Organisation for Economic Co-operation and Development

DELSA/ELSA/WD/SEM(2022)8

Unclassified English text only

30 August 2022

DIRECTORATE FOR EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS
EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS COMMITTEE

Young people's environmental sustainability competence

Emotional, cognitive, behavioural, and attitudinal dimensions in EU and OECD countries

OECD SOCIAL, EMPLOYMENT AND MIGRATION WORKING PAPERS No. 274

JEL classification: I20 J31 J24 Q50

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The paper is the first in a series of two papers mapping young people's environmental sustainability competence in EU and OECD countries that were prepared as background for the forthcoming OECD Skills Outlook 2023 publication. The papers are the results of a collaboration between the OECD Centre for Skills and the European Commission - Joint Research Centre (Unit B4) on students' environmental sustainability competence. The second paper is titled: 'The environmental sustainability competence toolbox: From leaving a better planet to our children to leaving better children for our planet' (https://doi.org/10.1787/27991ec0-en).

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Acknowledgements

This working paper was prepared within the framework of the OECD Skills Outlook 2023, supported by the European Commission through the Erasmus+ programme.

The authors would like to thank OECD colleagues from the Directorate for Employment, Labour and Social Affairs, the Directorate for Education and Skills and the Environment Directorate for their review of the paper. In particular, we would like to thank Enrico Botta, Marc Fuster, Katia Karousakis, Miyako Ikeda, El Iza Mohamedou and Mark Pearson for their valuable comments and feedback as well as Jennifer Cannon and Marie-Aurélie Elkurd for their administrative and editorial work. Many thanks to Diana Horvath, Irina Vogel and Sarah Wildi for their support. The authors would also like to thank JRC colleague Guia Bianchi for her valuable comments and feedback.

Abstract

This paper is part of a two-paper series exploring the competences youngsters need to acquire in order to promote environmental sustainability today and in the future. The paper first presents a conceptual framework defining environmental sustainability competence and identifying emotional, cognitive, behavioural and attitudinal dimensions. The paper then maps young people's environmental sustainability competence in EU and OECD countries using data from various editions of the Programme for International Student Assessment (PISA). Analyses reveal differences in the different dimensions of environmental sustainability competence between boys and girls and between students with a different socio-economic background. The paper then identifies the extent to which young people's engagement in pro-environmental activities align with the engagement of their parents' generation, as well as within-household similarities in pro-environmental behaviours. The paper concludes by examining the role of school-related factors in promoting students' environmental sustainability competence.

Résumé

Le présent document fait partie d'une série de deux documents portant sur les compétences que les jeunes doivent acquérir pour favoriser la durabilité environnementale aujourd'hui et demain. Il présente tout d'abord un cadre conceptuel permettant de définir les compétences en matière de durabilité environnementale et d'en dégager les dimensions émotionnelle, cognitive, comportementale et psychologique. Les compétences des jeunes en matière de durabilité environnementale dans les pays de l'UE et de l'OCDE sont ensuite cartographiées à l'aide de données tirées de plusieurs cycles du Programme international pour le suivi des acquis des élèves (PISA). Les analyses révèlent des différences au regard des diverses dimensions des compétences en durabilité environnementale entre garçons et filles et entre élèves issus de milieux socioéconomiques différents. On cherche ensuite à déterminer dans quelle mesure la participation des jeunes à des activités écofavorables fait écho à l'engagement de la génération de leurs parents, ainsi que les similitudes dans les comportements écofavorables au sein des familles. Enfin, le document examine l'importance des facteurs liés à l'école dans le développement des compétences des élèves en matière de durabilité environnementale.

Executive summary

To promote a more sustainable and greener future, today's societies must nurture in young generations not only a solid understanding of science but also an appreciation of the fragility of the environment and ecosystems. This, in turn, can help youngsters evaluate the environmental consequences of their actions, promote their willingness to protect the planet and empower them to contribute to the green transition through their work, civic participation and everyday actions. Having high levels of environmental sustainability competence requires having a wide range of knowledge, skills, attitudes and values.

This paper takes a comprehensive and crosscutting approach to defining environmental sustainability competence covering cognitive, emotional, attitudinal and behavioural dimensions. The paper follows the European Union (EU) GreenComp framework, which defines four main competence areas of environmental sustainability competence: embodying sustainability values, embracing complexity in sustainability, envisioning sustainable futures and acting for sustainability. Based on this framework, the paper uses data from various rounds of the OECD's Programme for International Student Assessment (PISA) to assess youngsters' environmental sustainability competence and consider which factors are associated with students' environmental sustainability competence.

Throughout countries, the vast majority of 15-year-old students reported being aware of climate change and global warming (78% and 79% on average throughout EU and OECD countries, respectively). However, students' level of perceived environmental awareness varies greatly by environmental topic. In 2015, on average throughout countries, students reported the highest levels of awareness about air pollution (84% of students throughout EU countries and 83% throughout OECD countries) and the lowest levels of awareness about the use of genetically modified organisms (42% on average throughout EU and OECD countries). Variation is also found in students' pro-environmental behaviour. For example, in 2018, around 6 out of 10 students reported being engaged in saving energy for environmental reasons (69% in EU countries and 71% in OECD countries), while fewer than 2 out of 5 students reported participating in activities in favour of the environment (around 37% and 39% on average throughout EU and OECD countries, respectively).

There are large disparities in youngsters' environmental sustainability competence between students with different socio-economic backgrounds. Overall, students from socio-economically disadvantaged backgrounds are less likely to care about the environment and be aware of environmental issues than students from more advantaged households. On average, they also have lower science achievement scores, engage less in pro-environmental behaviours and are less likely to be environmental sustainability all-rounders.

Gender differences in students' environmental sustainability competence are subtle, but pervasive. For example, gender differences in the awareness of environmental problems differ depending on the nature of such problems. Throughout EU and OECD countries, boys report higher levels of awareness of nuclear waste, the increase of greenhouse gases in the atmosphere, the use of genetically modified organisms and the consequences of clearing forests for other land use. Girls reported higher levels of awareness of water shortage, air pollution and extinction of plants and animals. Similarly, while boys scored higher in physical, and earth and science, areas, girls performed better in biology.

Multiple factors determine the extent to which youngsters are able to acquire environmental sustainability competence, including the household and school environments young people have been raised in. For example, analyses reveal that, within families, there is a positive correlation between parents' and children's environmental behaviours. Parents and families play a crucial role in the way children and young people are socialised. At the same time, children can educate their parents on the importance of engaging in protecting the environment and engaging in pro-environmental behaviours.

Analyses reveal large differences between schools in science achievement. By contrast, on average, students' awareness of environmental problems, engagement in pro-environmental behaviours and caring for the environment vary little across students attending different schools. For example, calculations based on PISA 2015 and 2018 data show that, whereas across EU countries 34% of performance differences in science achievement were observed between schools (31% across OECD countries), only 6% of the overall variance in environmental awareness was between schools (6% across OECD countries).

Synthèse

Pour promouvoir un avenir plus durable et plus vert, la société moderne doit favoriser chez les jeunes générations non seulement une solide compréhension des sciences, mais aussi une conscience de la fragilité de l'environnement et des écosystèmes. Les jeunes peuvent alors être plus à même d'évaluer les conséquences environnementales de leurs actes, d'affirmer leur volonté de protéger la planète et de contribuer à la transition écologique par leur travail, leur participation citoyenne et leurs actions au quotidien. Pour atteindre des niveaux élevés de compétence en durabilité environnementale, il faut posséder un large éventail de connaissances, de compétences, de dispositions et de valeurs.

Le présent document adopte une approche globale et transversale pour définir les compétences en matière de durabilité environnementale, y compris dans ses dimensions cognitive, émotionnelle, psychologique et comportementale. Il suit le cadre GreenComp de l'Union européenne (UE), lequel définit quatre grands domaines de compétence en matière de durabilité environnementale : intégrer les valeurs propres à la durabilité, appréhender la complexité que cette notion recouvre, imaginer des avenirs durables et agir en faveur de la durabilité. À partir de ce cadre, on utilise des données issues de plusieurs cycles du Programme international de l'OCDE pour le suivi des acquis des élèves (PISA) afin d'évaluer les compétences des jeunes en matière de durabilité environnementale et d'examiner les facteurs associés à ces compétences.

Dans l'ensemble des pays, la grande majorité des élèves de 15 ans déclarent être conscients du changement climatique et du réchauffement planétaire (respectivement, 78 % et 79 % en moyenne dans les pays de l'UE et de l'OCDE). Toutefois, le niveau de sensibilisation perçu des élèves aux problèmes environnementaux varie très largement selon le sujet abordé. En 2015, en moyenne dans l'ensemble des pays, les niveaux les plus élevés de sensibilisation concernaient la pollution de l'air (84 % des élèves dans l'UE et 83 % dans les pays de l'OCDE) et les plus faibles l'utilisation d'organismes génétiquement modifiés (42 % en moyenne dans l'UE et les pays de l'OCDE). Des variations existent également en ce qui concerne les comportements écofavorables. En 2018, par exemple, environ 6 élèves sur 10 déclaraient avoir fait des économies d'énergie pour des raisons environnementales (69 % dans les pays de l'UE et 71 % dans les pays de l'OCDE), tandis que moins de 2 élèves sur 5 indiquaient avoir participé à des activités en faveur de l'environnement (respectivement, environ 37 % et 39 % en moyenne dans les pays de l'UE et de l'OCDE).

Il existe de grandes disparités quant aux compétences des jeunes en matière de durabilité environnementale selon leur milieu socioéconomique d'origine. Dans l'ensemble, les élèves issus de milieux défavorisés sont moins susceptibles de se soucier de l'environnement et d'être sensibilisés aux enjeux environnementaux que les élèves de milieux plus favorisés. En moyenne, ils obtiennent également des scores plus faibles en sciences, adoptent moins de comportements écofavorables et sont moins susceptibles d'avoir des compétences en durabilité environnementale dans tous les domaines étudiés.

Les écarts de compétences entre filles et garçons en matière de durabilité environnementale sont plus nuancés, mais généralisés. Par exemple, les différences de sensibilisation aux problèmes environnementaux entre les sexes varient selon la nature de ces problèmes. Dans l'ensemble des pays de l'UE et de l'OCDE, les garçons enregistrent des niveaux de sensibilisation plus élevés aux déchets

nucléaires, à l'augmentation des gaz à effet de serre dans l'atmosphère, à l'utilisation d'organismes génétiquement modifiés et aux conséquences de la déforestation pour d'autres affectations des terres. Les filles sont plus conscientes des pénuries d'eau, de la pollution atmosphérique et de l'extinction des plantes et des animaux. De même, alors que les garçons obtiennent de meilleurs résultats en physique et en sciences de la terre, les filles ont de meilleurs résultats en biologie.

De multiples facteurs déterminent la capacité des jeunes à acquérir des compétences en durabilité environnementale, notamment le cadre familial et scolaire dans lequel ils grandissent. Les analyses révèlent par exemple qu'au sein des familles, il existe une corrélation positive entre les comportements des parents et ceux des enfants en matière d'environnement. Les parents et la famille jouent un rôle crucial dans la socialisation des enfants et des jeunes. Dans le même temps, les enfants peuvent sensibiliser leurs parents à l'importance de s'engager dans la protection de l'environnement et d'adopter des comportements écofavorables.

Les analyses révèlent de grandes disparités entre les établissements scolaires en termes de résultats en sciences. En revanche, le degré de sensibilisation aux problèmes environnementaux, l'adhésion à des comportements écofavorables et le souci de l'environnement varient en moyenne peu d'un établissement à l'autre. Ainsi, les calculs fondés sur les données des cycles 2015 et 2018 du PISA montrent que, si dans les pays de l'UE, 34 % des écarts de résultats en sciences s'expliquent par l'établissement fréquenté (31 % dans les pays de l'OCDE), 6 % seulement de la variance globale liée à la sensibilisation aux questions environnementales s'expliquent de cette façon (6 % dans les pays de l'OCDE).

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1 Education, sustainability and the environment – A framework

1. In 2000, Paul Crutzen and Eugene Stormer suggested that the world has entered a new epoch, the Anthropocene. The term Anthropocene derives from the Greek words anthropo 'man', and cene 'new', and stands to indicate an age in which human activities significantly affect the Earth's climate and ecosystem (Crutzen and Stoermer, 2017[1]). The Anthropocene has not been formally adopted as a new epoch by the International Union of Geological Sciences (IUGS) since official definitions require changes in Earth systems to be reflected in changes in rock strata. Even among proponents of the Anthropocene, whether the first industrial revolution in the 1800s or the testing and use of nuclear bombs mark the start of this new age is strongly debated.

2. Irrespective of evidence indicating major changes in rock strata inside Earth, the Intergovernmental Panel on Climate Change (IPCC) indicates that human activity is responsible for the rapid warming of the planet and associated environmental modifications on Earth and in the Earth's atmosphere (IPCC, 2021[2]). For example, estimates suggest that, compared to those born in the 1960s, children born at the onset of the COVID-19 pandemic in 2020 may experience 6.8 times more heatwaves during their lifetime (Luten, Ryan and Wakefield, 2021[3]). However, limiting global warming to 1.5 °C above pre-industrial levels could reduce this additional exposure to heatwaves by 45% (Global Commission on Adaptation, 2019[4]). Given this outlook, today's policy makers have a responsibility not only to do all they can to put in place ambitious plans to limit global warming but also to empower future generations, equipping them with the competences that they will need to adapt to changing environmental conditions and take decisions to promote green growth.

3. The Friday for Future movement has profoundly changed public discourse on climate change and the role of education. Younger generations are increasingly seen as important stakeholders in climate change discussions. Their engagement in climate policy-making and action is recognised as key to meeting the targets required to mitigate the worst impacts of human activities on the planet. Education systems are considered to have a duty not only to equip youngsters with the skills needed for them to be productive and involved citizens but also with the competences that would help them adopt environmentally sustainable behaviours and hence positively affect the health of the planet. As governments from around the world commit to implementing concrete actions and work towards halting global warming and the impact of human activities on the planet, young generations are both the ultimate recipients of these efforts in the future and agents of change today.

4. This paper presents a comprehensive framework to identify the extent to which youngsters from OECD and European Union (EU) countries possess sustainability competences, drawing from rich data sources that identify the attitudes towards and knowledge of environmental problems youngsters have and the actions they take to protect the environment.

1.1. Defining sustainability in education

5. Sustainability is complex to define. While there is widespread consensus on the need to introduce sustainability themes in education, the variety of expressions used to refer to it reflects the lack of an agreed direction (Box 1.1).

Box 1.1. The evolutions of sustainability competence in education

Sustainability elements appeared in education in the 1960s. They are documented through global declarations and the formation of several networks at international level (Michelsen, 2015[5]; Sipos, Battisti and Grimm, 2008[6]). Although their focus has greatly changed since the beginning, they have primarily concerned people's values and how people perceive their relationship with others and the natural world.

The evolution of sustainability concepts in education can be divided into four main categories:

- environmental education
- education about sustainable development
- education for sustainable development
- sustainability education.

Each type of education corresponds to a certain period in time. **Environmental education** has a strong focus on environmental issues. It spread in the early 1960s and remained prominent until the 1990s. This may be due to the visibility of environmental disasters that, for the first time, were happening on a global scale and, consequently, society started to realise that it had to protect the environment.

From the 1990s to the 2000s, **education about sustainable development** aimed to raise awareness about social and development aspects alongside environmental ones. The United Nations Conference on Environment and Development (UNCED) in Rio in 1992, focusing on the role of education in the context of sustainable development, was the most influential policy forum.

From the early 2000s, this was followed by **education for sustainable development**, whereby education is a catalyst for sustainable development, e.g. to achieve the Sustainable Development Goals (SDGs). The platform provided by the UN Decade of Education for Sustainable Development (DESD, 2005-2014) helped highlight this message at global level. In fact, it culminated in the embedding of education for sustainable development in SDG 4[1]. SDG 13 (climate change) also recognised the importance of education's role in responses to climate change[1].

Sustainability education is therefore often associated with transformative learning (Mezirow, 2018[7]), as it aims to profoundly change learners' perspectives, beliefs and behaviours. Learners reflect on what they do and do not know, and question their understanding of themselves in relation to how they interpret their environments (Simsek, 2012[8]).

Source: Bianchi (2020[9]).

6. The first step is to thus adopt a definition linking the concept of sustainability to education. This paper follows the concept of sustainability education proposed in the recent EU sustainability competence framework (GreenComp). According to this approach, sustainability education aims 'to nurture a

[1] This is similar to the concept of 'competency' in the OECD Learning Compass 2030. A competency is 'a holistic concept that includes knowledge, skills, attitudes and values' (OECD, 2019[95]).

sustainability mindset from childhood to adulthood with the understanding that humans are part of and depend on nature. Learners are equipped with knowledge, skills and attitudes that help them become agents of change and contribute individually and collectively to shaping futures within planetary boundaries' (Bianchi et al., 2022, p. 13[10]).

7. This definition associates sustainability education with competences, which the EU key competences for lifelong learning framework identifies as 'a combination of knowledge, skills and attitudes' (Council of the European Union, 2018, p. 7[11]). In this framework, knowledge is composed of the facts and figures, concepts, ideas and theories which are already established and support the understanding of a certain area or subject. Skills are defined as the ability and capacity to carry out processes and use the existing knowledge to achieve results. Attitudes describe the disposition and mind-sets to act or react to ideas, persons or situations; attitudes also include values, thoughts and beliefs. Consequently, the GreenComp approach sees education and sustainability as connected at all levels within disciplines and subjects through the competences embedded within the curriculum. It recognises that all sustainability dimensions (environmental, social, cultural and economic) are interlinked (Figure 1.1).

Figure 1.1. The main dimensions of sustainability

8. As it focuses on the environmental dimension of sustainability, this paper uses the term environmental sustainability competence.[2]

1.2. From concepts to measurement

9. GreenComp operationalises its definition of sustainability education by identifying four competence areas. Each of them includes a combination of relevant knowledge, skills and attitudes:

[2] 'Environmental sustainability' is also one of the four knowledge domains of PISA 2018 global competence. It requires students to develop a strong base in environmental topics to be able to foster and support sustainability (OECD, 2020[92]).

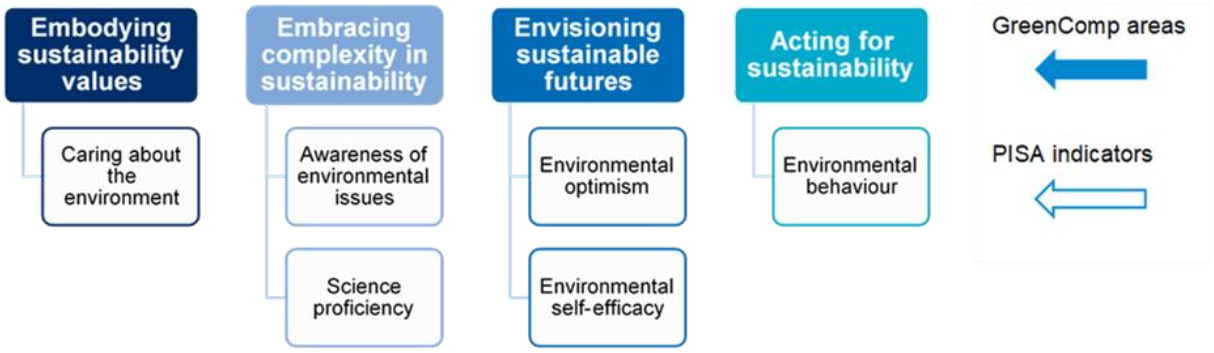
- **embodying sustainability values** encourages learners to reflect on personal values and worldviews and compare them with unsustainability and sustainability values and worldviews;
- **embracing complexity in sustainability** promotes learners' systemic and critical thinking to better assess information and frame current or future challenges as sustainability problems;
- **envisioning sustainable futures** is about imagining alternative future scenarios and identifying steps to achieve a sustainable future by using creativity and adapting to changes;
- **acting for sustainability** promotes acting both individually and collectively to shape sustainable futures, as well as demanding effective policy action for sustainability.

10. This paper exploits data from various editions of the OECD's Programme for International Student Assessment (PISA) to map the distribution of these four competence areas in EU and OECD countries, and identify how families, schools and societies can promote environmental sustainability competence (Figure 1.2). PISA allows an in-depth examination of the environmental sustainability competence of 15-year-old students. Considering the competences pupils have is important to promote their full and active participation as young citizens of the world, but also because they will have the responsibility to shape the future of the planet. In order to paint a comprehensive picture, the paper makes extensive use of data from the PISA 2015 and 2006 waves, in which science was the main competence domain and, thus, a large set of specific questions related to environmental sustainability was included. Furthermore, a focus on 2015 and 2006 allows the evolution of aspects of environmental sustainability competence to be analysed over time. Such data are complemented by data from the 2018 edition of PISA, where students were asked to report their attitudes towards the environment as well as other issues of social significance (see Box 1.2).

11. Two caveats should be made. First, in GreenComp, environmental sustainability competences are defined in broad terms, without specific reference to measurement issues. On the other hand, PISA had already started to consider the area of environmental awareness, attitudes and behaviours in 2006, when GreenComp was far from being developed. Henceforth, in this paper, information available in PISA on environmental awareness, attitudes and behaviours is used to proxy (some of) the competences defined in GreenComp. Second, attitudes and actual behaviour are different concepts. According to the European Commission's definition, attitudes 'describe the disposition and mind-sets to act or react to ideas, persons or situations' (Council of the European Union, 2018, p. 7[11]), which are hence different from actual behaviour. Behaviour reflects individual choices and takes into account the trade-offs and relative preferences for different outcomes. This also explains why it is interesting to explore the relationship between attitudes and behaviour.

12. With these caveats in mind, Figure 1.2 presents the relationship between the theoretical concept developed in GreenComp and its measurement, through proxies available in PISA data. It is important to note that because the GreenComp framework and indicator development in PISA were not aligned, some of the specific PISA indicators contain elements that refer to more than one competence area in GreenComp and vice versa. In particular, environmental self-efficacy reflects elements that can reasonably refer to young people's ability to embrace complexity in sustainability, to envision sustainable futures and act for sustainability. The decision to consider environmental self-efficacy primarily as a proxy for students' ability to envision sustainable futures reflects both theoretical considerations and the fact that the envisioning sustainable futures competence area would otherwise not be proxied by any indicator measured in 2018.

Figure 1.2. Environmental sustainability competence areas in GreenComp and PISA indicators of environmental sustainability competence



Box 1.2. What is PISA?

The OECD's Programme for International Student Assessment (PISA) is a low-stake, international large-scale assessment that has been administered to samples of 15-year-old students every 3 years since 2000. PISA involves large, representative samples of students from countries that vary widely in cultural, linguistic and social backgrounds; levels of economic development, technological adoption; and how the education system is organised. The core PISA instruments are a cognitive test and a background questionnaire.

The scope and nature of the assessments and background information are established by leading experts in participating countries and steered jointly by governments based on shared policy-driven interests. Substantial effort and resources are devoted to achieving cultural and linguistic breadth and balance in the assessment materials. Stringent quality assurance mechanisms are applied in translation, sampling and data collection. As a consequence, estimates based on PISA data have a high degree of validity and reliability, and can significantly improve the understanding of the outcomes of education in the world's most economically developed countries, as well as in a growing number of countries in earlier stages of economic development.

The assessment focuses on the core school subjects of science, reading and mathematics. Students' proficiency in an innovative domain was also assessed in 2015 (collaborative problem solving) and in 2018 (global competence). The triennial nature of the study means that PISA can be used to monitor trends in students' acquisition of knowledge and skills throughout countries and in different demographic subgroups within each country. In each edition, one of the core domains is assessed in greater depth. In 2000, 2009 and 2018, reading was the main core domain. In 2003 and 2012, mathematics was the main core domain, and in 2006 and 2015 science was the main core domain. With this alternating schedule of major domains, a thorough analysis of achievement in each of the three core areas is presented every 9 years; an analysis of trends is possible every 3 years. When a domain is the main domain, as a larger share of the test material pertains to such a domain, it is possible to estimate how well students do on specific features of such a domain. For example, in editions with science as the main domain, it is possible to consider not just students' broad 'ability to engage with science-related issues, and with the ideas of science, as a reflective citizen'. It is also possible to assess their ability in specific scientific-content areas (such as physical systems, living systems, earth and space and

scientific cognitive processes (such as explaining phenomena scientifically, evaluating and designing scientific enquiry, interpreting data and evidence scientifically).

To gather contextual information, PISA 2015 asked students and their school principals to respond to questionnaires. The student questionnaire took about 35 minutes to complete, the questionnaire for principals about 45 minutes. In some countries/economies, optional questionnaires were distributed to parents, who were asked to provide information on their perceptions of and involvement in their child's school, their support to learning at home and their child's career expectations, particularly in science. Data from the parental questionnaire were used in this paper.

As a consequence of the rotation of the subject domains in PISA editions, the background questionnaires that accompany the assessment are tailored to explore, in depth, the learning practices which promote students' proficiency in the core domain. When reading is the main domain, the background questionnaire asks students to report on their reading experiences inside and outside of school, the structure of their language-of-instruction classes, as well as their attitudes towards and self-belief in reading and language more generally. Similarly, when science is the main domain, the questionnaires explore, in depth, students' attitudes, self-belief and learning experiences in science and their formal learning of science in school.

2 Young people's environmental sustainability competence around the world

2.1. Embodying environmental sustainability values

13. Embodying environmental sustainability values reflects 'learners' ability to think about personal values and worldviews and compare them with unsustainability and sustainability values and worldviews. It supports intra- and inter-generational equity and justice, while also promoting nature' (see Chapter 1). Students who took part in PISA 2018 were asked to report the extent to which they embody environmental sustainability values through a question on whether they consider it important to look after the environment (see Box 2.1). In this paper, this question is used to map the distribution of environmental sustainability values across countries and within countries throughout different groups of students.

Box 2.1. How students' ability to embody environmental sustainability values is measured

In 2018, students participating in PISA were asked to report using a 4-point Likert scale, ranging from strongly agree to strongly disagree, how much they agreed with a range of statements related to the following issues of global significance:

- Looking after the global environment is important to me.
- I think of myself as a citizen of the world.
- When I see the poor conditions that some people in the world live under, I feel a responsibility to do something about it.
- I think my behaviour can impact people in other countries.
- It is right to boycott companies that are known to provide poor workplace conditions for their employees.
- I can do something about the problems of the world.

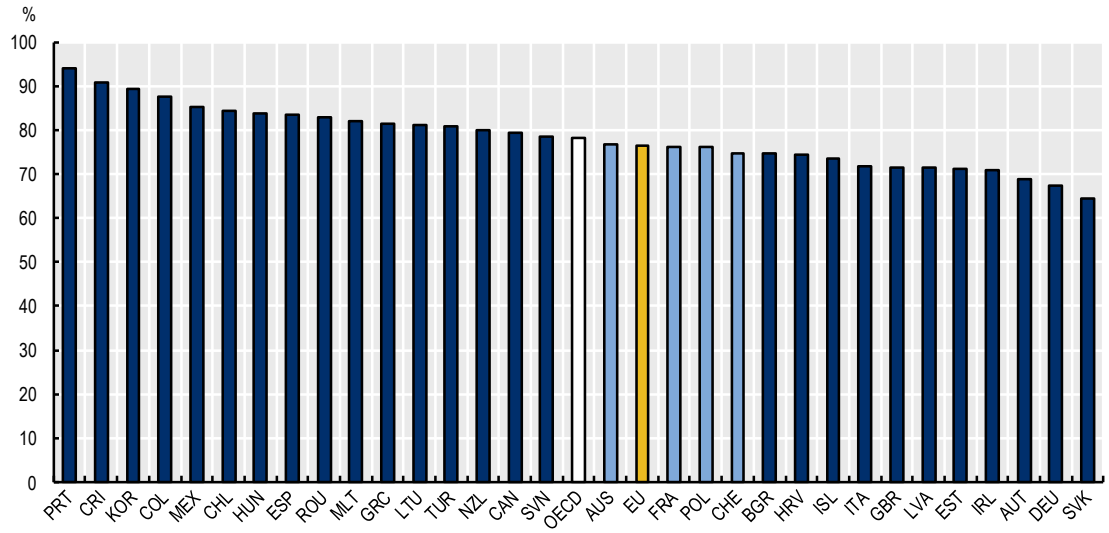
As an indicator of embodying sustainability values, a dichotomous indicator takes value 1 if students report agreeing or strongly agreeing that looking after the global environment is important to them and 0 if they report disagreeing or strongly disagreeing with the statement.

14. Figure 2.1 suggests that the majority of students in EU and OECD countries indicate that looking after the environment is important to them. On average throughout EU countries, 77% of 15-year-old students agreed or strongly agreed that looking after the environment was important to them, and throughout OECD countries this percentage was 78%. In Portugal, 94% of 15-year-old students reported

that looking after the environment was important to them, the largest share throughout all EU and OECD countries. Among those countries where more than eight in ten 15-year-old students reported that looking after the environment was important to them were Costa Rica, Korea, Colombia, Mexico, Chile, Hungary, Spain, Romania, Lithuania and Turkey. By contrast, fewer than seven in ten 15-year-old students in Austria, Germany and the Slovak Republic reported that looking after the environment was important to them.

Figure 2.1. Students' care for the environment (PISA 2018)

Percentage of 15-year-old students who reported that looking after the environment was important to them



Note: The figure shows the share of students who 'Agree' or 'Strongly agree' with the statement 'Looking after the global environment is important to me'. Light colours denote values that are not significantly different from the EU average at the 5% significance level. Countries are sorted in descending order of students' average care for the environment for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

2.2. Embracing complexity in environmental sustainability

15. Embracing complexity in sustainability refers to 'how well learners have developed systemic and critical thinking to better assess information and frame current or future challenges as sustainability problems' (see Chapter 1). Embracing complexity in sustainability requires learners to be aware of specific problems that threaten environmental well-being but also to have developed the scientific skills that are needed to understand the scientific underpinnings of such problems. This section considers evidence from the 2018, 2015 and 2006 editions of PISA to illustrate how aware 15-year-old students are of key environmental challenges as well as their understanding of scientific problems, their ability to explain phenomena scientifically, to evaluate and design scientific enquiry and to interpret data and evidence scientifically.

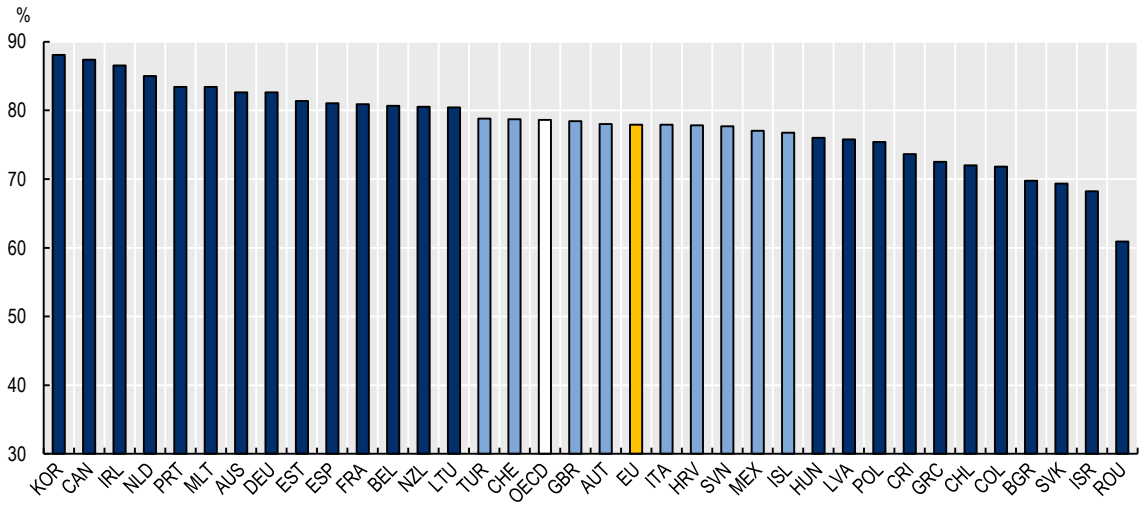
16. In 2018, students were asked how familiar they considered themselves to be with a range of global challenges, among which were climate change and global warming. Climate change and global warming are key environmental challenges that have grown in gravity over the past decades. Therefore, 2018 PISA data can be used to evaluate 15-year-old students' familiarity with a key environmental challenge, as well as how this level of awareness compares to levels of awareness of other challenges the world faces today.

Individuals' and policy makers' resources, including time and attention, are scarce; therefore, behavioural decisions and support for policies and concrete actions to promote environmental protection often depend not only on how many individuals are familiar with an issue, but also on how familiar they are with other issues that could potentially compete for time, attention and financial resources. By contrast, in 2015 and 2006, students were asked for detailed information about their awareness of a range of environmental challenges, making it possible to compare awareness of different environmental problems and examine how awareness evolved over time (see Box 2.2).

17. Figure 2.2 illustrates the percentage of students who reported either being familiar with or knowing something about climate change and global warming and could either explain such problems well or in broad terms. In 2018, throughout EU countries, 78% of 15-year-old students (and 79% throughout OECD countries), i.e. the vast majority, reported being aware of climate change and global warming. Countries differed little in levels of awareness: levels of awareness of climate change and global warming were higher than 85% in Korea, Canada and Ireland and lower than 70% in Bulgaria, the Slovak Republic, Israel and Romania.

Figure 2.2. Students' awareness of climate change and global warming, by country (PISA 2018)

Percentage of 15-year-old students who reported being aware of climate change and global warming



Note: The figure shows the share of students knowing about ('I know something about this and could explain the general issue') or being very familiar with ('I am familiar with this and I would be able to explain this well') the topic of climate change and global warming. Light colours denote values that are not significantly different from the EU average at the 5% significance level. Topics are sorted in descending order of students' global mean awareness for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

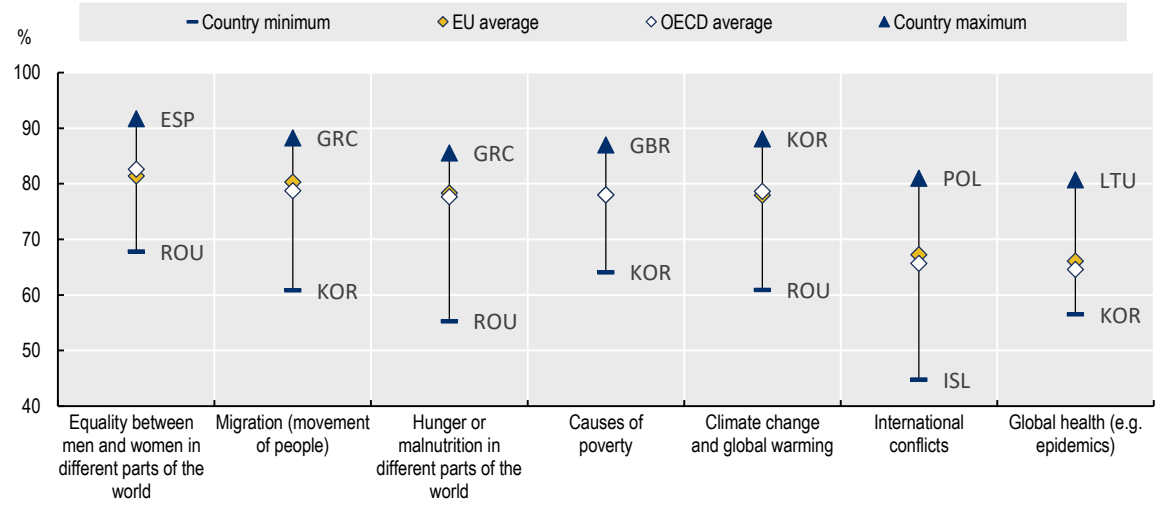
18. Figure 2.3 illustrates average levels of awareness of different issues of global significance throughout EU and OECD countries. On average throughout EU and OECD countries, a larger proportion of students reported being very familiar with or being able to generally explain problems surrounding the equality between men and women; migration; hunger or malnutrition; and climate change and global warming. The percentage of students who reported being familiar with or knowing something about these three issues was around 81%, 80% and 78% for the two latter topics, respectively, throughout EU countries and 83%, 79%, 78% and 78% throughout OECD countries. In contrast, a comparatively lower share of students reported being familiar with topics such as international conflicts and global health. In 2018, on average throughout EU countries, only 67% of students reported being familiar with topics related to

international conflicts (and 66% on average throughout OECD countries), and 66% of students reported being familiar with topics related to global health issues (and 65% on average throughout OECD countries).

19. Figure 2.3 also suggests that between-country variation in familiarity differs across different global issues and that countries where students are most aware of one issue are not necessarily also the countries in which most students are aware of other issues. For example, the range in the share of students who reported being aware of causes of poverty varied moderately in 2018 – from 64% in Korea to 87% in the United Kingdom, a difference of 23 percentage points. However, the share of students who reported being aware of international conflicts varied from 45% in Iceland to 81% in Poland (a difference of 36 percentage points). Data suggest that the between-country variation regarding specific global issues may be associated with the intensity at which countries are affected by these issues. For example, awareness of migration in 2018 was highest among students in Greece (81%), a country that was one of the main entry points to Europe for refugees and migrants travelling on the Eastern Mediterranean route (OECD, 2019[13]). Since this figure reflects students' awareness in 2018, it can be expected that recent global developments such as the COVID-19 pandemic and the conflict in Ukraine may have led to an increase in students' levels of awareness of global health, international conflict and migration.

Figure 2.3. Students' awareness of global issues, by EU and OECD averages (PISA 2018)

Percentage of 15-year-old students who reported being aware of issues of global significance



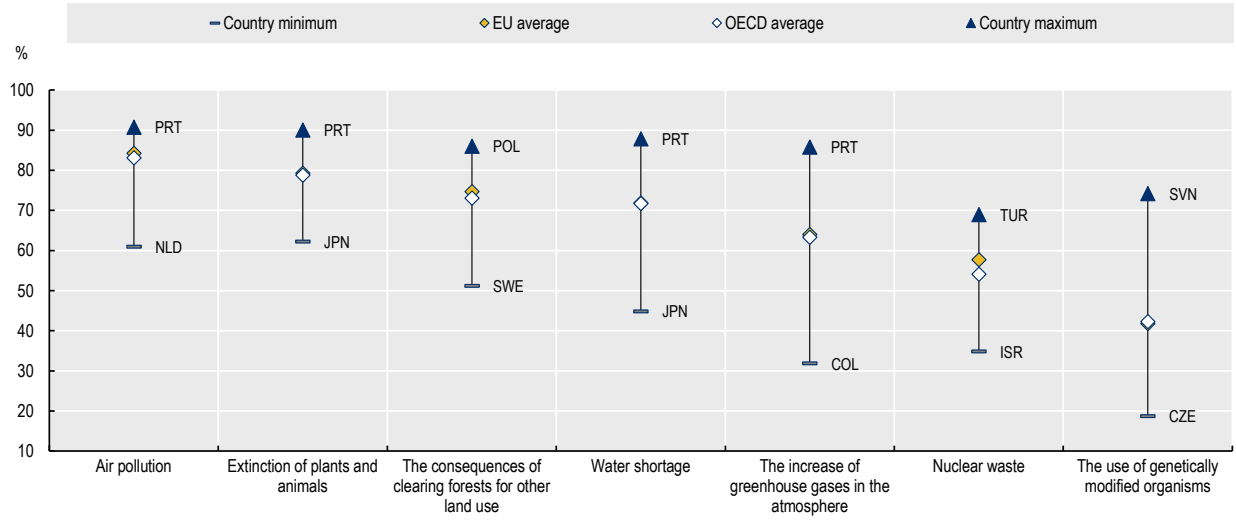
Note: The figure shows the share of students who reported knowing about ('I know something about this and could explain the general issue') or being very familiar with ('I am familiar with this and I would be able to explain this well') global topics. For each global issue, the figure shows the EU and OECD average, country minimum and country maximum. Topics are sorted in descending order of students' mean awareness for available EU countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

20. Students' level of perceived environmental awareness varies strongly by environmental topic. Figure 2.4 illustrates the percentage of students who, in 2015, reported being very familiar or knowing something about the following topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortage, the increase of greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. On average, students reported the highest levels of awareness about air pollution and the lowest levels of awareness about the use of genetically modified organisms.

21. For example, on average throughout EU countries, 84% of 15-year-old students have high levels of awareness, meaning they reported either 'being familiar' with or 'knowing something about' air pollution, while only 42% reported the same when asked about the use of genetically modified organisms. Throughout OECD countries, these figures were 83% and 42%, respectively. Students also reported high levels of awareness about the extinction of plants and animals (79% of students throughout EU and OECD countries reported having high levels of awareness about this issue); the consequences of clearing forests for other land use (75% of students throughout EU countries and 73% of students throughout OECD countries reported having high levels of awareness); and water shortage (72% of students throughout EU and OECD countries reported having high levels of awareness). By contrast, fewer students reported being aware of the increase of greenhouse gases in the atmosphere (64% of students throughout EU countries and 63% of students throughout OECD countries reported having high levels of awareness); and nuclear waste (58% of students throughout EU countries and 54% of students throughout OECD countries reported having high levels of awareness).

Figure 2.4. Students' awareness of environmental issues, by EU and OECD averages (PISA 2015)

Percentage of 15-year-old students who reported being aware of a range of environmental issues



Note: The figure shows the share of students who reported knowing about ('I know something about this and could explain the general issue') or being familiar with ('I am familiar with this and I would be able to explain this well') the environmental issues listed in the figure. For each issue, the figure shows the EU and OECD average, country minimum and country maximum. Topics are sorted in descending order of students' mean awareness for available EU countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

22. Even though levels of awareness of greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms were comparatively low in 2015, levels of awareness of these issues grew markedly between 2006 and 2015. Figure 2.5 illustrates a significant increase in students' self-reported levels of awareness within EU countries of the environmental impacts of the increase of greenhouse gases in the atmosphere, nuclear waste, genetically modified organisms and consequences of clearing forests for other land use. While only a significant increase in awareness for the first three topics is observed within OECD countries, awareness of clearing forests for other land use remained unchanged. It should be noted, however, that of the four comparable environmental issues between 2006 and 2015, the issue of clearing forests for other land uses received, comparatively, the highest level of awareness in 2006. In 2006, 74% of students in EU countries reported being familiar with or knowing something about the consequences of clearing forests for land use, while only 37% reported being aware of the use of genetically modified organisms.

Box 2.2. Environmental awareness

In 2018, students participating in PISA were asked to report how aware they were about the following global issues:

- climate change and global warming
- global health
- migration
- international conflicts
- hunger or malnutrition
- causes of poverty
- equality between men and women.

Students could select one of the four following answers: 1) I have never heard of this; 2) I have heard about this but I would not be able to explain what it is really about; 3) I know something about this and could explain the general issue; 4) I am familiar with this and I would be able to explain this well. In this chapter, students were considered to have high levels of awareness of a particular issue if they reported being familiar with and being able to explain a specific topic well or knowing something about the topic and being able to explain the general issue.

Students participating in PISA 2015 were asked to report how familiar they were with a range of environmental issues. Students could select one of the four following answers: 1) I have never heard of this; 2) I have heard about this but I would not be able to explain what it is really about; 3) I know something about this and could explain the general issue; 4) I am familiar with this and I would be able to explain this well. Students were presented with the following environmental issues:

- the increase of greenhouse gases in the atmosphere
- the use of genetically modified organisms
- nuclear waste
- the consequences of clearing forests for other land use
- air pollution
- the extinction of plants and animals
- water shortage.

In this chapter, students were considered to have high levels of awareness of a particular environmental issue if they reported being familiar with and being able to explain a specific topic well or knowing something about the topic and being able to explain the general issue. An index of environmental awareness was constructed by combining student responses to these questions. The index was standardised so that the average student in OECD countries would have a value of 0 on the index and two thirds of students would have values on the index between −1 and 1 (i.e. the index had a standard deviation of 1). Therefore, negative values on the index indicate that a student had lower levels of awareness than the average student throughout OECD countries and positive values indicate higher levels of awareness than the average student throughout OECD countries.

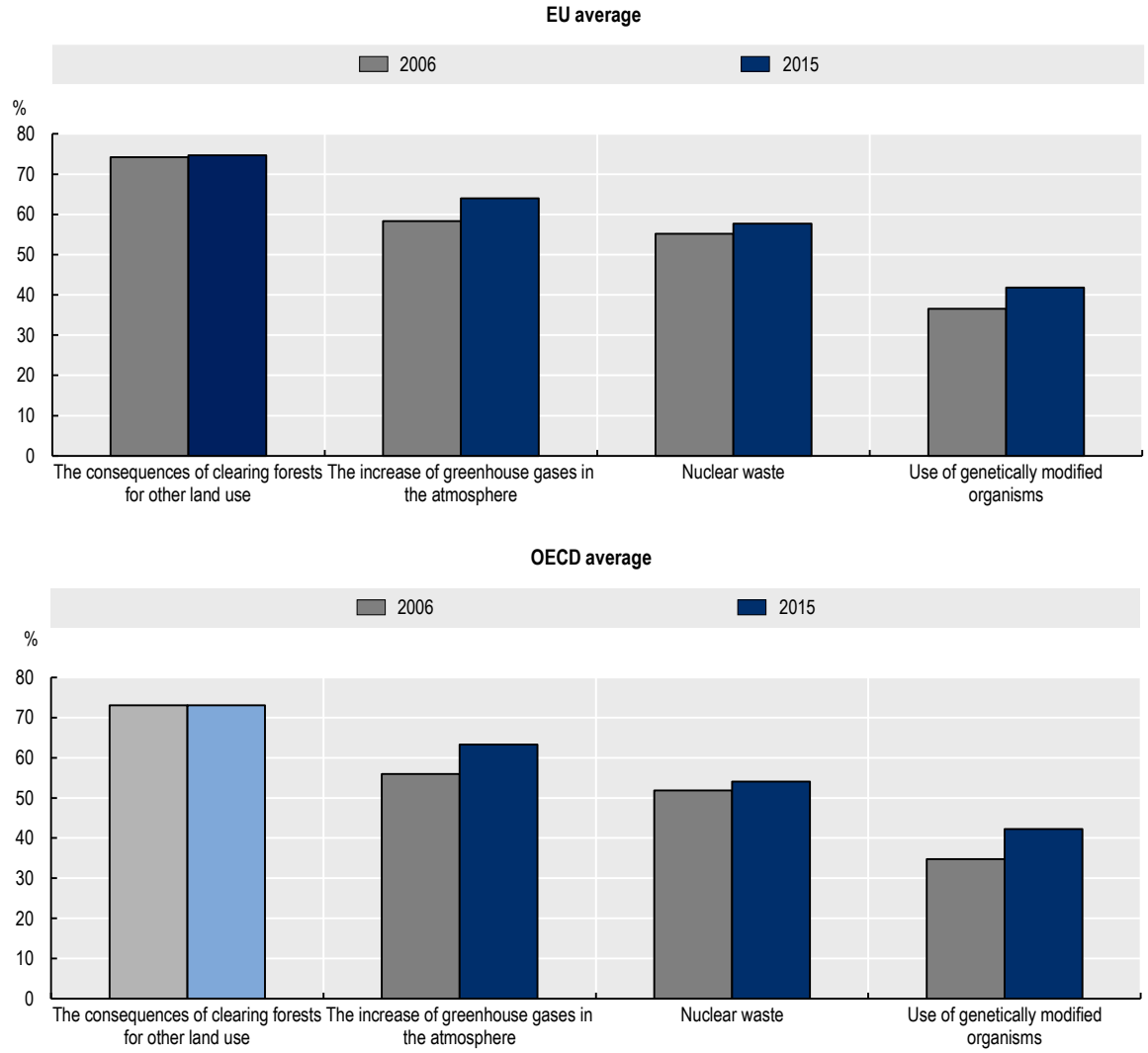
In 2006, students participating in PISA were also asked to report how informed they felt about a range of environmental issues using the same question format. Environmental issues that were asked in both 2006 and 2015 and can therefore be compared over time are:

- the increase of greenhouse gases in the atmosphere
- the use of genetically modified organisms
- nuclear waste
- the consequences of clearing forests for other land use.

23. Between 2006 and 2015, students' awareness of environmental issues increased the most (both in absolute and relative terms) for issues related to the use of genetically modified organisms (GMO) and the consequences of greenhouse gases in the atmosphere. For example, in 2006, only around 37% of 15-year-old students in EU countries and 35% of 15-year-old students in OECD countries reported being familiar with or knowing something about GMO. By 2015, as many as 42% of 15-year-old students throughout EU and OECD countries did so – an increase of 5 percentage points (EU) and 7 percentage points (OECD). This corresponds to an increase of 14% (EU) and 20% (OECD). Similarly, in 2006, only around 55% of 15-year-old students in EU countries and 52% of 15-year-old students in OECD countries reported being familiar with or knowing something about nuclear waste. By 2015, as much as 58% of 15-year-old students throughout EU countries reported this, and 54% of 15-year-old students throughout OECD countries did so – an increase of 3 percentage points (EU) and 2 percentage points (OECD).

Figure 2.5. Trend in levels of environmental awareness about specific issues between 2006 and 2015, by EU and OECD averages (PISA 2006 and 2015)

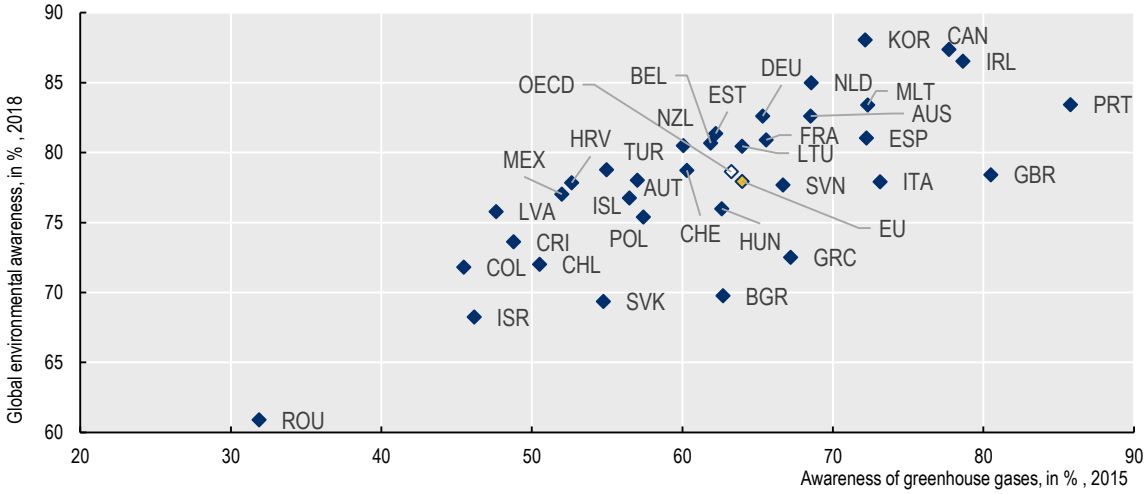
Percentage of 15-year-old students who reported being aware of environmental issues



Note: The figure shows the share of students knowing about ('I know something about this and could explain the general issue') or being very familiar with ('I am familiar with this and I would be able to explain this well') the following topics: the consequences of clearing forests for land use, the increase of greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Topics are sorted in descending order of average awareness within EU countries in 2006. Light bars denote that increases over time are not significantly different at the 5% significance level.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/ and OECD (2006[15]), PISA Database 2006, https://www.oecd.org/pisa/data/database-pisa2006.htm.

24. The lack of comparable data between 2015 and 2018 means that it is not possible to directly compare awareness in the two latest editions of PISA. The lack of comparability is due to the fact that in PISA 2018, the assessment was in fact on global topics, while in PISA 2015, it was about specific environmental topics. In particular, whereas PISA 2018 asked students to report their levels of awareness of a specific environmental issue – climate change and global warming – in 2015, students were asked to report on a range of issues, and climate change and global warming were not among these. However, Figure 2.6 suggests that, at country level, levels of awareness estimated using data from the single question in PISA 2018 and data from specific environmental issues in 2015 are highly correlated.

Figure 2.6. Country-level association between global environmental awareness measured in 2018 and the increase of greenhouse gases as part of environmental awareness measured in 2015 (PISA 2018 and 2015)



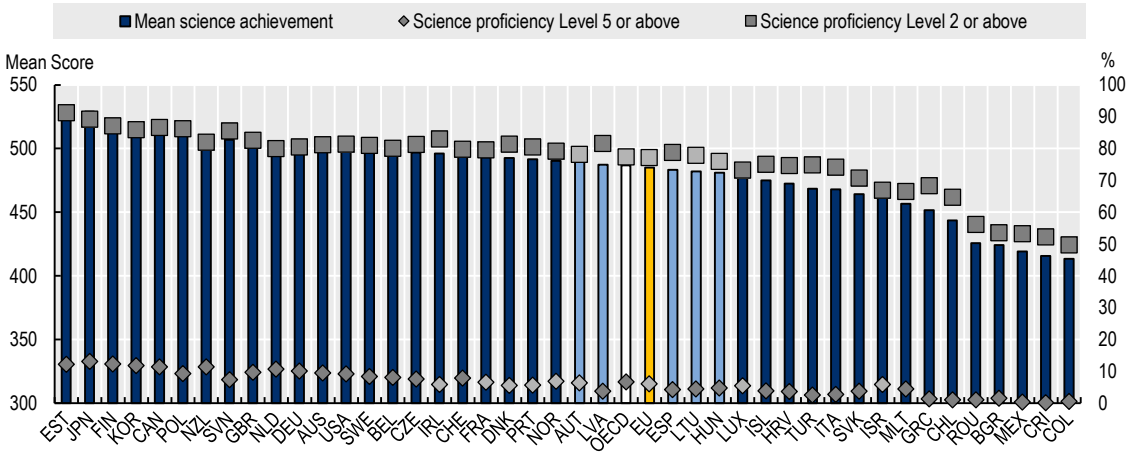
Note: The figure shows the association between environmental awareness regarding greenhouse gases measured in 2015 ('How informed are you about the increase of greenhouse gases') and environmental awareness regarding climate change and global warming measured in 2018 ('How informed are you about climate change and global warming?').
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/ and OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

25. A second dimension of students' ability to embrace complexity in environmental sustainability is their understanding of and ability to use scientific concepts to solve real-life problems. The PISA science assessment focuses on measuring students' ability to engage with science-related issues and the ideas of science as reflective citizens. Engaging in reasoned discourse about science and science-based technology requires a sound knowledge of facts and theories to explain phenomena scientifically. It also requires knowledge of the standard methodological procedures used in science, and knowledge of the reasons and ideas used by scientists to justify their claims, in order to evaluate (or design) scientific enquiry and to interpret evidence scientifically (see Box 2.3).

26. Figure 2.7 shows the level of students' proficiency in science based on data from PISA 2018. In 2018, on average throughout EU countries, 77% of students attained baseline levels of proficiency in science (i.e. they attained PISA Level 2 proficiency or higher). At a minimum, these students could recognise the correct explanation for familiar scientific phenomena and could use such knowledge to identify, in simple cases, whether a conclusion is valid based on the data provided. Throughout OECD countries, the same percentage of students attained at least baseline levels of proficiency in science. In Estonia, the country with the highest share, 91% of 15-year-old students achieved this benchmark. On average throughout EU countries, 6% of students were top performers in science in 2018 (and 7% on average throughout OECD countries), meaning that they could creatively and autonomously apply their knowledge of and about science to a wide variety of situations, including unfamiliar ones (top performers are students who achieved either at PISA proficiency Level 5 or Level 6). The share of top performers is highest in Japan at 13% and lowest in Costa Rica at 0.1%. Science achievement scores were 485 on average throughout EU and 487 on average throughout OECD countries, with top-performing countries being Estonia, Japan and Finland and lowest-performing Colombia, Costa Rica and Mexico.

Figure 2.7. Students' science achievement, by country (PISA 2018)

Mean score of 15-year-old students' science achievement and share of students with science proficiency Level 5 or above and share of students with science proficiency Level 2 or above



Note: The figure shows the mean science achievement score of 15-year-old students (left y-axis), and the share of students with at least science proficiency Level 2 or Level 5 and above (right y-axis). Light colours denote that averages and shares are not significantly different from the EU average at the 5% significance level. Topics are sorted in descending order of students' mean science achievement for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

Box 2.3. Science achievement

The PISA assessment of science focuses on measuring students' ability to engage with science-related issues, and with the ideas of science, as reflective citizens. Engaging in reasoned discourse about science and science-based technology requires a sound knowledge of facts and theories to explain phenomena scientifically. It also requires knowledge of the standard methodological procedures used in science, and knowledge of the reasons and ideas used by scientists to justify their claims, in order to evaluate (or design) scientific enquiry and to interpret evidence scientifically. The PISA science test was significantly expanded in 2015 to make use of the capabilities of computers – the new mode of delivery used in most participating education systems – for example, through its interactive interface,

since PISA 2015 was able to assess students' ability to conduct scientific enquiry by asking test-takers to design (simulated) experiments and interpret the resulting evidence.

In the paper, students' proficiency in science is reported as a score on the PISA scale, which was standardised to have a mean of 500 and a standard deviation of 100 throughout OECD countries when the scale was first set in 2006. This means that two thirds of students in countries that were members of the OECD in 2006 had scores between 400 and 600 points on the scale. Higher scores denote higher levels of proficiency.

In this paper, data from the PISA 2018 science assessment are reported since it is the most recent evidence on students' achievement in science. However, in some analyses, data from 2015 are reported, when science achievement is used to consider between-country or between-group differences in indicators of environmental sustainability competences that are only available in 2015 and to illustrate between-group differences in specific areas of science achievement. Since reading was the main assessment domain in 2018, science was not assessed with the level of detail that allows meaningful subdomain analyses and interpretation.

Moreover, in order to aid interpretability, some analyses in the paper do not consider the continuous PISA science scale but, rather, the percentage of students who achieve specific, critical achievement benchmarks. Two benchmarks are considered. First, students achieving at or above PISA proficiency Level 2 are considered. PISA Level 2 is the baseline level of achievement, which represents the level of achievement, on the PISA scale, at which students begin to demonstrate the science competences that enable them to engage in reasoned discourse about science and technology. At Level 2, students demonstrate basic or everyday scientific knowledge, and a basic understanding of scientific enquiry, which they can apply in predominantly familiar contexts. Second, students achieving PISA proficiency Levels 5 and 6 are considered. These are top performers in science. Students at this level are sufficiently skilled in and knowledgeable about science to be able to apply their knowledge and skills creatively and autonomously to a wide variety of situations, including unfamiliar ones.

2.3. Envisioning environmentally sustainable futures

27. Figure 2.8 and Figure 2.9 suggest that the majority of students feel that they are well-informed about key environmental challenges. A high level of awareness about environmental problems, their complexity and the challenges that are inherent in finding solutions could lead students to be pessimistic about the likelihood that such problems will improve in the near future. At the same time, awareness is the first step in developing an understanding of what is required to tackle such problems and improve the situation. Furthermore, students participating in PISA in 2015 and 2006 were asked to report if they thought that a range of problems associated with the environmental issues would improve or get worse over the next 20 years, while students participating in PISA in 2015 and 2018 were asked to report how confident they felt about using their science knowledge to explain a range of environmental problems. Environmental optimism (Box 2.4) and environmental self-efficacy (Box 2.5) identify the extent to which students envision environmentally sustainable futures by having a positive outlook and the agency that is necessary to take action.

Box 2.4. Environmental optimism

In PISA 2015, the student questionnaire also required students to specify their level of environmental optimism by reflecting on whether they perceive environmental issues to improve or get worse over the next 20 years. Their perceived optimism about the following environmental issues was assessed:

- air pollution
- extinction of plants and animals
- clearing of forests for other land use
- water shortage
- nuclear waste
- the increase of greenhouse gases in the atmosphere
- the use of genetically modified organisms.

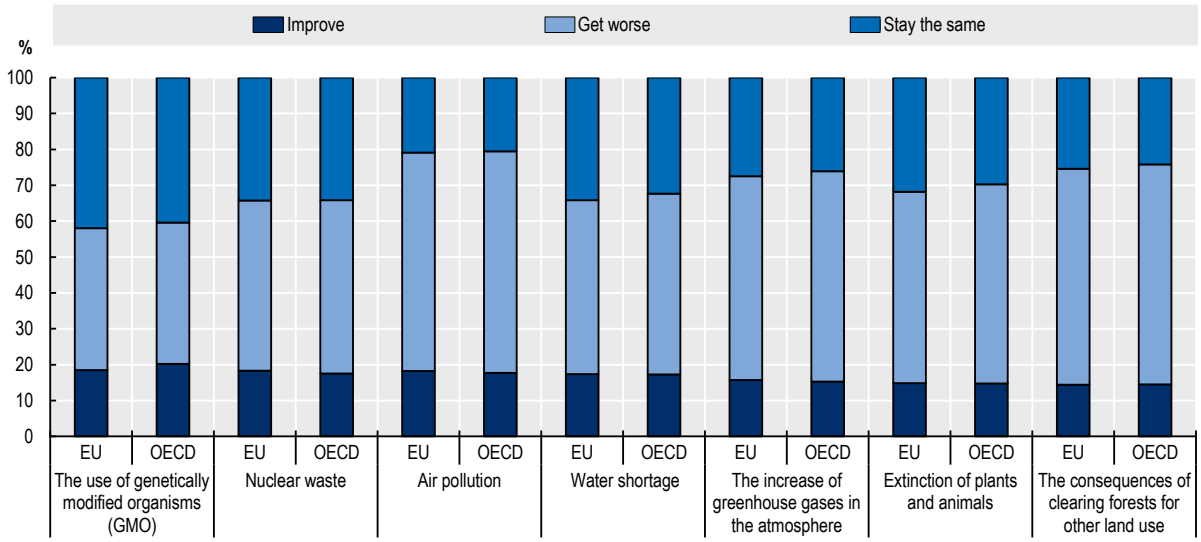
Students rated their answers on a three-point Likert scale: 'improve', 'stay about the same' and 'get worse'. Indices for environmental optimism were constructed with the average OECD student having a value of 0 and the index having a standard deviation of 1. Negative mean index values indicate that, on average, countries responded less positively than students throughout OECD countries (OECD, 2009[16]).

Source: Source: OECD (2009[16]), *Green at Fifteen?: How 15-Year-Olds Perform in Environmental Science and Geoscience in PISA 2006*, PISA, https://dx.doi.org/10.1787/9789264063600-en.

28. Figure 2.8 illustrates the percentage of students in EU and OECD countries who, in 2015, expected that a number of key environmental problems would improve, remain the same or get worse over the next 20 years. Figure 2.8 suggests that only around two in ten students or less expected environmental problems such as problems associated with the use of genetically modified organisms, air pollution, nuclear waste, water shortage, the increase of greenhouse gases in the atmosphere, the extinction of plants and animals and the clearing of forests for other land use to improve over the following 20 years. However, Figure 2.8 indicates that there are significant differences in students' perceptions that the same problems would improve or remain the same. For example, only 21% of students in EU and OECD countries reported that they expected problems related to air pollution to remain the same over the following 20 years, while, on average, 61% of students throughout EU countries and 62% throughout OECD countries expected such problems to get worse. 25% of students in EU countries and 24% of students in OECD countries expected problems related to the clearing of forests for other land use to stay the same, and 60% throughout EU and 61% throughout OECD countries expected such problems to become worse. Similarly, 27% of students in EU countries and 26% of students in OECD countries expected problems related to the increase of greenhouse gases in the atmosphere to stay the same, and 57% throughout EU countries and 59% throughout OECD countries expected such problems to grow worse. By contrast, 42% of students in EU countries and 40% of students in OECD countries expected problems related to genetically modified organisms to remain the same and a similar number expected such problems to get worse.

Figure 2.8. Students' environmental optimism, by topic OECD and EU averages (PISA 2015)

Percentage of students who reported that the following environmental issues would improve, get worse or stay the same over the following 20 years



Note: The figure shows the average share of students in EU and OECD countries who reported that the listed environmental issues would improve, get worse or stay the same over the following 20 years. Topics are sorted in descending order based on the percentage of students who reported that the environmental issues would improve on average throughout EU countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

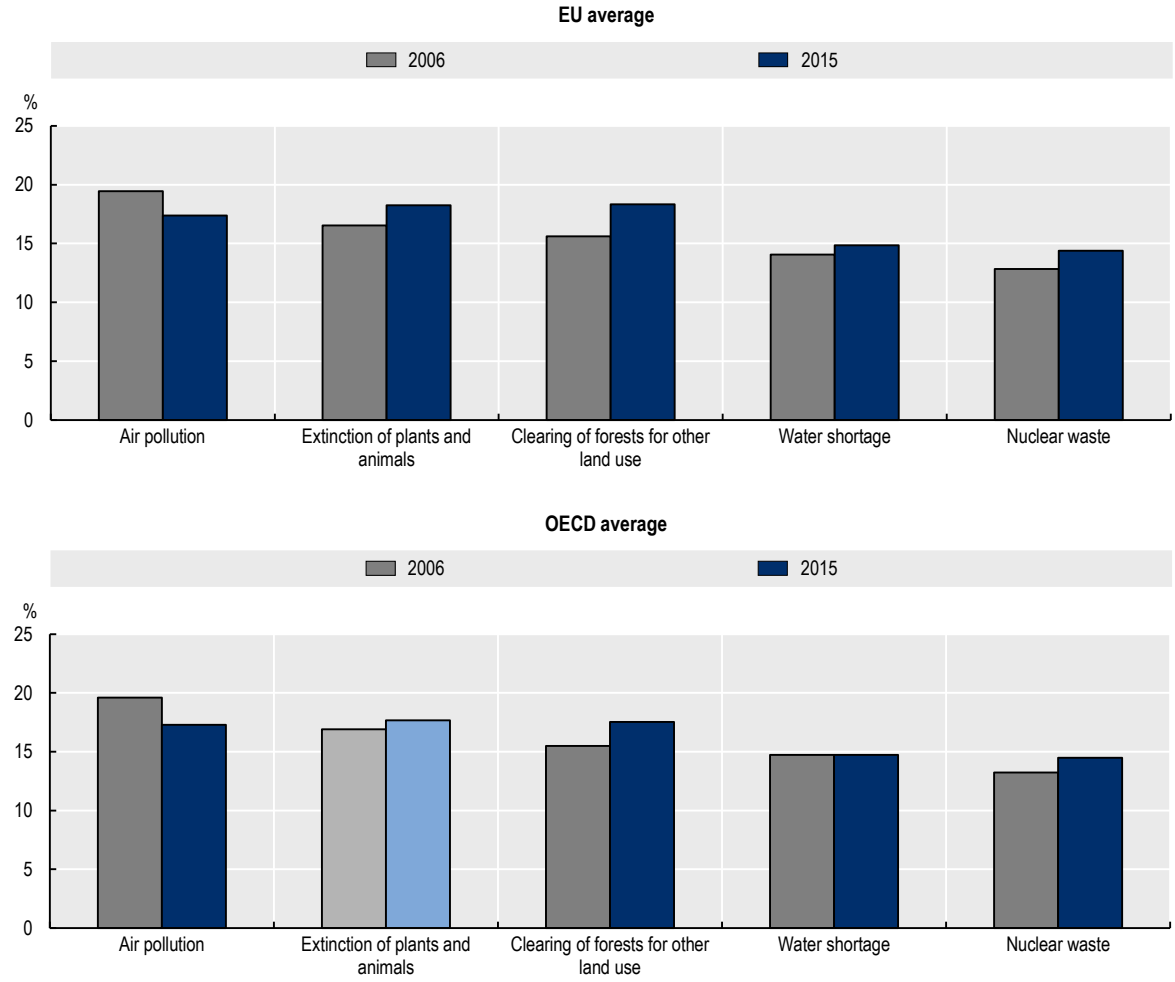
29. Figure 2.9 indicates that levels of environmental optimism changed less consistently between 2006 and 2015 than levels of environmental awareness did. In particular, 15-year-old students in EU countries reported higher levels of optimism with respect to improvements in air pollution, nuclear waste and clearing forests for other land use and extinction of animals and plants but became more pessimistic about water shortage. Among students in OECD countries, significant increases in optimism were reported for air pollution, nuclear waste and clearing forests for other land use, while they became more pessimistic about water shortage and no change in optimism was observed for clearing forests for other land use.

30. In 2006, on average throughout EU countries, 16% of students reported that they expected improvements in the management of nuclear waste over the next 20 years (and 15% on average throughout OECD countries). By 2015, on average throughout EU and OECD countries, this percentage had grown to 18%, a difference of 2 percentage points compared to 2006 for EU and 3 percentage points for OECD countries. In 2006, on average throughout EU and OECD countries, 17% of students reported that they expected improvements in problems associated with air pollution over the next 20 years and 13% reported the same when asked about problems associated with clearing forests for other land use. By 2015, these percentages had grown to 18% and 14%, a difference of 1 percentage point compared to 2006.

31. By contrast, throughout EU countries in 2006, 19% of students reported that they expected improvements over the next 20 years in the management of water shortages. By 2015, this percentage had shrunk to 17%, a decline of 2 percentage points. Similarly, in 2006, on average throughout OECD countries, 20% of students reported that they expected improvements over the next 20 years in the management of water shortages. By 2015, this percentage had shrunk to 17%, a decline of 3 percentage points.

Figure 2.9. Trend in students' environmental optimism between 2006 and 2015, EU and OECD averages (PISA 2006 and 2015)

Share of 15-year-old students believing that environmental issues would improve over the following 20 years



Note: The figure shows the average share of students in EU and OECD countries believing that environmental issues will improve over the next 20 years. Light colours denote that changes in shares over time did not significantly differ at the 5% significance level. Topics are sorted in descending order of students' average environmental optimism in 2006 for EU countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/ and OECD (2006[15]), PISA Database 2006, https://www.oecd.org/pisa/data/database-pisa2006.htm.

Box 2.5. Environmental self-efficacy

Students participating in PISA 2018 were asked to report the extent to which they felt it would be easy for them to do a range of tasks on their own, with tasks marked in bold denoting self-efficacy on environmental issues:

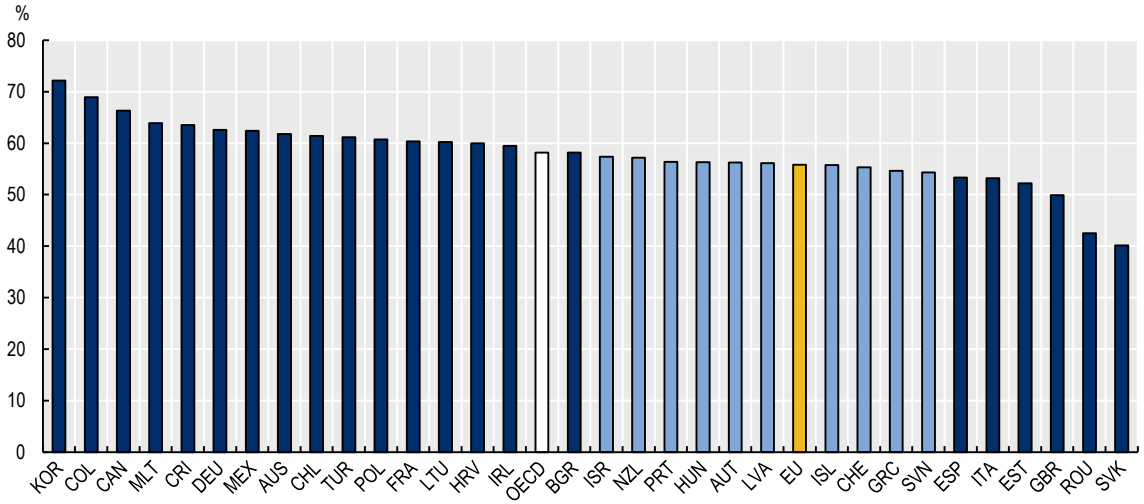
- explain how carbon-dioxide emissions affect global climate change;
- establish a connection between prices of textiles and working conditions in the countries of production;
- discuss the different reasons why people become refugees;
- explain why some countries suffer more from global climate change than others;
- explain how economic crises in single countries affect the global economy;
- discuss the consequences of economic development on the environment.

Students were asked to report if: 1) they could not perform the task; 2) they would struggle to perform the task on their own; 3) they could do the task with a bit of effort; or 4) they could perform the task easily. The answers to these questions were used to derive an environmental self-efficacy index. In this chapter, students who reported that they could easily perform at least one of the three tasks or reported that they could perform all three with a bit of effort were considered to display high levels of environmental self-efficacy.

32. Figure 2.10 indicates students' self-efficacy that is related to environmental topics such as: 'Explain how carbon-dioxide emissions affect global climate change', 'Explain why some countries suffer more from global climate change than others', 'Discuss the consequences of economic development on the environment'. The figure shows the share of students with high levels of environmental self-efficacy, meaning students who either report that they could perform one of the tasks easily or that they could perform all tasks with a bit of effort. On average throughout EU countries, 56% of students show a high level of environmental self-efficacy, while this share is 58% among OECD countries. While 72% of students in Korea are among the highest self-efficacious students, this share is only 40% in the Slovak Republic.

Figure 2.10. Students' environmental self-efficacy, 2018, by country (PISA 2018)

Percentage of 15-year-old students who reported being very self-efficacious

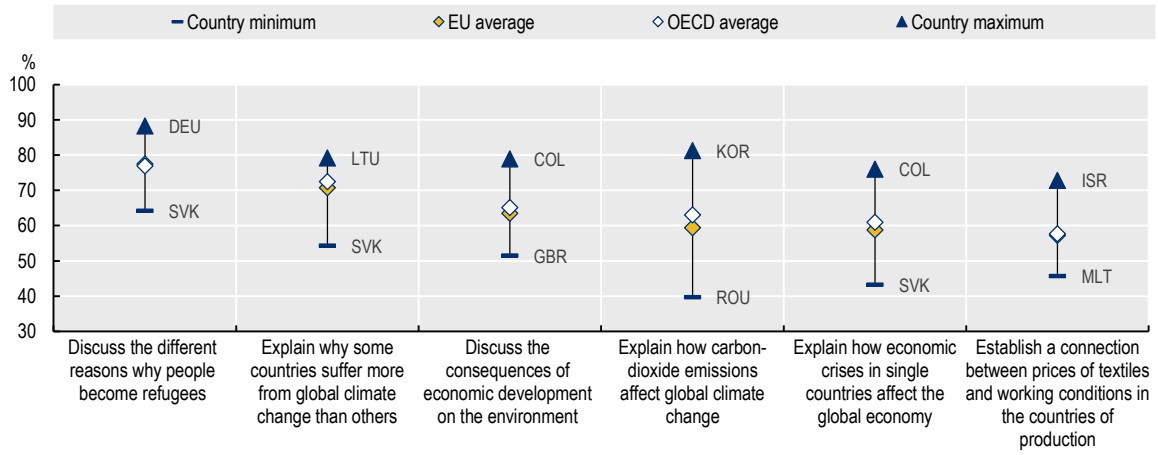


Note: The figure shows the share of students with high levels of self-efficacy regarding the following environmental topics: 'Explain how carbon-dioxide emissions affect global climate change', 'Explain why some countries suffer more from global climate change than others', 'Discuss the consequences of economic development on the environment' with answer options 'I could do this easily', 'I could do this with a bit of effort', 'I would struggle to do this on my own' and 'I couldn't do this'. Students are defined as having high levels of self-efficacy if they either report 'I could do this easily' in one of the topics or report 'I could do this with a bit of effort' for all topics. Light colours denote that shares are not significantly different from the EU average. Countries are sorted in descending order of students' environmental self-efficacy.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

33. Figure 2.11 suggests that throughout EU and OECD countries, students feel most confident about their ability to explain the different reasons why people become refugees and least confident about their ability to establish a connection between the prices of textiles and working conditions in the countries of production. With regard to self-efficacy concerning environmental issues, in 2018, 70% in EU and 72% in OECD countries reported they could discuss easily or with a bit of effort why some countries suffer more from global climate change than others. Slightly fewer students, 63% of students in EU and 65% of students in OECD countries, reported that they could discuss easily or with a bit of effort the consequences of economic development on the environment. Finally, 59% of students in EU and 61% of students in OECD countries, reported that they could discuss easily or with a bit of effort the consequences of economic development on the environment. Students' self-efficacy varies not only between topics but also largely within topics. While students' confidence regarding explaining carbon-dioxide consequences ranges between 40% in Romania and 81% in Korea, explaining why countries suffer from climate change ranges between 54% in the Slovak Republic and 79% in Lithuania.

Figure 2.11. Students' confidence in their ability to meaningfully engage in discussions about issues of global significance, EU and OECD averages (PISA 2018)

Percentage of 15-year-old students who reported being very self-efficacious regarding the following global topics



Note: The figure shows the share of students who are very self-efficacious about different environmental topics. Students are defined as having high levels of self-efficacy if they either report 'I could do this easily' or report 'I could do this with a bit of effort'. Topics are sorted in descending order of students' self-efficacy for available EU countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

2.4. Acting for environmental sustainability

34. Acting for environmental sustainability involves acting both individually and collectively to shape sustainable futures and demanding effective policy action for sustainability. Students participating in PISA 2018 were asked to report on their engagement in a series of actions that signal their willingness to engage in exerting change, even when acting entails them suffering some penalties and facing difficulties as a result (Box 2.6). For example, students were asked to report if they boycotted certain products and companies for political, ethical or environmental reasons or if they chose certain products for ethical or environmental reasons, even if these were more expensive. This section looks at countries where a larger number of students reported being engaged in individual and collective forms of pro-environmental behaviours. Although available data allow only a comparison of the extent to which students reported reducing energy consumption for environmental reasons and participating in activities that favour environmental protection, energy consumption is studied heavily in the literature on behavioural interventions (Grilli and Curtis, 2021[17]), and there is evidence of positive spillover effects on participation in different pro-environmental activities (Maki et al., 2019[18]).

Box 2.6. Pro-environmental behaviours

Students participating in PISA in 2018 were asked to report if they engaged in the following actions:

- I reduce the energy I use at home (e.g. by turning the heating down or turning the air conditioning up or down or by turning off the lights when leaving a room) to protect the environment;
- I choose certain products for ethical or environmental reasons, even if they are a bit more expensive;

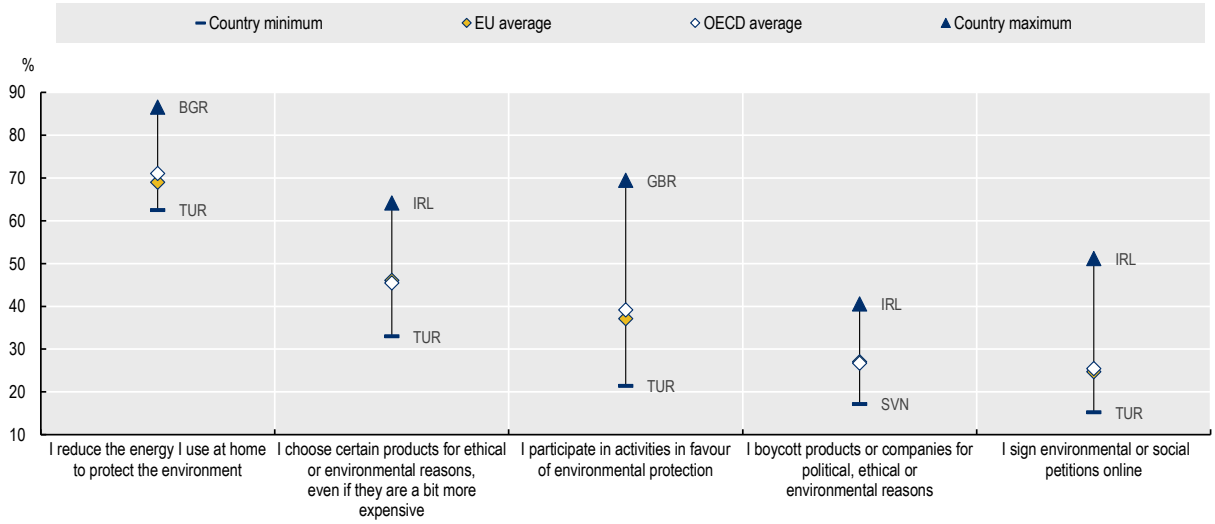
- I sign environmental or social petitions online;
- I keep myself informed about world events via <Twitter> or <Facebook>;
- I boycott products or companies for political, ethical or environmental reasons;
- I participate in activities promoting equality between men and women;
- I participate in activities in favour of environmental protection;
- I regularly read websites on international social issues (e.g. poverty, human rights).

The items highlighted in bold reflect students' engagement in pro-environmental behaviours. However, only the first and the seventh statements reflect engagement in pro-environmental behaviours alone since statements two, three and five could also reflect students' engagement with other issues of social and political significance. Therefore, as indicators of acting for environmental sustainability, this paper considers students' willingness to reduce energy consumption at home as an indicator of an individual form of pro-environmental behaviour and participation in activities in favour of environmental protection as an indicator of a collective form of pro-environmental behaviour.

35. Figure 2.12 suggests that students are most engaged in reducing energy at home or choosing certain products for ethical or environmental reasons, even if they are more expensive. Around 6 out of 10 students reported being engaged in energy saving (69% in EU countries and 71% in OECD countries). By contrast, on average among EU countries, only around 37% reported being engaged in participating in activities in favour of the environment, 27% reported boycotting products or companies for political, ethical or environmental reasons and 25% reported signing environmental petitions online (with respective shares for OECD countries being 39%, 27% and 25%).

Figure 2.12. Students' socially valuable behaviours, EU and OECD averages (PISA 2018)

Percentage of 15-year-old students who report having socially valuable behaviours



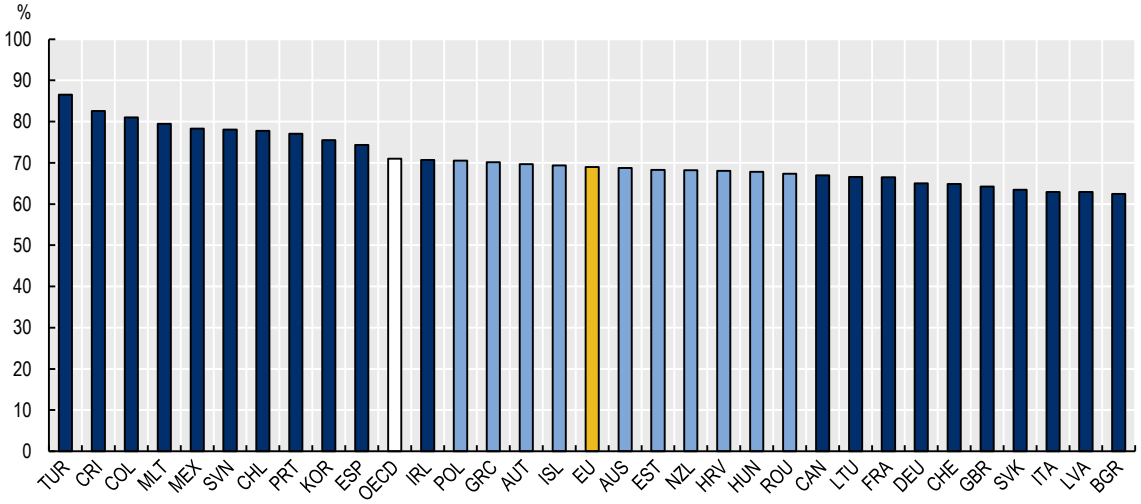
Note: For each issue, the figure shows the EU and OECD average, country minimum and country maximum. Countries are sorted in descending order of students' socially valuable behaviours for available EU countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

36. Figure 2.13 shows the percentage of 15-year-old students in EU and OECD countries who, in 2018, reported that they reduced energy consumption for environmental reasons. Turkey, Costa Rica and

Colombia were the countries where over 8 out of 10 15-year-old students reported having saved energy for environmental reasons, while in the Slovak Republic, Italy, Latvia and Bulgaria, close to only around 6 out of 10 15-year-olds did so.

Figure 2.13. Students' energy consumption, by country (PISA 2018)

Percentage of 15-year-old students who reported reducing energy consumption for environmental reasons

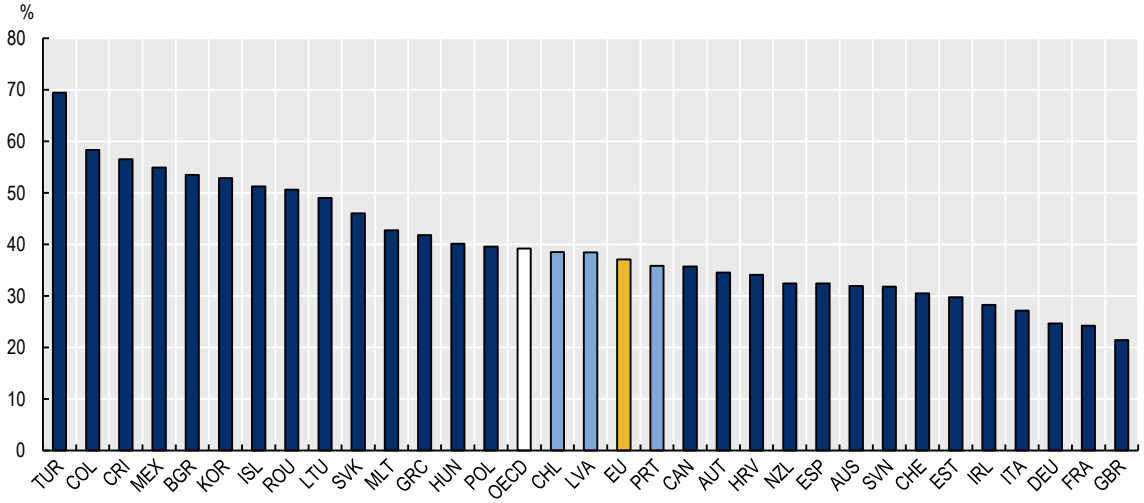


Note: Figure shows the share of students engaging in energy consumption. Light colours denote that shares are not significantly different from the EU average. Countries are sorted in descending order of students' engagement in energy consumption.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

37. Figure 2.14 shows the percentage of 15-year-old students who in the same year reported participating in (collective) activities in favour of environmental protection. While, in Turkey, the highest share of students reported participating in activities in favour of environmental protection was almost 70%, the following countries with almost 10-percentage-points-lower participation rates are Colombia and Costa Rica. In Estonia, Ireland, Italy, Germany, France and the United Kingdom, fewer than 3 in 10 students reported participating in activities in favour of environmental protection. Interestingly, while in most countries individual and collective forms of participation went hand in hand (such as in Turkey, Colombia and Mexico, where both forms of participation were widespread and in Italy, Germany, France and the United Kingdom, where engagement was comparatively low), in other countries, such as Bulgaria, individual forms of participation were comparatively low but collective forms were comparatively high.

Figure 2.14. Students' participation in environmental protection activities, by country (PISA 2018)

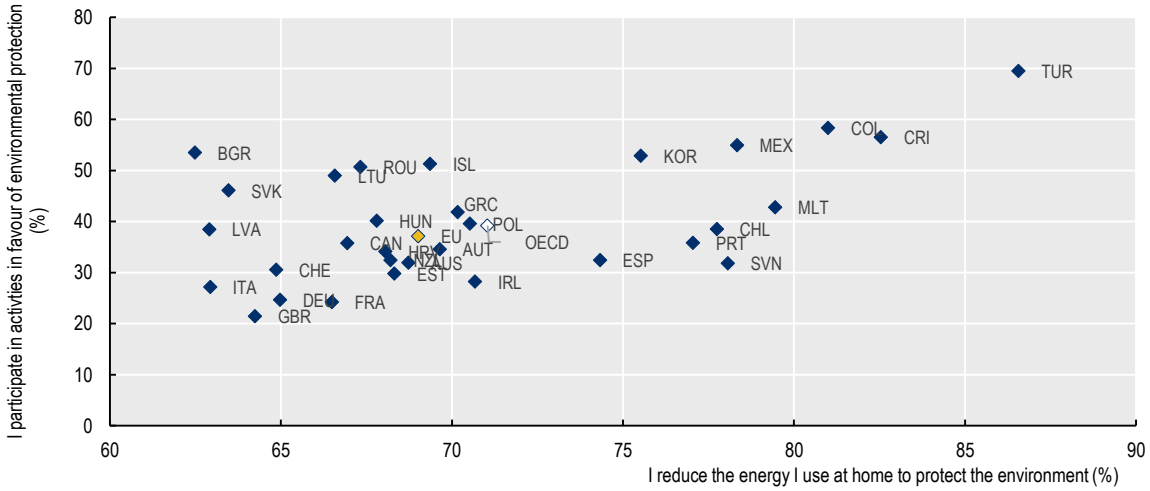
Percentage of 15-year-old students who reported participating in activities in favour of environmental protection



Note: Figure shows the share of students engaging in environmental protection activities. Light bars denote that shares are not significantly different from the EU average. Countries are sorted in descending order of students' engagement.
Source: Calculations based on OECD (2018[12]), PISA 2018Database, https://www.oecd.org/pisa/data/2018database/.

38. Figure 2.15 suggests that, in general, in countries where more 15-year-old students engaged in individual forms of pro-environmental behaviours, students were also more likely to engage in collective forms of pro-environmental behaviours. At the same time, in a number of countries, collective forms of pro-environmental behaviours were considerably more prevalent than what would be expected given participation in individual forms of pro-environmental behaviours and vice versa. For example, in 2018, Slovenia was one of the countries where the largest share of students reported reducing energy consumption at home to protect the environment (78% of students reported doing this), but where students were below the EU and OECD averages when participation in activities in favour of environmental protection was considered (32% of students reported doing this). By contrast, Lithuania and the Slovak Republic were countries where, in 2018, 15-year-old students were most likely to report participating in activities in favour of environmental protection (49% and 46% of students reported doing this), but were least likely to report reducing energy consumption at home to protect the environment (67% and 63% of students reported doing this).

Figure 2.15. Country-level association between collective and individual behaviour (PISA 2018)



Note: Figure shows the country-level correlation between students who participate in activities in favour of environmental protection and reduce energy at home to protect the environment.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

Box 2.7. Comparability of self-reports

The attitudinal and behavioural components of environmental sustainability competence are based on students' self-reports. Likert-type scales administered to individuals through self-reports are by far the most widely used instrument to assess attitudes, perceptions and self-belief in large-scale settings. Self-reports have the advantage of being designed to reflect well-defined theoretical constructs, can be measured in a questionnaire with a relatively short time burden for respondents and give participants a voice (Kyllonen and Kell, 2018[19]).

However, self-reports have been shown to be sensitive to misinterpretation, a lack of information and memory bias, social desirability bias, response-style bias and reference-group bias (see Kankaraš (2017[20]) for a comprehensive review). Most of the indicators used in this paper to map the attitudinal components of environmental sustainability competence exploit single items present in PISA 2018 and complex indices reflecting different facets of underlying constructs could therefore not be developed. Similarly, it was not possible to assess cross-country and between-country comparisons through invariance testing.

Source: Kankaraš, M. (2017[20]), 'Personality matters: Relevance and assessment of personality characteristics', *OECD Education Working Papers,* https://doi.org/10.1787/8a294376-en; Kyllonen, P. & Kell, H. (2018[19]), 'Ability Tests Measure Personality, Personality Tests Measure Ability: Disentangling Construct and Method in Evaluating the Relationship between Personality and Ability', *Journal of Intelligence*, Vol. 6(3), p. 32, https://doi.org/10.3390/jintelligence6030032.

3 Who is environmentally literate?

3.1. Introduction

39. Chapter 2 indicated that there are significant differences between countries in the environmental sustainability competences acquired by 15-year-old students. Successfully halting human activities that deteriorate the Earth's climate and reversing the negative consequences of past actions requires not only communities in different countries to acquire high levels of environmental sustainability competences, but also to develop and nurture such competences overall. Within countries, polarisation in support of environmental action across different population groups is, in fact, likely to create tensions and slow progress in green growth policies. However, past research indicates that substantial variations exist in environmental sustainability competences within countries between individuals with different characteristics, and that within-country differences are larger than between-country differences (Franzen and Meyer, 2009[21]).

40. This chapter sheds light on variations in environmental attitudes by gender and economic, social and cultural status (ESCS). The PISA questionnaire assessed 15-year-old students' care for the environment (caring for the environment, PISA 2018), confidence in accomplishing science-related tasks (science self-efficacy, PISA 2015), how informed students are about environmental issues (environmental awareness, PISA 2015), how they think environmental issues will evolve over the next 20 years (environmental optimism, PISA 2015) and students' capacity to take action in environment-related activities (environmental behaviour, PISA 2018) (see Chapter 2).

3.2. Gender differences in environmental sustainability competences

41. This section examines gender differences in the four areas that characterise environmental sustainability competence (see Chapter 1). The literature indicates that women generally have higher overall levels of environmentalism[3] (Zelezny, Chua and Aldrich, 2000[22]): women are more likely to engage in pro-environmental behaviour, such as participating in political action to support the environment (Casaló and Escario, 2018[23]; Casaló and Escario, 2016[24]; Diekmann, 1998[25]; Stern, Dietz and Kalof, 1993[26]), possess higher levels of environmental responsibility (Boeve-de Pauw and Van Petegem, 2010[27]) and express greater concern for environmental issues (Franzen and Vogl, 2013[28]). Women's higher levels in some of the areas of environmental sustainability competence could reflect social norms, with women being associated with a caring ethos (Eagly, 2013[29]; Gilligan, 1982[30]).

3.2.1. Embodying environmental sustainability values

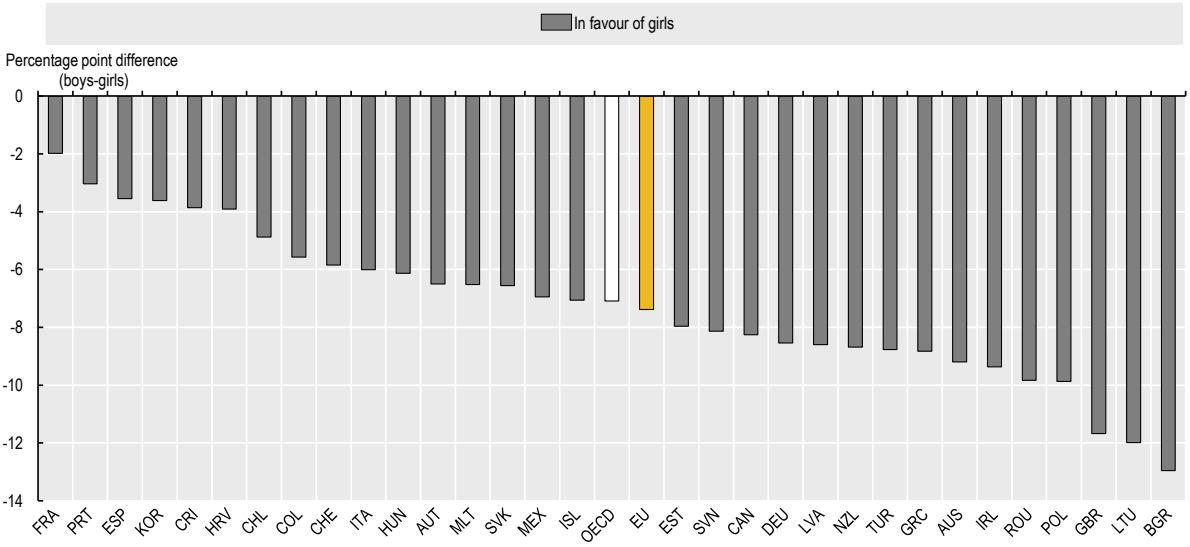
42. Figure 3.1 reveals that in 2018, throughout all EU and OECD countries, girls were more likely than boys to agree or strongly agree that looking after the environment was important to them. For example,

[3] Environmentalism can be defined as the 'advocacy of the preservation, restoration, or improvement of the natural environment' (Merriam-Webster, n.d.[93]).

throughout EU and OECD countries, 15-year-old girls were 7 percentage points more likely than 15-year-old boys to report that they cared about the environment. The gender gap was widest in the United Kingdom, Lithuania and Bulgaria, where the gender gap was larger than 10 percentage points, and was smallest in France, where it was 2 percentage points.

Figure 3.1. Gender differences in care for the environment, by country (PISA 2018)

Percentage point difference between 15-year-old boys and girls who reported that looking after the environment was important to them



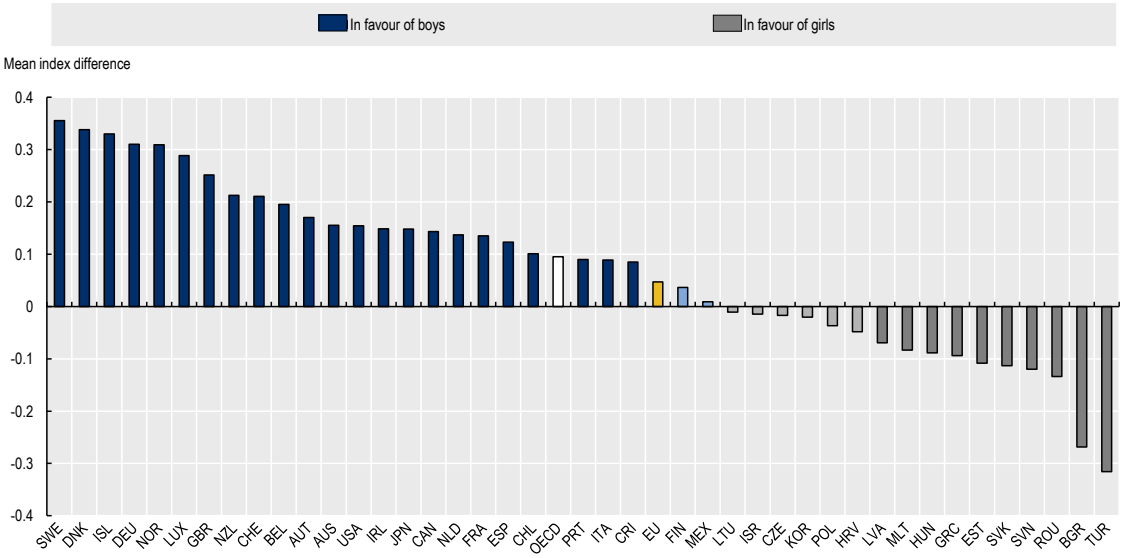
Note: The figure shows the percentage point difference between 15-year-old boys and girls who 'Agree' or 'Strongly agree' with the statement 'Looking after the global environment is important to me'. Countries are sorted in descending order of the average gender difference in caring for the environment for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

3.2.2. Embracing complexity in sustainability

43. Figure 3.2 illustrates that countries differ greatly with respect to how aware 15-year-old boys and girls reported themselves to be about environmental topics such as air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortage, the increase of greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms (see Box 2.2 on the index of environmental awareness). In 2015, on average throughout EU and OECD countries, boys reported greater levels of environmental awareness than girls. The gender gap was in favour of boys and corresponded to 4.7% of a standard deviation throughout EU and 9.5% of a standard deviation throughout OECD countries; however, in as many as 10 EU and OECD countries, the gender gap was in favour of girls. Boys reported a greater awareness than girls in 23 countries, and the gender gap was widest in Sweden, Denmark and Iceland, with differences of about one third of a standard deviation. In contrast, girls' environmental awareness in Turkey was around one third of a standard deviation higher compared to that of boys.

Figure 3.2. Gender differences in awareness of environmental issues, by country (PISA 2015)

Mean index difference between 15-year-old boys and girls who reported being aware of a range of environmental issues

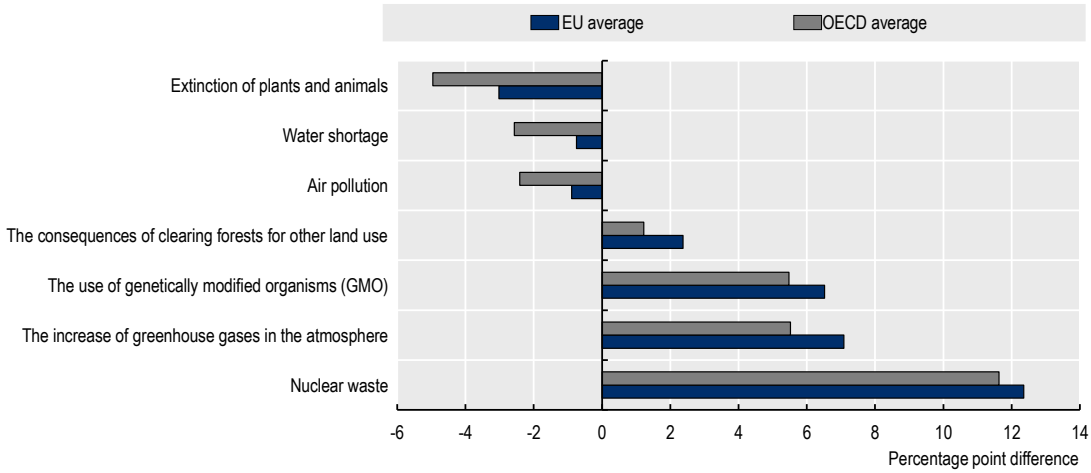


Note: The figure shows the mean index difference between 15-year-old boys and girls who reported knowing about ('I know something about this and could explain the general issue') or being familiar with ('I am familiar with this and I would be able to explain this well') the following environmental topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortage, the increase of greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Light colours denote that the mean index differences are not significantly different at the 5% significance level. Topics are sorted in descending order of the average gender difference for available EU and OECD countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

44. Interestingly, Figure 3.3 suggests that gender differences in awareness of environmental problems differ depending on the nature of such problems. For example, throughout EU and OECD countries, boys reported higher levels of awareness of nuclear waste, the increase of greenhouse gases in the atmosphere, the use of genetically modified organisms and the consequences of clearing forests for other land use, while girls reported higher levels of awareness of water shortage, air pollution and extinction of plants and animals. On average throughout EU and OECD countries, gender differences in favour of boys were widest and corresponded to 12 percentage points in terms of the percentage of boys and girls who reported knowing something about nuclear waste and being able to explain the general issue or being familiar with and being able to explain problems associated with nuclear waste well. By contrast, girls were more likely than boys to report being aware of problems associated with the extinction of animals and plants, while girls reported a 5-percentage-point-higher awareness throughout EU countries, and 3 percentage points throughout OECD countries.

Figure 3.3. Gender differences in awareness of environmental problems, EU and OECD averages (PISA 2015)

Percentage point difference between 15-year-old boys and girls in awareness of environmental problems



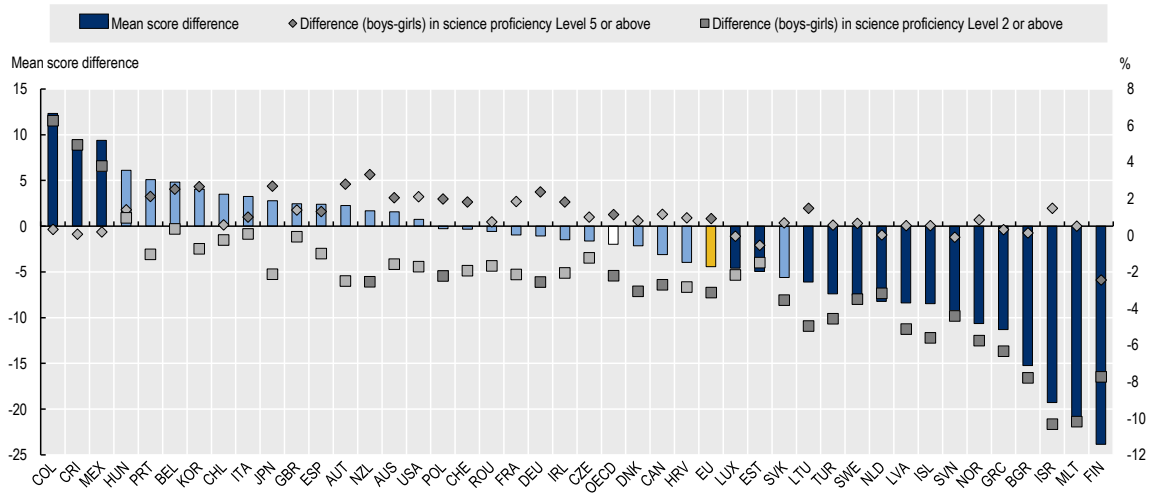
Note: The figure shows the percentage point difference between 15-year-old boys and girls who reported knowing about ('I know something about this and could explain the general issue') or being familiar with ('I am familiar with this and I would be able to explain this well') the environmental issues listed in the figure. For each issue, the figure shows the EU and OECD average. Topics are sorted in descending order of percentage point difference for available EU countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

45. Figure 3.4 reveals that in 2018, on average, there were few gender differences in the mean science achievement, although the average 15-year-old girl and the average 15-year-old boy scored at different levels in the PISA science assessment in some countries. In Finland, Malta and Israel, on average, 15-year-old girls outperformed boys, with a gender gap of at least 19 score points. By contrast, in 15 out of the 42 EU and OECD countries with available data, on average 15-year-old girls outperformed boys.

46. Figure 3.4, however, indicates that in the majority of countries, gender gaps in science in favour of boys were especially pronounced among top performers: 6% of boys and girls, on average, throughout EU countries achieved levels in the PISA science test demonstrating the ability to be able to apply their science knowledge and skills creatively and autonomously to a wide variety of situations, including unfamiliar ones (7% of boys and 6% of girls throughout OECD countries). By contrast, in the majority of countries, 15-year-old boys are more likely than girls to fail to meet minimum levels of proficiency. The percentage point difference between boys and girls who achieved levels in the PISA science test demonstrating at least basic or everyday scientific knowledge, and a basic understanding of scientific enquiry, was 3 percentage points throughout EU countries (and a difference of 2 percentage points throughout OECD countries).

Figure 3.4. Gender differences in science achievement, by country (PISA 2018)

Mean score difference between science achievement of 15-year-old boys and girls, percentage point difference between 15-year-old boys and girls in science proficiency Level 5 or above and between 15-year-old boys and girls in science proficiency Level 2 or above



Note: The figure shows mean difference in the science achievement score of 15-year-old boys and girls (left y-axis), and the percentage point difference of boys and girls with a science achievement of at least Level 2 or Level 5 (right y-axis). Light colours denote that averages and shares are not significantly different from the EU average at the 5% significance level. Topics are sorted in descending order of students' mean science achievement for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

47. Gender differences in science achievement differ not only depending on whether top performers or low achievers are considered but also when different areas of science are considered. In particular, in line with the finding that 15-year-old boys and girls in 2015 reported different levels of awareness of different environmental topics, boys and girls are not equally likely to achieve high levels in areas of science that pertain to physics, biology or geoscience. Figure 3.5 illustrates the gender gap in PISA 2015 in different areas of science, both at the average and between students with different levels of achievement. Among science competencies, which include explaining phenomena, evaluating and designing and interpreting data and evidence, the average gender gap was in favour of boys in terms of explaining phenomena (with an 11 and 12 mean score difference throughout EU and OECD countries, respectively). It was in favour of girls with respect to evaluating and designing (with a 6-score-point difference in EU countries and a 5-score-point difference in OECD countries), and interpreting data and evidence (with a 3-score-point difference in EU countries and 1-score-point difference in OECD countries). When focusing on students with science proficiency Level 5 or above in PISA 2015, gender differences in the three science competencies were in favour of boys (by 3 percentage points in explaining phenomena, 1 percentage point in evaluating and designing and 1 percentage point in interpreting data and evidence, on average throughout EU and OECD countries). When expanding the focus on students with at least proficiency Level 2, gender differences in science competencies in 2015 were, on average, in favour of boys by 1 percentage point in terms of explaining phenomena throughout EU countries and 2 percentage points in OECD countries. In contrast, girls scored higher in evaluating and designing (a 4-percentage-point difference on average throughout EU countries and a 3-percentage-point difference throughout OECD countries) as well as in terms of interpreting data and evidence (3-percentage-point and 2-percentage-point differences on average throughout EU and OECD countries, respectively).

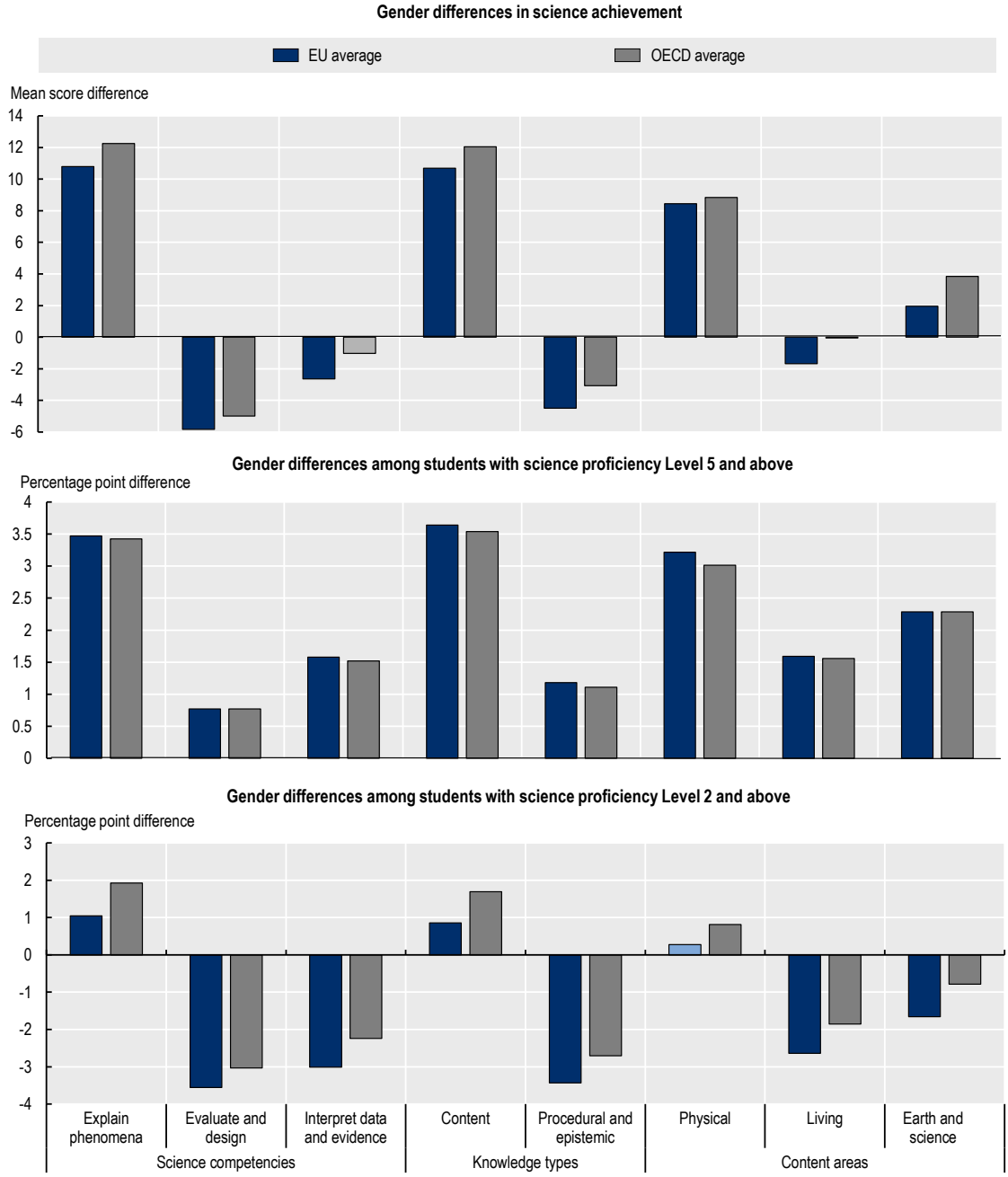
48. In terms of knowledge types, the average gender gap in PISA 2015 was in favour of boys for content (11-and 12-score-point differences on average throughout EU and OECD countries, respectively)

and in favour of girls for procedural and epistemic science knowledge (4- and 3-score-point differences throughout EU and OECD countries, respectively). Among 15-year-old girls and boys with science proficiency Level 5 or above, boys scored higher than girls in both knowledge types (by 4 percentage points in content knowledge and 1 percentage point in epistemic and procedural knowledge on average throughout EU and OECD countries). In contrast, among students with at least science proficiency Level 2, boys outperformed girls only in content-based knowledge (by 1 percentage point on average throughout EU countries and 2 percentage points throughout OECD countries), while girls scored higher than boys in epistemic and procedural knowledge (by around 3 percentage points on average throughout both EU and OECD countries).

49. When looking at science content areas, in 2015, boys scored higher than girls in physical, and earth and science, areas. In physics, the average gender gap was of 8 and 9 score points on average throughout EU and OECD countries, respectively. In earth and science, on average, the gap equalled 2 and 4 score points, respectively, in EU and OECD countries. Girls scored higher than boys in biology (living science area), with a 2-score-point difference on average throughout EU countries and a 1-score-point difference throughout OECD countries. Among students with science proficiency Level 5 or above, both in EU and OECD countries, gender differences were in favour of boys in all content areas and corresponded to 3 percentage points in physics, around 2 percentage points in biology and earth and science. Among students with at least science proficiency Level 2, girls outperformed boys in biology (by 3 percentage points on average throughout EU countries and 2 percentage points in OECD countries) and earth and science (by 2 percentage points on average throughout EU countries and 1 percentage point in OECD countries). Instead, boys scored higher than girls in physics but this difference was only significant throughout OECD countries (1 percentage point).

Figure 3.5. Gender differences by science competency subscale (PISA 2015)

Mean score difference in science achievement by science competency subscale between 15-year-old boys and girls, and percentage point difference between 15-year-old boys and girls in science proficiency Level 5 and above and science proficiency Level 2 and above by science competency subscale



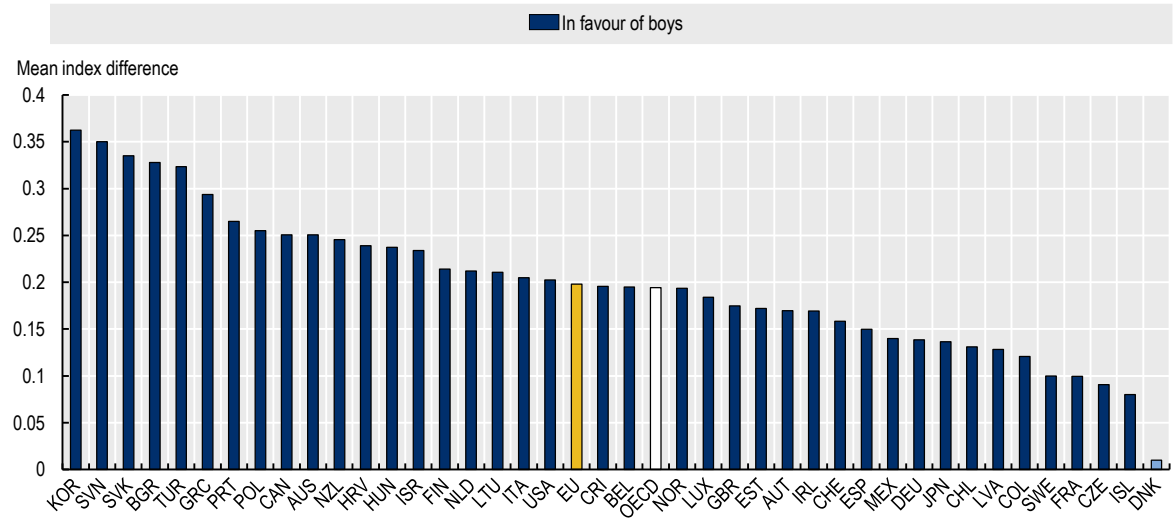
Note: The figure shows the mean difference in the science achievement score of 15-year-old boys and girls by science competency subscale (upper panel), the percentage point difference in science proficiency Level 5 and above of 15-year-old boys and girls by science competency subscale (middle panel) and the percentage point difference in science proficiency Level 2 and above of 15-year-old boys and girls by science competency subscale (bottom panel).
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

3.2.3. Envisioning environmentally sustainable futures

50. Figure 3.6 illustrates that in 2015, in all EU and OECD countries, girls reported being less optimistic than boys about improvements in the state of the environment over the following 20 years. On average throughout EU countries, boys expressed higher levels of optimism than girls and the gender gap in environmental optimism corresponded to 20% of a standard deviation (19% throughout OECD countries) (see Box 2.4 for a description of the index of environmental optimism). Gender differences in environmental optimism were greatest in Korea, the Slovak Republic and Slovenia, and the smallest differences were in Denmark, Iceland and the Czech Republic.

Figure 3.6. Gender differences in environmental optimism, by country (PISA 2015)

Mean index difference between 15-year-old boys and girls who reported that environmental issues would improve, get worse or stay the same over the following 20 years

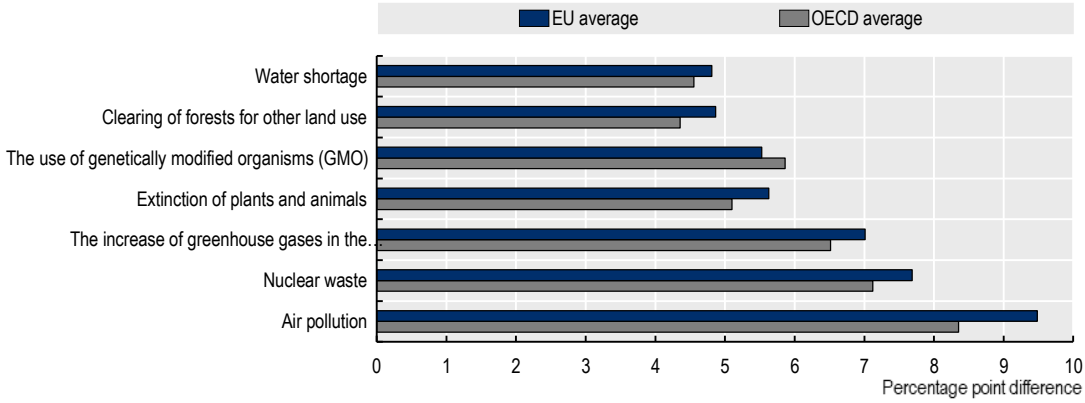


Note: The figure shows the mean index difference between 15-year-old boys and girls in EU and OECD countries who reported that environmental issues would improve, get worse or stay the same over the following 20 years. Topics are sorted in descending order based on the mean index difference of students who reported that environmental issues would improve on average throughout EU countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

51. While gender differences in awareness differed depending on the environmental problem considered, Figure 3.7 suggests that 15-year-old boys in 2015 reported being more optimistic than 15-year-old girls about all of the environmental issues participating students were asked about. The gender gap in favour of boys was largest when students were asked to consider air pollution and nuclear waste. For example, throughout EU countries, 23% of boys but only 14% of girls in 2015 reported that they expected problems associated with air pollution to improve over the next 20 years (22% and 14% throughout OECD countries).

Figure 3.7. Gender differences in optimism over improvements in specific environmental problems (PISA 2015)

Percentage point difference between 15-year-old boys and girls believing that the following environmental issues would improve over the following 20 years

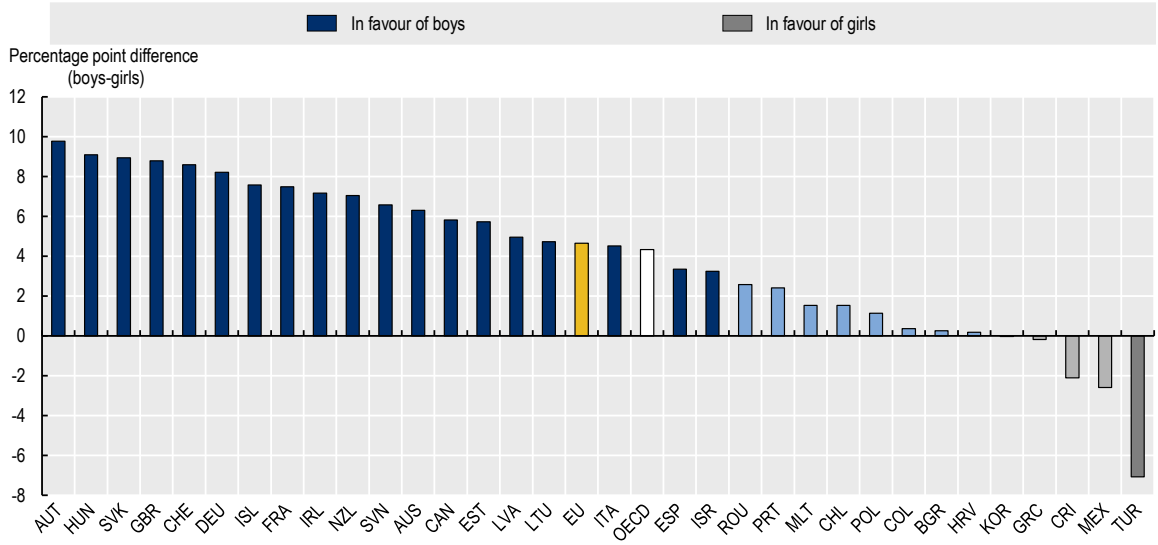


Note: The figure shows the average share of students in EU and OECD countries believing that the environmental issues listed in the figure would improve over the next 20 years. Topics are sorted in descending order of students' average environmental optimism for the EU average.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

52. A second dimension that characterises students' ability to envision environmentally sustainable futures is students' environmental self-efficacy. This reflects how confident students feel about being able to discuss or explain a series of environmental problems. Figure 3.8 illustrates the gender gap in the percentage of 15-year-old students who, in 2018, had high levels of environmental self-efficacy, i.e. who felt it would be easy for them to explain how carbon-dioxide emissions affect global climate change, explain why some countries suffer more from global climate change than others and discuss the consequences of economic development on the environment. Figure 3.8 indicates that, on average throughout EU countries, boys were 5 percentage points more likely than girls to have high levels of environmental self-efficacy (and 4% on average throughout OECD countries). The figure also shows that boys reported a higher sense of self-efficacy than girls in 19 of the 32 countries with available data. By contrast, Turkey was the only country where the gender gap was in favour of girls, quantitatively large (7 percentage points), and statistically significant at conventional levels.

Figure 3.8. Gender differences in environmental self-efficacy, by country (PISA 2018)

Percentage point difference between 15-year-old boys and girls who reported being very self-efficacious



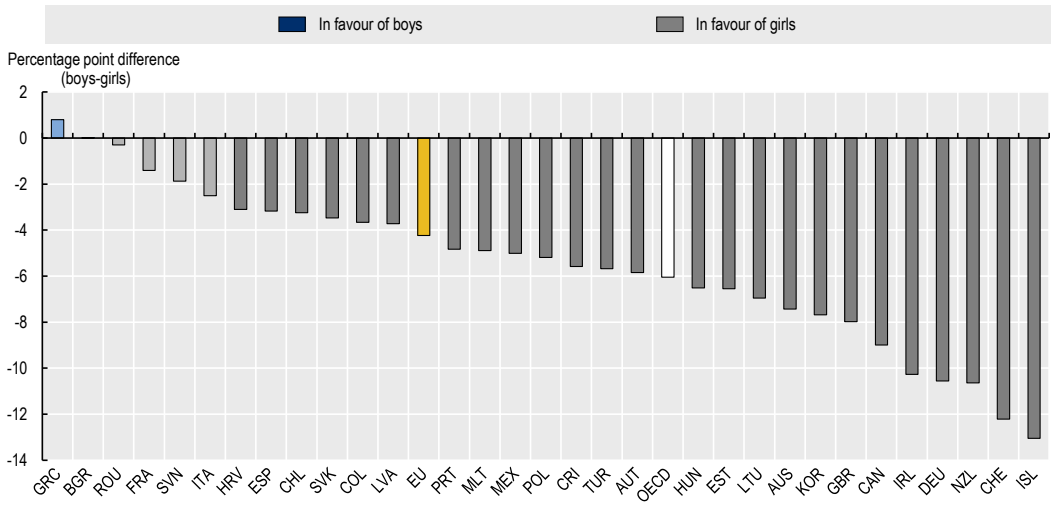
Note: The figure shows the percentage point difference between 15-year-old boys and girls with high levels of self-efficacy regarding the following environmental topics: 'Explain how carbon-dioxide emissions affect global climate change', 'Explain why some countries suffer more from global climate change than others', 'Discuss the consequences of economic development on the environment' with answer options 'I could do this easily', 'I could do this with a bit of effort', 'I would struggle to do this on my own' and 'I couldn't do this'. Students are defined as having high levels of self-efficacy if they either report 'I could do this easily' in one of the topics or report 'I could do this with a bit of effort' for all topics. Light colours denote that gender differences are not significantly different at the 5% significance level. Countries are sorted in descending order of gender differences in students' environmental self-efficacy.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

3.2.4. Acting for environmental sustainability

53. Figure 3.9 indicates that in 2018, in the vast majority of countries in the EU and OECD areas, 15-year-old girls were more likely than 15-year-old boys to engage in individual forms of pro-environmental behaviours. Throughout EU countries, girls were 4 percentage points more likely than boys to report having engaged in energy saving at home to protect the environment. Throughout OECD countries, the gender gap was wider and corresponded to 6 percentage points. The gender gap was widest in Iceland where it was 13 percentage points, and quantitatively small and not statistically significant in Greece, Bulgaria, Romania, France, Slovenia and Italy.

Figure 3.9. Gender differences in energy consumption, by country (PISA 2018)

Percentage point difference between 15-year-old boys and girls who reported reducing energy consumption for environmental reasons

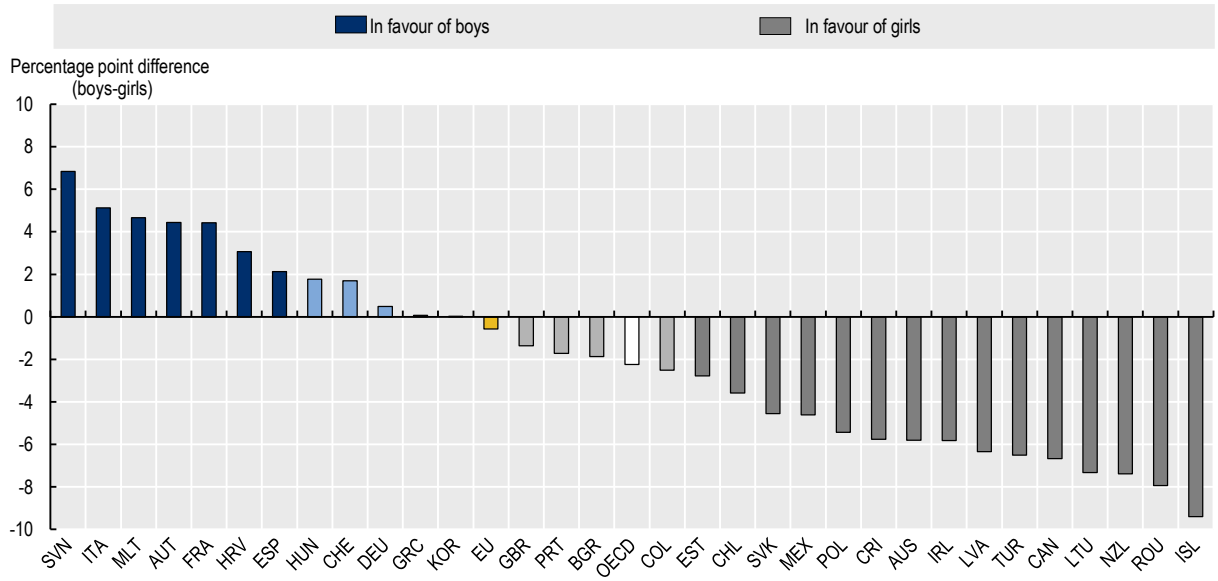


Note: The figure shows the percentage point difference between 15-year-old boys and girls engaging in energy consumption. Light colours denote that gender differences are not significantly different at the 5% significance level. Countries are sorted in descending order of gender differences in students' engagement in energy consumption.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

54. In contrast to findings presented in Figure 3.9, Figure 3.10 suggests greater between-country variation in the engagement of 15-year-old boys and girls in collective forms of environmental action. In particular, Figure 3.10 reveals that in 2018, on average throughout EU countries, 15-year-old boys and girls were equally likely to report participating in activities in favour of environmental protection. Throughout OECD countries, girls were 2 percentage points more likely than 15-year-old boys to report having participated in activities in favour of environmental protection. Girls were more likely to report having participated in such activities in 15 EU and OECD countries, while boys were more likely to report having participated in such activities in 7 EU and OECD countries.

Figure 3.10. Gender differences in participation in environmental protection activities, by country (PISA 2018)

Percentage point difference between 15-year-old boys and girls who reported participating in activities in favour of environmental protection



Note: The figure shows the percentage point difference between 15-year-old boys and girls engaging in environmental protection activities. Light bars denote that gender differences are not significantly different at the 5% significance level. Countries are sorted in descending order of gender differences in students' engagement.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

55. Results from this section reveal that boys are over-represented among students with the highest levels of scientific skills, especially in areas of science that could be instrumental in promoting the green transition, such as physics. Evidence in fact suggests that engineering, for which physics is crucial, is a key workplace skill to facilitate the transition towards environmentally sustainable economies because it enables the design and production of green technologies (Vona et al., 2018[31]). By contrast, 15-year-old girls are more likely than boys to report that looking after the global environment is important to them, to have higher skills in biology and areas of science that pertain to living systems and to report high levels of awareness of environmental problems that are related to such knowledge, such as the disappearance of plants and animals. Biology can also be crucial to promote the green transition: biological processes can, for example, be leveraged to efficiently break down waste and produce materials with less pollution, water, land and energy use than traditional methods. Bioplastics, enzymatic detergents, biofuels, cultivated meat, biofertilisers and biopesticides and new ways and compounds used in the cosmetics, textiles and construction industries represent ways in which biology could reduce the environmental footprint of human production and consumption.

56. Results reported in this section also suggest that 15-year-old boys reported being more optimistic about the state of the environment improving over a period of about 20 years, but also indicated being less active than girls in pro-environmental behaviours, especially individual forms of pro-environmental behaviours such as conserving energy at home. Despite boys reporting being more aware than girls and being more confident about their ability to understand and discuss environmental problems, they reported caring less about the environment than girls and engaging less in pro-environmental behaviours.

3.3. Socio-economic disparities in environmental sustainability competences

57. This section considers differences in environmental sustainability competences between students coming from families with socio-economically advantaged and disadvantaged households. Socio-economic advantage and disadvantage reflect whether a student comes from the top or bottom quartile of the national distribution of the PISA index of economic, social, and cultural status (ESCS). ESCS is a composite measure based on information about the educational attainment and occupation of the parents of participating students as well as material and cultural (e.g. books, artwork) possessions present in the students' homes. Since higher values of the index indicate a higher ESCS, students with ESCS values in the top quartile of the national distribution of ESCS can be considered to be the most socio-economically advantaged, and those with ESCS values in the bottom quartile of the national distribution of ESCS to be the most socio-economically disadvantaged.

58. Living in a family with highly educated parents, parents who work in prestigious occupations and with good economic conditions may mean that children are exposed to a context in which their families understand the importance of environmental sustainability and, given the fact that they have fewer financial worries, can make decisions and value environmental sustainability without worrying about the consequences it has on their livelihood (Coertjens et al., 2010[32]).

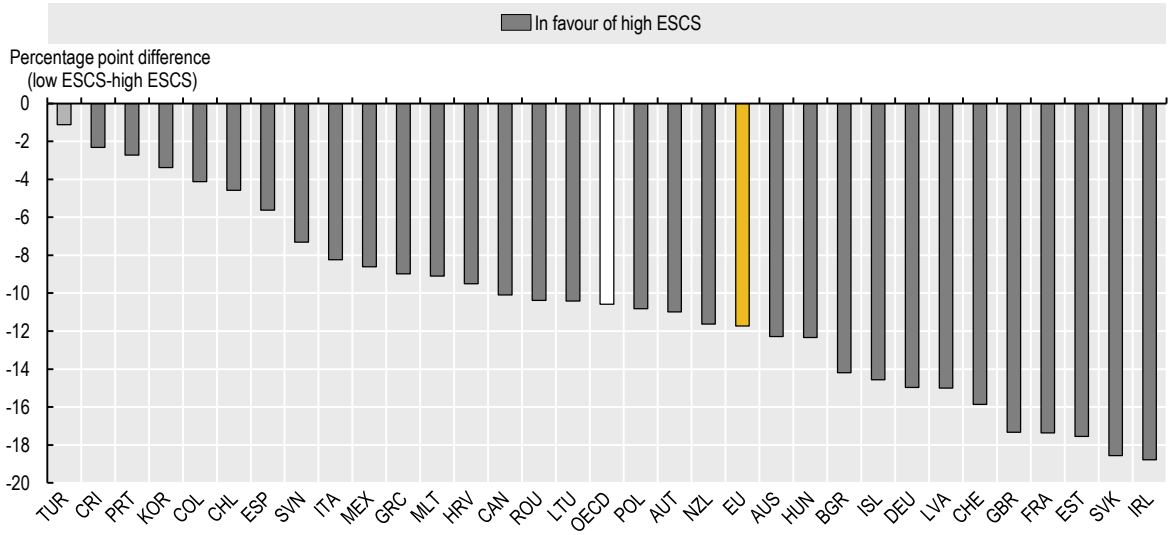
59. Socio-economically advantaged individuals are less likely to be directly affected by environmental problems such as air pollution and are more likely to be able to put in place adaptation and mitigation strategies to suffer less when environmental problems occur. For example, they are more likely to be able to afford air conditioning systems, can purchase bottled water, live in areas that are less polluted and are less reliant on public transportation. Furthermore, technological change and the green transition are likely to have significant effects on labour market reallocation, with individuals with low-level educational qualifications being most likely to lose their jobs (Chateau, Bibas and Lanzi, 2018[33]). Although socio-economically disadvantaged families are more directly affected by climate change and other environmental problems, they may have fewer cultural and social resources to be fully aware of such effects to demand change and see environmental deterioration as a priority.

3.3.1. Embodying environmental sustainability values

60. Figure 3.11 reveals that throughout EU and OECD countries, 15-year-old students from socio-economically advantaged households are more likely to report that looking after the global environment is important to them. In 2018, in all countries except Turkey, advantaged students were more likely than their disadvantaged counterparts to report that looking after the global environment was important to them. On average, the difference was 12 percentage points in EU countries and 11 percentage points in OECD countries and was greatest in Ireland and the Slovak Republic, where it corresponded to around 19 percentage points.

Figure 3.11. Socio-economic disparities in caring about the environment, by country (PISA 2018)

Percentage point difference between 15-year-old students with low and high ESCS who reported that looking after the environment was important to them



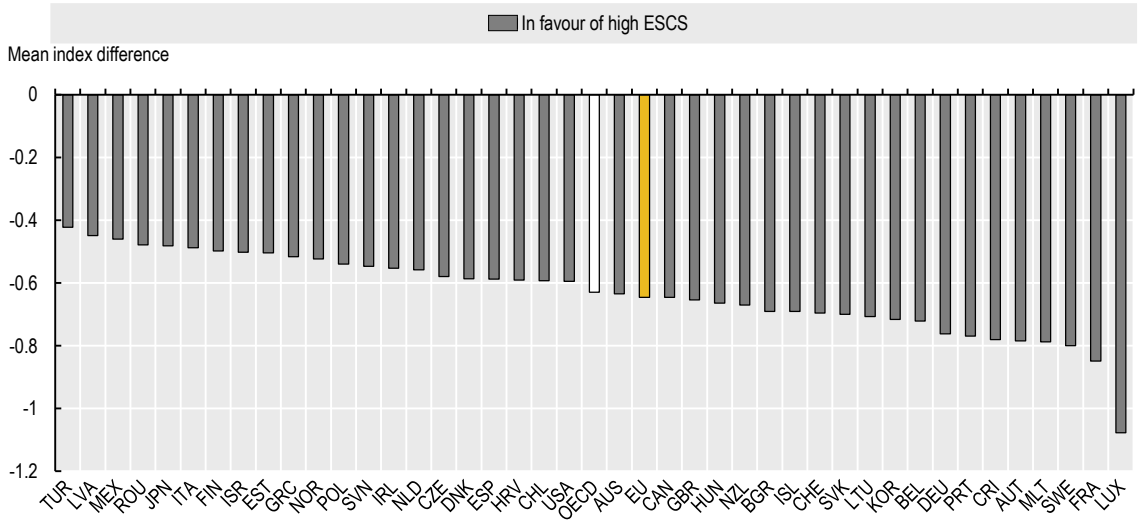
Note: The figure shows the percentage point difference between 15-year-old students with a high and low ESCS who 'Agree' or 'Strongly agree' with the statement 'Looking after the global environment is important to me'. Light colours denote that shares are not significantly different between boys and girls at a 5% significance level. Countries are sorted in descending order of the average gender difference in caring for the environment for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

3.3.2. Embracing complexity in environmental sustainability

61. Figure 3.12 reveals that the socio-economic divide in self-reported awareness of environmental problems such as the increase of greenhouse gases in the atmosphere, the use of genetically modified organisms, nuclear waste, the consequences of clearing forests for other land use, air pollution, the extinction of plants and animals and water shortage are extremely large (see Box 2.2 on the index of environmental awareness). Whereas many socio-economically advantaged students reported being familiar with these topics and being able to explain them well, far fewer disadvantaged students did so. In 2015, in all EU and OECD countries, socio-economically advantaged students reported being more aware of environmental problems than their socio-economically disadvantaged peers. On average throughout EU countries, the difference in self-reported levels of awareness between socio-economically advantaged and disadvantaged students corresponded to 65% of a standard deviation. This difference was 63% of a standard deviation on average throughout OECD countries. The difference between the two groups was less than 50% of a standard deviation only in Turkey, Latvia, Mexico, Romania and Japan, while it was as large as 80% in Sweden, 85% in France and 108% of a standard deviation in Luxembourg.

Figure 3.12. The socio-economic divide in awareness of environmental problems, by country (PISA 2015)

Mean index difference between 15-year-old students with low and high ESCS who reported being aware of a range of environmental issues



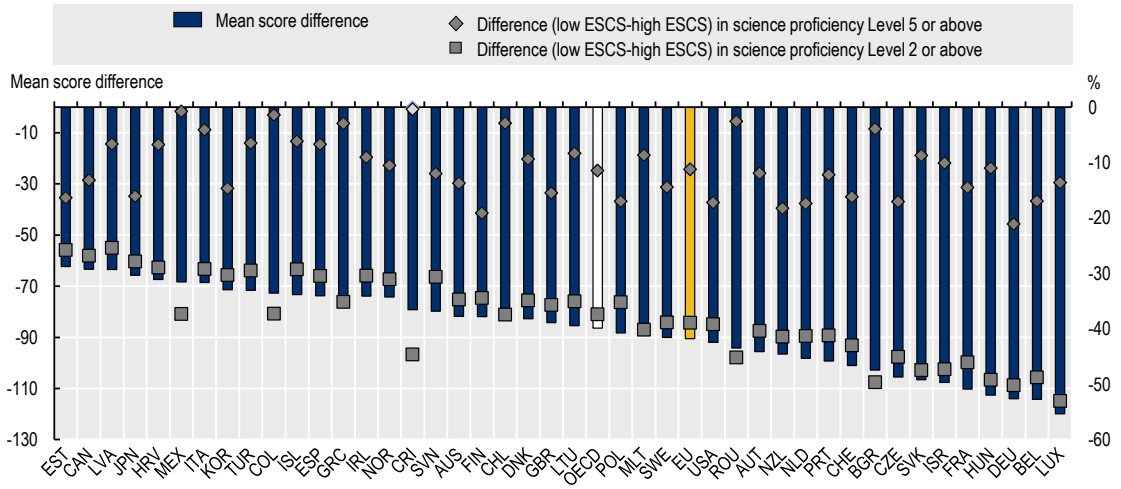
Note: The figure shows the mean index difference between 15-year-old students with low and high ESCS who reported knowing about ('I know something about this and could explain the general issue') or being familiar with ('I am familiar with this and I would be able to explain this well') the following environmental topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortage, the increase of greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Topics are sorted in descending order of the average mean index difference for available EU and OECD countries.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

62. Figure 3.13 shows the socio-economic divide in science achievement in 2018. Throughout EU and OECD countries, the difference in the science scores of socio-economically advantaged and disadvantaged 15-year-old students was 91 and 86 score points, respectively, on the PISA science scale. Socio-economic differences were smallest in Estonia and Canada, where the score-point difference separating an average advantaged and an average disadvantaged student was 62 and 63, respectively. They were largest in Hungary, Germany, Belgium and Luxembourg, where the gap was over 110 score points.

63. Figure 3.13 also reveals that socio-economically disadvantaged students were less likely to both achieve the baseline levels of scientific knowledge and understanding, demonstrating basic or everyday scientific knowledge, and be top performers in science, demonstrating the ability to apply their science knowledge and skills creatively and autonomously to a wide variety of situations, including unfamiliar ones. For example, throughout EU and OECD countries, socio-economically advantaged students were 28 percentage points and 26 percentage points, respectively, more likely to achieve at least baseline levels in science and 11 percentage points more likely to be top performers in science. In all EU and OECD countries, socio-economically disadvantaged students are less likely than their advantaged peers to achieve baseline levels of proficiency and are less likely to be top performers in science. These results suggest that throughout the EU and OECD area, education systems and societies failed to equip many socio-economically disadvantaged students with the skills and knowledge needed not only to protect themselves, their loved ones and their communities from the potential threats associated with environmental degradation, but to also take meaningful action to protect the environment in their everyday lives and be the green innovators of tomorrow.

Figure 3.13. The socio-economic divide in science skills, by country (PISA 2018)

Mean score difference between science achievement of 15-year-old students with low and high ESCS, percentage point difference between 15-year-old students with low and high ESCS in science proficiency Level 2 or above and between 15-year-old students with low and high ESCS in science proficiency Level 5 or above



Note: The figure shows mean difference in the science achievement score of 15-year-old students with low and high ESCS (left y-axis), and the percentage point difference of students with low and high ESCS with at least science achievement at Level 2 or Level 5 (right y-axis). Light colours denote that averages and shares are not significantly different from the EU average at the 5% significance level. Topics are sorted in descending order of students' mean science achievement for available EU and OECD countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

64. Figure 3.14 shows the differences between 15-year-old students with low and high ESCS by science competency subscale in 2015. On average, students with high ESCS performed better than students with low ESCS in terms of science competencies, procedural and epistemic knowledge and all content areas, with the only exception being content knowledge where students with low ESCS performed better (with an 11-percentage-point difference on average throughout EU countries and a 12-score-point difference throughout OECD countries). For science competencies, this socio-economic divide ranged between 93 and 94 score points on average throughout EU countries and 87 and 89 score points on average throughout OECD countries. In terms of procedural and epistemic knowledge, students with high ESCS scored 88 and 93 score points higher than students with low ESCS, respectively, in EU and OECD countries. The socio-economic divide ESCS in science achievement with respect to content areas ranged between 93 and 94 score points on average throughout EU countries and between 87 and 88 score points on average throughout OECD countries.

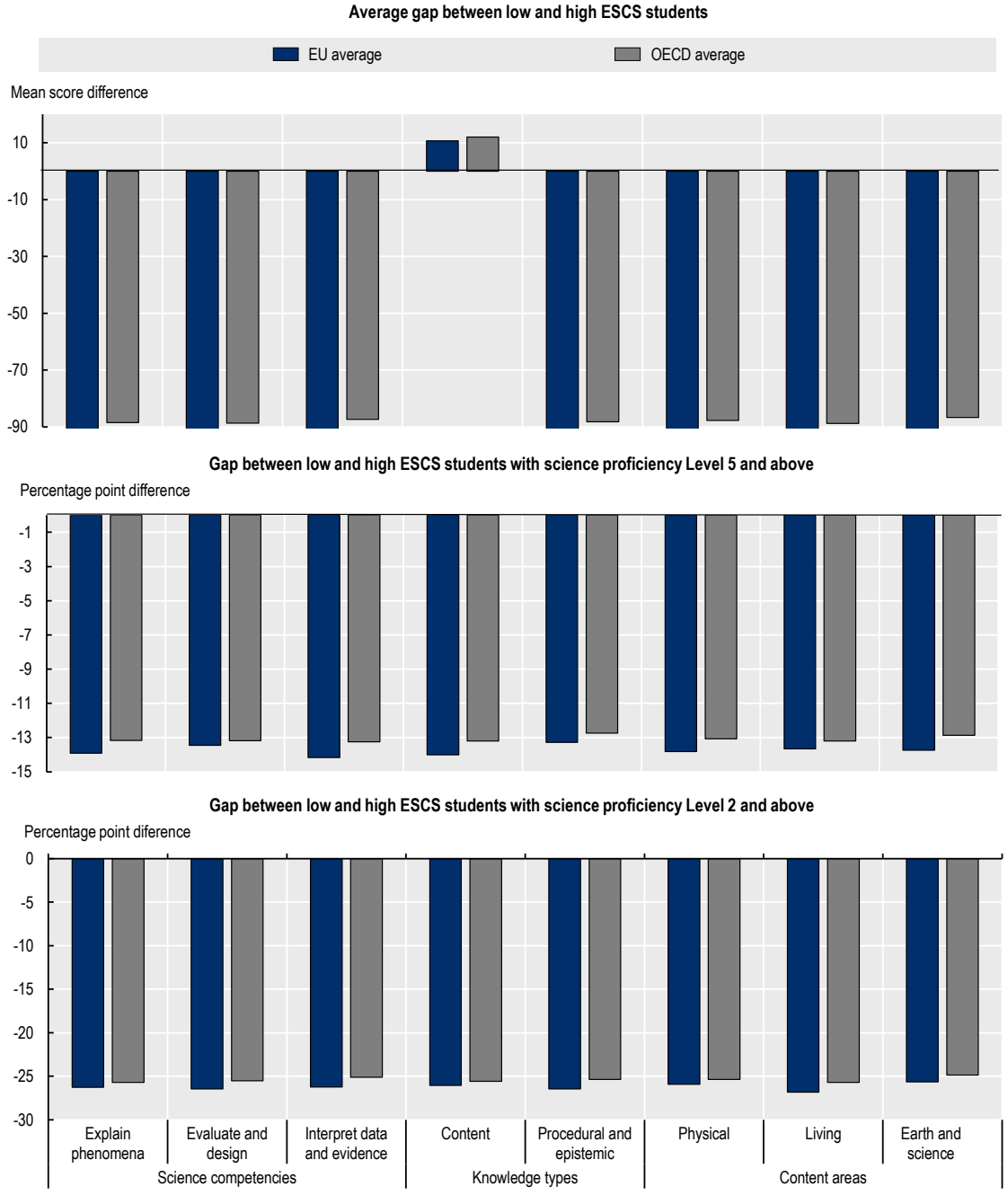
65. Among 15-year-old students with low and high ESCS with science proficiency Level 2 or above in PISA 2015, the socio-economic divide in favour of students with high ESCS was considerable and significant across all three science competencies (between 13 and 14 percentage points throughout EU countries and 13 percentage points throughout OECD countries), knowledge types (between 13 and 14 percentage points throughout EU countries and 13 percentage points throughout OECD countries) and content areas (of around 14 percentage points on average throughout EU countries and 13% throughout OECD countries).

66. Similarly, among 15-year-old students with low and high ESCS with at least science proficiency Level 2, the socio-economic divide was in favour of students with high ESCS in all science competencies (of 26 score points throughout EU countries and ranging between 25 and 26 score points on average

throughout OECD countries), knowledge types (of around 26 percentage points on average throughout EU countries and ranging between 25 and 26 percentage points throughout OECD countries) and content areas (ranging between 26 and 27 score points on average in EU countries and 25 and 26 percentage points in OECD countries).

Figure 3.14. The socio-economic divide by science competency subscale (PISA 2015)

Mean score difference in science achievement by science competency subscale between 15-year-old students with low and high ESCS, and percentage point difference between 15-year-old students with low and high ESCS in science proficiency Level 5 and above and science proficiency Level 2 and above by science competency subscale



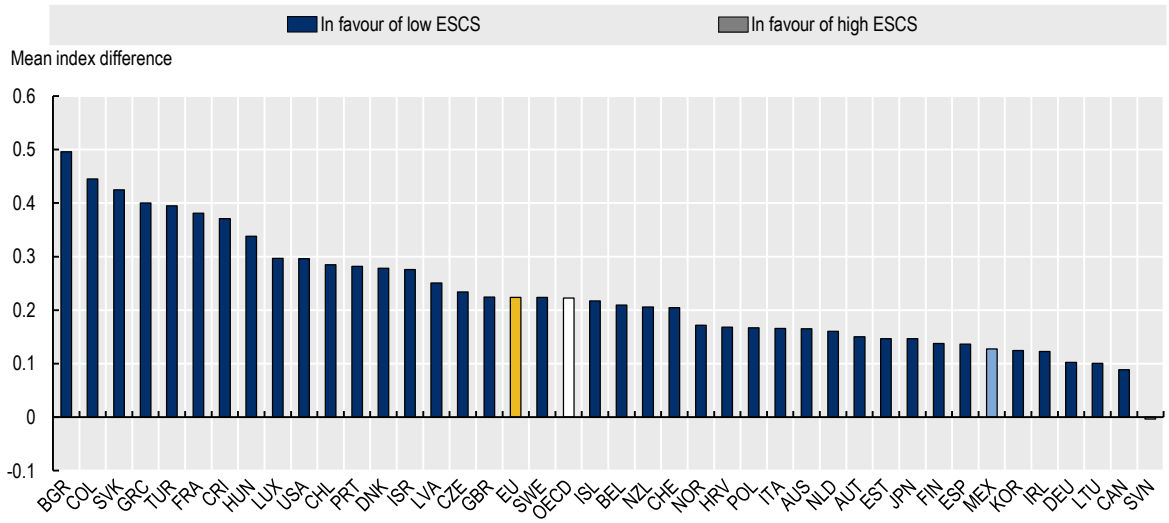
Note: The figure shows the mean difference in the science achievement score of 15-year-old students with low and high ESCS by science competency subscale (upper panel), the percentage point difference in science proficiency Level 5 and above of 15-year-old students with low and high ESCS by science competency subscale (middle panel) and the percentage point difference in science proficiency Level 2 and above of 15-year-old students with low and high ESCS by science competency subscale (bottom panel).
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

3.3.3. Envisioning environmentally sustainable futures

67. Figure 3.15 illustrates that in 2015 in all EU and OECD countries, socio-economically advantaged students reported being less optimistic than their disadvantaged counterparts about improvements in the state of the environment over the following 20 years, with the difference between the two groups not being statistically significant only in Mexico (see Box 2.4 for a description of the index of environmental optimism). On average throughout EU and OECD countries, socio-economically disadvantaged students expressed higher levels of optimism than socio-economically advantaged students and the gap in environmental optimism between the two groups corresponded to 22% of a standard deviation. The socio-economic divide in environmental optimism was widest in Bulgaria, Colombia and the Slovak Republic, and smallest in Slovenia, Canada and Lithuania.

Figure 3.15. The socio-economic divide in environmental optimism, by country (PISA 2015)

Mean index difference between 15-year-old students with low and high ESCS who reported that environmental issues would improve, get worse or stay the same over the following 20 years



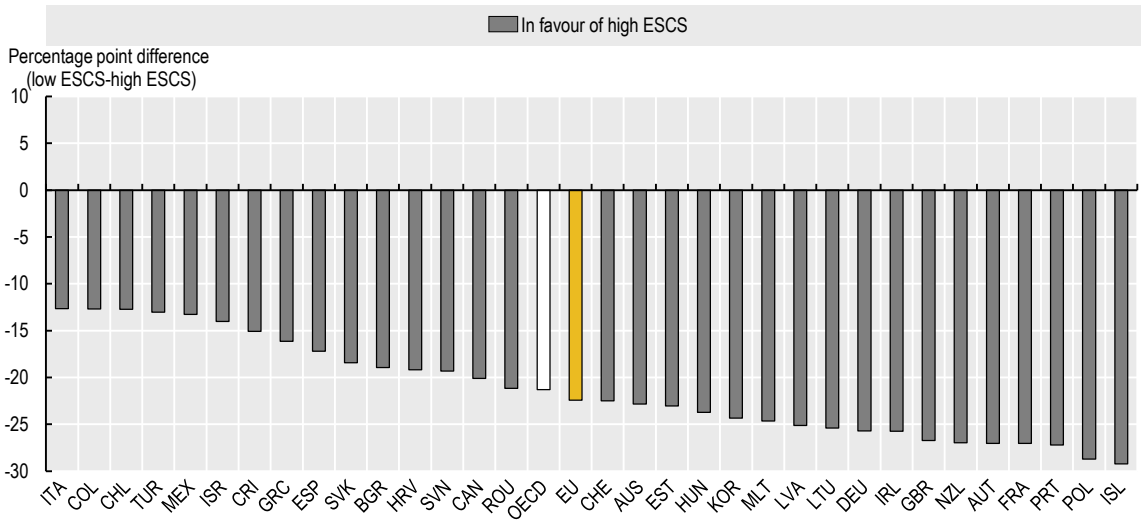
Note: The figure shows the mean index difference between 15-year-old students with low and high ESCS in EU and OECD countries who reported that environmental issues would improve, get worse or stay the same over the following 20 years. Topics are sorted in descending order based on the mean index difference of students who reported that the environmental issues would improve on average throughout EU countries. Light colours denote that the mean index differences are not significantly different at the 5% significance level.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

68. Whereas socio-economically disadvantaged students expressed greater optimism about environmental problems improving in the near future, they expressed considerably lower levels of confidence than their advantaged peers about being able to discuss or explain a series of environmental problems, i.e. they reported lower levels of self-efficacy. Figure 3.16 illustrates the socio-economic divide in the percentage of 15-year-old students who, in 2018, had high levels of environmental self-efficacy, i.e. who felt it would be easy for them to explain how carbon-dioxide emissions affect global climate

change, explain why some countries suffer more from global climate change than others and discuss the consequences of economic development on the environment. Figure 3.16 indicates that on average throughout EU and OECD countries, socio-economically advantaged students were 22% and 21 percentage points, respectively, more likely than their disadvantaged peers to have high levels of environmental self-efficacy and that socio-economically advantaged students reported a higher sense of self-efficacy in all countries with available data. The socio-economic divide in environmental self-efficacy was greatest in Iceland (29-percentage-point difference) and smallest in Italy (13-percentage-point difference).

Figure 3.16. The socio-economic divide in environmental self-efficacy, by country (PISA 2018)

Percentage point difference between 15-year-old students with low and high ESCS who reported being very self-efficacious



Note: The figure shows the difference in the share of students with low and high ESCS who are very self-efficacious about the following environmental topics: 'Explain how carbon-dioxide emissions affect global climate change', 'Explain why some countries suffer more from global climate change than others', 'Discuss the consequences of economic development on the environment' with answer options 'I could do this easily', 'I could do this with a bit of effort', 'I would struggle to do this on my own' and 'I couldn't do this'. Students are defined as having high levels of self-efficacy if they either report 'I could do this easily' in one of the topics or report 'I could do this with a bit of effort' for all topics. Countries are sorted in descending order of students' environmental self-efficacy.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

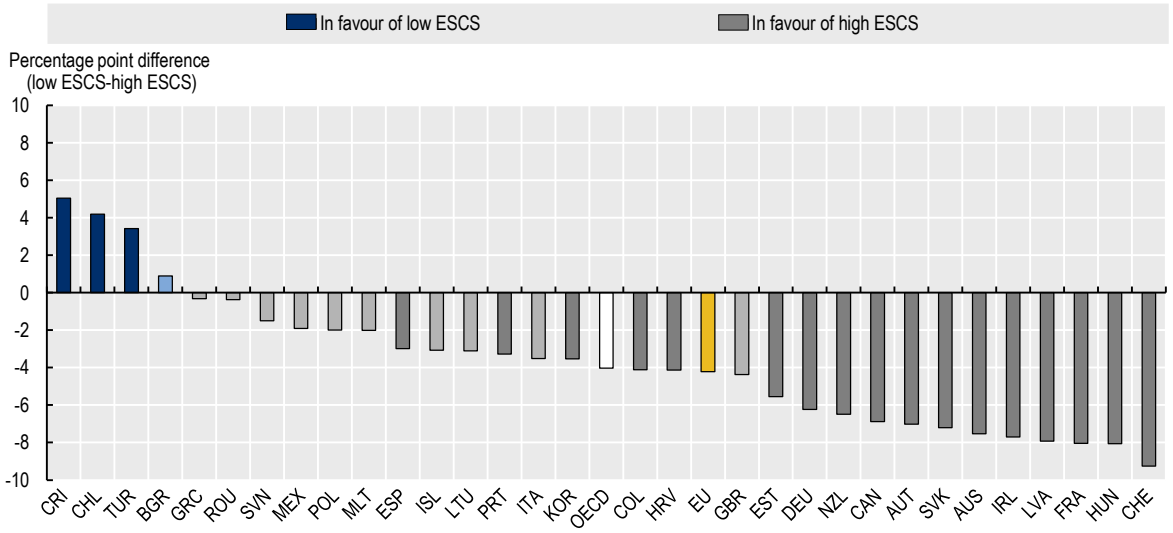
3.3.4. Acting for environmental sustainability

69. Figure 3.17 indicates that 15-year-olds who live in socio-economically advantaged households are more likely to engage in individual forms of pro-environmental behaviours, such as reducing their energy consumption at home. In 2018, on average throughout EU countries, 71% of socio-economically advantaged but 67% of disadvantaged 15-year-old students reported that they reduced energy consumption at home, a difference of 4 percentage points. On average throughout OECD countries, 73% of socio-economically advantaged students and 69% of socio-economically disadvantaged students reported doing so (a difference of 4 percentage points). The socio-economic divide in individual pro-environmental action was most pronounced in Switzerland, Hungary and France, corresponding to 9 percentage points, 8 percentage points and 8 percentage points, respectively. By contrast, in Costa Rica

and Chile, socio-economically disadvantaged 15-year-old students were more likely to report reducing energy consumption at home for environmental reasons.

Figure 3.17. The socio-economic divide in energy conservation for environmental reasons, by country (PISA 2018)

Percentage point difference between 15-year-old students with low and high ESCS who reported reducing energy consumption for environmental reasons

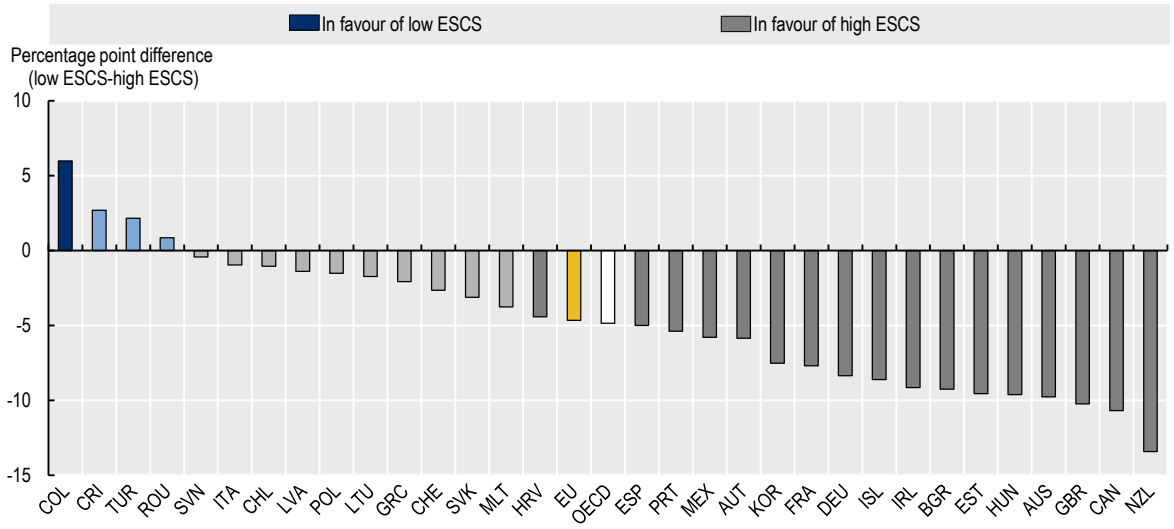


Note: The figure shows the percentage point difference between 15-year-old students with low and high ESCS engaging in energy consumption. Light colours denote that gender differences are not significantly different at the 5% significance level. Countries are sorted in descending order of gender differences in students' engagement in energy consumption.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

70. Similarly, Figure 3.18 indicates that socio-economically advantaged 15-year-old students in 2018 were more likely than their disadvantaged peers to have participated in activities in favour of environmental protection. On average throughout EU and OECD countries, the difference in the percentage of socio-economically advantaged and disadvantaged 15-year-old students who participated in activities in favour of environmental protection was 5 percentage points. The socio-economic divide in participation in collective forms of pro-environmental behaviours was largest in Canada and New Zealand, where socio-economically advantaged 15-year-old students were over 10 percentage points more likely to report having participated in activities in favour of environmental protection.

Figure 3.18. The socio-economic divide in participation in activities in favour of environmental protection (PISA 2018)

Percentage point difference between 15-year-old students with low and high ESCS who reported participating in activities in favour of environmental protection



Note: The figure shows the percentage point difference between 15-year-old students with low and high ESCS engaging in environmental protection activities. Light bars denote that gender differences are not significantly different at the 5% significance level. Countries are sorted in descending order of gender differences in students' engagement.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

4 Like parents like children

4.1. Introduction

71. Youngsters' environmental sustainability competence, especially attitudinal and emotional aspects of such competence, are determined by a variety of factors related to the cultural setting in which they are born and raised (e.g. family, peer-group and exposure at school), which varies in importance depending on the stage of development (Maccoby, 2007[34]). Additionally, factors related to the individual (e.g. achievement and socio-economic background (Boeve-de Pauw and Van Petegem, 2010[27])), to the country (e.g. gross domestic product, human development index (Boeve-de Pauw and Van Petegem, 2010[27]) or exposure to media and public debates (Grønhøj and Thøgersen, 2012[35])) also matter.

72. Among these factors, parents play a pivotal role in their children's socialisation (Kuczynski and Parkin, 2007[36]; Maccoby, 2007[34]; Whitbeck and Gecas, 1988[37]). In their role as primary socialising agents, parents may pass on values, attitudes and behaviours to their children through intergenerational transfer by, for instance, observational learning or direct influence, resulting in congruency between generations (Grønhøj and Thøgersen, 2009[38]; Meeusen, 2014[39]). This is especially important because engaging in pro-environmental action often means that individuals face immediate personal costs. Children who are socialised into assuming a personal identity consistent with environmental protection are considerably more likely to engage in pro-environmental behaviours than children who have not developed the same identity (Chawla, 1998[40]; Gatersleben, Murtagh and Abrahamse, 2012[41]; Kollmuss and Agyeman, 2002[42]). Students may report pro-environmental attitudes and values and yet face trade-offs between these and other motivators (e.g. immediate comfort). Empirical evidence provides ample support for an association between dyads of parents and their children's attitudes and behaviours. Associations have been found for environmental concern (Casaló and Escario, 2016[24]; Meeusen, 2014[39]), but also for specific environmental behaviour such as energy consumption (Hansen and Jacobsen, 2020[43]; Wallis and Klöckner, 2020[44]) and buying organic products, source-separating waste and saving electricity (Grønhøj and Thøgersen, 2012[35]; Grønhøj and Thøgersen, 2009[38]). Although the idea that environmental values are transferred from parents to children is obvious at first, the intergenerational transfer of values resulting in within-family similar behaviours and attitudes is not necessarily unidirectional. Transfers may not only flow from parents to children but also from children to parents. Children can and do act as agents of environmental change for older generations. Supportive evidence of bidirectional influences is, for example, documented for waste-related consumption (Žukauskienė et al., 2020[45]), change-related knowledge (Parth et al., 2020[46]) and waste management (Grodzinska-Jurczak et al., 2003[47]).

73. What are the underlying processes that shape children's attitudes and behaviours within families? The literature has identified a number of factors that moderate the way in which parents can influence their descendants. A key factor is 'parenting style'. Parenting style is the type of interaction between parents and their children (Gentina and Muratore, 2012[48]; Maccoby, 2007[34]) shaping if and to what extent the child identifies with the parent (Grønhøj and Thøgersen, 2012[35]) and communication patterns (Meeusen, 2014[39]). Despite the possible intergenerational transfer of environmental sustainability competence, notable differences may exist between generations. Gaps could be explained by differences in historical, economic or social contexts (Handy et al., 2021[49]; Grønhøj and Thøgersen, 2009[38]), leading to different

motivations to (dis)engage in pro-environmental behaviours and have different levels of environmental sustainability competence (Handy et al., 2021[49]).

74. Since most of the literature investigating the association between the environmental sustainability competence of parents and their children is based on cross-sectional studies, so far, there is little evidence on causal paths and on the direction of intergenerational transfers. While most analyses rely on self-reported attitudes and behaviours, there are only a few studies using actual data. One such exception is Hansen and Jacobsen (2020[43]), who use panel data covering a time span of 5 years on the actual registered energy consumption of children and their parents. Hansen and Jacobsen (2020[43]) found that energy consumption patterns between adults and their mothers correlate, and that the strength of this association is slightly higher for adults with lower levels of income.

75. This chapter uses information from parent-child dyads available in the PISA 2018 study to identify the association between parents' and children's willingness to act for environmental sustainability (i.e. their engagement in pro-environmental behaviours). Parent-child information is available only for a subset of EU and OECD countries, namely Chile, Croatia, Germany, Italy, Ireland, Korea, Malta, Mexico and Portugal. These countries administered the optional parent questionnaire in PISA 2018. The availability of information on the environmental behaviour of parents and children allows for the study of similarities and differences between the generation of children who were 15 in 2018 and their parents' generation, including within-family associations.

4.2. Parent-child generational similarities in environmental behaviour

76. Panel A in Figure 4.1 illustrates the percentage of parents and 15-year-old students who, in 2018, reported being engaged in different environmental behaviours in all EU and OECD countries where parent-child comparisons are possible. The highest shares of environmental engagement among parents and children are observed for energy-saving behaviour (93% for parents and 73% for students); followed by choosing products for ethical or environmental reasons, even if they are more expensive (59% for parents and 43% for students); participating in activities in favour of environmental protection (38% for parents and students); and signing environmental or social petitions (30% for parents and 25% for students). The lowest shares are observed for boycotting products for environmental or social reasons (28% for parents and 24% for students). The figure further indicates that parents consistently reported being more engaged in each of the environmental actions than 15-year-old children. The only exception is engagement in collective action: a similar share of students and parents reported being engaged in this form of pro-environmental behaviour.

77. The pattern of parents being, on average, more engaged in environmental behaviour is consistent with the literature. Compared to children, the literature found that parents generally express higher levels of concern for the environment (Casaló and Escario, 2016[24]), are more likely to engage in environmentally friendly behaviours (Grønhøj and Thøgersen, 2009[38]; Handy et al., 2021[49]; Wallis and Klöckner, 2020[44]) and generally express more positive attitudes towards the environment (Grønhøj and Thøgersen, 2009[38]). However, some studies suggest that girls tend to have similar pro-environmental attitudes to their parents (Leppänen et al., 2012[50]). The higher levels of environmental sustainability competence displayed by parents could be evidence of a parent-to-child intergenerational transfer (if values, attitudes or behaviours were to be primarily transferred from parents to children, children should have, on average, weaker competences than parents) (Grønhøj and Thøgersen, 2009[38]). It could also reflect that age is strongly and positively correlated with engagement in pro-environmental behaviours (Leppänen et al., 2012[50]).

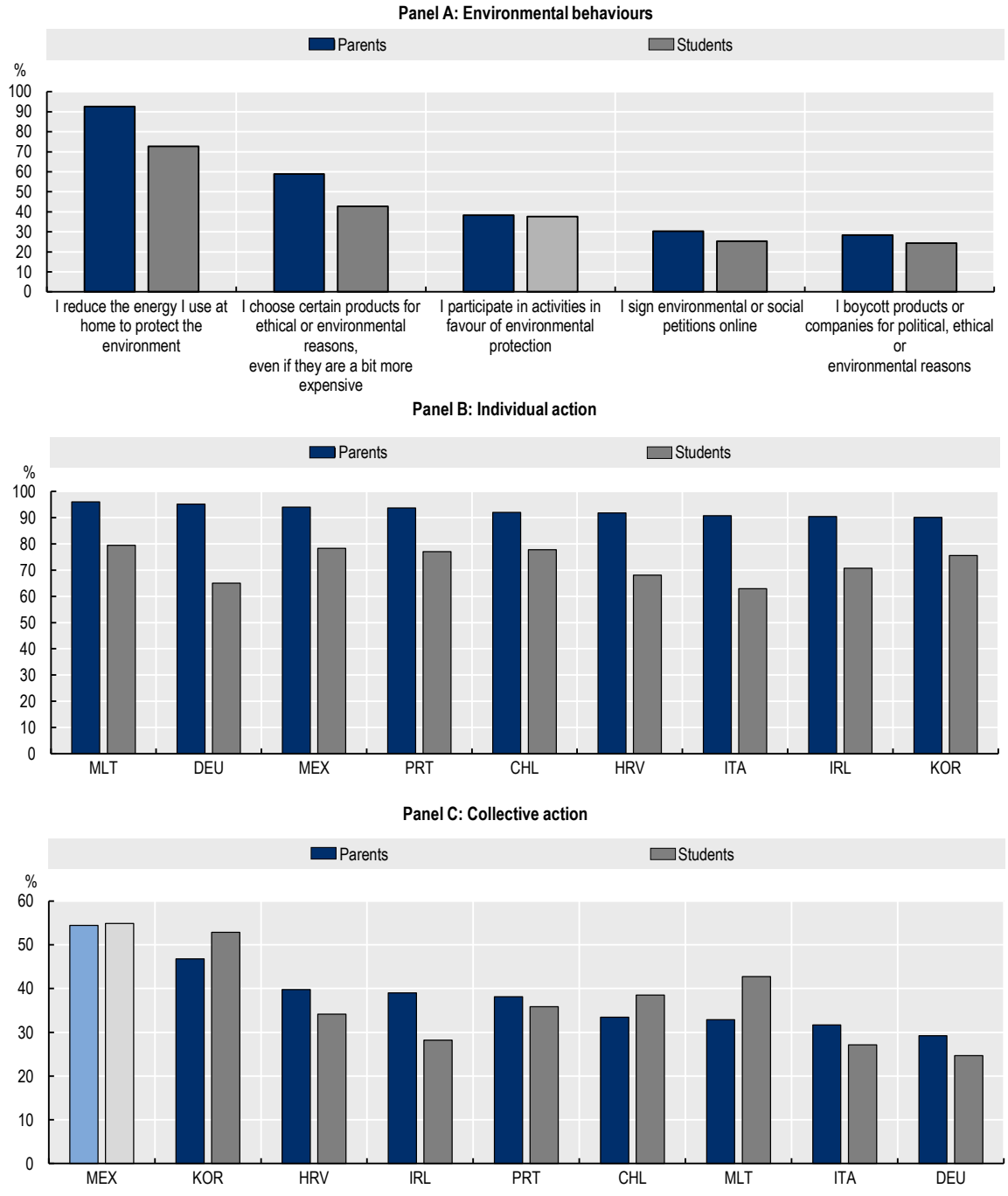
78. As mentioned in Chapter 1, action for environmental sustainability involves acting both individually and collectively to shape sustainable futures. The remaining two panels of Figure 4.1 highlight differences in energy-saving behaviour (individual action) and in participating in activities in favour of environmental protection (collective action).

79. The percentage of parents and students who, in 2018, were engaged in energy-saving behaviour is reported in Panel B. Parents' engagement ranged between 96% and 90%, while it ranged between 79% and 63% for children, reflecting higher variation in engagement rates among students than among parents. Engagement in energy-saving behaviour was highest among parents in Malta, Germany and Mexico, and lowest in Italy, Ireland and Korea. Among students, engagement rates were highest in Malta, Mexico and Chile, and lowest in Croatia, Germany and Italy. Panel C shows the percentage of parents and students engaged in activities in favour of environmental protection. Parents' engagement ranged between 54% and 29%, while it ranged between 55% and 25% among students. Collective action was highest among parents in Mexico, Korea and Croatia, and lowest in Malta, Italy and Germany. For students, engagement rates were highest in Mexico, Malta and Korea, and lowest in Germany, Italy and Ireland.

80. Results presented in Figure 4.1 reveal that, on average, engagement was lower for collective forms of pro-environmental behaviours among both parents and children compared to engagement in individual forms of pro-environmental behaviours. They also reveal that while the share of parents engaged in individual forms of pro-environmental behaviours was larger than that of students, this was not the case when participation in collective action is considered. In Korea, Chile and Malta, significantly more students reported being engaged in collective forms of pro-environmental behaviours compared to parents. Finally, variation in engagement rates was greater when collective forms of pro-environmental behaviours were considered than when individual forms of pro-environmental behaviours were taken into account. The data also show that relatively high engagement rates for one form of behaviour do not necessarily go hand in hand with high engagement rates for another. For example, among the nine countries with comparable data, in Korea, parents' engagement rates were, in comparison, lowest in energy-saving behaviour, while Korea ranks second in collective action.

Figure 4.1. Engagement in environmental behaviour, by country and by type of behaviour (PISA 2018)

Percentage of parents and 15-year-old students who reported engaging in environmental behaviours



Note: The figure reports for all nine countries with available parent-child information the average percentage of those engaged in different pro-environmental behaviours (Panel A), the percentage of engagement in energy-saving behaviour by country (Panel B) and the percentage of engagement in activities in favour of the environment (Panel C). Light blue and light grey bars indicate that differences between the parent and child generations are not statistically significant at the 5% significance level. Environmental topics in Panel A and countries in Panel B and Panel C are ordered in descending order of parents' behaviour.

Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

81. Table 4.1 presents the correlation coefficients between parents' and students' environmental behaviour, for each of the five environmental actions previously described. The correlations presented do not reflect intra-family similarities but only similarities between generations and between all countries. Cells on the diagonal show correlations between parents and children for the same action, while off-diagonal cells show correlations between different actions. Significant, positive and quantitatively strong intergenerational correlations (on the diagonal) emerge for 'signing petitions' and 'participating in actions in favour of environmental protection', while for others, no significant correlation is found. Positive associations can also be identified between parents 'signing petitions online' and children's 'boycotting of products or companies".

Table 4.1. Association between parents' and children's generations' environmental behaviour, by topic (PISA 2018)

Correlation coefficient between environmental behaviour of children's and parents' generations

		Students				
		I reduce the energy I use at home to protect the environment.	I choose certain products for ethical or environmental reasons, even if they are a bit more expensive.	I sign environmental or social petitions online.	I boycott products or companies for political, ethical or environmental reasons.	I participate in activities in favour of environmental protection.
Parents	I reduce the energy I use at home to protect the environment.	0.05	0.50	−0.40	−0.13	−0.07
	I choose certain products for ethical or environmental reasons, even if they are a bit more expensive.	0.21	0.47	0.00	0.12	0.04
	I sign environmental or social petitions online.	0.41	0.14	**0.77**	**0.68**	0.30
	I boycott products or companies for political, ethical or environmental reasons.	−0.14	−0.32	0.35	0.26	-0.10
	I participate in activities in favour of environmental protection.	0.45	0.32	0.29	0.45	**0.79**

Note: The table shows correlation coefficients between parents' and childrens' pro-environmental actions. Numbers in bold indicate that correlations are significant at the 5% significance level.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

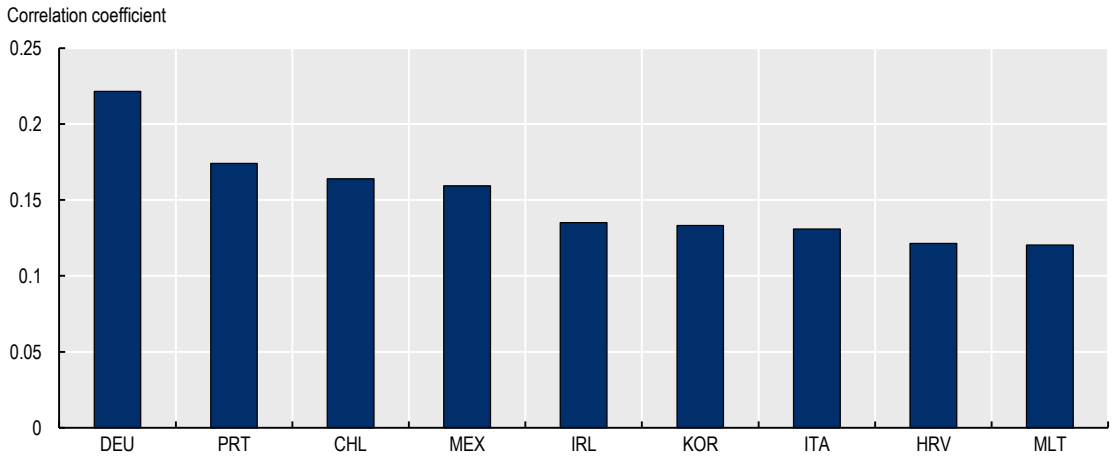
4.3. Parent-child dyad similarities in environmental behaviour

82. To analyse whether intra-family similarity in environmental behaviour does in fact exist, the following analyses look at correlations between parents' behaviour and the behaviours of their children when considering a composite indicator reflecting the number of pro-environmental behaviours parents and their children report being engaged in (see Box 2.6, Chapter 2 for the environmental behaviour index). Throughout all nine countries with matching parent-child information, the estimates point to a correlation coefficient equal to 0.15; while the positive sign reflects a positive behavioural association, its magnitude is rather small.

83. Figure 4.2 shows the correlation coefficient separately by country, with each coefficient being statistically significant at the 5% significance level. These associations provide evidence suggestive of an intergenerational transfer of behaviour throughout all countries. However, the magnitude of the correlation coefficients throughout the nine countries is low (between 0.12 and 0.22).

Figure 4.2. Association between parents' and their children's environmental behaviour, by country (PISA 2018)

Correlation coefficient between environmental behaviour index of parents and their children



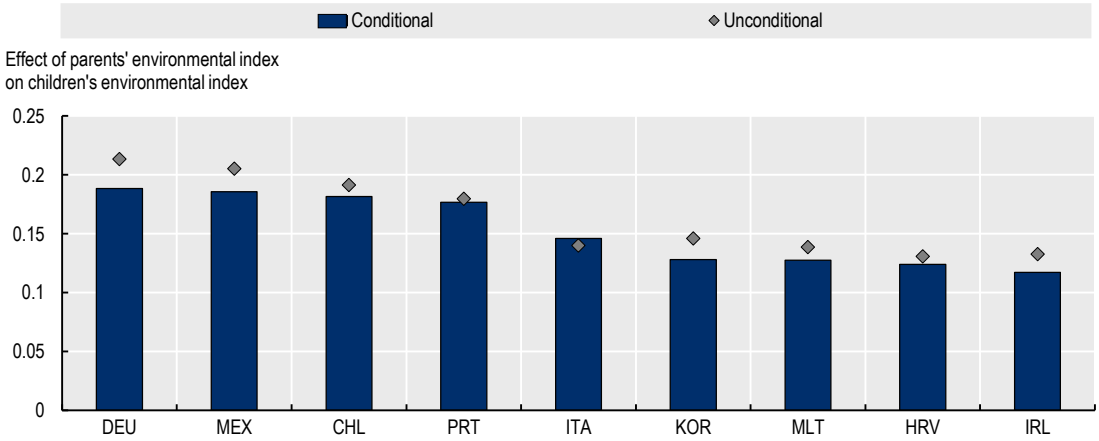
Note: The figure shows within-country correlations between the parents' and children's environmental behaviour index. All correlations are significant at the 5% significance level. Countries are ordered in descending order of estimated correlation coefficients.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

4.4. Parent-child dyad associations in environmental behaviour

84. Figure 4.3 illustrates the association between parental engagement in environmental behaviours and their children's engagement. Estimates identify associations before and after controlling for students' gender, language spoken at home, immigrant background, the ESCS of the family and the ESCS intake of the school attended by children. Estimates range between 0.13 and 0.21 for the model that does not control for background characteristics and 0.12 and 0.19 for the model that considers parents and children with similar background characteristics.

Figure 4.3. Relationship between parents' and their children's environmental behaviour index (PISA 2018)

Change in children's environmental behaviour index associated with a one-unit increase in the index of parents' environmental behaviour



Note: The unconditional model estimates the children's behaviour index as a function of the parental behaviour index, while the conditional model includes the following conditioning variables: gender, language at home, immigrant background, ESCS and schools' ESCS. All estimated coefficients are statistically significant at the 5% significance level. Countries are ordered in descending order of the magnitude of the estimated coefficient in the conditional model.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

85. Table 4.2 shows the likelihood of students engaging in a given environmental action when their parents do the same, relative to the likelihood of students engaging in environmental behaviour when parents do not (i.e. the odds ratio[4]). Almost all associations are significant at the 5% significance level, the only exception is in Malta for 'boycotting products or companies for political, ethical or environmental reasons.' The magnitude of these associations differs between countries and topics. While for energy-saving behaviour, in 2018, 15-year-old students in Germany were around 70% (odds ratio = 1.76) more likely to save energy for environmental reasons when their parents saved energy compared to when their parents did not, in Malta, 15-year-old students were even more likely to engage in energy-saving behaviour (odds ratio = 3.17). However, the likelihood of engaging in pro-environmental behaviour also varies between the type of behaviour. For example, 15-year-old students in Malta are 44% (odds ratio = 1.44) more likely to sign environmental or social petitions when their parents do so as well, compared to when they do not.

[4] A value above (below) 1 means that students whose parents engage in a specific environmental action have a higher (lower) probability of performing the same action.

Table 4.2. Effect of parents' engagement on students' engagement (PISA 2018)

Odds ratio of students' engagement in a given environmental action when their parents do the same, relative to the likelihood of students engaging in environmental behaviour when parents do not

	I reduce the energy I use at home to protect the environment.	I choose certain products for ethical or environmental reasons, even if they are a bit more expensive.	I sign environmental or social petitions online.	I boycott products or companies for political, ethical or environmental reasons.	I participate in activities in favour of environmental protection.
CHL	**2.22**	1.78	1.64	1.52	1.70
DEU	1.76	2.32	1.58	**2.41**	1.72
HRV	**2.21**	1.42	1.39	1.28	1.68
IRL	**1.83**	1.51	1.56	1.79	1.45
ITA	1.78	**1.97**	1.66	1.49	1.42
KOR	**1.79**	1.54	1.31	1.50	1.37
MEX	**2.28**	1.74	1.65	1.78	1.70
MLT	**3.17**	1.61	1.44	1.00	1.50
PRT	**2.55**	2.32	1.27	1.86	1.72

Note: Each cell represents a separate estimate of students' behaviour on parent's behaviour, controlling for gender, languge spoken at home, immigrant background, ESCS and schools' ESCS. These are the odds ratios from logistic regressions. All coefficients are statistically significant at the 5% significance level. Numbers highlighted in bold indicate that odds ratios are highest across topics for a specific country.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

5 The role of schools

5.1. Differences in environmental sustainability competence between schools

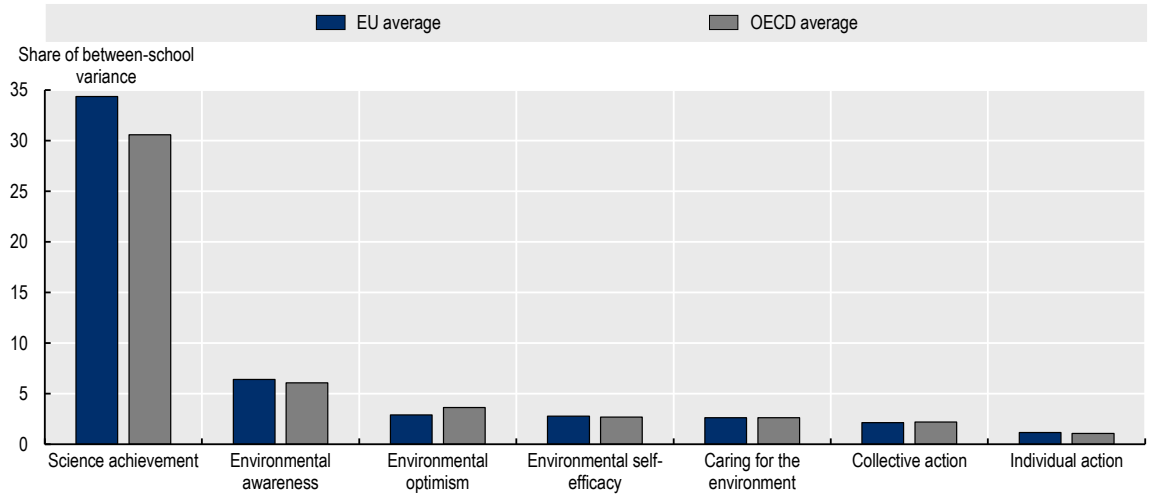
86. This chapter focuses on the role of school-related factors in influencing students' environmental sustainability competence. Although individual characteristics play a primary role in explaining environmental attitudes (Coertjens et al., 2010[32]), there is ample evidence that schools play an important independent role, which, at times, reinforces and magnifies individual differences. Previous research suggests that students attending the same school are more likely to share similar levels of environmental awareness than students attending different schools (Coertjens et al., 2010[32]; List et al., 2020[51]).

87. Figure 5.1 shows the share of the overall variance in the variables captured by the four areas of environmental sustainability competence displayed by 15-year-old students that lies between schools. In other words, this measure indicates the share of the variance in students' competences that can be explained by school-level factors, versus students' characteristics. Between-school variance could be due to selection effects, with similar children being more likely to attend the same school, or to schooling effects, whereby the content of schooling and teachers' approaches lead children to become similar. Selection effects could reflect the academic requirements of different programmes and children's achievement before they entered secondary school, as well as children's and parents' preferences for schools that have a particular ethos. For example, children who embody environmental sustainability values could be drawn to attend schools organising extra-curricular activities that support local community efforts to promote environmental protection. By contrast, schooling effects could reflect the extent to which environmental sustainability competence are, or are not, embedded in the formal and informal curriculum and are valued by the broader school community.

88. Figure 5.1 suggests that the share of the overall variance that lies between schools differs markedly between the different indicators of environmental sustainability competence captured in PISA. It reveals considerably larger between-school differences in science achievement than between-school differences in environmental awareness and between-school differences in the more attitudinal areas of environmental sustainability competence. In particular, whereas throughout EU countries, 34% of performance differences in science achievement were observed between schools (31% throughout OECD countries), only 6% of the overall variance in environmental awareness was between schools (6% throughout OECD countries). The share of the overall variance between schools was even lower for the other indicators: it was 3% for environmental optimism (4% throughout OECD countries); 3% for caring for the environment (3% throughout OECD countries); 1% for energy conservation (1% throughout OECD countries); 2% for participation in environmental groups (2% throughout OECD countries); and 3% for environmental self-efficacy (3% throughout OECD countries).

Figure 5.1. Between-school variance of knowledge, skills and attitudes, EU and OECD averages (PISA 2015 and 2018)

Between-school variance as a percentage of the average total variance

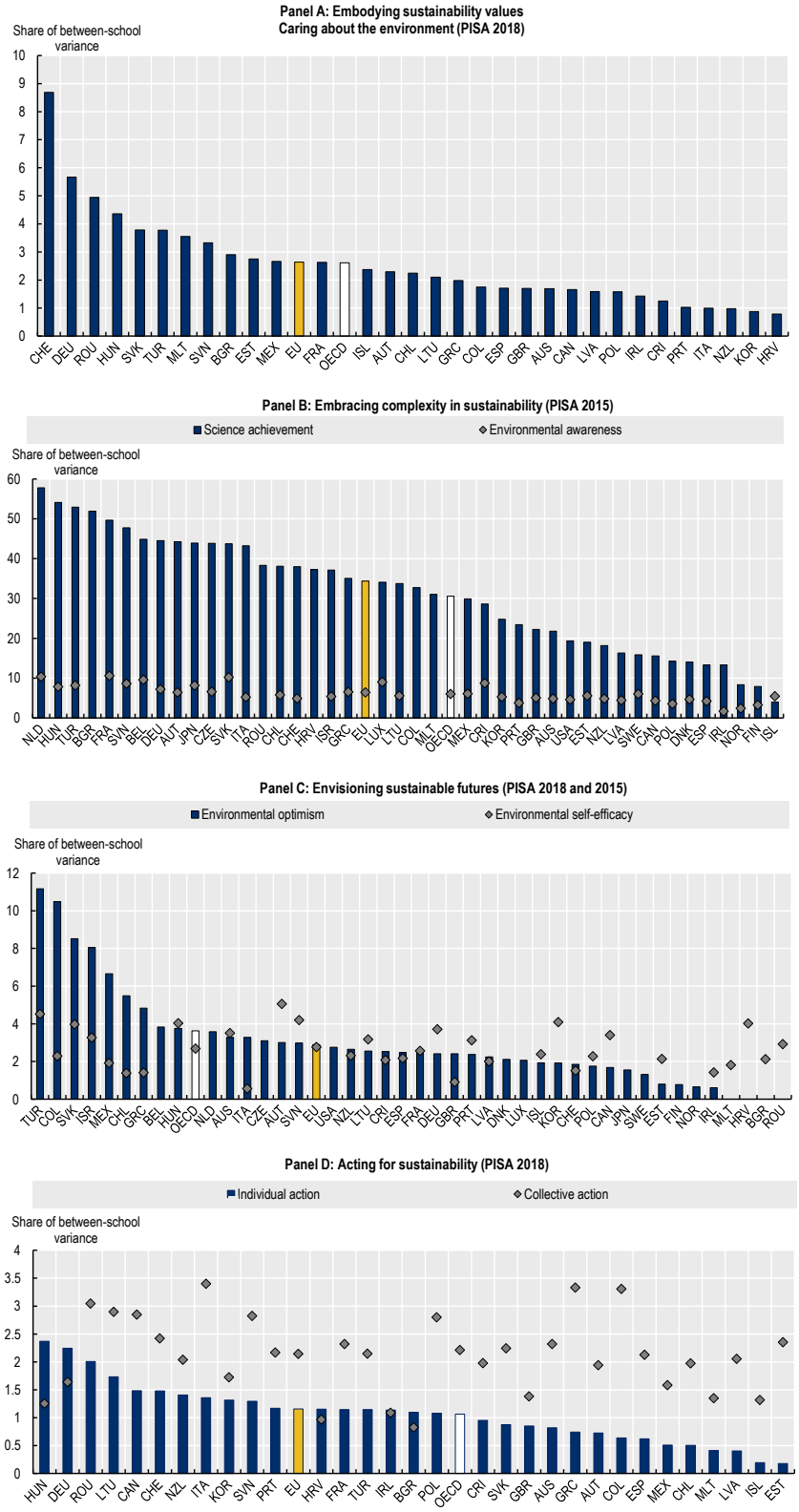


Note: The figure shows the between-school variance as a percentage of the average total variance of the respective knowledge, skills or attitudes which are part of the four competence areas. Variables are sorted in descending order of the average share of between-school variance throughout EU countries.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/ and OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

89. Figure 5.2, Panels A-D indicate that, except for science achievement, between-school differences in all other competence areas were low in all countries despite the fact that the absolute levels of environmental sustainability competence attained by 15-year-old students differed greatly between countries. These results could reflect that secondary schools currently play little or no role in promoting environmental sustainability competence. If this were to be the case, the observed large between-school difference in science achievement observed in PISA would be due to either the explicit or the implicit selection of students with different abilities in different schools. Since no such selection occurs for other environmental sustainability competence, between-school differences in such competences are low. In this interpretation, environmental sustainability competence would be promoted effectively outside of school or by some inspired teachers, but not systematically promoted at school. Alternatively, it is possible that sustainability competence is effectively promoted at younger ages in primary school and/or at secondary school, but national curricula and competence frameworks are so standardised that they lead to little between-school variance as variance is mostly due to individuals' aptitude and interests.

Figure 5.2. Between-school variance of knowledge, skills and attitudes, by country (PISA 2018 and 2015)

Between-school variance as a percentage of the average total variance



Note: The figure shows the between-school variance as a percentage of the average total variance of the respective knowledge, skills or attitude, which is part of the four competence areas by country. Panel A reports the variance for the competence area 'Embodying sustainability values', Panel B for 'Embracing complexity in sustainability', Panel C for 'Envisioning a sustainable future' and Panel D for 'Acting for sustainability'. Countries are sorted in descending order of the average share of between-school variance.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/ and OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

5.2. How and why schools can promote environmental sustainability competence

90. Schools can influence the likelihood that 15-year-old students will develop environmental sustainability competence through two main channels: socialisation and curricular content and instructional practices. The literature indicates that the social context individuals experience can significantly influence environmental attitudes (Stern, Dietz and Guagnano, 1995[52]). For example, Duarte et al. (2015[53]) have shown that students in small towns, who are more involved in the natural environment, report higher levels of environmental attitudes compared to their peers in larger cities. Similarly, Hinds and Sparks (2008[54]) indicate that students in rural areas in the United Kingdom were more likely to have a positive environmental orientation than students in urban settings. At the same time, the role of context can be very country-specific (Gifford and Nilsson, 2014[55]): for instance, people living in large cities in China report higher levels of environmental behaviours compared to those residing in smaller towns (Chen et al., 2011[56]). More generally, the literature recognises the existence of peer social effects on the environmental attitudes of students belonging to the same school. Schools represent the most important social environment outside the family (Coertjens et al., 2010[32]), where they spend most of their daytime during the academic year (Bernelius and Kauppinen, 2011[57]; List et al., 2020[51]). Duarte et al. (2015[53]) revealed that by assigning a random student to a school where the mean level of students' feelings of responsibility for sustainable development is one point higher than their level, such a student will display greater feelings of responsibility.

91. The second channel through which schools could shape environmental sustainability competence is curricular and extracurricular activities organised in schools as well as the pedagogical approaches used by the teaching staff. For example, previous studies suggest that the use by teachers of active learning techniques and the adoption of constructivism pedagogies[5] may enhance scientific understanding and, therefore, improve a key dimension characterising environmental sustainability competence (Liang and Gabel, 2005[58]; Lester et al., 2006[59]; Littledyke, 2008[60]). Moreover, student-centred and collaborative teaching methods can foster students to critically elaborate on environmental problems and increase their awareness of the topic (MCKeown and Hopkins, 2007[61]; Tilbury and Wortman, 2005[62]). In the same way, by helping students to enjoy science and increase their curiosity about the topic, extracurricular activities may have a positive effect on environmental attitudes (Littledyke, 2008[60]; Fröhlich, Sellmann and Bogner, 2013[63]).

5.2.1. Curricula on climate change and global warming

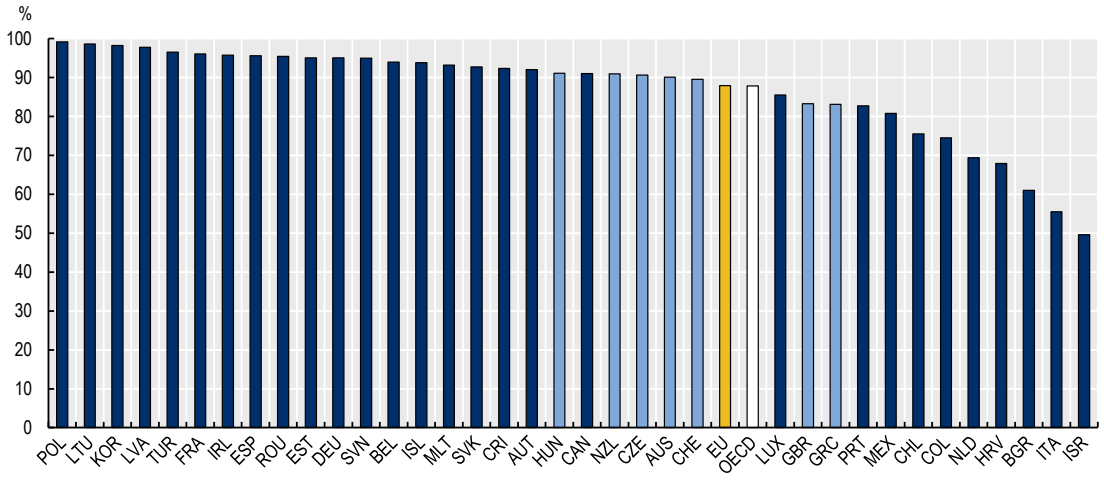
92. Figure 5.3 reveals that, on average throughout EU and OECD countries, 88% of students in 2018 attended schools in which the head teacher reported that a formal curriculum – defined either at national, state, regional or school level – guided the teaching of climate change and global warming in the year typically attended by 15-year-old children. In fact, in 30 out of the 36 countries with available data, at least three in four children attended schools with formal curricula on climate change and global warming, and in Poland, Lithuania, Korea, Latvia, Turkey, France, Ireland, Spain, Romania, Estonia, Germany and

[5] Constructivism pedagogy refers to a supportive relationship between students and teachers. Within this learning context, teachers provide constructive and contingent feedback to activate a positive approach towards students' errors (Peterson et al., 2018[94]).

Slovenia, over 95% of 15-year-olds attended such schools. Colombia, the Netherlands, Croatia, Bulgaria, Italy and Israel are the only countries where fewer than three in four children attended schools with formal curricula guiding the teaching of climate change and global warming.

Figure 5.3. Curricula on climate change and global warming, by country (PISA 2018)

Percentage of 15-year-old students attending schools where school principals report that a formal curriculum guided the teaching of climate change and global warming

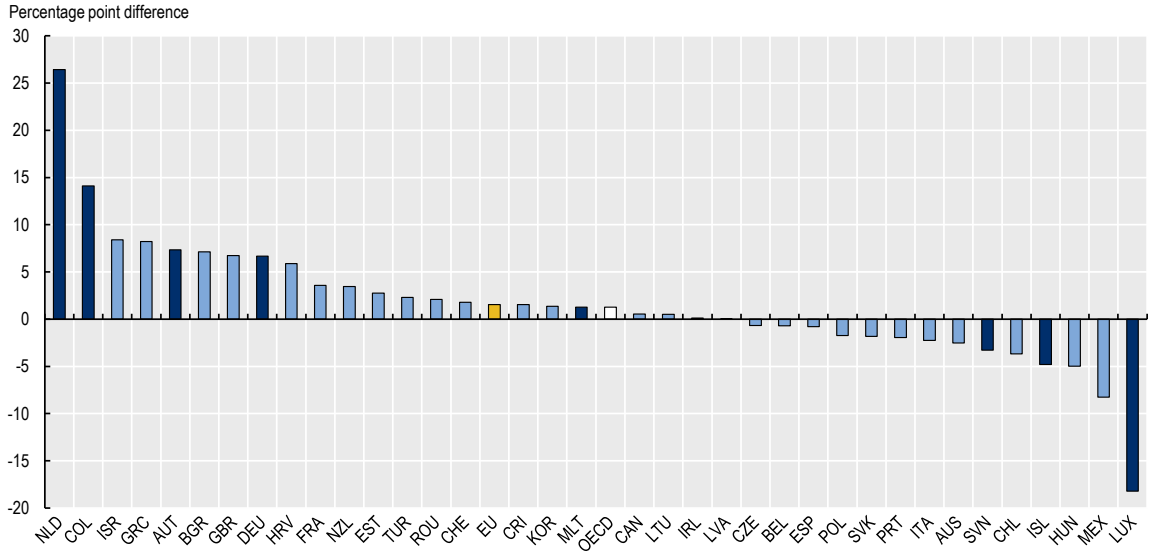


Note: The figure shows the percentage of 15-year-old students attending schools where school principals report that a formal curriculum guided the teaching of climate change and global warming. Countries are sorted in descending order of the share of students. Light blue colours denote that the share of students does not significantly differ compared to the EU average at the 5% significance level.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

93. Since Figure 5.3 reveals that in most countries, virtually all students attended schools where national curricula guided the teaching of climate change and global warming. It is not surprising that few differences exist in the percentage of students who attended schools with a socio-economically advantaged and disadvantaged intake with respect to the use in their school of formal curricula guiding the teaching of climate change and global warming. Figure 5.4 provides results from the PISA ESCS index and shows that, in 2018, differences were greater than 10 percentage points only in the Netherlands, Colombia and Luxembourg. Whereas students in the Netherlands and Colombia who attended schools with an advantaged intake were more likely to have their teaching on climate change and global warming being guided by formal curricula, in Luxembourg, students who attended schools with a disadvantaged intake were more likely to have their teaching on climate change and global warming guided by formal curricula.

Figure 5.4. Curricula on climate change and global warming, by school ESCS, by country (PISA 2018)

Percentage point difference in curricula on climate change and global warming between students in low and high ESCS schools



Note: The figure shows the percentage point difference in curricula on climate change and global warming between schools with rather socio-economically advantaged compared to disadvantages students. Countries are ordered in descending order of percentage point differences. Light blue colours denote that percentage point differences do not differ compared to the EU average at the 5% significance level.
Source: Calculations based on OECD (2018[12]), PISA 2018 Database, https://www.oecd.org/pisa/data/2018database/.

94. The widespread adoption of formal curricula guiding the teaching of key environmental problems such as climate change and global warming explains why the between-school variance in environmental sustainability competence is so low: virtually all children are exposed to a set of well-defined curricula. At the same time, the large overall variance in levels of environmental sustainability competence and the fact that systematic differences exist between different population groups suggests that formal curricula are still not sufficient in equipping all students with the competences needed to promote high levels of environmental sustainability competence. Some of the opportunities that children have to develop such competences occur within the family and are discussed in Chapter 4. Others occur in the wider society. Others still occur within schools but are not equally available to all children. For example, some teachers may adopt teaching practices that could promote a critical approach to problems in their science classes.

5.2.2. Pedagogical approaches to science teaching

95. The literature has generally conferred a relevant role to teaching practices in influencing students' performance (Isac et al., 2015[64]; Da Costa and Araújo, 2018[65]). Adaptive teaching (Gomendio, 2017[66]) and continuous feedback to students (Hattie and Timperley, 2007[67]; Lipko-Speed, Dunlosky and Rawson, 2014[68]) can stimulate academic achievement (Brussino, 2021[69]). However, besides students' results at school, teaching methods also appear to foster their environmental awareness (MCKeown and Hopkins, 2007[61]; Tilbury and Wortman, 2005[62]). Indeed, specific teaching approaches may foster the critical understanding of scientific and environmental problems (Littledyke, 2008[60]; MCKeown and Hopkins, 2007[61]).

96. Students participating in PISA 2015 were asked to report the extent to which their science teachers, i.e. those teachers who are most critical in the development of environmental sustainability competence, used approaches that have been identified as important to foster a critical understanding of scientific and environmental problems. These are teacher-directed instruction, perceived feedback, adaptive instruction and teacher support to students (see Box 3.1 in Borgonovi et al. (2022[70]) for more details on the variables). The adoption of these approaches is not mutually exclusive but, on the contrary, teachers use a variety of these approaches in their classes and over the academic year to equip students with sound environmental sustainability competence (see Figure A 7.1 in the Annex of OECD (2016[71])).

97. The use of pedagogical approaches could be associated in a different way with achievement and non-achievement dimensions of environmental sustainability competence (Littledyke, 2008[60]; Fröhlich, Sellmann and Bogner, 2013[63]). There is a lack of consensus over the extent to which the use of these teaching methods promotes achievement (OECD, 2016[71]). For instance, whereas the use of teacher-directed instruction is positively associated with students' achievement in science, the use of enquiry-based teaching methods is negatively associated with science achievement (OECD, 2016[71]). Enquiry-based methods allow students to engage with science by applying similar processes of scientific investigation (Gee and Wong, 2012[72]), but if students lack guidance when they design their own experiment, students' learning could be compromised (Jiang and McComas, 2015[73]). However, it could be argued that experiential learning pedagogies are both more demanding in terms of teacher preparation and expertise and more uncommon, and therefore existing practices portrayed as experiential (as captured by PISA) may differ hugely in terms of quality, which may not be true of teacher-led ones, or not to the same extent.

Box 5.1. Measuring teacher-level factors – Variables and definitions

Students participating in the PISA 2015 study were asked, using the student questionnaire, to rank teaching and learning practices used by their teachers such as: enquiry-based science instruction, teacher-directed science instruction, perceived feedback and adaption of instruction.

Regarding enquiry-based instruction, students were asked to report using a 4-point Likert scale, ranging from 'in all lessons' to 'never or hardly ever', how frequently a range of activities occur at school when learning science topics:

- Students are given opportunities to explain their ideas.
- Students spend time in the laboratory doing practical experiments.
- Students are required to argue about science questions.
- Students are asked to draw conclusions from an experiment they have conducted.
- The teacher explains how an idea can be applied to a number of different phenomena (e.g. the movement of objects, substances with similar properties).
- Students are allowed to design their own experiments.
- There is a class debate about investigations.
- The teacher clearly explains the relevance of concepts to our lives.
- Students are asked to do an investigation to test ideas.

Regarding teacher-directed instruction, students were asked to report using a 4-point Likert scale, ranging from 'never or almost never' to 'every lesson or almost every lesson', how frequently things happen in science lessons:

- The teacher explains scientific ideas.
- A whole-class discussion takes place with the teacher.
- The teacher discusses our questions.

- The teacher demonstrates an idea.

Regarding perceived feedback, students were asked to report using a 4-point Likert scale, ranging from 'never or almost never' to 'every lesson or almost every lesson', how frequently things happen in science lessons:

- The teacher tells me how I am performing in this course.
- The teacher gives me feedback on my strengths in this subject.
- The teacher tells me in which areas I can still improve.
- The teacher tells me how I can improve my performance.
- The teacher advises me on how to reach my learning goals.

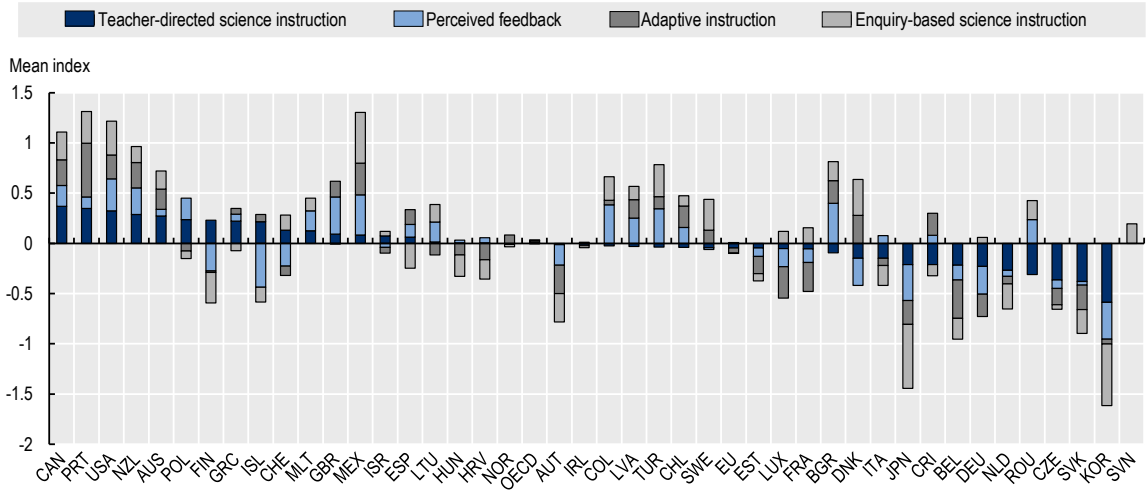
Regarding adaption of instruction, students were asked to report using a 4-point Likert scale, ranging from 'never or almost never' to 'every lesson or almost every lesson', how frequently things happen in science lessons:

- The teacher adapts the lesson to my class's needs and knowledge.
- The teacher provides individual help when a student has difficulties understanding a topic or task.
- The teacher changes the structure of the lesson on a topic that most students find difficult to understand.
- In PISA 2015, teaching and learning methods were measured using different items, which were then aggregated into standardised indices with the OECD average having a mean of 0 and SD of 1.

98. Figure 5.5 reveals that students in Anglo-Saxon countries such as Canada, the Unites States, New Zealand and Australia, but also Portugal, were generally more likely to have teachers who use teacher-directed science instruction than the average student in EU or OECD countries (see Box 5.1 for more details on the indices of teaching methods). Students in Belgium, Germany, the Netherlands, Romania, the Czech Republic, Estonia, Japan and Korea were more likely to have teachers who were less inclined to use teacher-directed science instruction. On the contrary, students in Bulgaria, Mexico, Colombia, the United Kingdom and Turkey were generally more likely (more than 30% of a standard deviation compared to the OECD average) to have teachers who provided informative and encouraging feedback in order to improve student outcomes. In Japan, Korea and Iceland, students were least likely to have teachers who provided informative and encouraging feedback (less than 30% of a standard deviation compared to the OECD average). Throughout all EU and OECD countries with available data, students in Portugal was, with 50% of a standard deviation compared to OECD countries, more likely to have teachers showing the highest levels of flexibility in their lessons, meaning teachers tailoring the lessons to the students in their classes, including to individual students who were struggling with a topic or a task. Students in Mexico, Denmark, the Unites States, Portugal, Turkey and Sweden were most likely to have teachers providing enquiry-based instruction such as experimentation and hands-on activities, and also challenging students and encouraging them to develop a conceptual understanding of scientific ideas.

Figure 5.5. Teaching methods, by country (PISA 2015)

Mean indices of teaching methods



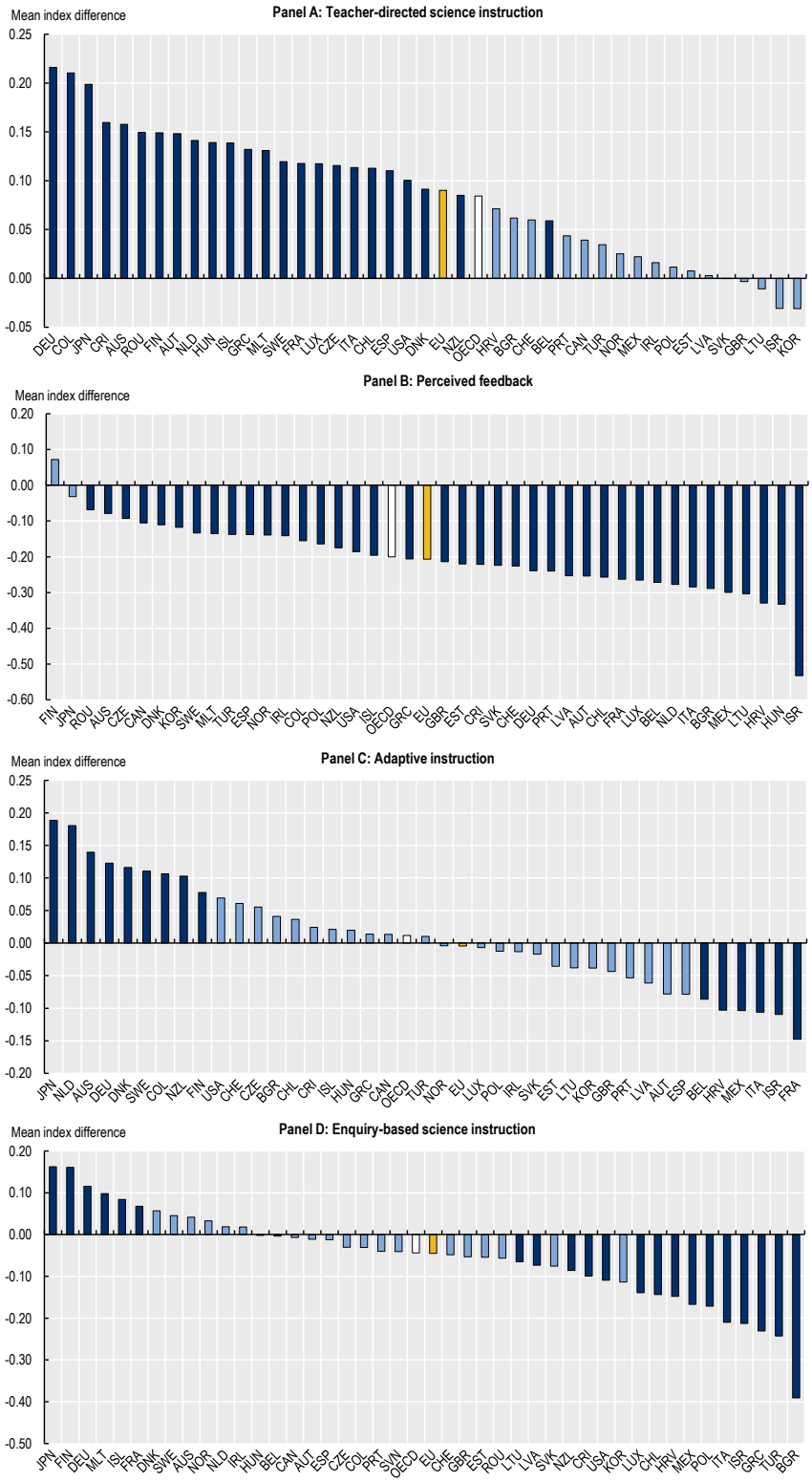
Note: The figure shows the mean indices of teaching methods by country. Countries are sorted in descending order of the mean index of teacher-directed science instruction. See Box 5.1 for more details on the indices of teaching methods.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

99. Figure 5.6 suggests that teacher-directed instruction was predominantly employed in schools with a socio-economically advantaged student intake (Panel A). Throughout EU countries, students in schools with a socio-economically advantaged student intake made greater use of teacher-directed instruction than students in schools with a socio-economically disadvantaged student intake, a difference of 9 index points. The difference in OECD countries was 8 index points. Conversely, students attending disadvantaged schools frequently reported a greater perception of feedback (Panel B). Considering that academic performance is positively correlated with schools' ESCS, the result can probably be explained by the fact that students in schools with a lower socio-economic status need to receive more feedback compared with those in advantaged schools (OECD, 2016[74]). On average, the difference in perceived feedback between schools with high and low ESCS was 18 score points throughout EU and OECD countries.

100. Figure 5.6 also reports the mean difference in the adaption of instruction (Panel C) and enquiry-based science instruction (Panel D) between schools with a socio-economically advantaged and disadvantaged student intake. Most of the countries analysed did not show any statistically significant difference between the two types of schools. EU and OECD averages were, indeed, not significantly different from zero, for adaption of instruction, while they reported only a difference of −0.04 index points (EU countries) and −0.05 (OECD countries) for enquiry-based science instruction. However, the results were mixed throughout the countries. For instance, in Japan, schools with a socio-economically advantaged student intake reported greater use of adaptive teaching and enquiry-based instruction –0.19 index points and 0.16 index points, respectively. On the other hand, schools with a socio-economically disadvantaged student intake showed greater use of the adaption of instruction in France, Israel, Italy, Mexico, Croatia and Belgium. Similarly, a more than 0.2 index-point difference in the use of enquiry-based science teaching was associated with schools with disadvantaged students in Bulgaria, Turkey, Greece, Israel and Italy.

Figure 5.6. Teaching methods by differences in high versus low school ESCS backgrounds (PISA 2015)

Mean index difference of teacher-directed science instruction, perceived feedback, adaptive instruction and enquiry-based science instruction during science classes between schools with high and low ESCS

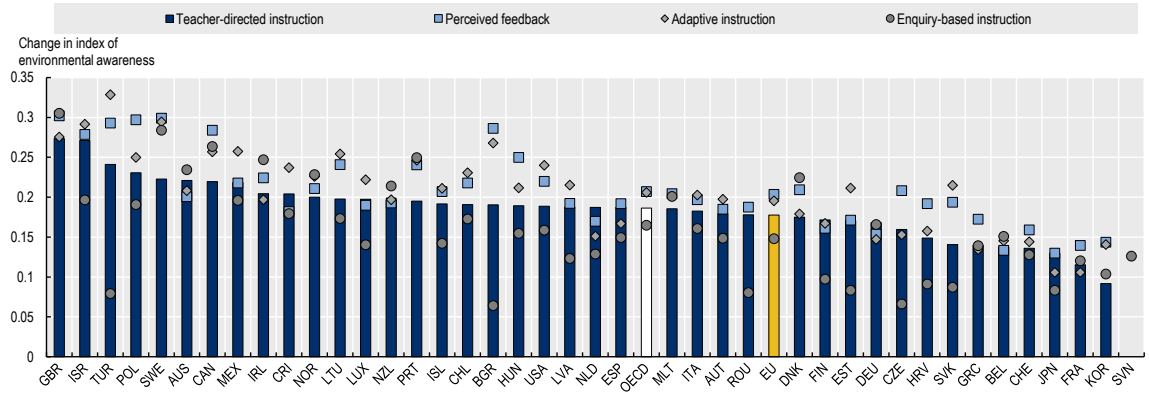


Note: The figure shows mean index differences in teacher-directed instruction, perceived feedback, adaptive instruction and enquiry-based instruction during science classes between schools with high and low ESCS. See Box 5.1 for more details on the indices of teaching methods. Mean index differences are reported in descending order of country averages. Light colours denote that differences between schools with high and low ESCS do not differ at the 5% significance level.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

101. Figure 5.7 describes the association between the use of teacher-directed instruction, perceived feedback, adaptive instruction and enquiry-based instruction and environmental awareness. In 2015, on average throughout EU and OECD countries, a standard deviation increase in students reporting teachers using perceived feedback was associated with an increase in students' environmental awareness by 0.20 standard deviation units throughout EU countries, when comparing students with similar background characteristics and a similar achievement in science. The estimated effect was 0.21 standard deviation units throughout OECD countries. Moreover, while enquiry-based teaching is generally associated with a lower level of science performance (OECD, 2016[71]), this teaching method instead produced a positive effect in terms of environmental competence (15% of a standard deviation throughout EU countries, and 16% of a standard deviation throughout OECD countries); the same holds for teacher-directed feedback (18% of a standard deviation throughout EU countries, and 19% of a standard deviation throughout OECD countries) and adaptive instruction (20% of a standard deviation throughout EU countries, and 21% of a standard deviation throughout OECD countries).

Figure 5.7. The association between the use of teaching methods and environmental awareness, country estimates (PISA 2015)

Estimated effect of the four teaching methods used in science classes on the environmental awareness index of students



Note: The estimates provided in the figure represent changes in the index of environmental awareness associated with one standard deviation increase in the respective teaching method. See Box 5.1 for more details on the indices of teaching methods. Each model includes controls for students' gender, immigrant background, language spoken at home, the households' ESCS index and schools' ESCS index and science achievement. Values are sorted in descending order.
Source: Calculations based on OECD (2015[14]), PISA Database 2015, https://www.oecd.org/pisa/data/2015database/.

Box 5.2. Teaching for climate action

Classroom education plays a crucial role in building a greener future. However, changes in the teaching and learning process are needed to improve the environmental awareness and behaviour of today's young generation. Teaching for Climate Action, an initiative by the OECD's Global Teaching InSights project, UNESCO and Education International, gathers the expertise of teachers on how to promote student agency and support students to act and lead on climate matters. Teachers from several different countries contributed with insights on how climate action can be transformed, and how teaching for climate action can be supported and enhanced.

The first aspect, how climate action can be transformed, not only includes the cultivation of climate literacy among students but also specifically encourages students' agency and empowerment. Teachers also acknowledged the necessity to go beyond traditional teaching methods and include active and student-centred approaches such as project-based and experiential learning. Another perceived crucial element of teaching methods is that students should be at the centre of learning, which gives students a greater sense of ownership of learning and sustained interest in climate action beyond the classroom. Since climate change is multidimensional and multidisciplinary, most teachers agree to break the borders of grade levels and subjects and embed climate education in different grades and subjects.

The second aspect, how teaching can be supported and enhanced, includes opportunities for teachers' professional learning and development to, for example, improve their knowledge on active pedagogies. Besides the necessity for professional development, teachers also expressed the need for professional collaboration. Another crucial aspect teachers identified is the support from school leadership to build a shared vision for implementing climate education in schools. To practically implement the active pedagogies, teachers identify the importance of having access to appropriate learning spaces that can support the implementation of active pedagogies for climate action. Beyond the school network, cultivating partnerships with communities is also seen as essential to help students learn about the opportunities for their future, and become more engaged and responsible citizens.

Source: OECD (2022[75]), 'Teaching for Climate Action: Summary of InSights', www.globalteachinginsights.org/summary-en.

Box 5.3. Results from the International Civic and Citizenship Education Study (ICCS)

Results presented in this chapter and previous empirical studies indicate that the education system appears mobilised to tackle the challenges to sustain the green transition. Although data from PISA on school-level interventions are limited, they align well with other cross-country comparative studies. For example, data from the International Civic and Citizenship Education Study (ICCS) conducted in 2016 reveal that the head teachers and teachers of year 9s in countries that participated in the study regarded the safeguarding of the environment as an important goal (Schulz et al., 2018). In 2016, the ICCS was conducted in 24 countries and contains information on lower secondary school students' knowledge and understanding of civics and citizenship. The study considers students' attitudes towards, perceptions of and activities related to civic institutions, behaviours and practices.

Most schools that took part in the ICCS reported that they had developed at least some initiatives related to environmental sustainability, such as differential waste collection, recycling and waste reduction and energy-saving, and teachers reported that many students participated in activities pertaining to the environment and mainly did so thanks to activities organised at school.

The ICCS 2016 reveals that 81% of students throughout participating countries were in schools in which the head teacher reported having adopted, to a large or moderate extent, energy-saving policies at school, and 74% were in schools where head teachers reported having implemented differential waste collection. Around 74% of students were in schools where posters were used to support students' environmentally friendly practices, 67% of students attended schools where efforts were made to reduce waste and 60% attended schools where environmentally friendly items were purchased.

The study also revealed that teachers reported that 48% of their students engaged in activities at school aimed at raising awareness about the importance of reducing energy consumption and 46% in activities aimed at raising awareness about reducing water consumption and promoting water conservation.

Source: Schulz (2018[76]), *Becoming Citizens in a Changing World*, https://doi.org/10.1007/978-3-319-73963-2.

6 Conclusions

102. Promoting an environmentally sustainable and inclusive economic growth model is key to ensuring that the pandemic's recovery leads to better long-term outcomes for all. Policy makers and policy documents underline the importance of public policies to support green growth. For example, the 2030 Agenda for Sustainable Development refers to combating climate change and its impacts as part of the 17 Sustainable Development Goals (UN General Assembly, 2015[77]; United Nations, 2015[78]); the Paris Agreement, which was adopted by almost 200 parties, identifies the goal of reducing emissions below 2 °C above pre-industrial levels (United Nations, 2021[79]); and the European Green Deal represents the commitment of 27 EU Member States to making the EU the first climate-neutral continent by 2050 (European Commission, 2019[80]).

103. On the education front, many education systems emphasise the protection of the environment or education for environmental sustainability in their curricula (Ainley, Schulz and Friedman, 2013[81]; Schulz et al., 2010[82]) and acquiring environmental sustainability competence as key for education systems to develop involved and responsible citizens (Dobson, 2003[83]; Dobson and Bell, 2006[84]; Ferreira, 2013[85]; Hayward, 2006[86]). Previous empirical studies indicate that teachers and school principals endorse these policy objectives, recognise the key role education systems can play in promoting the green transition and regard the promotion of students' respect for and safeguarding of the environment as an important goal (Schulz et al., 2018[87]).

104. Historically, for every 1% increase in the global GDP, CO2 emissions have risen by approximately 0.5% (World Bank, 2018[88]). In 2021, with the start of the economic recovery following the COVID-19 disruption, global CO2 emissions rebounded to their highest level in history, with a 6% increase from 2020 (IEA, 2022[89]). Decoupling economic growth from emissions growth and fighting the extent to which energy extraction and human production generate pollutants and create a loss of biodiversity are within the grasp of our societies. This may be possible only if education and social systems ensure that most people possess the technical and scientific skills needed to work in the new jobs that will be created as a result of the green transition, and create the technologies that will propel such a transition.

105. Decarbonisation of the economy will have a profound impact on labour markets worldwide in the coming years and decades. The green transition could propel economic growth, but the speed and efficiency with which the transition will occur depend on individuals having the right set of skills to sustain and power green innovations. Moreover, and equally important, unless all individuals have the right set of skills, labour market transformations due to the transition to net-zero emissions could create social tensions and ultimately halt progress towards a new growth paradigm that does not depend on environmental degradation. The labour market changes required to meet net-zero targets will change the skills required in the economy. Skills needed to fulfil the old 'brown' jobs are projected to decline in demand, while skills needed to fulfil the new 'green' jobs are projected to increase in demand. Enacting a just and inclusive green transition depends on education systems providing all youngsters with a solid foundation upon which to build job-specific skills, otherwise individuals will not be able to participate fully in the labour market.

106. Equipping all youngsters with such skills is a necessary but not a sufficient condition. As Gus Speth reminds us so powerfully, the lack of willingness to take action, apathy and failure to accept the costs associated with protecting the environment are even greater threats to the green transition than a lack of technical and scientific skills and understanding (Speth, 2015[90]). Therefore, equipping individuals not only

with knowledge and skills, but also attitudes and values, is essential for them to understand the environmental consequences of their actions. Therefore, this paper takes a broad definition of environmental sustainability competence that encompasses four competence areas, covering cognitive as well as emotional, attitudinal and behavioural dimensions. Following the recent EU GreenComp framework, these competence areas are: embodying sustainability values, embracing complexity in sustainability, envisioning sustainable futures and acting for sustainability.

107. Societies must nurture in new generations not only a sound understanding of science but also an appreciation of the fragility of the environment and national ecosystems. The goal is to propel their willingness to protect the planet and empower them to contribute through their work and everyday actions to the green transition.

108. Few indicators could be mapped over time. Therefore, this paper contains only a few pointers for analysts and policy makers on the pace of change in levels of environmental sustainability competence among successive birth cohorts. What emerges from the analyses that were conducted is that 15-year-olds increased their awareness of less-familiar environmental problems. For example, of five different environmental issues, awareness of the increase of greenhouse gases in the atmosphere increased by 7 percentage points in 2015 compared to 2006. However, the slow pace of change and lack of progression in other aspects left large minorities of 15-year-olds in EU and OECD countries reporting being unfamiliar with key environmental challenges.

109. The foundation for this is environmental sustainability competence. Results presented in this paper make it clear that large disparities exist in the extent to which education systems and societies generally equip children with this key foundation for their future. Children from socio-economically disadvantaged households are less likely than their more advantaged peers to care about the environment or to be aware about environmental problems, have lower levels of science achievement scores and engage less in pro-environmental behaviour. For example, on average throughout EU countries, disadvantaged children are 12 percentage points less likely to care about the environment, and 11 percentage points less likely throughout OECD countries. Disparities in the acquisition of different environmental sustainability competence areas are compounded and socio-economically disadvantaged youths are, in particular, less likely to be environmental sustainability all-rounders. On average throughout EU countries, analyses presented reveal that they are 19 percentage points less likely to be baseline all-rounders and 18 percentage points less likely to be advanced all-rounders compared to their more advantaged peers.

110. A second key dimension of inequality is gender. Subtle but pervasive gender differences exist when granular indicators are available and can be analysed. Delivering a just and inclusive green transition can only be achieved with the participation of all, and the barriers and stereotypes that continue to lead boys and girls, men and women to make different educational and life choices should be dismantled. In particular, gender differences in the awareness of environmental problems differ depending on the nature of such problems. For example, throughout EU and OECD countries, boys report higher levels of awareness of nuclear waste, the increase of greenhouse gases in the atmosphere, the use of genetically modified organisms and the consequences of clearing forests for other land use. By contrast, girls reported higher levels of awareness of water shortage, air pollution and the extinction of plants and animals. Similarly, while boys scored higher than girls in physical, and earth and science, areas, girls scored higher than boys in biology. These differences map onto gender differences in broad science areas in tertiary education, with few women engaged in science, technology, engineering and mathematics (STEM), while more likely to pursue degrees in biology than physics and engineering (McNally, 2020[91]).

111. The extent to which individuals are able to acquire environmental sustainability competence is determined by a variety of factors, among others the cultural setting in which students are born and raised as well as the school environment they are exposed to. Within schools, different potential underlying processes may shape students' environmental sustainability competence, such as formal curricula and teaching practices. This paper indicates that, on average throughout EU and OECD countries, 34% and

31% of performance differences in science achievement were observed between schools, whereas only 6% of the differences in environmental awareness related to the school a student attended at age 15. These results could reflect the fact that secondary schools currently play little or no role in promoting some aspects of environmental sustainability competence among 15-year-olds, either because these are acquired earlier or because some competence areas are not currently promoted in formal education. Alternatively, they could reflect the standardised nature of curricula and competence framework in the acquisition of environmental sustainability competence.

112. Parents play a pivotal role in their children's socialisation. Within families, values, attitudes and behaviours may be passed on, resulting in an alignment of attitudes, values and behaviours between generations. The degree of transfer may depend on the extent and type of parents' interaction with their children. On average, analyses presented in this paper reveal a positive significant correlation between the environmental behaviour of parents and children within families. The responsibility to equip new generations with solid environmental sustainability competence, does not therefore lie solely with the formal education sector, but is a shared responsibility that all families should take on themselves. Parents are the first and probably most important role models for their children and their attitudes and behaviours have long-lasting impacts on the possibility of new generations tackling environmental degradation and propelling the green transition. At the same time, children worldwide have developed a new environmental consciousness and can stimulate their parents to modify long-held actions and behaviours to adopt more sustainable lifestyles. In this framework of mutual influence, it is even more urgent to equip youngsters with environmental sustainability competence to also create change within harder-to-reach generations.

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Annex A. Data tables

The Excel file with the data for the figures and tables in chapters 2, 3, 4 and 5 is available at:

https://www.oecd.org//skills/centre-for-skills/Young-people's-environmental-sustainability-competence-data-tables.xlsx.