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Climate change and sustainability in science and social science secondary school curricula

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SHORT SUMMARY

Adapting school curricula to better integrate sustainability in learning

There is an urgent need to transform the way climate change and sustainability are taught in classrooms and at schools. Learners must grasp the environmental impacts of climate change, how climate change relates to their own context and what actions can be undertaken and contribute to making societies more sustainable, equitable, just and climate-resilient.

The findings presented in this publication indicate that accelerated efforts are needed. In a study of over 530 Grade 9 science and social science curricula from 85 countries worldwide, we found that 69 per cent of curricula contained no references to climate change, while 66 per cent had no references to sustainability.

69%
of Grade 9 science and social science curricula contain no references to climate change

Furthermore, while 69 per cent of surveyed teachers from eight of the countries studied reported that environment, sustainability and climate change topics were included in the science and social science curricula in their schools only 50 per cent included them in their teaching.

While there is a notable inclusion of environment, sustainability and climate change in science and social science curricula across countries, the depth of focus of this inclusion varies widely. Cognitive learning prevails over social and emotional or action-oriented learning. Climate change and sustainability in school practices must be strengthened, with teachers playing a key role in enhancing integration through teaching methods and materials.

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"Since wars begin in the minds of men and women it is in the minds of men and women that the defences of peace must be constructed"

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Climate change and sustainability in science and social science secondary school curricula

Foreword

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An unprecedented global movement in response to the climate crisis is underway: Greening society and education. This started with young people's aspirations and anxiety about their future and urgent demands for accelerated action across the world.

At the 2022 UN Transforming Education Summit, youth leaders called on countries to commit to invest in education for sustainable development (ESD) across curricula, particularly in climate education. They demanded education systems that instil in learners the competencies and knowledge needed to forge resilience to mitigate the impacts of the climate crisis and ensure climate justice.

At UNESCO, we have actively promoted ESD, building on over 30 years of expertise on environmental education. 132 countries from all regions have pledged to address climate change and sustainability issues through education. It is now time to urgently translate these political commitments into concrete action.

Our study from 2021 revealed that less than half of the countries surveyed by UNESCO included climate change in their national curriculum frameworks. And less than 30 per cent of surveyed teachers in another study said they felt ready to teach about climate change. In addition, 70 per cent of youth surveyed in 2022 said that they cannot explain climate change or only in broad principles.

Based on this worrisome reality, UNESCO decided to further investigate how climate change and sustainability are addressed in secondary schools through an analysis of science and social science subject curricula. The study also looked at how teachers are experiencing the demand of addressing climate change in their classrooms.

This publication outlines the findings of this analysis and confirms the assumptions made by earlier studies. The degree to which climate change is included in the relevant curricula remains very limited and fragmented, and cognitive learning is much more prevalent than action-oriented learning. But there are hopeful signs. Most surveyed teachers acknowledged that climate change is included in the science and social science curricula in their schools.

We need to make education the long-term solution to the climate crisis. In addition to this publication, UNESCO, together with the Greening Education Partnership, has developed a new guidance to green curriculum and engage students through head (knowledge), heart (values) and hands (action). Impressively, three-quarters of countries that joined the Partnership have committed to embedding climate change content in their curriculum frameworks within three years.

Let's work together to transform learning and ensure all learners receive climate change education!

Stefania Giannini
Assistant Director-General for Education
UNESCO

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List of acronyms and abbreviations

ASPnet	UNESCO Associated Schools Network
CCE	Climate change education
ESD	Education for sustainable development
EE	Environmental education
GEP	Greening Education Partnership
MECCE Project	Monitoring and Evaluating Climate Communication and Education
NCF	National Curriculum Framework
SDGs	Sustainable Development Goals
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-IBE	United Nations Educational, Scientific and Cultural Organization International Bureau of Education

I. Summary of findings and recommendations: Grade 9 education

FINDINGS

Based on a review of 536 Grade 9 science and social science subject curricula in 85 countries

1. Seventy-seven per cent of science and social science secondary curricula across 85 countries mention environment, sustainability or climate change at least once; the majority of which have a moderate level of focus on these topics. However, 69 per cent contain no references to climate change and 66 per cent have no mention of sustainability.
2. Environment content is much more common than sustainability and climate change content in science and social science curricula. Overall science and social science curricula include more environment and climate change content than national curriculum frameworks. By contrast, sustainability content is slightly more common in national curriculum frameworks than subject curricula.
3. In federal countries, different approaches are commonly found across those countries' sub-national jurisdictions in relation to the type and extent of inclusion of environment, sustainability and climate change in the science and social science curricula.
4. After accounting for the number and length of curricular documents analysed, the science and social science curricula from countries in Europe and Northern America, Oceania and Central and Southern Asia had, on average, a moderate focus on environment, sustainability and climate change (between 1,001 and 10,000 references per million words); the subject curricula from countries in Eastern and South-Eastern Asia, Latin America and the Caribbean, Northern Africa and Western Asia and sub-Saharan Africa had, on average, a low focus on these themes (between 301 and 1,000 references per million words).
5. Environment content is more often included in science curricula and sustainability and climate change content is more common in social science curricula.
6. References to environment, sustainability and climate change content in the science and social science curricula rarely address these issues in terms of school facilities and operations, community partnerships or overall school governance.

Based on an in-depth review of Grade 9 science and social science subject curricula in 12 countries

7. A focus on cognitive learning is much more prevalent than a focus on social and emotional or action-oriented learning across environment, sustainability and climate change content in the science and social science curricula.
8. Environment, sustainability and climate change content in the science and social science curricula is usually focused more on learning outcomes than learning processes.
9. Indigenous knowledge and justice-related issues are rarely addressed in environment, sustainability and climate change content in the science and social science curricula.
10. When all the science and social science curricula are analysed by the period of their publication, two findings emerge: a) there is a consistently high level of inclusion of environment content in all three time periods (before 2001; 2001-2012; 2013-2023) and b) subject curricula published in the past 10 years include higher levels of content on climate change and sustainability than in earlier time periods.

Based on a survey of teachers in eight countries

11. A majority of surveyed teachers indicated that environment, sustainability and climate change are included in the science and social science curricula in the school in which they work. They indicate the focus is usually on gaining a cognitive understanding of these issues.

12 A majority of surveyed teachers reported that the most common school practices related to environment, sustainability and climate change are reducing waste and energy use. School meetings on these topics were reported to focus on facilities and operations and school governance practices.

13 A majority of surveyed teachers reported that educational materials and teacher preparation are key opportunities for integrating environment, sustainability and climate change content into the science and social science curricula.

14 Half of surveyed teachers reported including environment, sustainability and climate change content in their classes. Such content is reported by teachers as being included in a wide array of science and social science subjects.

15 Almost 40 per cent of surveyed teachers reported going beyond requirements of the 'official' science and social science curricula in including content on environment, sustainability and climate change in their lessons.

16 A majority of surveyed teachers reported using action-oriented methods when teaching about environment, sustainability and climate change.

RECOMMENDATIONS

1 Science and social science curricula can be improved to help equip students to contribute to climate change mitigation and adaptation for building climate-smart, resilient and sustainable societies. More content is needed on environment, sustainability and crucially on climate change in school subject curricula in all countries including those most responsible for the climate crisis and those vulnerable to climate risks.

2 Siloed disciplinary approaches to environment, sustainability and climate change diminish the potential of education to promote transformative and systemic change on these issues. Environment, sustainability and climate change issues should be integrated throughout the curriculum, as all knowledge and disciplinary areas are necessary to address environmental and sustainability challenges under a unified and robust curriculum vision across levels, settings and provisions. The relationships among the three elements also should be addressed. Climate change also needs to be addressed in a broader context of sustainable development.

3 More education systems need to be taking a whole institution approach to tackling the climate crisis within school subject curricula. Such approaches link teaching and learning with taking up environmental priorities in overall school governance, in collaboration with community partners and through school facilities' and operations' innovations. Informal learning opportunities could be linked with formal subject-based curricula.

4 Science and social science curricula in secondary education, if they adopt holistic learning approaches, can better support young people in taking action and responsibility on environmental challenges. This can be done by strengthening the focus on social and emotional competencies and action capacities and not only cognitive learning.

5 Including Indigenous and local knowledge in relation to environment, sustainability and climate change in school subject curricula furthers recognition, respect and understanding, as well as benefiting from the depth and breadth of knowledge on these issues and actions.

6 Education on environment, sustainability and climate change can include mention of action-oriented, place-based and participatory teaching and learning methods in school subject curricula to help ensure education related to these topics empowers students and teachers to address, act individually and collectively and take responsibility on these issues.

7 Further study across all grades and subject areas is recommended to support broader understanding of how school subject curricula and pedagogy are supporting transformative education related to environment, sustainability and climate change.

II. Methodology

Interest in how to address education for sustainable development (ESD) and climate change education (CCE) in education has expanded rapidly in recent years. At the UN Transforming Education Summit, countries and other interested parties agreed to promote "greening education" to ensure that by 2030 every learner is climate ready, that all education systems become more resilient to climate change and that schools become safer and more adapted to climate change (UN, n.d.a; UN, n.d.b). Youth input to the Summit's vision statement included calls for increased quantity and quality of ESD and CCE (UN, 2022). To support this initiative, UNESCO together with UN and Member State partners established a Greening Education Partnership, which involves greening schools, greening curriculum, greening teacher training and education systems' capacity and greening communities (UNESCO, n.d.a.; UNESCO, n.d.b.).

To increase the pool of knowledge on how to integrate these topics in education, the current study examines the inclusion of environment, sustainability and climate change[1] in Grade 9 science and social science subject curricula in public secondary education around the world[2]. It provides an indication of the extent and type of inclusion of these topics in education systems in different regions of the world and supports furthering the quality and quantity of this focus in school systems globally. As argued by the UNESCO-International Bureau of Education (IBE), the school curriculum is the "'DNA of the education system'... [and is] key in any initiative for social improvement" (UNESCO-IBE, 2023, p. 5).

Study data were collected and analysed through three study components, which included an overall analysis of science and social science curricula across 85 countries, including five federal countries; an in-depth case study of a subset of curricula in 12 countries; and a survey of Grade 9 teachers across eight countries. These components are described further below.

STUDY COMPONENT 1

A systematic analysis of Grade 9 science and social science curricula in 85 countries

The aim of this study component is to explore theextent and type of environment, sustainability and climate change content found in science and social science curricula from countries around the world. Among other things, the analysis establishes a baseline on the status of the greening of Grade 9 school curricula globally.

Countries were selected for inclusion in the sample to ensure representation of all Sustainable Development Goal (SDG) regions. In total 85 countries are included: 80 countries with national education systems and uniform curriculum policies and five with federal or devolved education systems, with curricular policies set by sub-national jurisdictions.

Data collection included up to nine Grade 9 science and social science subject curricula for each country or subnational jurisdiction (**Table 1**). In some instances, different subnational jurisdictions use the same subject curricula. In total, 536 subject curricula from 85 countries were included in the study.

1 Herein referred to as environment, sustainability and climate change content.
2 For two countries (Benin and Togo) Grade 8 materials were used because Grade 9 materials were not available.

TABLE 1

Prioritization of science and social science curricula collected for up to four science and four social science subjects

Science Subjects	Social Science Subjects	Names of EE/ESD curricula
1. General science 2. Applied science/ technology 3. Earth science and agriculture 4. Life science 5. Physical science	1. General social science 2. Geography 3. History 4. Civics/citizenship 5. Economics 6. Philosophy, religious and moral studies 7. Cultural and art studies	▶ Environmental education ▶ Environmental education/education for sustainable development ▶ Environmental and outdoor education ▶ Sustainability

Table note. The number of science subjects never exceeded four subjects in any country, so all science subjects were collected for the countries included in the sample. Any curricula related to Environmental Education (EE) or ESD were also collected. In total, four countries had EE/ESD specific curricula.

Science and social science curricula were collected by searching archives from recent studies of curricula, as well as government websites. Curricula were also provided by National Commissions for UNESCO, following a request by the UNESCO-IBE. In cases where the above methods did not yield the relevant Grade 9 curricula, country experts were consulted. Once the document collection process was completed, 12 cases were selected in which the collected science and social science curricula were authenticated by country experts. (See Annex A for a list of all countries included in the study).

Data analysis involved using keywords to search the science and social science curricula for environment, sustainability and climate change content. English keywords (**Table 2**) were translated into 25 other languages to enable searching in curricula in other languages. Keyword searches were conducted using the qualitative management software NVivo 12 for science and social science curricula in the languages of Azerbaijani, Bahasa Indonesia, Bulgarian, English, French, Georgian, German, Greek, Hungarian, Italian, Lithuanian, Mandarin, Mongolian, Polish, Romanian, Slovak, Spanish, Tagalog and Turkish. Manual coding was used for curricula in Arabic, Armenian, Japanese, Korean, Portuguese, Russian and Slovenian.

The subject curricula ranged in length from fewer than 1,000 to over 190,000 words. To account for this variation, keyword frequency counts were standardized by 1,000,000 words. The resulting standardized frequency counts were then analysed using matrix queries in relation to other characteristics of interest (e.g., SDG region, science/ social science subject, publication date, language, country of origin).

The inclusion of environment, sustainability and climate change in subject curricula was also analysed in relation to the inclusion of the same content in the national curriculum frameworks (NCFs)[3] of 80 of the 85 countries[4] using the same coding procedures. This analysis was undertaken to determine if and how national curriculum framework emphases on environment, sustainability and climate change relate to the extent and type of inclusion in science and social science subject curricula.

3 NCFs are policy documents typically prepared by senior education officials for multiple audiences in the country, such as for use in guiding curriculum priorities, as well as for some external stakeholders outside the country. The subject specific documents analysed in the current study represent the work of curriculum specialists inside ministries of education, with possible inputs by other experts and textbook writers. These curriculum documents are mainly read by teachers in the relevant subject areas and by school leaders.

4 This includes 5 countries in which Education Sector Plans rather than NCFs were used. This decision corresponds with methods employed in a previous UNESCO (2021*c*) study.

TABLE 2

Environment, sustainability and climate change keywords searched in English, organized by 'cluster'

	English keywords			
Environment cluster	▶ environmental ▶ ecosystem*	▶ biodiversity ▶ greening	▶ green curricul* ▶ blue curricul*	
Sustainability[5] cluster	▶ "education for sustainability"	▶ "sustainable development"	▶ ESD	
Climate change cluster	▶ "climate change" ▶ "global warming" ▶ "climate crisis" ▶ "climate action*" ▶ "greenhouse gas*" ▶ "GHG emission*" ▶ "Carbon Dioxide emission*" ▶ "CO2 emission*"	▶ "climate hazard*" ▶ "climate impact*" ▶ "climate vulnerab*" ▶ "renewable energy" ▶ "climate resilien*" ▶ "carbon footprint*"	▶ "low emission*" ▶ "net-zero emission*" ▶ "carbon neutral" ▶ "just transition*" ▶ "climate justice" ▶ adaptation (within 15 words of 'climate')	▶ mitigation (within 15 words of 'climate') ▶ "climate change impact*" ▶ "net-zero CO_2 emission*" ▶ "net zero CO_2 emission*"

STUDY COMPONENT 2

Case studies of holistic uptake in the Grade 9 science and social science curricula of 12 countries

This study component provides a more in-depth analysis of environment, sustainability and climate change content identified in Study Component 1 as well as pedagogical approaches to teaching these topics.

Countries were selected for inclusion in this smaller sample due to having relatively high inclusion of content on environment, sustainability and climate change in their science and/or social science curricula in order to identify examples of good practice. Care was also taken to ensure the countries selected represented different levels of development and climate vulnerability, as well as SDG regions. The countries selected were: Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden. In total, 54 curricular documents were analysed in Study Component 2.

For data analysis, the content was qualitatively coded to classify it according to 1) a whole institution approach, 2) holistic learning dimensions and 3) other thematic areas relevant to environment, sustainability and climate change, including justice, Indigenous knowledge, climate change adaptation and/or mitigation (see Annex B for the codebook used).

A whole institution approach to environment, sustainability and climate change in schools involves not only a focus on teaching and learning, but also on overall governance (e.g., integrating environment, sustainability and climate change in overall school planning and decision-making), community partnerships (e.g., collaborating with organizations or others in the surrounding community on environment, sustainability and climate change action) and facilities and operations (e.g., reducing the environment, sustainability and climate change footprint of school grounds and buildings). In the context of this study, the curricula were analysed to see if these other domains of institutional activity were also addressed in the curricula (e.g., facilities' audits by students being part of the curriculum).

This study component also examined the degree to which science and social science curricula include a focus on three interlinked learning dimensions – cognitive (e.g., teaching the facts of climate change, including understanding the link between climate

5 The word "sustainability" was not included among the sustainability keywords due to the common use of this word in relation to topics not related to environmental sustainability.

change and other sustainability issues), social and emotional (e.g., addressing climate grief and anxiety, developing a sense of solidarity and responsibility for others) and action-oriented (e.g., individual and societal opportunities for taking action on climate change).

Finally, additional thematic categories included justice (e.g., discussions of those most vulnerable to environment, sustainability and climate change issues), Indigenous knowledge (e.g., bringing an Elder into a classroom for learning in these areas) and climate change adaptation and mitigation (e.g., both adapting to a changing climate and reducing emissions).

A codebook was developed and used to identify content related to the whole institution domains, holistic learning dimensions and thematic categories (Annex B). This codebook drew on coding practices used in prior UNESCO studies and involved searching for the 'meaning of the concept' rather than the exact keywords and terms (UNESCO MGIEP, 2019, p. 22).

The science and social science curricula were coded by native speakers in seven languages: English, Georgian, Korean, Portuguese, Slovenian, Spanish and Tagalog, which covered the languages of the curricula for all 12 countries. Like in Study Component 1, frequency counts for the coded material were standardized by 1,000,000 words to account for curricula of varying lengths. Coding frequency counts were analysed using matrix queries in relation to the four domains of a whole institution approach, the three holistic learning dimensions and the other thematic areas of interest.

STUDY COMPONENT 3

An analysis of survey responses from Grade 9 science and social science teachers across eight countries

The online survey explored Grade 9 teacher perceptions of the inclusion of environment, sustainability and climate change content in the science and social science curricula of their country, as well as of how this has been implemented in the classroom in relation to whole institution domains, holistic learning dimensions and key thematic areas (e.g., justice, Indigenous knowledge, climate change mitigation and adaptation). Information on barriers to inclusion and how to overcome these barriers was also collected.

In many comparative studies of student learning, teachers are asked about the extent to which they cover the official curriculum in a subject area, a measure of the 'opportunity to learn' about a subject (O'Donnell, 2008; Nevenglosky et al., 2019). In this survey, teachers were also asked to assess the degree to which they cover topics related to environment, sustainability and climate change as specified in the official Grade 9 curriculum.

Countries were selected for inclusion in this study component based on having relatively high inclusion of environment, sustainability and climate change content in their curricula in order to identify examples of good practice, as well as to ensure the countries selected represented different levels of development and climate vulnerability, as well as SDG regions. The online survey was distributed in seven languages (Arabic, English, Korean, Sinhala, Spanish, Swedish and Tamil) in eight countries (Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden). A total of 1,509 responses from Grade 9 science and social science teachers were collected during a 10-week period from August to October 2023. The survey questionnaire was hosted on Qualtrics.

The views presented in this report do not reflect a representative sample of teachers in the eight countries in which the survey took place. In particular, two countries – Kuwait and the Republic of Korea – have disproportionately large numbers of respondents although overall only a small number of teachers took part in the survey. Furthermore, survey respondents were self-selected, which means they were more likely to have a pre-existing interest in climate change and sustainability topics and to be less representative of teachers in general. Furthermore, teachers with little or no access to computers or the internet will mostly have been unable to participate in the survey.

The findings should, therefore, be understood as being based on the responses of teachers who participated in the survey. They are mainly indicative of perceptions and opinions of Grade 9 science and social science teachers and can serve as a point of reference for future studies.

Despite these limitations, the study provides a valuable insight into responding teachers' perceptions of the extent to which they are able to integrate climate change and sustainability issues in their teaching.

Most Grade 9 teachers that responded to the survey are from two countries (83 per cent – Kuwait and the Republic of Korea, n=1,509), are women (65 per cent, n=1,029), have a Bachelor's degree (or equivalent) or teacher certification (65 per cent, n=1,040), have between 6 and 20 years of teaching experience (49 per cent, n=1,507) and teach in a public school (76 per cent, n=1,499, see **Table 3**).

TABLE 3

Demographic highlights

Country (n=1,509)	▶ Republic of Korea**: 57%** ▶ Kuwait: **26%** ▶ Australia: **6%** ▶ Chile: **5%** ▶ Sweden: **4%** ▶ Sri Lanka: **1%** ▶ Sierra Leone**: 0.4%** ▶ Papua New Guinea: **0.2%**
Gender (n=1,029)	▶ **65%** of responding Grade 9 teachers are women. ▶ **69%** of responding Grade 9 **science** teachers are women. ▶ **61%** of responding Grade 9 **social science** teachers are women.
Education (n=1,040)	▶ Bachelor's degree (or equivalent) or teacher certification: **65%** ▶ Master's degree (or equivalent): **34%**
Experience (n=1,507)	▶ 5 years of teaching experience or less: **27%** ▶ 6 to 20 years of teaching experience: **49%** ▶ More than 20 years of teaching experience: **24%**
Type of School (n=1,499)	▶ Public school: **76%** ▶ Private school: **24%** ▶ School designated as Eco-school, Green school or ASPnet school: **12%**

Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

The survey was distributed through UNESCO field offices, the UNESCO Associated Schools Network (ASPnet) and the MECCE Project's Regional Hubs and listserv. Support was also received from various teacher networks and associations, education experts, teacher unions, Departments of Education and other organizations, such as Educational International. Data analysis involved the calculation of basic frequency distributions of teacher responses and cross-tabulations.

III. Review of previous literature

As background for the study, a comprehensive review of the scholarly literature focusing on environment, sustainability and climate change content in primary and secondary curricula was conducted. This review focused on prior studies which analysed or described the integration of environment, sustainability and climate change issues in curriculum frameworks and subject curriculum, either at national or subnational levels. The focus of the review was mainly on the literature on secondary education, with some inclusion of material focused on primary education.

The review found little inclusion of environment, sustainability and climate change within curricula analysed in the scholarly literature (see Aikens & McKenzie, 2021; Dawson et al., 2022; Eilam et al., 2020; Greer et al., 2023; Khiri et al., 2022; McGarr & Lynch, 2021; Noguera-Méndez & Cifuentes-Faura, 2022; Salinas et al., 2022; Suárez-López & Gozalbo, 2022). For instance, an analysis of primary, middle and secondary curricula in Morocco found a low level of inclusion of water education (Khiri et al., 2022). When present, the focus was on defining the water cycle, sources of water pollution and water conservation, with no focus on laws related to water, valuing water landscapes, water accessibility, or water-related professions (Khiri et al., 2022). An analysis of the learning outcomes in the general curricula of Chile for Grades 1 to 10 found only five per cent of learning goals are connected to climate change (Salinas et al., 2022). A minor focus on climate change and sustainability was also found in Canada, where only six of 13 provinces and territories were found to have such content in education policy or curriculum frameworks (Aikens & McKenzie, 2021).

Research examining how curricula for all subjects in primary and secondary education included a focus on environment, sustainability and climate change, found it is more commonly included in science subjects and, to a lesser extent, in social science subjects, such as geography (see Acosta-Mesa, 2016; Howard-Jones et al., 2021; Salinas et al., 2022). For instance, an analysis of the Zenu Indigenous population's curriculum in primary and secondary schools in Colombia found that environment is usually embedded in the natural science curriculum (Acosta-Mesa, 2016). When the studies reviewed analysed a subset of general curricula for the inclusion of environment, sustainability and climate change, science and geography were usually analysed (see Dawson et al., 2022; Martínez-Borreguero et al., 2020; Reynaga-Peña et al., 2019; Tsakeni, 2018). For example, Dawson and colleagues (2022) analysed middle school (ages 7-10) science and geography curricula for six countries for the inclusion of climate change. Tsakeni (2018) analysed the secondary chemistry curriculum in South Africa for opportunities to incorporate education for sustainable development (ESD).

Some studies described the use of a cross-curricular approach to the inclusion of environment, sustainability and climate change in curricula (see Ndzimbomvu et al., 2021; Salinas et al., 2022; Sund & Gericke, 2020). For instance, in South Africa, the R-12[6] curriculum includes environmental education across all learning areas (Ndzimbomvu et al., 2021). Sweden's primary curriculum for years 7-9 requires teaching sustainability in all subjects using a cross-curricular approach (Sund & Gericke, 2020). One study found a cross-curricular app roach to climate change education in upper secondary education curricula in Victoria, Australia to be ineffective (Eilam et al., 2020). Specifically, they found limited climate change content and that the conceptualization of climate change in curricula tended towards problem management or technological efficiency and did not provide a complete understanding of the nature of climate change (i.e., as involving knowledge from multiple disciplines).

In terms of approach, studies found content often focuses on the causes of climate change versus solutions (see Dawson et al., 2022; Eilam et al., 2020; Howard-Jones et al., 2021; Karim et al., 2022) or misconceptions (see Eilam et al., 2020). Some studies also highlighted a "questionable technological optimism as the solution to sustainability problems" (in the primary and secondary curriculum of Portugal, Suárez-López & Gozalbo, 2022, p. 106; also see Bieler et al., 2018 regarding curricula in some Canadian provinces). An analysis of climate change inclusion in the curriculum of six countries also found that when climate change was included, it was often only done as an example concept (Dawson et al., 2022).

6 Grade R (or Reception Year) refers to schooling before Grade 1 of primary education in South Africa (Department of Education of South Africa, 2002).

Existing research suggests that curricula often focus on the development of cognitive or theoretical knowledge, in contrast to actions needed to address issues of environment, sustainability and climate change (see Glackin & King, 2020; Martínez-Borreguero et al., 2020; Spence et al., 2015). For instance, Martínez-Borreguero and colleagues (2020) found most references to energy, water and waste in Spain's primary curricula focused on developing basic knowledge, not on applying that knowledge. There were, however, some notable exceptions. In Croatia, one of the outcomes for the ESD subject in secondary education is to "[act] in accordance with the principles of sustainable development with the aim of promoting social justice" (Odluka, 2019, as in Vukić et al., 2021).

Some of the studies reviewed also referenced a tendency for economic values to dominate climate change curricula (in primary and secondary curricula and policy in England, Greer et al., 2023) or found a tendency to not question a capitalist ideology in relation to ESD (in secondary technology curricula in Ireland, McGarr & Lynch, 2021).

The studies reviewed rarely referenced the inclusion of justice or ethical issues in relation to content on environment, sustainability and climate change in the curricula (see Eilam et al., 2020; Vukić et al., 2021). In some cases, the absence of a justice-related focus was noted by the authors. In describing the national curricula context of England, Howard-Jones and colleagues (2021) wrote:

> The National Curriculum in England does not currently require children to understand the broader impacts of climate change on the environment, economy and society, or to consider issues of social justice in relation to climate change. There is no mandatory requirement for any school students in England to understand or engage with the types of social action most likely to bring about societal change. (p. 1661).

In the studies reviewed, there was also little inclusion of the importance of Indigenous knowledge for education on environment, sustainability and climate change (for exceptions, see Acosta-Mesa, 2016; Aikens & McKenzie, 2021; Muchanga and Nakazwe, 2015; Whitehouse et al., 2014). For example, Muchanga and Nakazwe (2015) highlighted the inclusion of Indigenous knowledge in relation to environmental management content in the primary school curricula in Zambia. A literature review of education policy and curriculum frameworks in Canada found three dominant orientations to sustainability across the country, one of which was Indigenous education in Nunavut and the Northwest Territories (Aikens & McKenzie, 2021).

When the studies reviewed discussed teaching or assessment methods in relation to curricular content on environment, sustainability and climate change, they found that teaching or assessment methods needed improvement, or that the curriculum reviewed did not include a focus on teaching methods (see Chatzifotiou, 2018; Bieler et al., 2018; Chang & Pascua, 2017; Jackson & Pang, 2017; Tal et al., 2016). There was also no focus in the studies reviewed of a whole institution approach to environment, sustainability and climate change in relation to countries' curricula.

Some studies published since 2015 included a focus on how countries are engaging with the SDGs (see Karim et al., 2022; Martínez-Borreguero et al., 2020; Tomás & Menoyo, 2020). In Malaysia, the Ministry of Education has developed a curriculum guideline that maps the secondary school curriculum to key elements of the SDGs. These elements include "sustainability production and consumption, global citizenship and unity" (Karim et al., 2022, p. 2). An analysis of biology and geology curricula in Spain for the first year of secondary school found a lack of a focus on systems and interrelationships that are necessary to achieve the SDGs (Tomás & Menoyo, 2020).

Finally, across the studies reviewed, several included a focus on international comparisons of approaches to environment, sustainability and climate change in curricula (but see Dawson et al., 2022; Suárez-López & Eugenio-Gozalbo, 2022; Vukić et al., 2021). For instance, Suárez-López & Eugenio-Gozalbo (2022) analysed the primary and secondary curricula of Spain and Portugal for sustainability content, finding little inclusion in the curricula of both countries and where present, the coverage was inconsistent and inadequate to support solutions.

Building on the prior work reviewed related to environment, sustainability and climate change done in previous years, the next section reviews how these themes are engaged in Grade 9 science and social science curricula. The results presented below combine the findings from Study Components 1 and 2.

IV. Study findings

Review of Grade 9 science and social science curricula in 85 countries worldwide.

FINDING #1

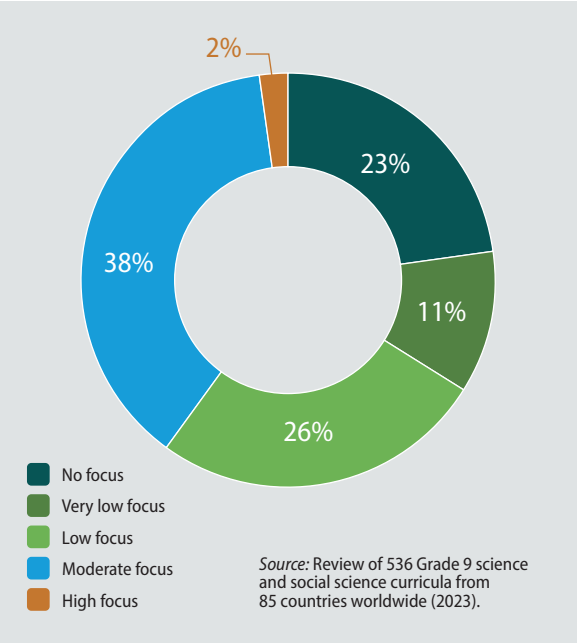
Seventy-seven per cent of science and social science secondary curricula across 85 countries mention environment, sustainability or climate change at least once; the majority of which have a moderate level of focus on these topics. However, 69 per cent contain no references to climate change and 66 per cent have no mention of sustainability.

Of the 536 Grade 9 science and social science curricula collected, 413 (77 per cent) include references to environment, sustainability or climate change content at least once. The depth of inclusion of these topics is usually moderate (**Figure 1**).

The content was categorized by depth of focus as: no focus (0 out of a million words), very low focus (1-300 keywords per million words), low focus (301-1,000 keywords per million words), moderate focus (1,001-10,000 keywords per million words) and high focus (at least 10,001 keywords per million words). This categorization draws on that used in prior studies, with the addition of a 'high focus' category (UNESCO, 2021b; 2021c).

FIGURE 1

Percentage of science and social science curricula by extent of focus on environment, sustainability and climate change content



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

FINDING #2

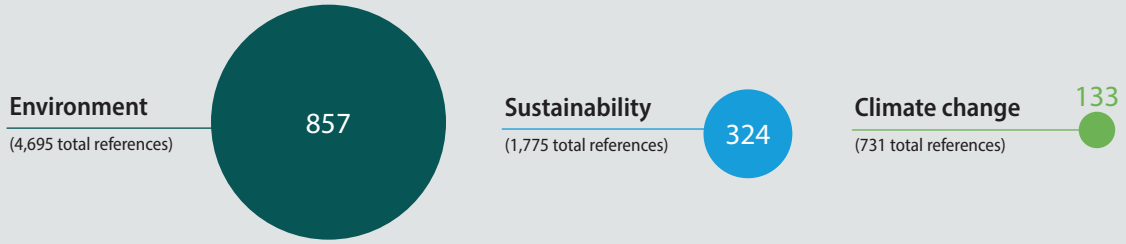
Environment content is much more common than sustainability and climate change content in science and social science curricula. Overall science and social science curricula include more environment and climate change content than national curriculum frameworks. By contrast, sustainability content is slightly more common in national curriculum frameworks than subject curricula.

Seventy per cent (376/536) of Grade 9 science and social science curricula include environment content at least once. Sustainability and climate change are included at least once in 34 per cent and 31 per cent of the curricular documents respectively.

Looking at how much content overall on each of the three areas is included, there is also substantially more environment content than on sustainability and climate change (**Figure 2**).

FIGURE 2

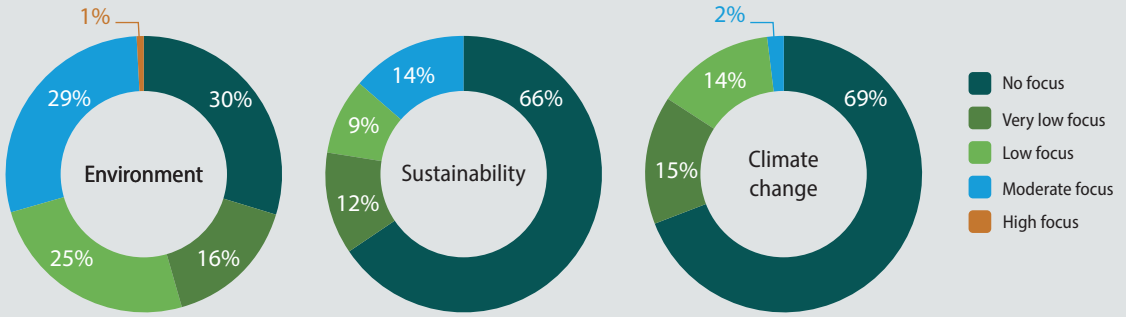
Extent of content on environment, sustainability and climate change (standardized references)



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

FIGURE 3

Percentage of subject curricula by extent of focus on environment, sustainability and climate change content



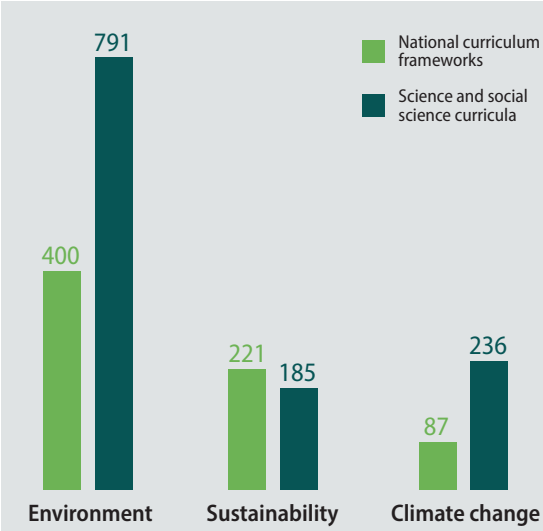
Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

The study also broke down the relative extent of focus on the three areas and found a majority of subject curricula had minimal extent of inclusion (using the same classification described in finding 1), in particular in relation to sustainability and climate change (**Figure 3**).

Subject curricula include the environment and climate change to a much greater degree than the NCFs for the same countries.[7] NCFs are more likely to refer to sustainability. Subject curricula include on average 2.7 times more references to climate change content and 2 times more references to environment content compared to the NCFs. The difference in inclusion of sustainability is small (**Figure 4**).

FIGURE 4

Comparison of means of NCFs and science and social science curricula (average standardized references)



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

7 These comparisons are based on averages, which could be skewed by outliers.

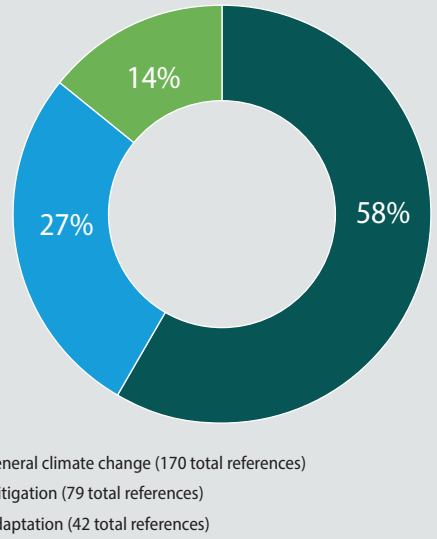
In-depth review of Grade 9 science and social science curricula in 12 countries

Climate change

The 12 case study countries were chosen due to their relatively high inclusion of environment, sustainability and climate change content. Of the subject curricula from the case study countries, 61 per cent (35/57 curricula) reference climate change at least once. General discussions of climate change are the most common, followed by more specific climate mitigation and adaptation content (**Figure 5** & **Table 4**). This trend is found in the subject curricula of eight out of 12 countries. In contrast, in Kuwait, the Philippines, the Republic of Korea and Sierra Leone, content on climate change mitigation is more common or equally common as both general climate change and climate change adaptation content (**Figure 6**).

FIGURE 5

Percentage of content on climate change



Source: Review of Grade 9 science and social science curricula in 12 selected countries (2023).

Note: General climate change refers to content on climate change causes, effects and solutions, as well as climate science. Mitigation refers to content related to lessening the impacts of climate change. Adaptation refers to content related to adapting to climate change.

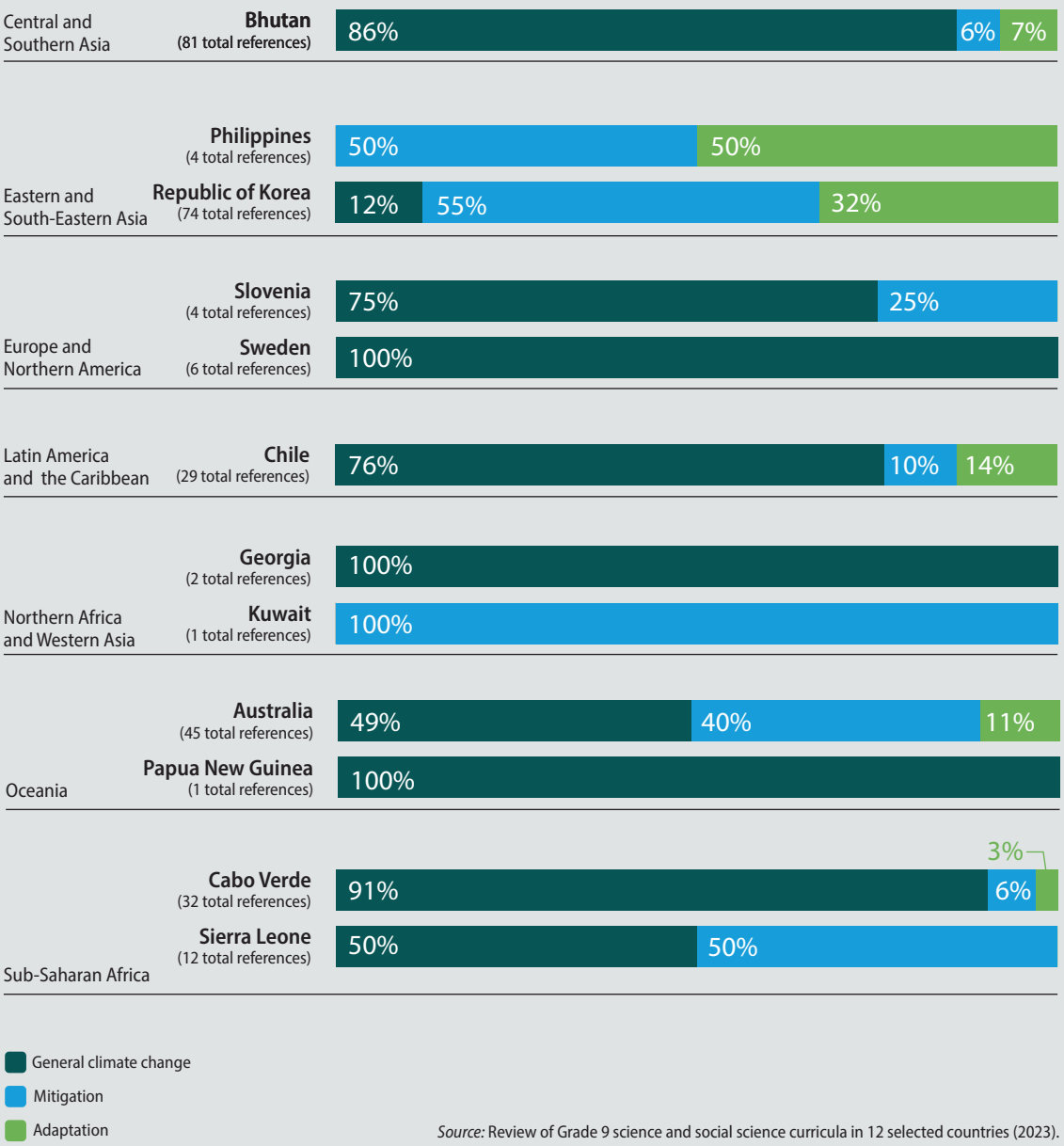
TABLE 4

Subject curriculum spotlight examples: Climate change

General Climate Change	"Investigate the causes of climate change on a global scale and the resulting local changes and evaluate local and international efforts to address these issues." (Republic of Korea, history curriculum, p. 73).
Mitigation	Recommended teaching approach: "Discuss with the learners ways to mitigate climate change e.g., grow more trees and avoid deforestation etc." (Sierra Leone, applied science/ technology curriculum, p. 42)
Adaptation	"With climate change becoming a more serious problem every day, it is important than ever for people to do their part by practising sustainable living to reduce the pressure on Earth's natural resources and to combat climate change. The following learning activities in science, for instance, promote sustainable living in learners. ▶ Apply the principles of green chemistry to design a Bhutanese house that can keep us warm in winter. ▶ Design a prototype to produce biofuel from local organic waste that may solve energy problems in the locality" (Bhutan, general science curriculum, p. 7).

FIGURE 6

Percentage of content on climate change by country and region



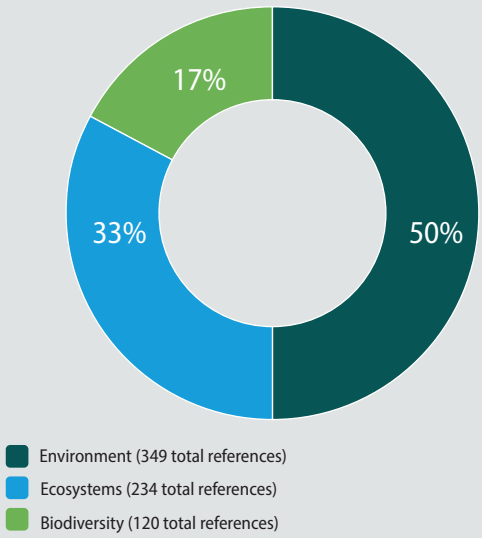
Source: Review of Grade 9 science and social science curricula in 12 selected countries (2023).

Environment

Eighty-four per cent of case study subject curricula (48/57 curricula) include content on environment. Within this, discussions of environmental processes, environmental science or environmental issues are most common, followed by content specifically on ecosystems and biodiversity (**Figure 7** & **Table 5**). Seven of the 12 case study countries predominantly focus on environment in a general way. Among the remaining five countries, a stronger focus on ecosystems is found in the subject curricula of Bhutan, Chile, Sierra Leone and Sweden; and biodiversity is a stronger focus in Georgia (**Figure 8**).

FIGURE 7

Percentage of content on the environment



Source: Review of Grade 9 science and social science curricula in 12 selected countries (2023).

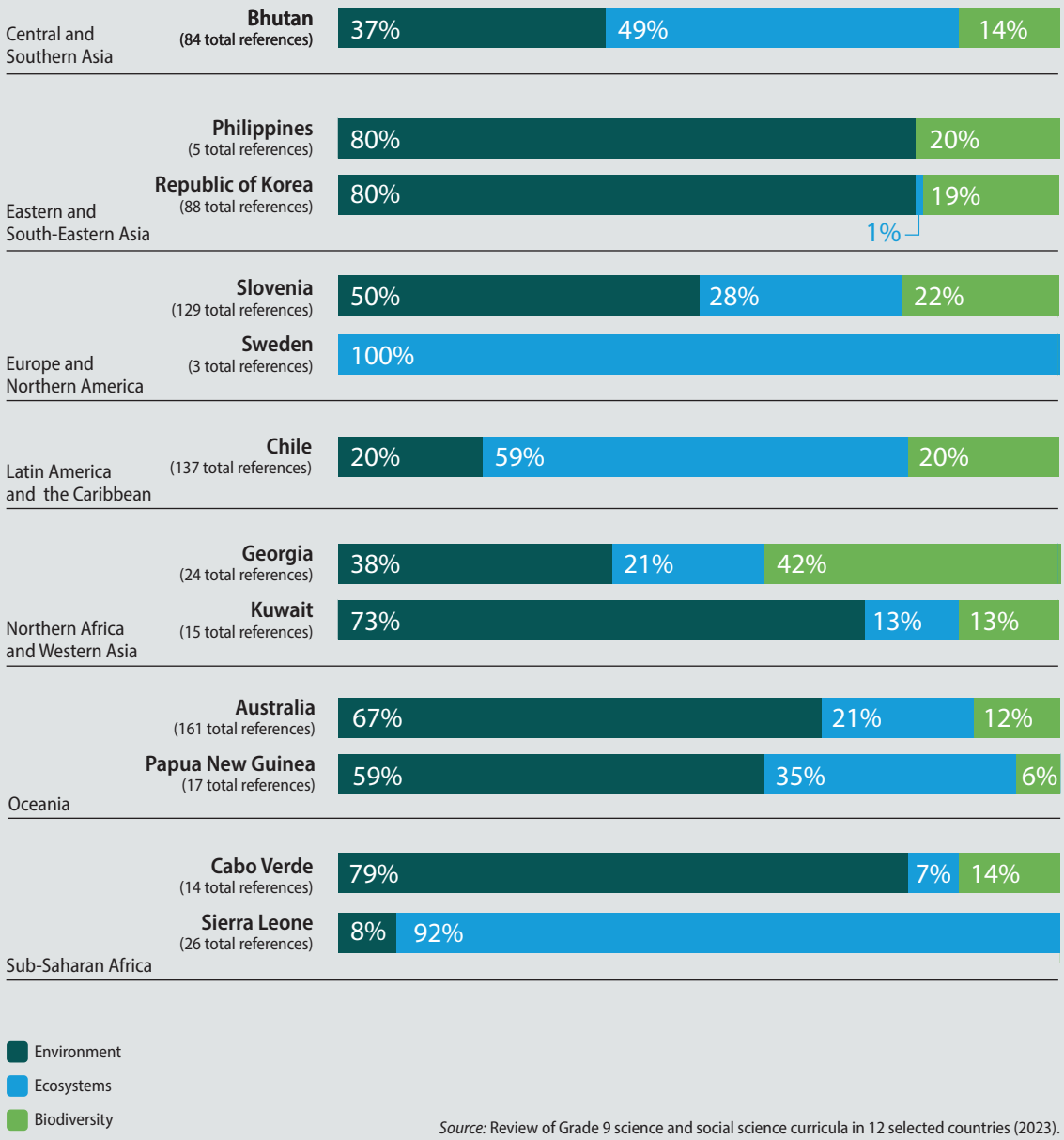
TABLE 5

Subject curriculum spotlight examples: Environment

Environmental	"Analyse and explain environmental diversity (climatic zones, terrain) across the continents" (Kuwait, general social sciences curriculum, p. 31).
Ecosystems	"Pupils study the impact of different factors on ecosystems and populations and describe complex ecological relationships and explain and make generalizations concerning the flow of energy and ecocycles" (Sweden, general science curriculum, p. 171)
Biodiversity	"Research local initiatives available to promote the sustainability of local knowledge and practices in terms of: ▶ self-demarcation of territory ▶ community recording of local knowledge and biodiversity ▶ community controlled research" (Papua New Guinea, general science curriculum, p. 22).

FIGURE 8

Percentage of content on the environment by country and region



Source: Review of Grade 9 science and social science curricula in 12 selected countries (2023).

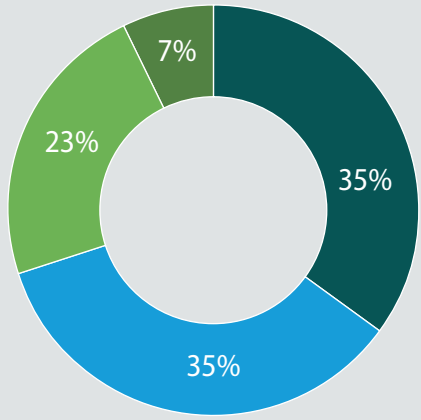
Sustainability

Thirty-nine per cent of case study subject curricula (22/57 curricula) include sustainability content. Most of the content is on conserving or preserving environmental sustainability or on the three pillars of sustainability (environment, social and economic), followed by sustainable production and consumption and the SDGs (**Figure 9** & **Table 6**).

More specifically, nine countries predominantly focus on environmental sustainability, two on the three pillars of sustainability and one on sustainable production and consumption (Figure 10). Often more than one sustainability topic is included within the same learning outcome; for instance, using the three pillars of sustainability to identify how to achieve the SDGs (e.g., in Bhutan).

FIGURE 9

Percentage of content on sustainability



- Environmental sustainability (125 total references)
- 3 pillars of sustainabilty (123 total references)
- Sustainable production and consumption (81 total references)
- Sustainable Development Goals (25 total references)

Source: Review of Grade 9 science and social science curricula in 12 selected countries (2023).

Note: Environmental sustainability refers to responsible interaction with the environment to allow for environmental protection, conservation, quality, and health. The three pillars of sustainability refer to environment, social, and economic content. Sustainable consumption and production refer to the use of resources, products and services that have a minimal impact on the environment. The Sustainable Development Goals (SDGs) refers to specific mention of the SDGs.

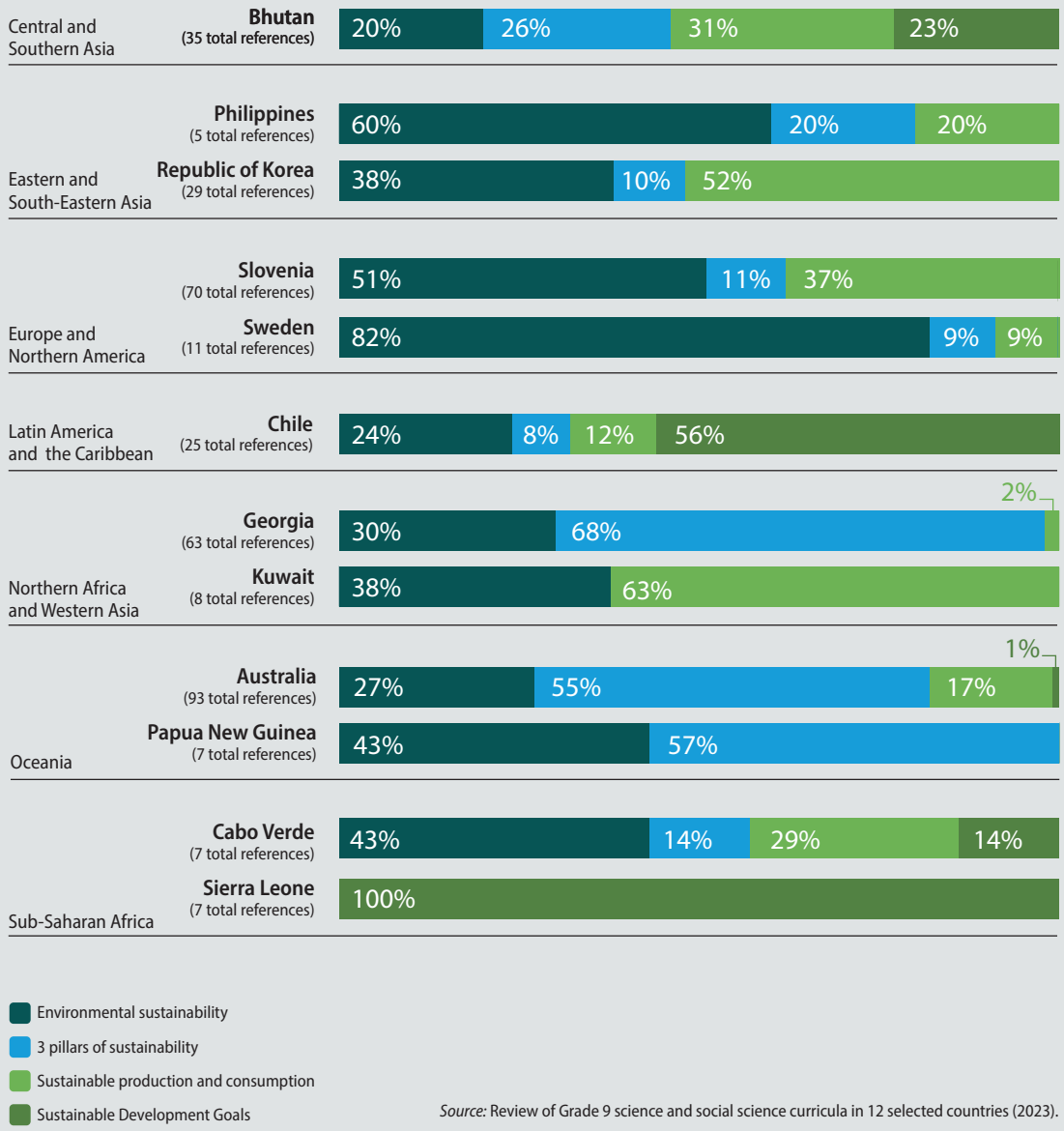
TABLE 6

Subject curriculum spotlight examples: Sustainability

Environmental sustainability	"The human relationship with society and the environment is a fundamental concept in social studies. This theme emphasizes the human being's part not only in his community and environment but also in the wider society and nature. In this way, the student will understand the following… The responsibility of the individual as a member of society and a guardian of the environment and sustaining natural development" (Philippines, general social science curriculum, p. 5).
Three pillars of sustainability	"Indicators to monitor progress in the different dimensions are necessary to help decision-makers and policy-makers at all levels stay focused on the path to sustainable development…Economic indicators are commonly the most used. However, social, environmental and institutional indicators are essential to have a more complete picture of what is happening with development" (Chile, general social science curriculum, p. 150).
Sustainable production and consumption	"Exploring the environmental impacts of the consumer product on the places that produce the raw materials, make the product and receive the wastes at the end of its life." (Australia, Victoria, geography curriculum, p. 18).
Sustainable Development Goals	"Analyse the diverse perspectives of development and evaluate the significance of social, economic and the environmental dimensions to identify ways and means towards achieving the sustainable development goals." (Bhutan, general science curriculum, p. 51).

FIGURE 10

Percentage of content on sustainability by country and region



Source: Review of Grade 9 science and social science curricula in 12 selected countries (2023).

Review of Grade 9 science and social science curricula in five federal or devolved countries

FINDING #3

In federal countries, different approaches are commonly found across those countries' sub-national jurisdictions in relation to the type and extent of inclusion of environment, sustainability and climate change in the science and social science curricula.

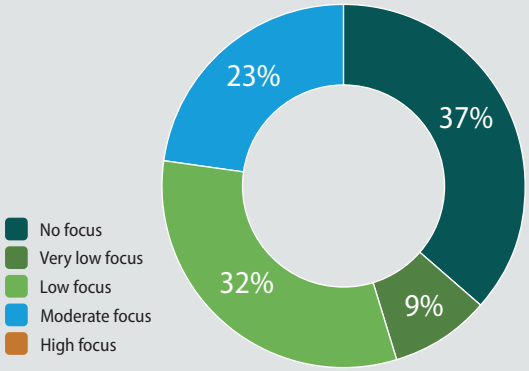
Argentina

In Argentina, 37 per cent of subject curricula (37/101 curricula) across 22 provinces and the autonomous city of Buenos Aires have no content on environment, sustainability or climate change (**Figure 11**)[8]. Of the subject curricula with environment, sustainability and climate change content, 23 per cent (23/101 curricula) have a moderate focus on these topics, 32 per cent (32/101 curricula) have a low focus and 9 per cent (9/101 curricula) have a very low focus.

All provinces include a stronger focus on environment than sustainability and climate change (**Figure 12**). In total, 48 per cent of provinces (11/23 provinces and autonomous city) include at least one reference to sustainability and 43 per cent (10/23 provinces and autonomous city) reference climate change at least once.

FIGURE 11

Percentage of science and social science curricula, by extent of focus on environment, sustainability and climate change: Argentina

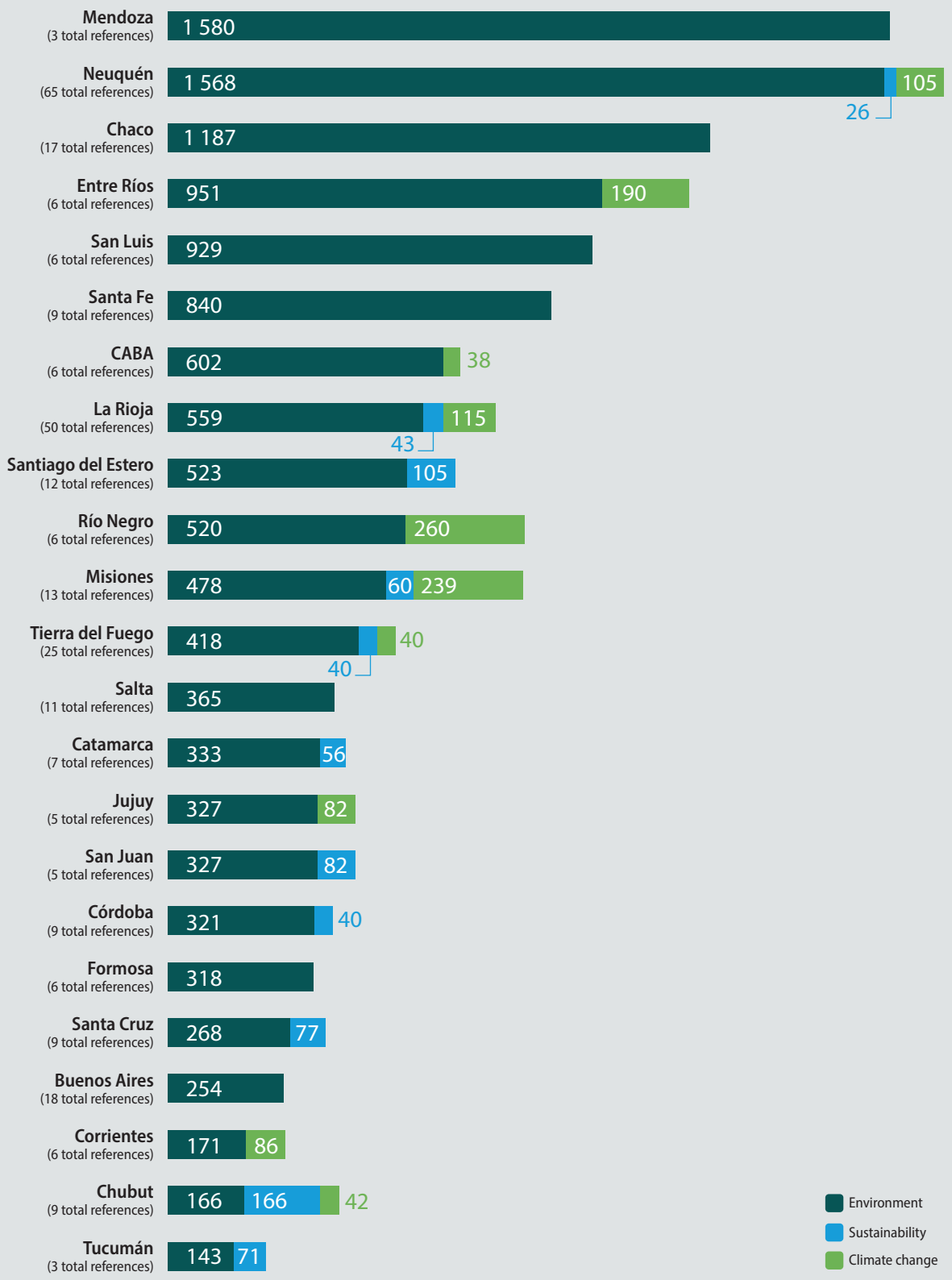


Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).

8 No subject curricula were found for the province of La Pampa.

FIGURE 12

Extent of content on environment, sustainability and climate change across provinces in Argentina (standardized references)



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).
Note: No subject curricula were found for La Pampa.

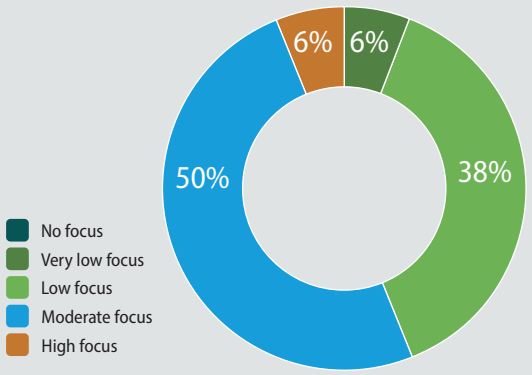
Australia

All 16 subject curricula collected for Australia have environment, sustainability and climate change content. Six per cent of subject curricula (1/16) include these topics to a high extent, 50 per cent (8/16 curricula) to a moderate extent, 38 per cent (6/16 curricula) to a low extent and six per cent (1/16 curricula) to a very low extent (**Figure 13**).

Across all states and territories (7/7 states and territories), environment content is most common, followed by climate change (**Figure 14**). Eighty-six per cent of states and territories (6/7 states and territories) include a minor focus on sustainability.

FIGURE 13

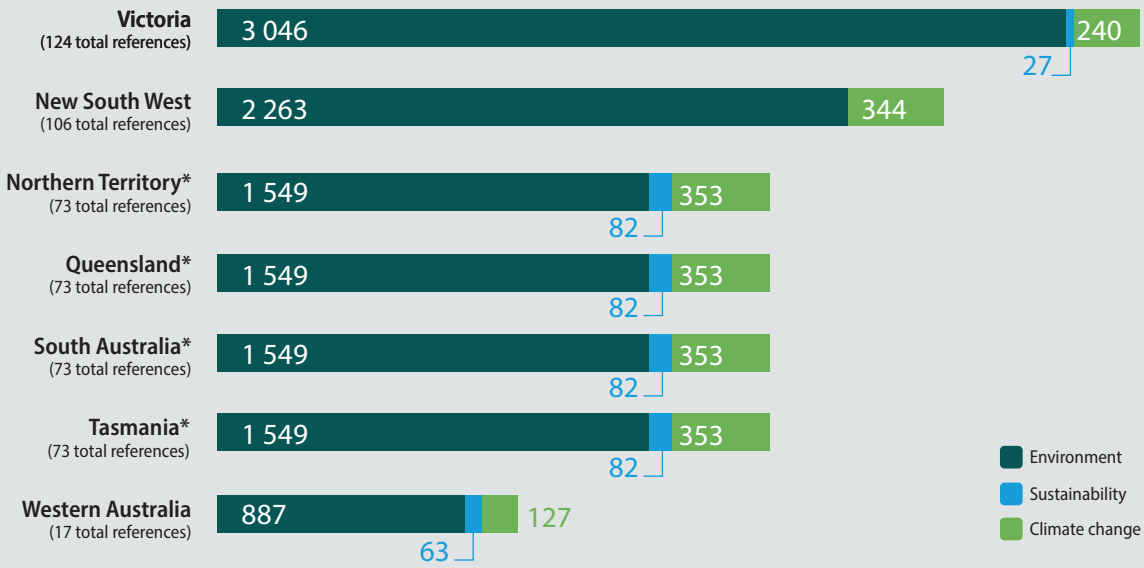
Percentage of science and social science curricula, by extent of focus on environment, sustainability and climate change: Australia



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).

FIGURE 14

Extent of content on environment, sustainability and climate change across states and territories in Australia (standardized references)



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).
Note: The Northern Territory, Queensland, South Australia and Tasmania all use the same subject curricula

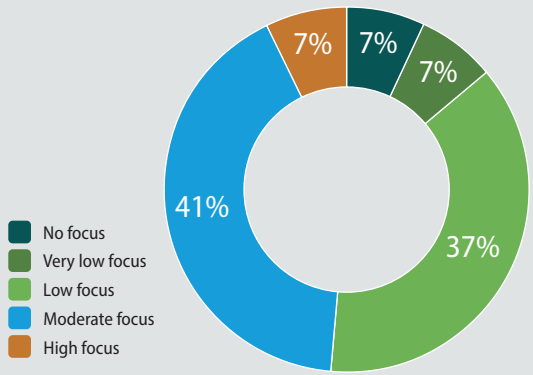
Canada

In total, seven per cent of subject curricula (2/27) have a high focus on environment, sustainability and climate change content, 41 per cent (11/27 curricula) have a moderate focus, 37 per cent (10/27 curricula) have low focus, seven per cent (2/27 curricula) have very low focus and seven per cent (2/27 curricula) have no focus (**Figure 15**).

All provinces and territories in Canada (13/13 provinces and territories) include more content on environment than sustainability and climate change (**Figure 16**). In total, 85 per cent of provinces and territories (11/13) include at least one reference to climate change and 46 per cent (6/13) include sustainability content.

FIGURE 15

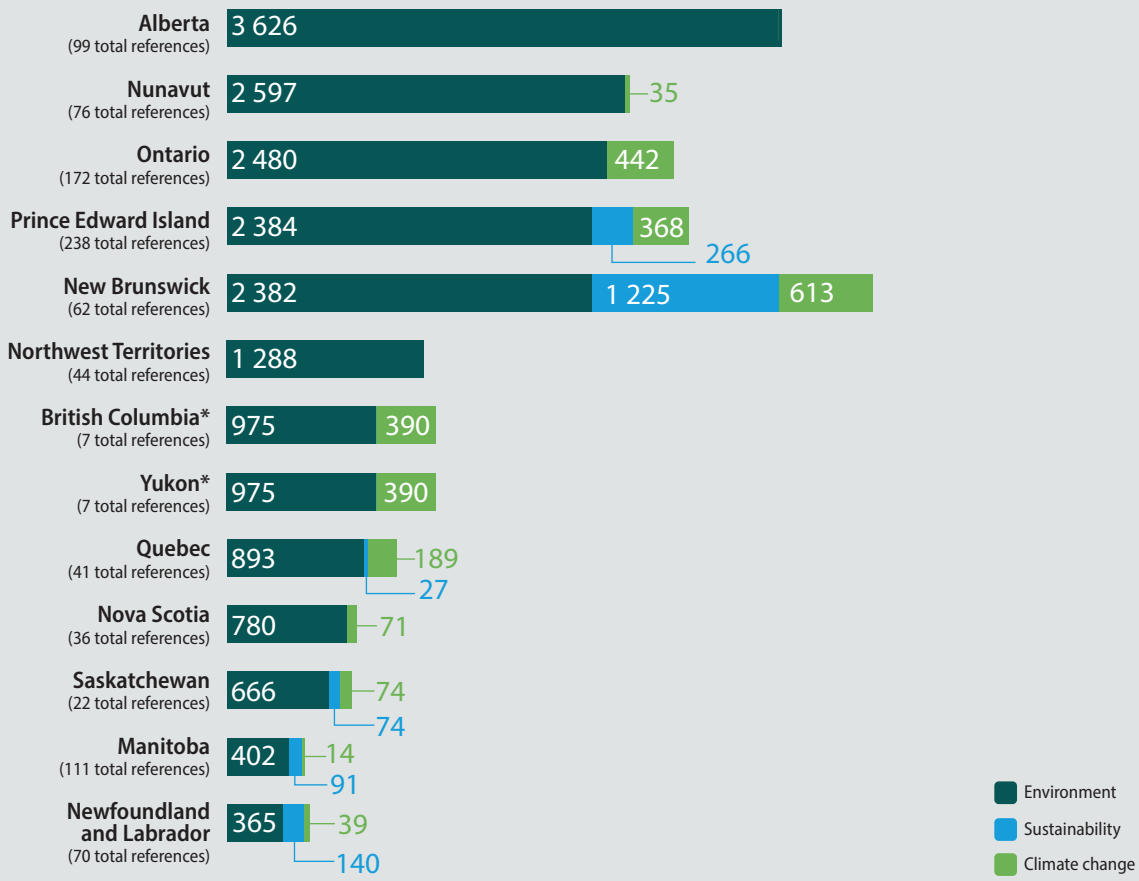
Percentage of science and social science curricula, by extent of focus on environment, sustainability and climate change: Canada



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).

FIGURE 16

Extent of content on environment, sustainability and climate change across provinces and territories in Canada (standardized references)



Source: . Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).
Note: British Columbia and Yukon use the same subject curricula. Nunavut uses subject curricula from Alberta and Northwest Territories.

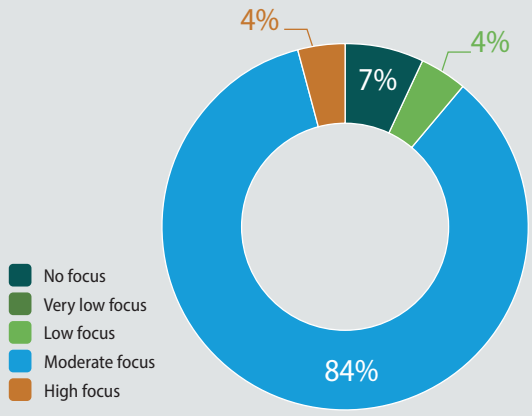
Switzerland

Four per cent of subject curricula have a high focus on environment, sustainability and climate change content (3/67 curricula), 84 per cent of subject curricula have a moderate focus (56/67 curricula), four per cent have a low focus (3/67 curricula) and seven per cent have no focus (5/67 curricula, **Figure 17**).

Eighty-one per cent of cantons (17/21 cantons) include more sustainability than environment and climate change content (**Figure 18**). All cantons (except Ticino, 20/21 cantons) include at least one reference to environment and climate change content. In Ticino, only environment and sustainability content are included.

FIGURE 17

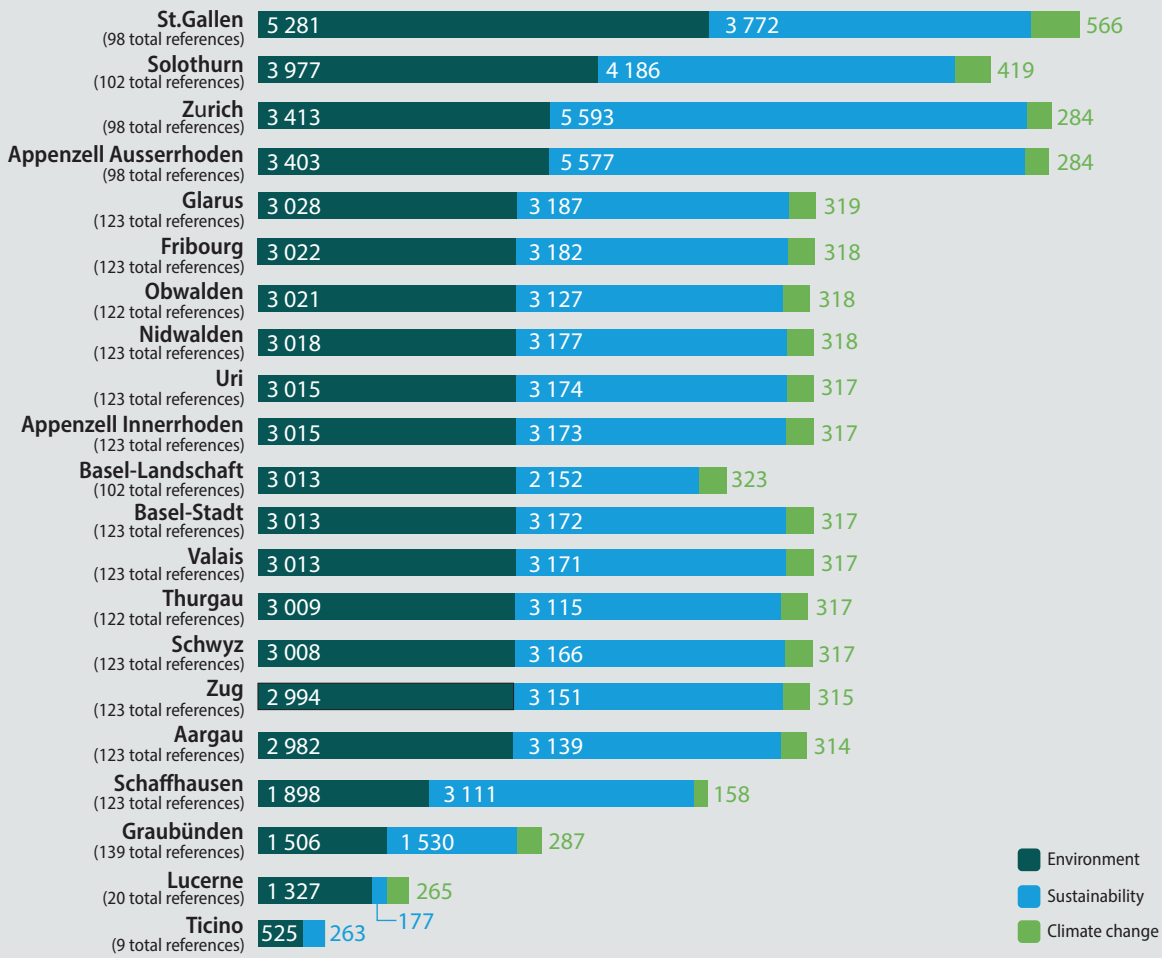
Percentage of science and social science curricula, by extent of focus on environment, sustainability and climate change: Switzerland



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).
Notes: No subject curricula were found for the states of Bern, Geneva, Grisons, Jura, Neuchatel or Vaud. No Romansch subject curricula were found for Graubünden.

FIGURE 18

Extent of content on environment, sustainability and climate change across cantons in Switzerland (standardized references)



Source: . Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).
Note: No subject curricula were found for the states of Bern, Geneva, Grisons, Jura, Neuchatel or Vaud. No Romansch subject curricula were found for Graubünden.

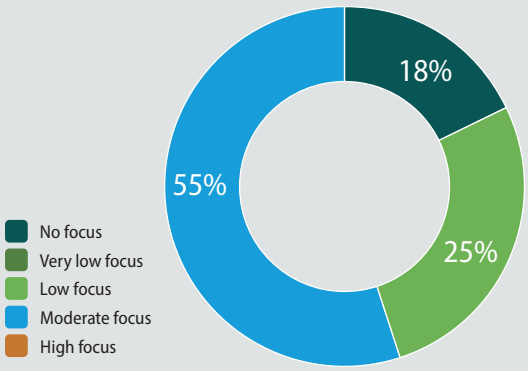
United Kingdom

Fifty-five per cent of subject curricula (6/11 curricula) have a moderate focus on environment, sustainability and climate change content, 27 per cent have a low focus (3/11 curricula) and 18 per cent have no focus (2/11 curricula, **Figure 19**).

All sub-national countries in the United Kingdom focus on environment themes, as opposed to sustainability and climate change (**Figure 20**). Seventy-five per cent of countries (3/4) include at least one reference to climate change and 25 per cent (1/4) include sustainability content.

FIGURE 19

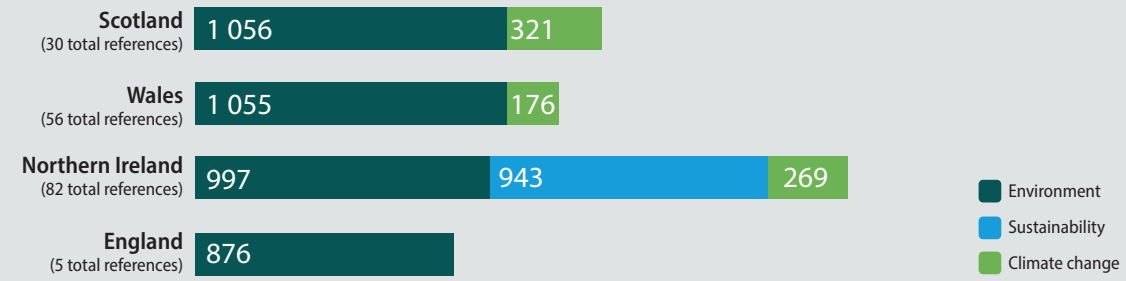
Percentage of science and social science curricula, by extent of focus on environment, sustainability and climate change: United Kingdom



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).

FIGURE 20

Extent of content on environment, sustainability and climate change across countries of the United Kingdom (standardized references)



Source: Review of Grade 9 science and social science curricula in five federal or devolved countries (2023).

Review of Grade 9 science and social science curricula in 85 countries worldwide

FINDING #4

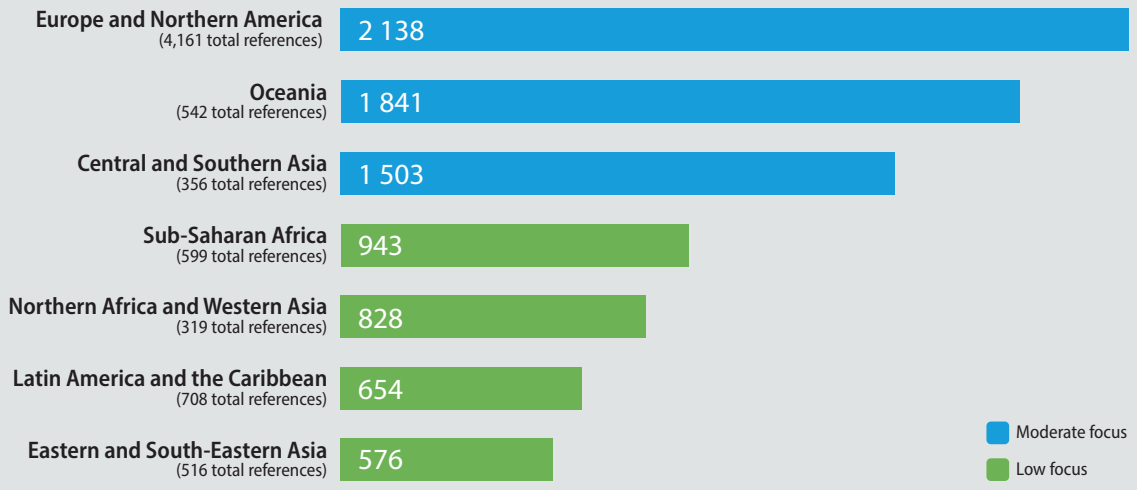
After accounting for number and length of curricular documents analysed, the science and social science curricula from countries in Europe and Northern America, Oceania and Central and Southern Asia had, on average, a moderate focus on environment, sustainability and climate change (between 1,001 and 10,000 references per million words); the subject curricula from countries in Eastern and South-Eastern Asia, Latin America and the Caribbean, Northern Africa and Western Asia and sub-Saharan Africa had, on average, a low focus on these themes (between 301 and 1,000 references per million words).

The SDG regions of Europe and Northern America, Oceania and Central and Southern Asia have considerably more content on environment, sustainability and climate change in their science and social science curricula than other regions (**Figure 21**).

With environment content most common across all regions; the second most frequent content area is sustainability in four SDG regions and climate change in three SDG regions (**Figure 22**). Subject curricula from Oceania and sub-Saharan Africa have the most climate change content, while those subject curricula from Europe and Northern America have considerably more sustainability content. This suggests that more climate change content is included in the subject curricula of countries in regions that are more affected by climate change.

FIGURE 21

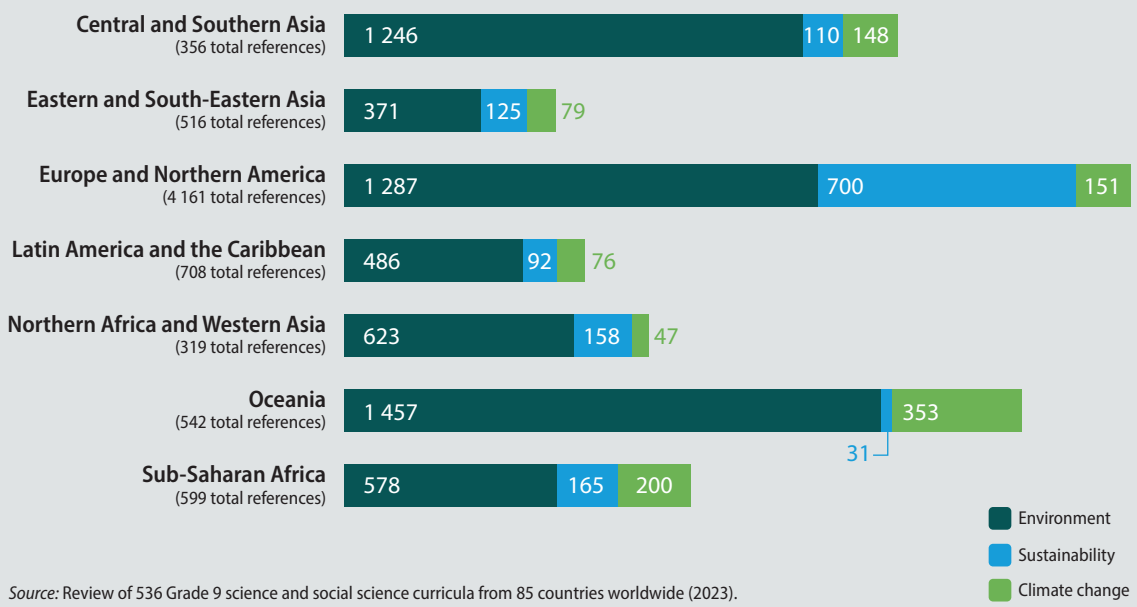
Extent of content on environment, sustainability and climate change by region (standardized references



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

FIGURE 22

Extent of content on environment, sustainability and climate change, by region (standardized references)



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

FINDING #5

Environment content is more often included in science curricula and sustainability and climate change content is more common in social science curricula.

Environment, sustainability and/or climate change are referenced at least once in 82 per cent of science curricula (191/234) and 73 per cent of social science curricula (217/297). When looking at the type of content, most environment content is included in science curricula and most sustainability and climate change content is included in social science curricula (**Figure 23**).

When looking at the depth of inclusion in those subject curricula with content, a moderate focus on environment, sustainability and climate change content is slightly more prevalent in science as opposed to social science subjects. No focus is more common in social science curricula than in science curricula (**Figure 24**).

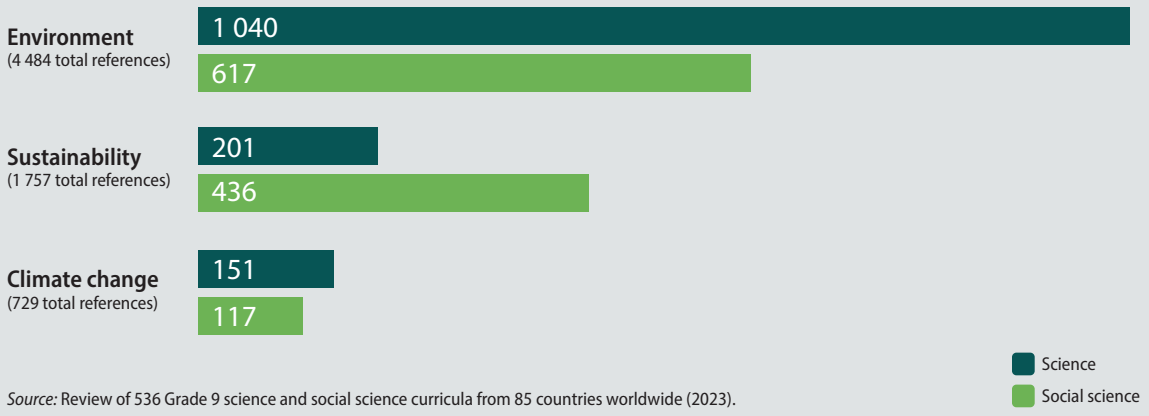
Looking in more detail at the extent of inclusion within specific science subjects, the majority of environment, sustainability and climate change content is found in general science and life science curricula; whereas within social science subjects, geography and general social science curricula have the most content (**Figure 25**).

Within the sciences, environment, sustainability and climate change content is found in 100 per cent of earth science and agriculture (1/1), 92 per cent of general science (97/106), 83 per cent of applied science/technology (15/18), 82 per cent of life science (31/38) and 66 per cent of physical science (47/71) curricula.

Environment, sustainability and climate change content is found in 98 per cent of geography (49/50), 88 per cent of economics (7/8), 84 per cent of general social science (86/102), 68 per cent of philosophy, religious and moral studies (25/37), 52 per cent of history (27/52), 50 per cent of cultural and art studies (1/2) and 26 per cent of civics (22/46) curricula.

FIGURE 23

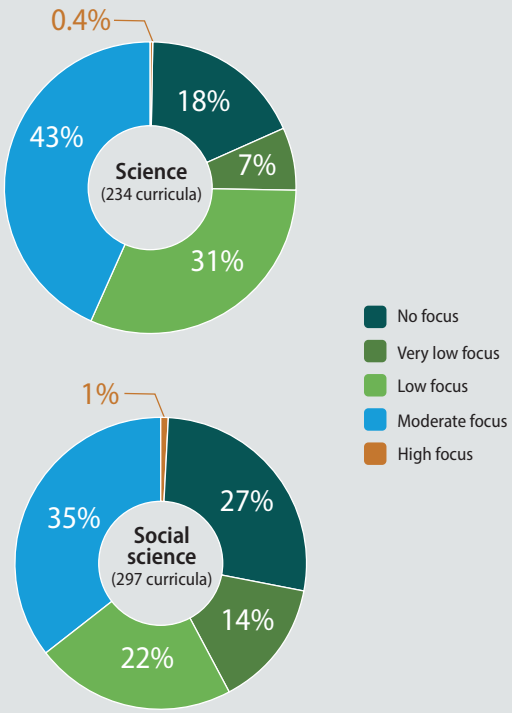
Extent of content on environment, sustainability and climate change by subject (standardized references)



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

FIGURE 24

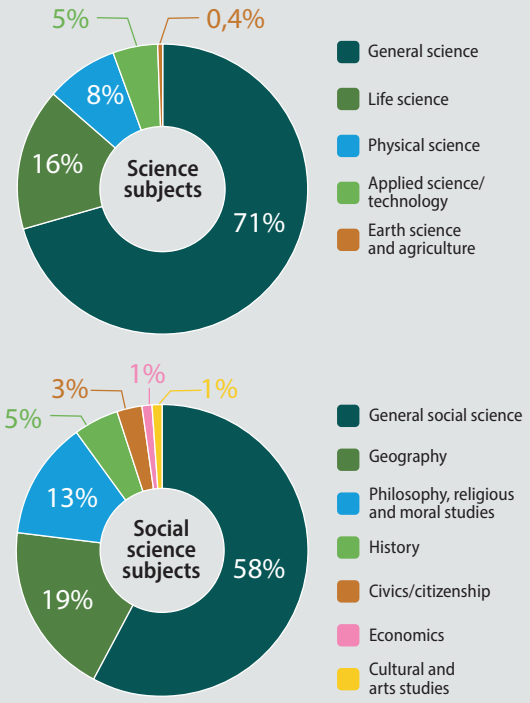
Percentage of science and social science curricula by extent of focus on environment, sustainability and climate change



Source: . Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

FIGURE 25

Percentage of content on environment, sustainability and climate change, by science and social science subject



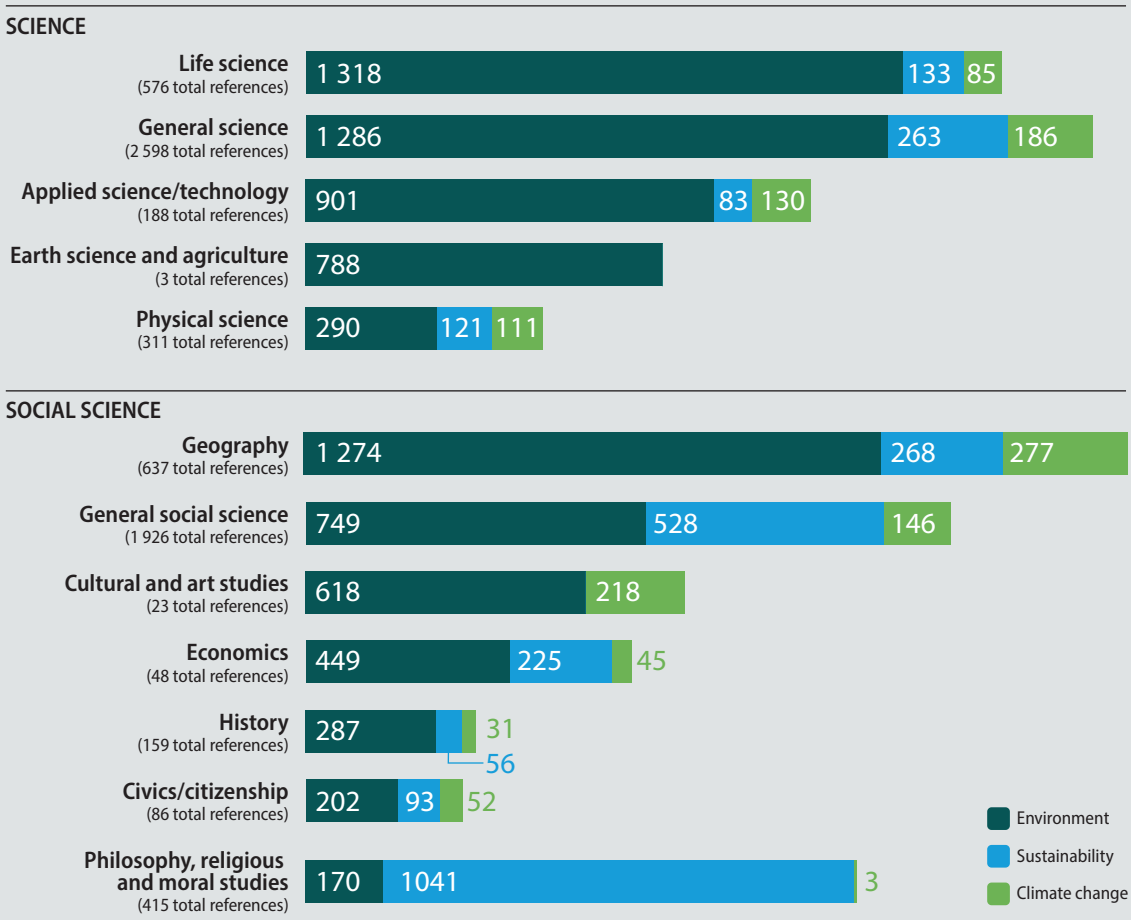
Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

Environment is the most common area discussed in all science curricula, followed by sustainability and climate change for all subjects except applied science/technology where there is a slightly higher focus on climate change. In social science curricula, philosophy, religious and moral studies curricula have more sustainability content than environment or climate change content (**Figure 26**). Cultural and art studies curricula have no sustainability content and philosophy, religious and moral studies curricula have no climate change content.

All five subject curricula categorized as EE/ESD had environment, sustainability, or climate change content. Eighty per cent of EE/ESD curricula (4/5 curricula) had a high focus and 20 per cent (1/5 curricula) had a moderate focus.

FIGURE 26

Extent of content on environment, sustainability and climate change by science and social science subject (standardized references)



Source: Review of 536 Grade 9 science and social science curricula from 85 countries worldwide (2023).

In-depth review of Grade 9 science and social science curricula in 12 countries

FINDING #6

References to environment, sustainability and climate change content in the science and social science curricula rarely address these issues in terms of school facilities and operations, community partnerships, or overall school governance.

When other domains are referenced in the case study countries' science and social science curricula content on environment, sustainability and climate change, the most commonly discussed is community partnerships, followed by facilities and operations and overall governance (**Figure 27** & **Table 7**).

Four countries (Georgia, the Philippines, Sierra Leone and Sweden) do not include content in the subject curricula on any other whole institution domains.

Five countries only include content on community partnerships (Bhutan, Cabo Verde, Kuwait, Papua New Guinea and the Republic of Korea). Only three countries include any content on facilities and operations (Australia, Chile and Slovenia).

Only one country includes any content on overall governance (Slovenia). This content focused on students working to change planning in schools for them to be more environmentally friendly.

Only one country (Slovenia) includes content on all of community partnerships, facilities and operations and governance.

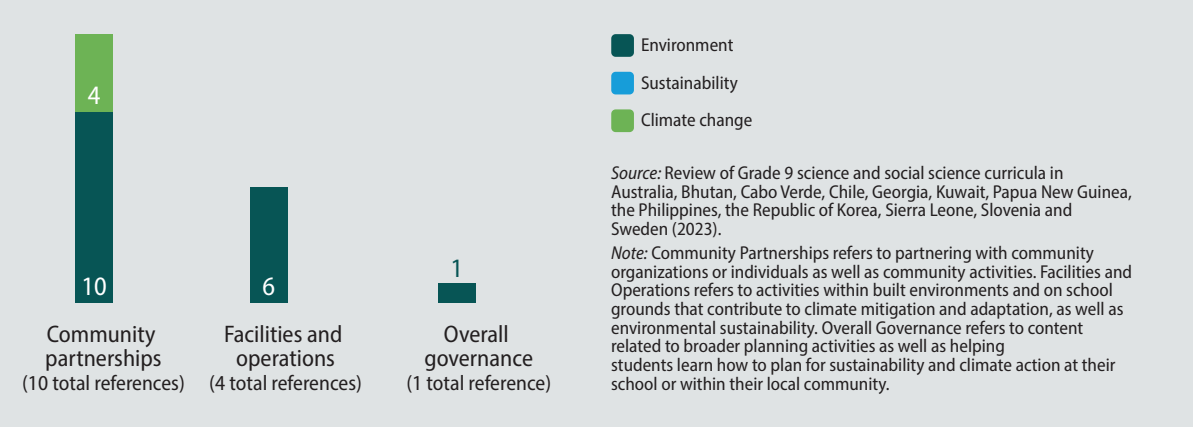
Community partnerships content usually focuses on students working with local organizations or community members to address environment and climate change issues (in Bhutan and Kuwait).

Students are also encouraged to speak to Ministry of Environment technicians about climate change impacts (in Cabo Verde) and attend field trips to foster environmental concern and understanding (in Chile and Papua New Guinea).

Facilities and operations content usually focuses on students learning how to reduce carbon footprints by changing school habits (e.g., transportation, waste practices) (in Australia and Slovenia).

FIGURE 27

Extent of content on environment, sustainability and climate change by whole institution domains (standardized references)



Source: Review of Grade 9 science and social science curricula in Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden (2023).

Note: Community Partnerships refers to partnering with community organizations or individuals as well as community activities. Facilities and Operations refers to activities within built environments and on school grounds that contribute to climate mitigation and adaptation, as well as environmental sustainability. Overall Governance refers to content related to broader planning activities as well as helping students learn how to plan for sustainability and climate action at their school or within their local community.

TABLE 7

Subject curriculum spotlight examples: Whole institution domains

Governance	"[Students] survey their classmates, neighbours and local residents about their values. They make a plan for how to change some habits in their school, town, or city to be more environmentally friendly" (Slovenia, environmental education curriculum, n.p.).
Community Partnerships	"Technical experts can also lend their credence towards developing agro-based entrepreneurial firms, tactics of smart and climate resilient agricultural practices and emerging technologies in agriculture. Therefore, the [agriculture for food security] curriculum aspires to encourage both learners and teachers to engage in close collaboration with those working in the community, relevant agencies and developmental partners." (Bhutan, applied science/technology curriculum, p. 8).
Facilities and Operations	"Students investigate how their classmates (neighbours) travel to school, to work, make an 'ecological footprint', compare between classes, monitor what happens over time … make a plan to change some habits in the school, the community, to be more environmentally friendly" (Slovenia, environmental education curriculum., 2004, p. 17)

FINDING #7

A focus on cognitive learning is much more prevalent than a focus on social and emotional or action-oriented learning across environment, sustainability and climate change content in the science and social science curricula.

When looking at the learning outcomes and processes included in case study countries' science and social science curricula, an emphasis on developing a cognitive understanding is much more common than developing social and emotional or action-oriented competencies in relation to environment, sustainability and climate change learning (**Figure 28** & **Table 8**).

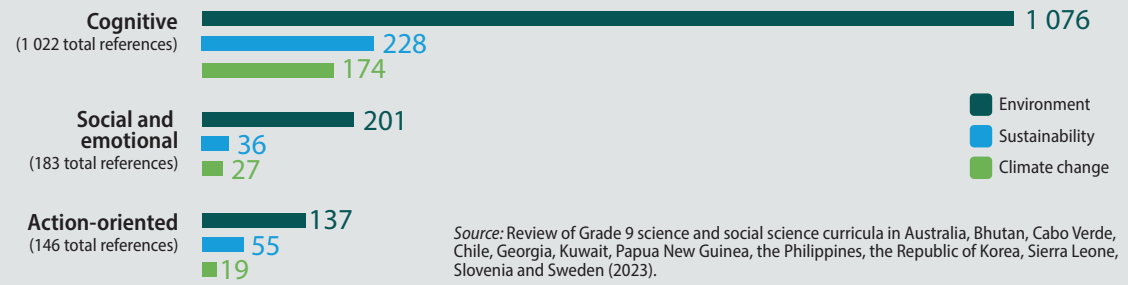
Looking across countries, the second most common learning dimension among countries is action-oriented in six countries and social and emotional learning in five countries (**Figure 29**). One country (Sweden) only includes content focused on cognitive learning. Learning outcomes often address more than one learning dimension. For instance, students are expected to learn knowledge about a topic and then take action.

The dominant focus on cognitive learning is found in all science and social science subject curricula, except philosophy, religious and moral studies, where action-oriented learning is most prevalent (**Figure 30**).

A similar focus on the learning dimensions was found in the EE/ESD curricula from Slovenia,[9] 63 per cent of content had a cognitive focus, 23 per cent had a social and emotional focus and 14 per cent had an action-oriented focus.

FIGURE 28

Extent of content on environment, sustainability and climate change by cognitive, social and emotional, and action-oriented learning dimensions (standardized references)



Source: Review of Grade 9 science and social science curricula in Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden (2023).

9 Slovenia is the only case study country with EE/ESD curricula.

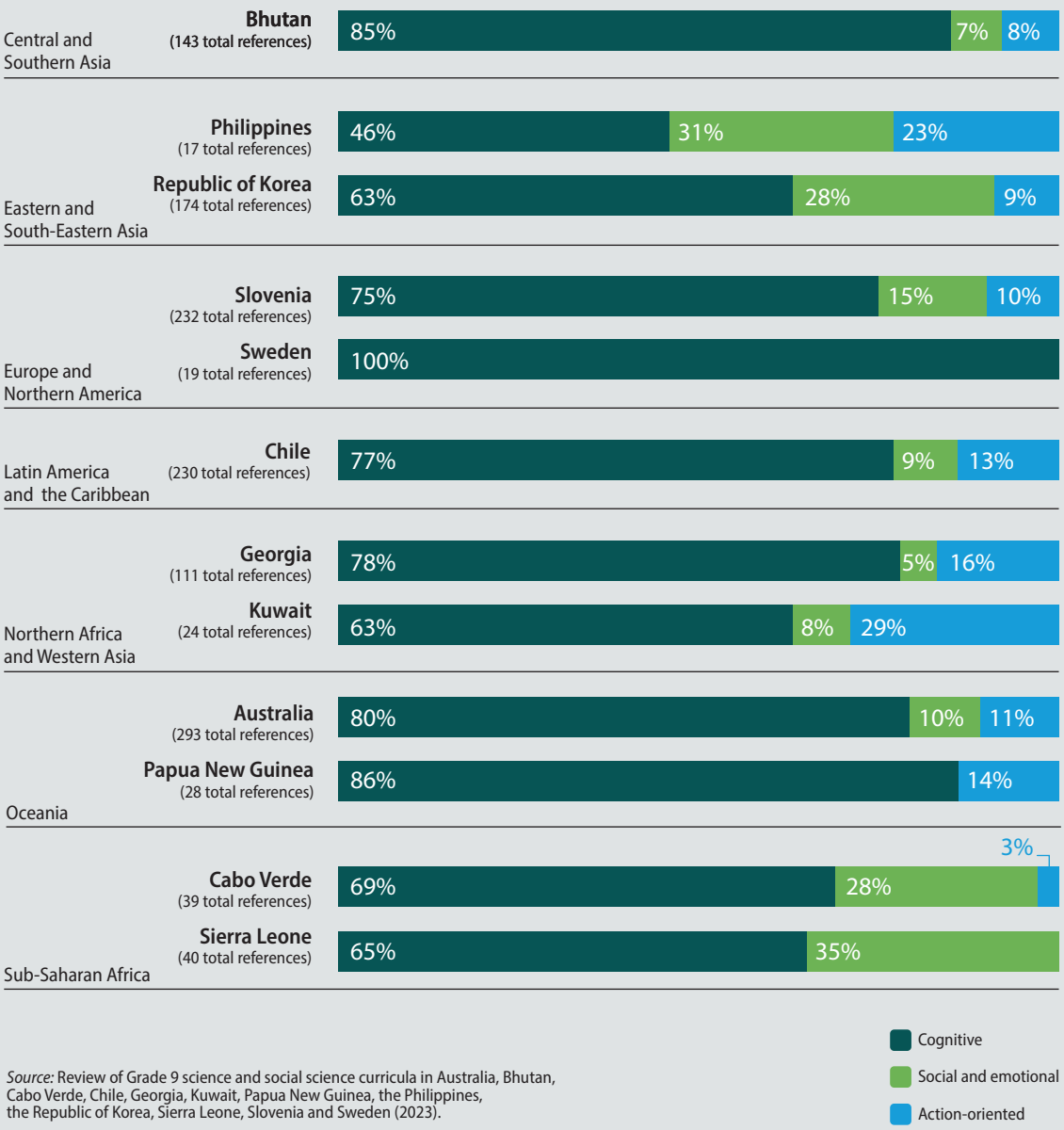
TABLE 8

Subject curriculum spotlight examples: Learning dimensions

Cognitive	"Analyse anthropogenic and natural factors that may affect the size of populations in situations of climate change phenomena" (Chile, general science curriculum, p. 127).
Social and emotional	"Organize discussions about some measures to combat climate change: aspects related to energy consumption and energy efficiency; use of renewable energies instead of fossil fuels." (Cabo Verde, physical science curriculum, p. 43).
Action-oriented	"Understanding the principles of sustainable development and acting on them" (Georgia, geography curriculum, p. 80).

FIGURE 29

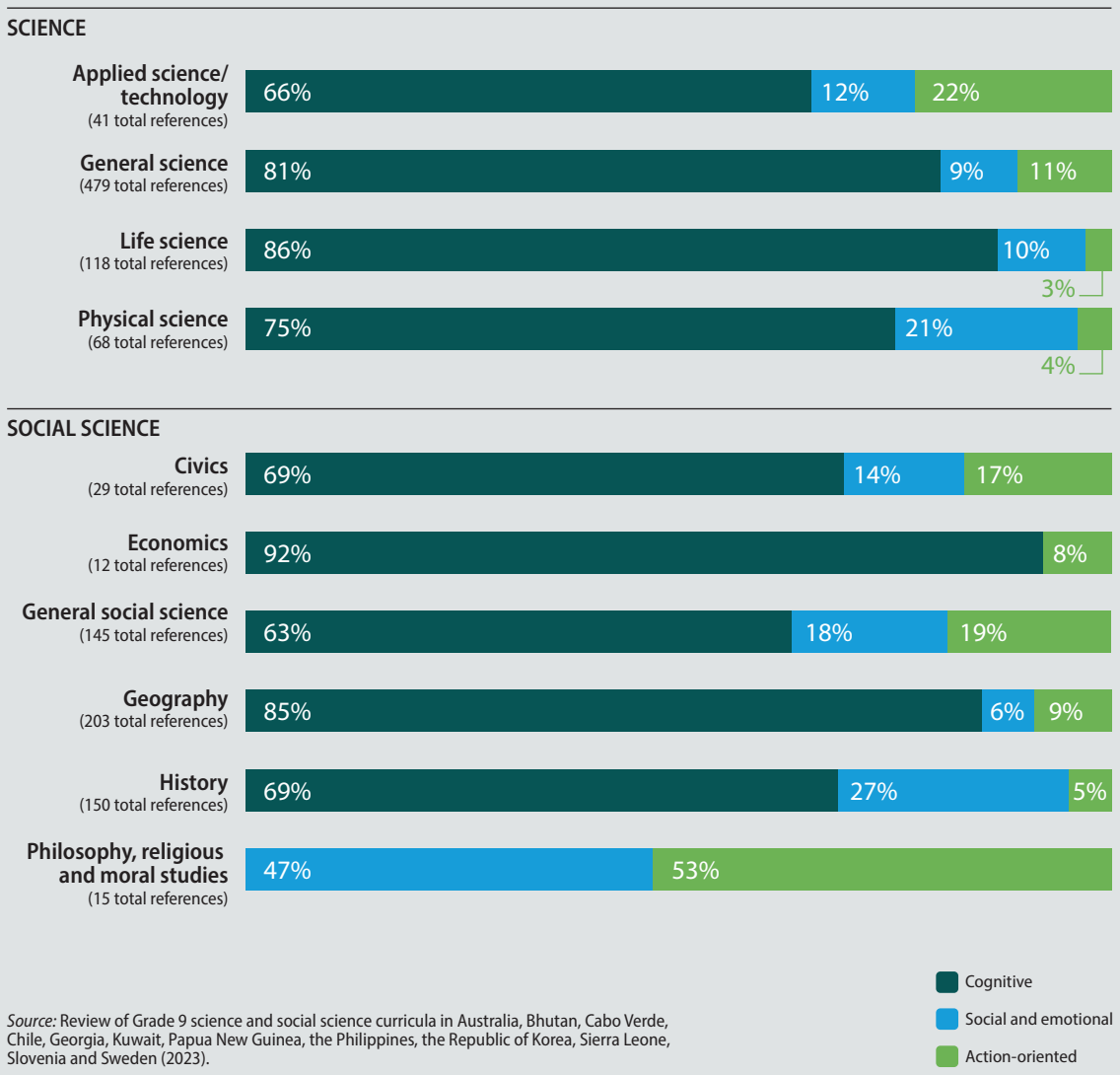
Percentage of content on environment, sustainability and climate change by country and learning dimension



Source: Review of Grade 9 science and social science curricula in Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden (2023).

FIGURE 30

Percentage of content on environment, sustainability and climate change in science and social science curricula by learning dimension



Source: Review of Grade 9 science and social science curricula in Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden (2023).

FINDING #8

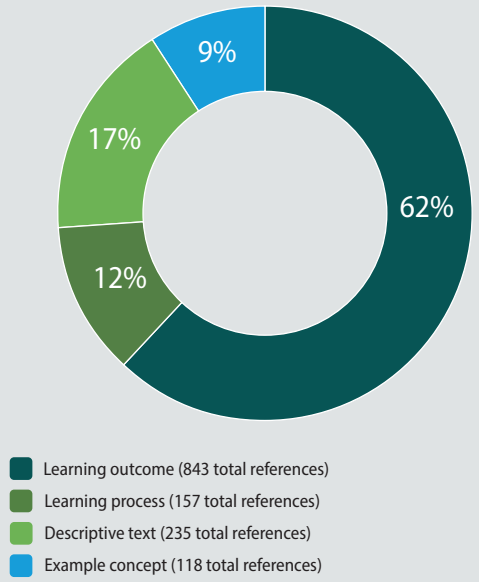
Environment, sustainability and climate change content in the science and social science curricula is usually more focused on learning outcomes than on learning processes.

The study also examined how content on environment, sustainability and climate is presented in the case study countries' science and social science curricula (e.g., in learning outcomes or processes, in descriptive text, or only included as an example concept). Sixty-two per cent of content on environment, sustainability and climate change is in learning outcomes, 12 per cent is in content on teaching processes or methods, 17 per cent is located in descriptive or introductory text in the subject curricula and nine per cent refers to such content as an example concept (**Figure 31** & **Table 9**).

In total, 11 per cent of the time environment, sustainability and climate change content is included in a learning outcome, it is only as an example concept and 10 per cent of these learning outcomes are optional.

FIGURE 31

Percentage of content on environment, sustainability and climate change by type of approach



Source: Review of Grade 9 science and social science curricula in Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden (2023).

TABLE 9

Subject curriculum spotlight examples: Type of approach

Learning outcome	"Become aware of the importance of lifestyle change and collective (local) action in tackling environmental problems" (Slovenia, environmental education, n.p).
Learning process	"Introduce the lesson by displaying charts or pictures about living things and their ecosystems" (Sierra Leone, general science curriculum, p.76)
Descriptive text	"The conditions for life on Earth are unique, changeable and vulnerable. It is thus the responsibility of all people to use the Earth's resources to support sustainable development" (Sweden, general social sciences curriculum, p. 198).
Example concept	"In teams, they research topics such as deforestation, acid rain, global warming, effects of burning and fires. They present a poster defining the research topic, explaining its causes, consequences and solutions, together with an evaluation of the human actions involved." (Chile, general science curriculum, p. 178).

FINDING #9

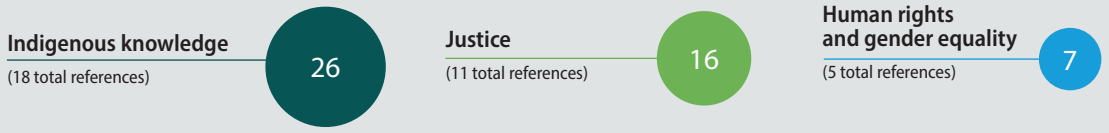
Indigenous knowledge and justice-related issues are rarely addressed in environment, sustainability and climate change content in the science and social science curricula.

Only 24 per cent of science and social science case study countries' curricula (13/54) include content on Indigenous knowledge, justice, or human rights and gender equality issues. When such content is included, content on Indigenous knowledge is most common, followed by justice and human rights and gender equality content (**Figure 32** & **Table 10**).

In total, five countries include a focus on Indigenous knowledge (all Australian states and territories except Western Australia, plus Bhutan, Chile, Georgia and the Republic of Korea), four countries include justice content (all Australian states and territories except New South Wales, Victoria and Western Australia, Georgia, the Philippines and the Republic of Korea) and three countries include human rights and gender equality content (Australia, the Philippines and Slovenia).

FIGURE 32

Extent of content on environment, sustainability and climate change in relation to Indigenous knowledge, justice and human rights and gender equality (standardized references)



Source: Review of Grade 9 science and social science curricula in Australia, Bhutan, Cabo Verde, Chile, Georgia, Kuwait, Papua New Guinea, the Philippines, the Republic of Korea, Sierra Leone, Slovenia and Sweden (2023).

Note: Indigenous knowledge refers to incorporating Indigenous knowledge or priorities. Justice-oriented refers to climate or environmental justice issues. Human Rights and Gender Equality refers to fundamental human rights, including the right to freedom from discrimination based on gender.

TABLE 10

Subject curriculum spotlight examples: Inclusion of key themes

Indigenous knowledge	"[Investigate] how First Nations Australians are reducing Australia's greenhouse gas emissions through the reinstatement of traditional fire management regimes" (Australia, Northern Territory, Queensland, South Australia and Tasmania, general science curriculum, p. 24).
Justice-oriented	"Critically recognize regional environmental inequality, focusing on the relocation of polluting industries to other countries" (Republic of Korea, history curriculum, p. 73).
Human rights and gender equality	"The advocacy of various civil societies is assessed based on their contribution to social justice, economic development (economic viability), citizen participation, environmental protection, peace, equality of women and men (gender equality) and spirituality (values needed in a sustainable society)" (Philippines, general social science curriculum, p. 126).

Review of Grade 9 science and social science curricula in 85 countries worldwide

FINDING #10

When all the science and social science curricula are analysed by the period of their publication, two findings emerge: a) there is a consistently high level of inclusion of environment content in all three time periods (before 2001; 2001-2012; 2013-2023) and b) subject curricula published in the past 10 years include higher levels of content on climate change and sustainability than in earlier time periods.

Overall, there is a consistently high level of inclusion of environment content in all three time periods in which science and social science curricula were published (i.e., before 2000, 2001-2012 and 2013 to 2023, **Figure 33**). Subject curricula published from 2013 to 2023 have more overall climate change and sustainability content than those published from 2001 to 2012.

There was a doubling of environment, sustainability and climate change content found in social science curricula published in the last ten years and those published in 2000 and prior (**Figure 34**). The increase in environment, sustainability and climate change content found in science curricula was notable in the 2001-2012 period and has since levelled off.

FIGURE 33

Extent of content on environment, sustainability and climate change, by publication period (standardized references)

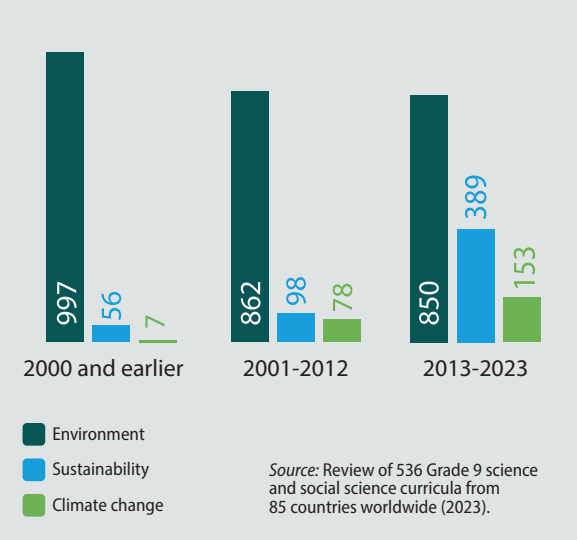
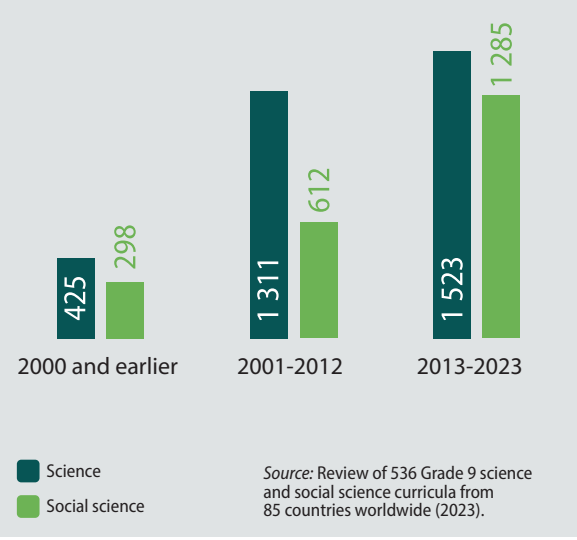


FIGURE 34

Extent of content on environment, sustainability and climate change by subject and publication period (standardized references)



Survey of teachers in eight countries

FINDING #11

A majority of surveyed teachers indicated that environment, sustainability and climate change are included in the science and social science curricula in the school in which they work. They indicate the focus is usually on gaining a cognitive understanding of these issues.

Sixty-nine per cent (1007/1450) of surveyed Grade 9 teachers indicate environment, sustainability and climate change issues are included in the official science and social science curricula of their schools.

In looking at the topics covered in the subject curricula, teachers indicated the following were integrated to a moderate or large extent: climate change (80 per cent of teachers), sustainable development (76 per cent of teachers), biodiversity (65 per cent of teachers), environmental justice (64 per cent of teachers) and other environmental topics (37 per cent, **Figure 35**).[10]

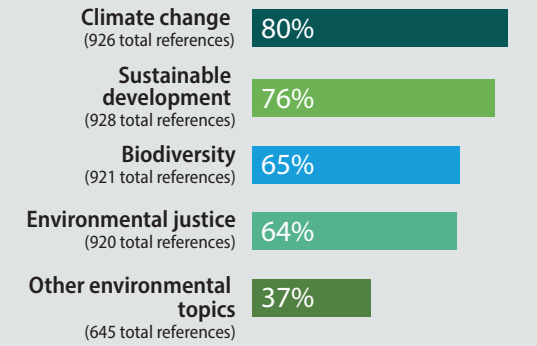
When teachers were asked to characterize the kinds of learning processes and outcomes associated with the inclusion of environment, sustainability and climate change in the subject curricula, they were asked to choose one or several of these options: a) acquiring knowledge and cognitive understanding; b) developing emotional or interpersonal skills; and c) developing action skills and/or practising taking action on these issues.

Just over half (52 per cent) of the teachers chose only one learning dimension focus; the majority of which selected the acquisition of knowledge and cognitive understanding (41 per cent, **Figure 36**). Just under half (48 per cent) of teachers choose one of several combinations: 20 per cent selected all three emphases, 19 per cent selected cognitive and social and emotional, 8 per cent selected cognitive and action oriented and less than one per cent selected social and emotional and action oriented.

While these results underscore the prevalence of a focus on cognitive learning, they also illustrate that additional foci - mainly social and emotional - are also perceived to be present in subject curricula.

FIGURE 35

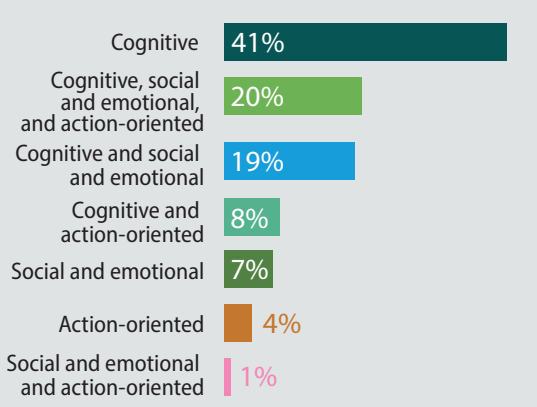
Percentage of teachers indicating that environment, sustainability and climate change is included in their school's science and social science curriculum to a moderate or large extent



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

FIGURE 36

Percentage of teachers reporting extent of focus on cognitive, social and emotional and action-oriented learning dimensions in science and social science curricula



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

10 The difference in extent of focus in the survey results from the keyword analysis of the curriculum is likely due to the overrepresentation of survey responses from the Republic of Korea, where 39% of content was found to include a focus on climate, as opposed to 46% on the environment and 15% on sustainability. Biodiversity and environmental justice were also included as part of environment content in the curricular analyses, which could also account for a lower focus on 'other environmental topics.'

FINDING #12

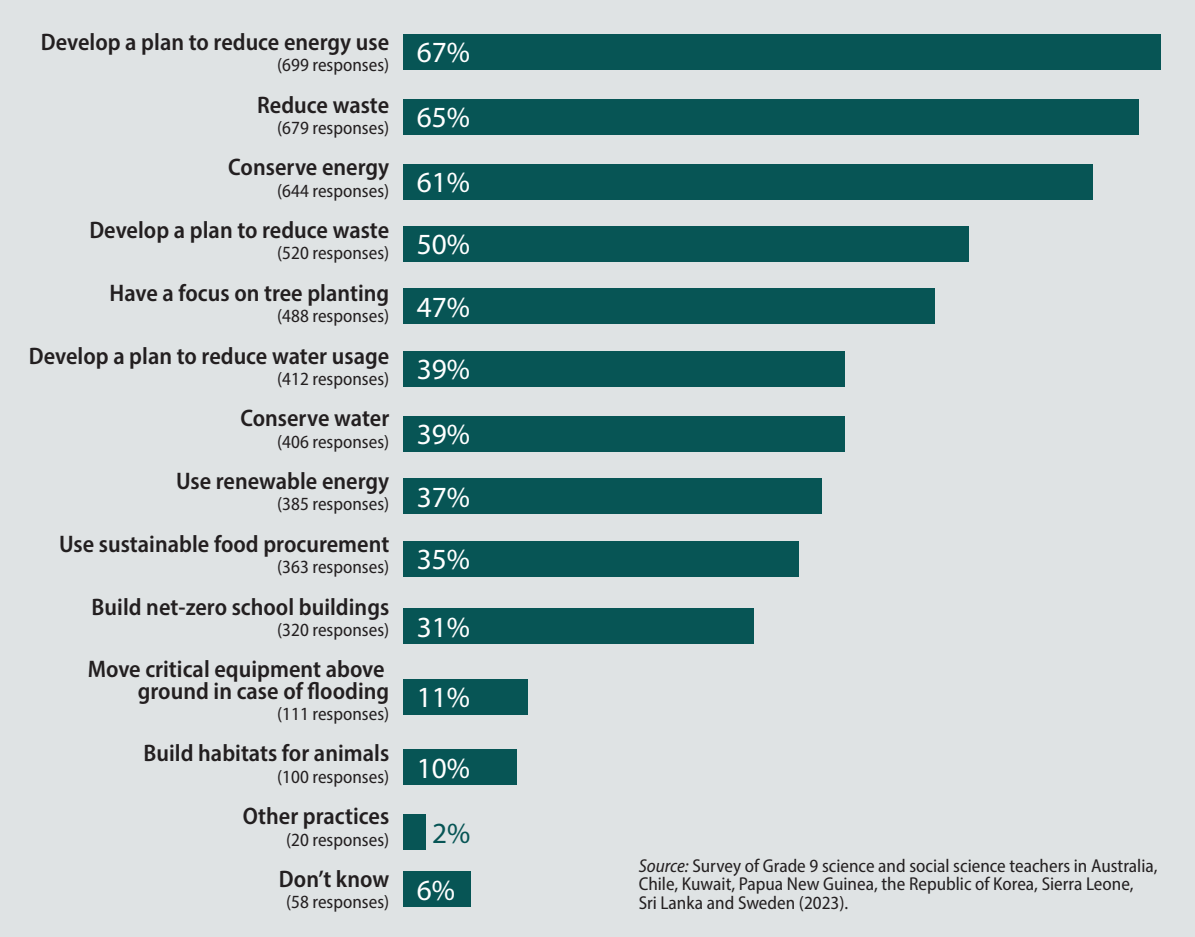
A majority of surveyed teachers reported that the most common school practices related to environment, sustainability and climate change are reducing energy use and waste. School meetings on these issues were reported to focus on facilities and operations and school governance practices.

When asked about school practices related to environment, sustainability and climate change, teachers indicated that the most common practices in their schools are developing a plan to reduce energy use (67 per cent), reducing waste (65 per cent), conserving energy (61 per cent) and developing a plan to reduce waste (50 per cent). Tree planting is also quite common, as noted by 47 per cent of teachers. Between 30 to 40 per cent of teachers also report that their schools are involved in reducing or conserving water (39 per cent), using renewable energy (37 per cent), procuring sustainable food products (35 per cent) and building net-zero school buildings (31 per cent, **Figure 37**).

Teachers indicated that school meetings with teachers, staff or school leaders on environment, sustainability and climate change usually are focused to 'a large or moderate extent' on facilities and operations practices (49 per cent), such as waste management, or energy, water or food related issues (**Figure 38**). A substantial proportion of teachers also indicated meetings are focused to 'a large or moderate extent' on school governance practices (34 per cent), such as developing a school strategy, action plan or goals, student council meetings with students or meetings with parents and community members.

FIGURE 37

Percentage of teachers responding that the practice is implemented in their school

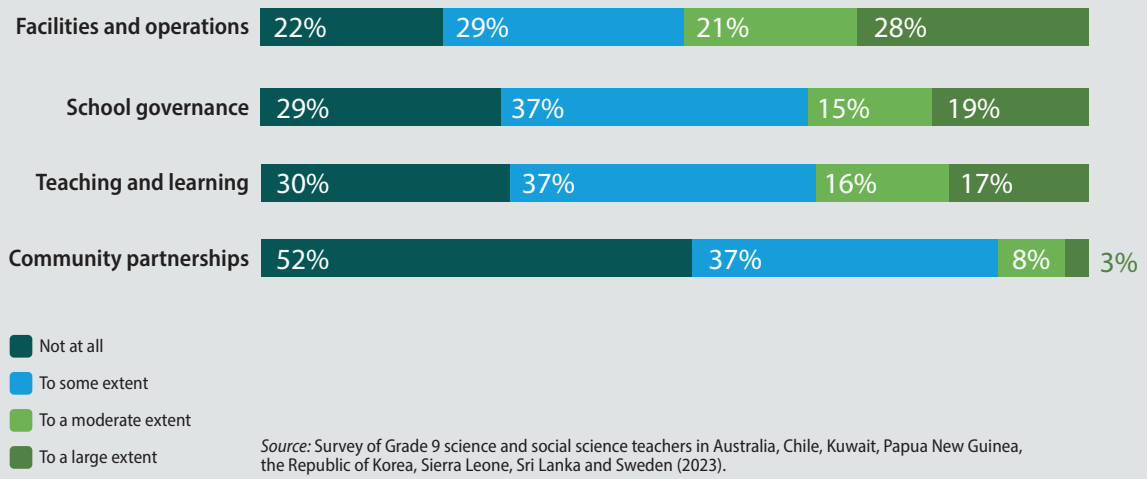


Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

A similar number of teachers indicated to 'a large or moderate extent' that school meetings address environment, sustainability and climate change in relation to teaching and learning practices (33 per cent), such as curriculum, instructional activities or place-based education. A smaller number of teachers indicated that school meetings address to 'a large or moderate extent' community partnership practices (10 per cent), such as field trips, guest speakers, or working with community members on teaching and learning activities or facilities and operations innovations.

FIGURE 38

Percentage of teachers responding that the meetings held at their school are related to facilities and operations, school governance, teaching and learning and community partnerships



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

FINDING #13

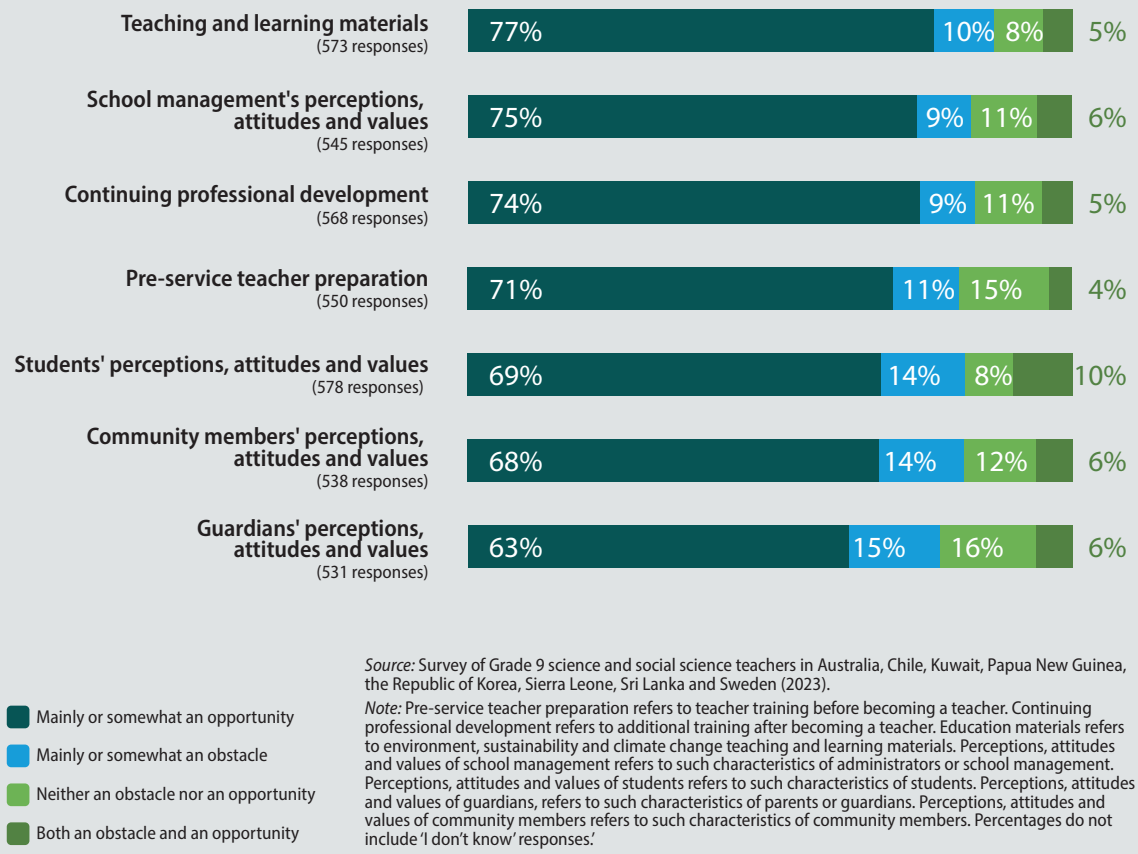
A majority of surveyed teachers reported that educational materials and teacher preparation are key opportunities for integrating environment, sustainability and climate change content into the science and social science curricula.

Teachers were asked to indicate which factors represent opportunities or obstacles in implementing environment, sustainability and climate change in the science and social science curricula. More than 70 per cent of survey respondents perceived teaching and learning materials, continuing professional development of teachers and pre-service teacher preparation as key opportunities for integrating environment, sustainability and climate change into the subject curricula (**Figure 39**).

Around two-thirds of respondents also highlighted the importance of the perceptions, attitudes and values of school administrators/leaders and students as opportunities to better implement curricular emphasis on environment, sustainability and climate change. Lesser, though still strong, attention was accorded to the perceptions, attitudes and values of community members and parents in implementing content in the subject curricula, 68 per cent and 63 per cent respectively. Few of these factors are seen as major obstacles.

FIGURE 39

Percentage of teachers reporting that various factors represent an opportunity or obstacle to the implementation of environment, sustainability and climate change content



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

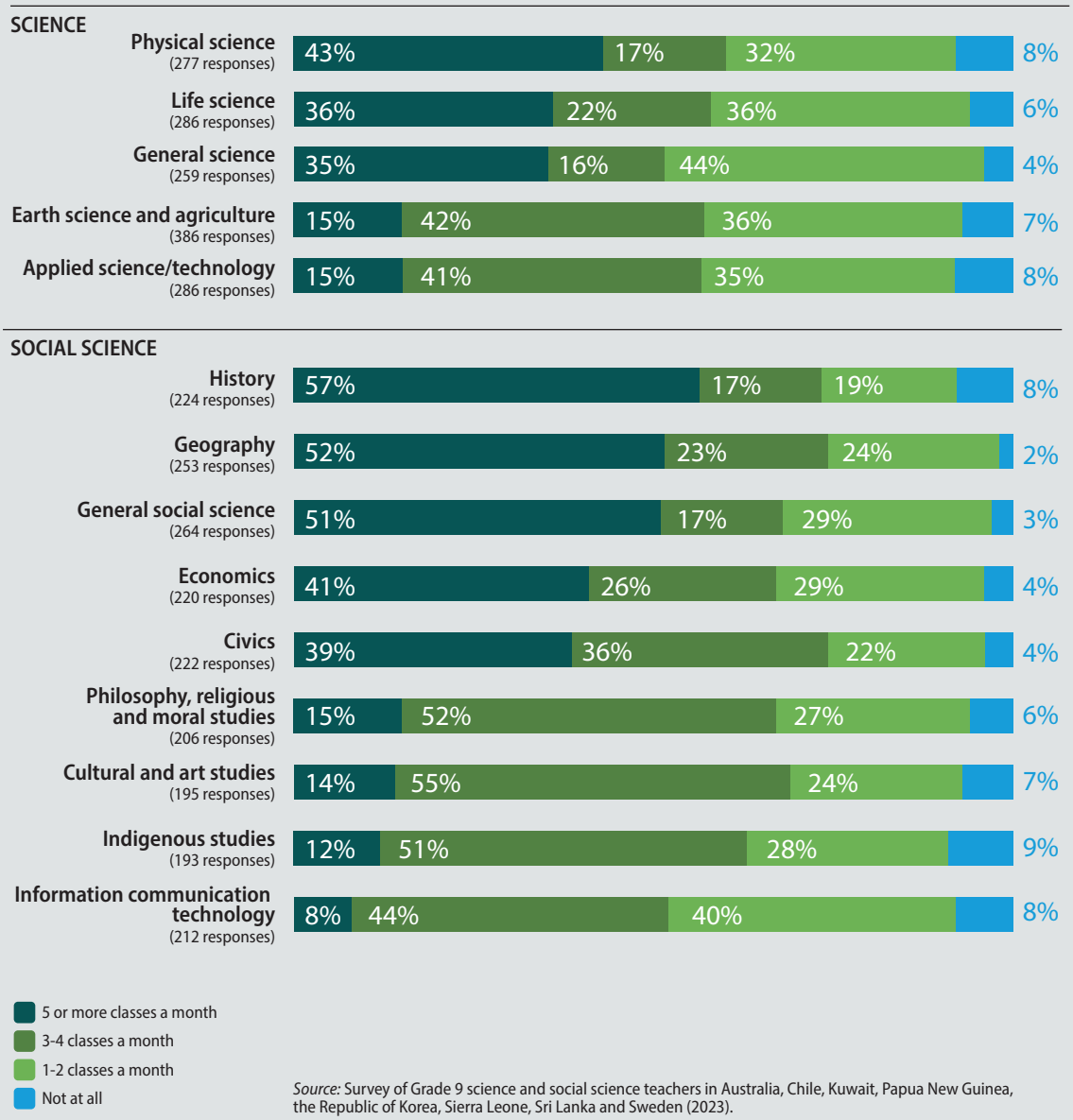
Note: Pre-service teacher preparation refers to teacher training before becoming a teacher. Continuing professional development refers to additional training after becoming a teacher. Education materials refers to environment, sustainability and climate change teaching and learning materials. Perceptions, attitudes and values of school management refers to such characteristics of administrators or school management. Perceptions, attitudes and values of students refers to such characteristics of students. Perceptions, attitudes and values of guardians, refers to such characteristics of parents or guardians. Perceptions, attitudes and values of community members refers to such characteristics of community members. Percentages do not include 'I don't know' responses.'

FINDING #14

Half of surveyed teachers reported including environment, sustainability and climate change content in their classes. Such content is reported by teachers as being included in a wide array of science and social science subjects.

FIGURE 40

Percentage of teachers reporting how often environment, sustainability and climate change content is included in science and social science subjects each month



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

Half of the surveyed teachers (725/1450) indicated environment, sustainability and climate change content is included in their teaching. Teachers were asked to respond about their teaching of these topics, both inside and outside the school building.

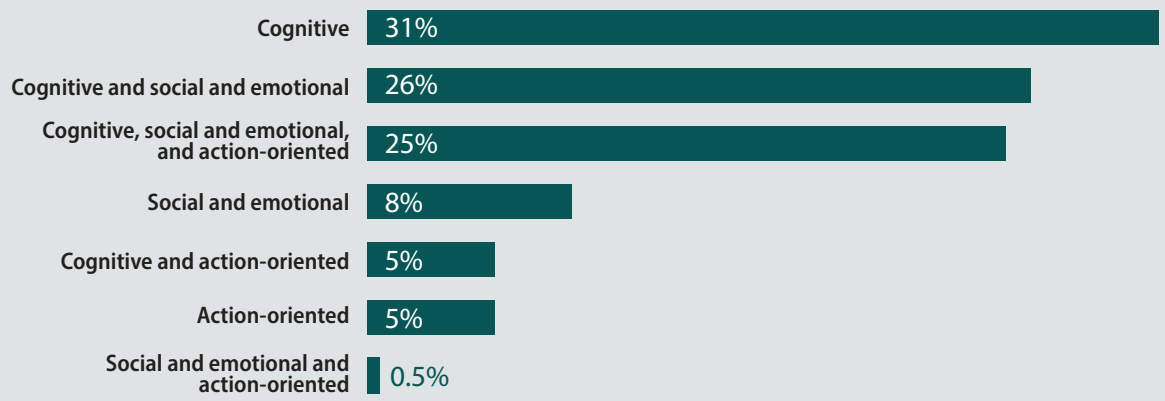
Teachers reported considerable variation in the extent to which environment, sustainability and climate change content is included in their teaching of specific science and social science subjects (**Figure 40**). Science teachers reported that environment, sustainability and climate change content is usually included in five or more classes per month in physical science (43 per cent), life science (36 per cent) and general science (35 per cent). They reported that content is usually included in 3-4 classes per month in earth science and agriculture (42 per cent) and applied science/technology (41 per cent) and 1-2 times per month in general science (44 per cent).[11]

Social science teachers reported including environment, sustainability and climate change content in five or more classes per month in the following subjects: history (57 per cent), geography (52 per cent), general social science (51 per cent), economics (41 per cent) and citizenship (39 per cent). Over half of teachers reported teaching these topics an average of once per week in the subjects of cultural and art studies, philosophy, religious and moral studies, Indigenous studies and information communication technology.

Teachers were also asked to characterize the kinds of learning processes and outcomes associated with their teaching on environment, sustainability and climate change. Less than half (43 per cent) chose only one focus (i.e., cognitive, social and emotional, or action-oriented), of which 31 per cent indicated they emphasized cognitive understanding in their teaching (**Figure 41**). 57 per cent of teachers chose one of the following combinations: 26 per cent selected cognitive and social and emotional, 25 per cent selected all three emphases, 5 per cent selected cognitive and action-oriented and less than one per cent selected social and emotional and action-oriented. While these results also indicate the prevalence of the cognitive dimension in the teaching of environment, sustainability and climate change content, they also indicate a strong inclusion of other dimensions, particularly social and emotional.

FIGURE 41

Percentage of teachers reporting extent of focus on cognitive, social and emotional and action-oriented learning dimensions in their teaching



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

11 For each subject listed, a substantial percentage of teachers responded that either they "do not know" (4 to 11 per cent), or that the question was not applicable (7 to 25 per cent), which suggests they did not believe environment, sustainability and climate change content was applicable to the listed subject.

FINDING #15

Almost 40 per cent of surveyed teachers reported going beyond the requirements of the 'official' science and social science curricula in including content on environment, sustainability and climate change.

A substantial proportion of teachers (38 per cent) reported going beyond the 'official' science and social science curricula by covering additional content on environment, sustainability and climate change (**Figure 42**). This approach demonstrates a commitment to providing students with enriched learning in relation to these issues.

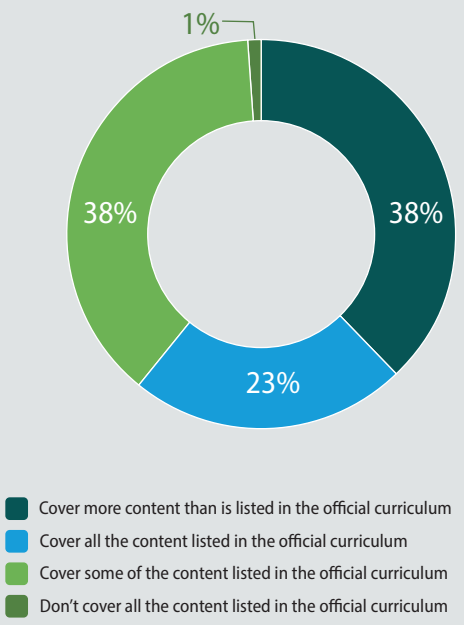
Another substantial group of teachers (38 per cent) indicated that they cover some of the content on environment, sustainability and climate change included in the subject curricula. A small minority of teachers (1 per cent) acknowledged that they do not cover all the content related to environment, sustainability and climate change issues listed in the official curriculum.

One-quarter of teachers (23 per cent) reported they cover all the content related to environment, sustainability and climate change included in the subject curricula.

Overall, about 60 per cent of teachers (373/613) reported providing their students with an opportunity for learning on environment, sustainability and climate change in a way that meets or exceeds official expectations. Most of the remaining teachers fall short in meeting curricular standards in this area.

FIGURE 42

Percentage of teachers reporting their coverage of environment, sustainability and climate change relative to inclusion in the science and social science curricula



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

FINDING #16

A majority of surveyed teachers reported using action-oriented methods when teaching about environment, sustainability and climate change in their lessons.

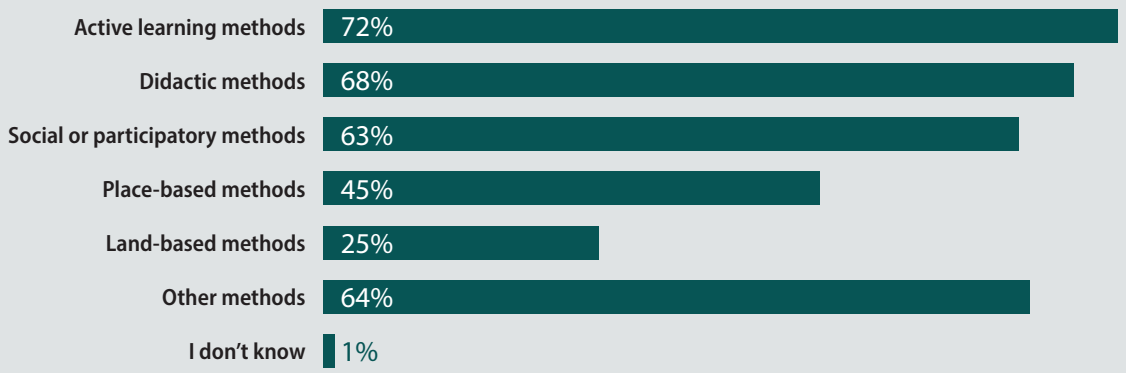
Seventy-two per cent of teachers indicated they use active methods when teaching environment, sustainability and climate change. Such teaching methods include inquiry-based approaches, posing problems or questions and engaging students in projects or scenarios that align with their interests (**Figure 43**). Sixty-eight per cent of teachers also report using didactic methods – namely, delivering content in structured lessons and through lectures. Sixty-three per cent of teachers report using social or participatory teaching methods, including collaborative learning approaches that involve students working together and learning from one another, including peer learning.

Two other instructional methods -- place-based and land-based teaching – were reported to be utilized by lower percentages of teachers: 45 per cent and 25 per cent, respectively. These methods shift learning to settings outside the school building and often seek to connect students to their environmental surroundings as well as the life and history of local communities and cultures. In some instances, teachers reporting engaging environment, sustainability and climate change to connect students to physical, Indigenous and spiritual places and land upon which they reside.

Overall, teachers reported employing a diverse array of teaching and learning methodologies when teaching on environment, sustainability and climate change, combining active, didactic, social, place-based and land-based methods.

FIGURE 43

Percentage of teachers reporting using different instructional methods when teaching environment, sustainability, and climate change issues in science and social science subjects



Source: Survey of Grade 9 science and social science teachers in Australia, Chile, Kuwait, Papua New Guinea, the Republic of Korea, Sierra Leone, Sri Lanka and Sweden (2023).

Note: Active learning methods refers to inquiry-based methods where a problem or question is posed and students create projects or other outputs based on their interests or other methods that involve the active participation of students (e.g., role plays, debates). Didactic methods refer to structured lessons given through lectures. Social or participatory methods refers to methods that involve working with others to learn with and from them. Place-based methods refers to taking learning outside of the school building into the school surroundings or local community. Land-based methods refers to methods that recognize the deep physical, mental, and spiritual connection to the land, which is part of Indigenous culture. Other methods refer to methods not included in the other categories.

5. Recommendations

Both science and social science curricula can be improved to help equip students to contribute to climate change mitigation and adaptation for building climate-smart, resilient and sustainable societies. More content is needed on environment, sustainability and crucially on climate change in school subject curricula in all countries including those most responsible for the climate crisis and those vulnerable to climate risks.

UN Secretary-General António Guterres has said regarding climate change that "We are in a battle for our lives, but it is a battle we can win" (UNFCCC, 2019). Education is key to achieving the rapid social, psychological and technical transformations necessary to limit global temperature rise to 1.5° Celsius, as agreed upon by 194 Parties through the ratification of the Paris Agreement (UNFCCC, 2015) and reaffirmed in the Berlin Declaration on ESD (UNESCO, 2021a). While the findings in this report indicate that the emphasis on sustainability and climate change in Grade 9 science and social science curricula has increased since 2001, the level of inclusion pales in comparison to what is needed in education to help address the climate crisis. That most climate change content is general, as opposed to specifically about adaptation and mitigation responses suggests a focus on climate science or superficial approaches to the topic.

The findings also indicate that more climate change content is included in the subject curricula of countries in regions that have contributed the least to climate change, but who are most affected by it (i.e., Oceania and sub-Saharan Africa). Countries across all SDG regions have a critically important role to play in equipping learners with the cognitive understanding, social and emotional skills and action competencies necessary to respond to climate change and other sustainability challenges with the urgency required to meet the Paris Agreement targets, especially countries that have historically had the highest greenhouse gas emissions.

Siloed disciplinary approaches to environment, sustainability and climate change diminish the potential of education to promote transformative and systemic change on these issues. Environment, sustainability and climate change issues should be integrated throughout the curriculum, as all knowledge and disciplinary areas are necessary to address environmental and sustainability challenges under a unified and robust curriculum vision across levels, settings and provisions. The relationships among the three elements also should be addressed. Climate change also needs to be addressed in a broader context of sustainable development.

Understanding and responding to environment, sustainability and climate change issues requires interdisciplinary approaches (Letouzey-Pasquier et al., 2023; Hargis & McKenzie, 2020; UNESCO-IBE, 2023; Walshe, 2017). If such issues are only included in science subjects, the implicit lesson imparted to students is that their causes, impacts and solutions are only scientific in nature. By contrast, when environment, sustainability and climate change are also addressed in social science and other subjects as cross-cutting and interconnected issues, students are better able to understand the social, historical and cultural nature of these problems and their solutions and make contextualized and responsible decisions.

Looking across the curriculum analyses and survey results, the subjects of life science, geography and general social science were ranked high both in terms of presence of environment, sustainability and climate change content and the number of classes taught on these issues within a month. Though some notable exceptions are identified where countries have a more balanced inclusion of environment, sustainability and climate change content in science and social science subjects (e.g., Australia, Switzerland), the findings indicate more work is needed to ensure that both science and social science subjects include sufficient coverage of these issues within a common vision.

More education systems need to be taking a whole institution approach to tackling the climate crisis within school subject curricula. Such approaches link teaching and learning with taking up environmental priorities in overall school governance, in collaboration with community partners and through school facilities and operations' innovations. Informal (extracurricular) learning opportunities could be linked with formal subject-based curricula.

A whole institution approach to environment, sustainability and climate change involves addressing these issues across as many domains of institutional activity as possible (i.e., teaching and learning, overall governance, community partnerships, facilities and operations) (Henderson & Tilbury, 2004; MECCE Project & NAAEE, 2022; 2023; UNESCO, n.d.b.; UNESCO, 2016). Past research has indicated how a whole institution approach can further higher levels of sustainability and climate action in education (Aikens & McKenzie, 2021; Hargis et al., in Press).

While the survey results indicate a range of practices related to environment, sustainability and climate change occurring in schools, this study's findings also point to an opportunity to strengthen the inclusion of a whole institution approach to environment, sustainability and climate change within subject curricula. This can include learning outcomes that focus on students participating in school sustainability governance (overall governance); working with community members on action projects that address the SDGs (community partnerships); and learning about the carbon footprint of their school and developing action projects that reduce greenhouse gas emissions (facilities and operations).

Science and social science curricula in secondary education, if they adopt holistic learning approaches, can better support young people in taking action and responsibility on environmental challenges. This can be done by strengthening the focus on social and emotional competencies and action capacities and not only on cognitive learning.

In line with previous literature reviews, the science and social science curricula analysed focus mainly on students understanding knowledge about climate change and other environmental challenges, as opposed to developing capacities to cope with, communicate about and act on these issues. Teachers also indicated through their survey responses that they mainly focus on cognitive learning in relation to these issues in their classes and that they view such understandings as the most important.

Research indicates that youth are already anxious and grieving due to climate impacts (Hickman et al., 2021) and more knowledge about climate change without addressing the social and emotional and without participating in action within and beyond their schools, can contribute to increased levels of distress (UNESCO, 2022c; MockCOP, 2023).

Including Indigenous and local knowledge in relation to environment, sustainability and climate change in school subject curricula furthers recognition, respect and understanding, as well as benefiting from the depth and breadth of knowledge on these issues and actions.

The results of this study indicate that science and social science curricula can engage further with Indigenous knowledge and justice issues in education on environment, sustainability and climate change. Including Indigenous knowledge supports a focus on more inclusive, equitable and relational approaches. This can include acknowledging the impacts of colonial expansionism on the environment and the historical and ongoing injustices faced by Indigenous communities, as well as decentring humans in environmental decision-making (Acharibasam, 2022; Karsgaard & Shultz, 2022; Nakashima et al., 2018; Newberry & Trujillo, 2018). Including Indigenous knowledge in education can also support communities to develop holistic solutions to mitigate and adapt to climate change (Acharibasam, 2022), reversing negative impacts of internal displacement and migration, food security and health and wellbeing.

The impacts of climate change and other environmental crises are more acutely felt by Indigenous, Black and other communities of colour (US EPA, 2021). These impacts are often amplified by existing environmental and social injustices on a range of factors, including race, gender identity, socio-economic status and colonial dispossession (Sultana, 2022). When education on environment, sustainability and climate change acknowledges these injustices, students are better able to understand how different communities are affected and better able to contribute to just solutions to climate change and other environmental crises, thus encouraging participation of youth in local communities as agents of change for sustainable development.

Finally, the collaboration among different "ways of knowing", i.e. Indigenous, local and scientific knowledge systems, is recognized to enhance the effectiveness of climate action as agreed at COP26 in Glasgow[12]. Indigenous Peoples have sustained themselves through their ability to live together and work with nature and climate variance, relying primarily on precipitation patterns, temperature variances and local biodiversity[13]. Full intercultural recognition of Indigenous scholars has not yet been achieved, and addressing these gaps also in education can promote the transformational change that is needed and a greater connection between climate change education and education for sustainable development with local contexts characteristics, cultures and development patterns and challenges.

> **Education on environment, sustainability and climate change can include mention of action-oriented, place-based and participatory teaching and learning methods in school subject curricula to help ensure education related to these topics empowers students and teachers to address, act individually and collectively and take responsibility on these issues.**

Teachers consistently indicate that they need more guidance on how to teach on environment, sustainability and climate change, including through approaches that go beyond cognitive learning to include social and emotional and action-oriented learning (UNESCO, 2021b; UNESCO, 2021d).

Teaching methods are just as important as the content taught, as methods communicate implicit value-laden messages to students (Sund & Wickman, 2011). For instance, if students are only presented with scientific facts about environmental issues, the implied message is that addressing environmental issues hinges on obtaining the right information, as opposed to learning how to address social and emotional considerations or developing the capacity to take action. While some countries include suggested teaching methods and approaches for environment, sustainability and climate change learning, it is evident that much more work is needed in this area, including through pre-service and in-service teacher education and training. The development of and access to high quality educational materials is also essential. Research also increasingly suggests that action-oriented, place-based and participatory teaching and learning methods can support transformative education related to environment, sustainability and climate change (Khadka et al., 2021; Howard-Jones et al., 2021). It is encouraging that most teachers reported that they use active learning and social and participatory methods when teaching on environment, sustainability and climate change.

> **Further study across all grades and subject areas is recommended to support broader understanding of how school subject curricula and pedagogy are supporting transformative education related to environment, sustainability and climate change.**

This study's focus on how science and social science curricula and teachers are engaging with environment, sustainability and climate change helps understand whether and how education systems are equipping learners to address environmental challenges and opportunities. Future studies are encouraged to support a more comprehensive understanding of how education systems globally are preparing learners for better and sustainable futures.

12 https://openarchive.icomos.org/id/eprint/2717/
13 (https://www.unesco.org/en/climate-change/links)

Annex A: Countries included in the study

Central and Southern Asia

Bhutan
India
Kazakhstan
Pakistan
Sri Lanka

Eastern and South-Eastern Asia

China
Indonesia
Japan
Mongolia
Philippines
Republic of Korea
Thailand

Europe and Northern America

Bulgaria
Canada
Estonia
France
Greece
Hungary
Ireland
Italy
Lithuania
Malta
Norway
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden
Switzerland
United Kingdom of Great Britain and Northern Ireland

Latin America and the Caribbean

Argentina
Bahamas
Brazil
Chile
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
Haiti
Mexico
Paraguay
Peru
Plurinational State of Bolivia
Uruguay

Northern Africa and Western Asia

Armenia
Azerbaijan
Cyprus
Georgia
Kuwait
Morocco
Oman
Qatar
State of Palestine
Türkiye

Oceania

Australia
Cook Islands
Marshall Islands
New Zealand
Papua New Guinea
Samoa

Sub-Saharan Africa

Benin
Botswana
Burkina Faso
Cabo Verde
Cameroon
Côte d'Ivoire
Democratic Republic of the Congo
Ethiopia
Gambia
Ghana
Madagascar
Mauritius
Namibia
Nigeria
Rwanda
Senegal
Sierra Leone
South Africa
South Sudan
Togo
Uganda
Zambia

Annex B: Codebook

Category	Code	Operational Definition and Examples
Whole institution domain approach to environment, sustainability and climate change *Teaching and learning is not included because it is assumed all content was on teaching and learning.	**1. Overall governance**	This code was used to identify content on broader planning activities in the school on environment, sustainability and climate change (e.g., policies, clubs, meetings). Content could include students participating in planning for sustainability and climate action at their school.
	2. Community partnerships	This code was used to identify content on partnering with community organizations or individuals (e.g., field trips, guest speakers), as well as community activities focused on environment, sustainability and climate change.
	3. Facilities and operations	This code was used to identify content on school facilities and operations in relation to environment, sustainability and climate change. For example, it could include student engagement in school energy audits, gardening programmes, etc.
Learning dimensions for environment, sustainability and climate change	**4. Cognitive**	This code was used to identify environment, sustainability and climate change teaching or learning outcomes or processes on knowledge and thinking skills or activities. Example content: Research, understand, know about, analyse, reason, evaluate, synthesize, apply knowledge, conceptualize, interpret or extrapolate, integrate, describe, explain, justify, compare and contrast, recognize, differentiate, solve problems, think critically, think independently, think creatively.
	5. Social and emotional	This code was used to identify environment, sustainability and climate change teaching or learning outcomes or processes on social and emotional skills or activities. Example content: Discuss, communicate, empathize, manage one's feelings, develop interpersonal skills, show care for others, avoid prejudice or bias, be inclusive, be cooperative, be kind, assertive, be able to negotiate and resolve conflicts, develop positive values such as care and compassion without discrimination, develop the ability to persevere, develop passion for and commitment, feel responsible, etc.
	6. Action and behavioural	This code was used to identify any environment, sustainability, or climate change teaching and learning content on furthering 'action competence' or intentional actions with respect to environment, sustainability, or climate change. Planning for action is included. Example content: Engage, participate, respond, learn to undertake some individual or collective action such as community engagement as part of school activities, be or plan to be a responsible citizen, regulate one's behaviour, live in a sustainable manner, be a responsible consumer, undertake action.
	7. Other learning dimension	This code was used for integrated approaches that combine multiple learning dimensions in a way that does not allow them to be separated out. It does not include general references to learning that do not specify a domain or approach to learning. Example content: Indigenous or other holistic approaches to living/education which integrate mental, physical, emotional and spiritual aspects of learning in ways that cannot be separated

Category	Code	Operational Definition and Examples
Type of content	**8. Learning outcome**	This code was used to identify content on what students are expected to know or skills they should learn by the end of an assignment, class, or course.
	9. Learning process	This code was used to identify content that mentions pedagogical methods that can be used by teachers (e.g., place-based education, land-based education, inquiry-based methods, problem-based learning).
Climate change specific learning outcomes or processes *Content coded here must specifically mention or be referring to climate change.	**10. Adaptation**	This code was used to identify content that refers to learning outcomes or processes designed to develop the skills, capacities and attitudes for adaptation in the face of climate change impacts.
	11. Mitigation	This code was used to identify content that refers to learning outcomes or processes on strategies and methods to reduce or mitigate climate change and its effects.
	12. Misinformation	This code was used to identify content that refers to learning outcomes or processes on climate change that go against the known science. This includes that the cause of recent climate change is not yet known.
	13. General climate change	This code was used to identify content that refers to learning outcomes or processes on climate change that is not covered by codes 10-12.
Environment specific learning outcomes or processes	**14. Environment**	All content that refers to learning outcomes or processes on the environment only was coded here (e.g., environmental processes, environmental science, environmental issues). Mentions of environmental sustainability (i.e., protecting or conserving the environment) should be coded to 17. Mentions of "the environment" should also be coded here. Content that only refers to environment as an example topic should be coded to 25. Mention of the three pillars of sustainability (environmental, social and economic) should be coded at 19. Content that refers to the environment in descriptive or introductory text should be coded to 26.
	15. Ecosystem	All mentions of 'ecosystem' that refer to learning outcomes or processes was coded here (i.e., not just listed as an example). Content that only refers to the word as an example should be coded to 25. Content that refers to the word in descriptive or introductory text should be coded to 26.
	16. Biodiversity	All mentions of 'biodiversity' that refer to learning outcomes or processes was coded here (i.e., not just listed as an example). Content that only refers to the word as an example should be coded to 25. Content that refers to the word in descriptive or introductory text should be coded to 26.
Sustainability specific learning outcomes or processes	**17. Environmental sustainability**	This code was used to identify content that refers to learning outcomes or processes on learning for or about environmental sustainability as responsible interaction with the environment to avoid depletion or degradation and to allow for environmental quality and health. Note that references to human production and consumption of resources should not be coded to this category; instead, code to 18 below. Example content: Caring for the planet, protecting nature, biodiversity, water

Category	Code	Operational Definition and Examples
Sustainability specific learning outcomes or processes	**18. Sustainable consumption and production**	This code was used to identify content that refers to learning outcomes or processes on learning for or about sustainable consumption as the use of resources, products and services that have a minimal impact on the environment. Sustainable consumption and production are about promoting resource and energy efficiency, sustainable infrastructure and green jobs. Note that references to production and consumption of natural resources should be coded to this code (not Code 17). Example content: responsible and sustainable lifestyles, green economy, green jobs, sustainable energy
	19. Three pillars of sustainability	This code was used to identify content that refers to learning outcomes or processes on 'Education for Sustainable Development' (ESD) or specific mentions of social, economic and environmental aspects of sustainability. Note that all three pillars must be referenced. Example content: Exact terms 'Education for Sustainable Development' or 'ESD,' or discussions of 'social, economic and environmental' together
	20. Sustainable development goals	This code was used to identify content that refers to learning outcomes or processes in relation to the Sustainable Development Goals (SDGs). The terminology of the SDGs must be included. Example content: Sustainable Development Goal, SDG
Environment, sustainability and climate change learning outcomes or processes *All content must be mentioned in relation to the environment and/ or climate change.	**21. Indigenous knowledge/ priorities**	This code was used to identify content on learning outcomes or processes that involve incorporating Indigenous knowledge or priorities in the context of environment, sustainability and climate change (e.g., bringing an elder into a classroom for environmental learning, discussing how colonialism is on climate change).
	22. Justice-oriented	This code was used to identify content on learning outcomes or processes that involve justice in the context of environment, sustainability and climate change. Includes discussion of those most vulnerable to climate change impacts.
	23. Humans rights and gender equality	This code was used to identify content on learning outcomes or processes about fundamental human rights, including the right to freedom from discrimination based on gender, in relation to environment, sustainability and climate change. Human rights are defined as moral principles or norms that describe certain standards of human behaviour and are regularly protected as individuals of all genders to develop their personal abilities and make choices without the limitations set by stereotypes, rigid gender roles and prejudices. Example content that addresses the following in relation environment, sustainability and/or climate change: Equality, inclusion and non-discrimination, for example by gender, caste, race, class, disability, justice and fairness, caring for those in need, treating others with respect and dignity, sharing equitably, promoting gender equality.
	24. Other intended learning outcomes	This code was used to identify content on learning outcomes or processes that involve intended learning for environment, sustainability and climate change that is not clearly captured by any of the above codes (10-23).

Category	Code	Operational Definition and Examples
Other	25. Example concept	This code was used to identify content on environment, sustainability and climate change as an example in a string of concepts without any further engagement. If the example is mentioned in a learning outcome, also code to 8.
	26. Descriptive text	This code was used to identify environment, sustainability and climate change content that is descriptive or introductory in nature. Content that refers to learning outcomes not captured by Codes 10-23 should be Coded at 24.
	27. Optional learning outcome	This code was used to capture learning outcomes regarding environment, sustainability and climate change that are listed as being 'optional'. Only code here if it is clear that the learning outcome is not required.
	28. Quotes	This code was used to identify content that includes an interesting quote. Up to 1-2 quotes per document can be coded here. If there are no interesting quotes in a document, do not code anything to this code for that document. Criteria for 'good' quotes: 1) illustrates the overall approach to environment, sustainability and climate change in the doc/country, 2) provides specific details to illustrate a thematic area, 3) mentions a notable aspect that is not common (e.g., justice, Indigenous knowledge).

Annex C: References

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Climate change and sustainability in science and social science secondary school curricula

Building on two earlier studies commissioned by UNESCO, *Learn for our planet* and *Getting every school climate-ready*, this publication summarizes the findings of new research to determine the extent to which climate change and sustainability issues are mainstreamed in secondary education around the world. Over 500 Grade 9 science and social science curricula from 85 countries worldwide were analysed to assess the level of content on climate change, sustainability and the environment. The subject curricula for 12 of the countries were examined in further detail to identify examples of good practice. And an online survey of teachers of Grade 9 students was also conducted in eight countries to assess howthe subject curricula are being delivered in the classroom.

The publication reviews where countries stand in terms of the integration of the three themes in curricula and teaching and makes recommendations on further steps education providers and policy-makers can take to strengthen the education on offer to students.

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4 QUALITY EDUCATION

Sustainable Development Goals