (MSB), 2014: 21). These competencies are relevant for understanding and evaluating current and future spatial challenges. On the other hand, treating multiperspectivity also requires promoting cooperative approaches and competencies for perspective-taking, such as recognizing and reflecting on one’s own perspective as well as the perspectives of those involved in the conflict (Vasiljuk and Budke, 2021). However, there are only a few mentions of social learning goals related to climate change in the analyzed curricula that correspond to these underlying competencies. Social learning objectives on climate change only appear in the Spanish decrees. This may be due to a focus of the curricula on the communication of facts about climate change, but also to the fact that social learning objectives, for example, are not among the competences prescribed in the German curriculum.

5. Limitations

A limitation of analyzing curricula is that curricula cannot be directly applied to what happens in classrooms, although they can influence whether a topic is covered in class at all. For example, Italy performed the worst in the quantitative analysis on ESD and CCE content, which may also be reflected in internal school curricula. In contrast to the OECD average of 88%, only 60% of Italian principals report having implemented climate change in their school curriculum (OECD, 2020: 188f). Likewise, the analyzed curricula differ in terms

of their scope (France: national, Germany: subnational), structure and focus. In addition, it is questionable whether one can speak of “pure” geography curricula in France and Spain if the subject is taught in a subject network. In these cases, comparability can be established to some degree, since the content and competencies of each subject are described separately. However, the curriculum analysis and the differences between the curricula also show that there is no European, universal approach to the implementation of CCE and ESD in curricula. Therefore, it would be beneficial to exchange approaches from different countries and educational systems to promote a more coherent and cross-cutting CCE.

6. Conclusion

After comparing the curricula for the subject of geography, it can be concluded that, with the exception of the Italian curriculum, all the curricula considered assign significant importance to the topic of climate change. The curricula of France, Spain and Germany already provide a solid foundation for understanding the causes, effects and consequences of climate change.

However, the contents of the curricula still vary significantly; an implication could therefore be to develop content CCE in the same way as for ESD through cross-country cooperation, following a best-practice approach and an international perspective on climate action.

In addition, the descriptions of the individual competencies and learning objectives in the curricula are at a very general and abstract level that does not provide any assistance at the level of teaching. The advantage of this is that the teachers have more room for creativity, but the disadvantage might be that, especially for inexperienced teachers, content that is not mentioned, such as the greenhouse effect, natural causes of climate change, or climate justice, for example, may not be taught. Follow-up studies can start here and analyze the status quo of CCE in the classroom, but also develop didactic approaches, media or teaching methods that promote underrepresented content or competencies such as social learning. As part of the ECCI project, for example, an escape room is being developed on solutions for climate change in the city, which incorporates aspects such as collaboration and social learning, as well as climate policy and multiperspectivity.

Promoting a better understanding of geography as a link between the social sciences and STEM could also help to better address the challenges of climate change and sustainability and foster a more holistic understanding of climate change. Incorporating climate change into the (geography-) classroom and strengthening interdisciplinary approaches is crucial to provide students with the scientific knowledge, critical skills, and perspectives they need to understand and address the global challenge of climate change. Moreover, climate change education can help students understand the importance of sustainable development and resilience, which are

critical in the face of climate change impacts, and prepare students to be informed decision-makers and responsible global citizens.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

KE designed the study, collected and analyzed the curricula, and wrote the manuscript. AB provided critical feedback on the manuscript and edited the final version. All authors reviewed and approved the final version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2023.1216780/full#supplementary-material>

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