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The environmental sustainability
competence toolbox: From
leaving a better planet for our
children to leaving better
children for our planet

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The environmental sustainability competence toolbox

From leaving a better planet for our children to leaving better children for our planet

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Authorised for publication by Stefano Scarpetta, Director, Directorate for Employment, Labour and Social Affairs

The paper is the second 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 first paper is titled 'Young people's environmental sustainability competence: Emotional, cognitive, behavioural and attitudinal dimensions in EU and OECD countries' (<https://doi.org/10.1787/1097a78c-en>).



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Abstract

The paper combines a developmental perspective with a subjective and child-centred perspective to identify the characteristics of young people who achieve given benchmarks across all areas that characterise environmental sustainability competence and examines the determinants of young people's engagement in pro-environmental behaviour. Using data from various editions of the Programme for International Student Assessment (PISA), the paper first provides an overview of students who have mastered the entire environmental sustainability toolbox, comprising emotional, cognitive, behavioural and attitudinal dimensions. The paper then considers the degree to which education systems have equipped students with an extended toolbox that comprises competences such as collaborative problem-solving, familiarity with digital tools and financial literacy. This extended toolbox helps young people to work with others to achieve a green future, contribute to the twin green and digital transition, become green entrepreneurs and appreciate the long-term costs of environmental inaction. The paper concludes by drawing policy implications and providing pointers for education policy-making.

Résumé

Le présent document associe une perspective développementale à une approche subjective et centrée sur l'enfant afin d'identifier les caractéristiques des jeunes qui atteignent des niveaux de référence donnés dans tous les domaines qui caractérisent les compétences en matière de durabilité environnementale, et examine les déterminants de l'adhésion des jeunes à des comportements écofavorables. À partir des données tirées de plusieurs cycles du Programme international pour le suivi des acquis des élèves (PISA), le document donne tout d'abord un aperçu des élèves qui maîtrisent l'ensemble des outils de la durabilité environnementale, y compris dans ses dimensions émotionnelle, cognitive, comportementale et psychologique. On cherche ensuite à déterminer dans quelle mesure les systèmes éducatifs parviennent à transmettre aux élèves un large éventail d'outils comprenant des compétences telles que la capacité à résoudre des problèmes de manière collaborative, la connaissance des outils numériques et la culture financière. Cette vaste boîte à outils aide les jeunes à travailler avec les autres pour bâtir un avenir vert, contribuer à la double transition écologique et numérique, devenir des entrepreneurs verts et prendre la mesure des coûts à long terme de l'inaction climatique. Enfin, le document décrit les implications que cela suppose pour l'action publique et propose des repères pour l'élaboration des politiques de l'éducation.

Executive summary

Equipping future generations with proficiency across all environmental sustainability competence areas – including cognitive, emotional, attitudinal and behavioural dimensions – is key to promoting a more sustainable and greener future. These dimensions include embodying sustainability values, embracing complexity in sustainability, envisioning sustainable futures and acting for sustainability. Young people's environmental sustainability competence toolbox can be extended to include additional key competences required in today's society, such as collaborative problem-solving, familiarity with and interest in digital devices and financial literacy to empower them with a solid foundation upon which to contribute to green and inclusive economic growth.

In particular, combining solid environmental sustainability competence with sound digital skills is key if young people are to contribute to the twin green and digital transitions. From global to local levels, tackling climate change and promoting sustainable growth also rely on collaborative problem-solving skills, as stakeholders need to work collaboratively to solve the most pressing environmental challenges. Finally, to promote sustainability and the green transition, financial literacy helps youngsters conduct research before making decisions, weighing alternatives, understanding intertemporal trade-offs and identifying and seizing opportunities.

This paper builds on the findings from Borgonovi et al. (2022^[1]) and looks at the intersection between students' environmental sustainability competence, collaborative problem-solving skills, as well as digital and financial literacy through an analysis of data from various rounds of the OECD's Programme for International Student Assessment (PISA).

Results indicate that in 2018, only 31% of 15-year-old students, on average, throughout EU countries and 33% throughout OECD countries could be classified as baseline all-rounders, meaning that they demonstrated having achieved at least minimum benchmarks across all four environmental sustainability competence areas. In EU and OECD countries, only 13% of students were classified as advanced all-rounders, meaning that they demonstrated having achieved the same benchmarks across the competence areas as baseline all-rounders but higher standards in their science achievement.

Being a top performer in the field of science, reading or mathematics is not sufficient to develop greater awareness of environmental issues. Being a top performer is related to greater awareness of environmental issues for only the science domain, but not for reading and mathematics. Hence, students' general secondary school performance does not necessarily determine students' environmental awareness; it is rather the content covered in the curriculum that can play an important role. Students with high levels of knowledge and understanding, who can solve complex scientific problems using their knowledge, are likely to have gained a greater understanding of environmental issues, which in turn can lead to greater environmental awareness.

Throughout EU and OECD countries, students who differed by one standard deviation (SD) in collaborative problem-solving scores differed by around 39% of a standard deviation in environmental awareness. However, no difference existed when students with similar background characteristics were compared. By contrast, a change of one standard deviation in the index of valuing relationships was associated with a difference of around 24% of a standard deviation in environmental awareness before controlling for

background characteristics and 18% of a standard deviation when differences in background characteristics among students were accounted for. Finally, a difference of one standard deviation in the index of teamwork was associated with a difference of 2.5% of a standard deviation in environmental awareness before controlling for background characteristics and 6% after controlling for background characteristics.

Advanced environmental-sustainability all-rounders reported more positive self-belief in their competence in using ICT as well as a higher level of interest in ICT than other students. For example, on average throughout EU countries, 15-year-old advanced all-rounders reported levels of ICT competence that were around 23% of a standard deviation higher than the average student throughout OECD countries. By contrast, students who were not advanced all-rounders reported levels of ICT competence that were lower than those reported by the average OECD student. Many students throughout EU and OECD countries report low levels of interest in digital tools, lack of self-efficacy when using digital tools and low levels of self-reported digital competence. For example, differences in levels of interest in ICT and self-belief in ICT use and competence seem to be very pronounced depending on whether students reported agreeing or strongly agreeing that caring about the environment is important to them. On average throughout EU and OECD countries, students who reported that caring about the environment was important to them had values on the assessing credibility index that were 20% of a SD above those reported by students who did not, expressed levels of perceived competence in ICT use that were over 25% of a SD higher and levels of perceived autonomy that were almost 30% of a SD higher than those who did not.

Students with higher levels of financial literacy levels show higher levels of environmental awareness, care and self-efficacy. For example, for all the EU and OECD countries included in the analysis, students with a financial proficiency level of 2 and above (baseline performers) reported higher levels of environmental awareness, environmental care and environmental self-efficacy compared to students with less-than-basic proficiency. However, in all countries but three, they are less likely to report pro-environmental behaviour compared to their peers. Students who reported higher levels of family involvement in financial matters and inclusion of financial topics at schools seem to be more prone to exhibit pro-environmental behaviour.

Synthèse

Pour promouvoir un avenir plus durable et plus vert, il est essentiel de doter les générations futures de compétences dans tous les domaines liés à la durabilité environnementale - y compris ses dimensions émotionnelle, cognitive, comportementale et psychologique. Il peut s'agir par exemple d'intégrer les valeurs propres à la durabilité, d'appréhender la complexité que cette notion recouvre, d'imaginer des futurs durables et d'agir en faveur de la durabilité. L'éventail des compétences que possèdent les jeunes en matière de durabilité environnementale peut être élargi pour y inclure d'autres aptitudes essentielles dans la société moderne, comme l'aptitude à résoudre des problèmes de manière collaborative, la connaissance et le goût des outils numériques ainsi que la culture financière, afin qu'ils possèdent des bases solides sur lesquelles contribuer à une croissance économique verte et inclusive.

Il est notamment crucial d'associer de solides compétences en durabilité environnementale à de solides compétences numériques si l'on veut que les jeunes contribuent à la double transition écologique et numérique. De l'échelon mondial au niveau local, la lutte contre le changement climatique et la promotion d'une croissance durable reposent également sur la capacité à résoudre collectivement des problèmes, les parties prenantes devant collaborer pour relever les défis environnementaux les plus urgents. Enfin, pour promouvoir la durabilité et la transition écologique, la culture financière aide les jeunes à mener des recherches avant de prendre des décisions, à évaluer les solutions alternatives, à comprendre les arbitrages intertemporels et à identifier et saisir les opportunités.

Le présent document s'appuie sur les conclusions de Borgonovi et al. (2022^[1]) et examine l'articulation entre les compétences des élèves en matière de durabilité environnementale, leur aptitude à collaborer pour résoudre des problèmes, ainsi que leurs cultures numérique et financière, au moyen d'une analyse des données issues de différents cycles du Programme international de l'OCDE pour le suivi des acquis des élèves (PISA).

Les résultats indiquent qu'en 2018, seuls 31 % en moyenne des élèves de 15 ans dans l'ensemble des pays de l'UE, et 33 % dans l'ensemble des pays de l'OCDE, pouvaient être considérés comme ayant un niveau de référence dans tous les domaines, autrement dit comme ayant atteint au moins le niveau de référence minimum dans les quatre domaines de compétence en durabilité environnementale. Dans les pays de l'UE et de l'OCDE, seuls 13 % des élèves atteignent un niveau avancé dans tous les domaines, autrement dit ils ont atteint le même niveau de référence que la catégorie précédente, mais ont en outre un niveau plus élevé en sciences.

Il ne suffit pas d'être très performant en sciences, en compréhension de l'écrit ou en mathématiques pour être davantage sensibilisé aux enjeux environnementaux. Le fait d'être très performant est associé à une plus grande sensibilisation aux problèmes environnementaux uniquement pour ce qui est du domaine des sciences, mais pas de celui de l'écrit ou des mathématiques. Par conséquent, les performances générales des élèves dans le secondaire ne déterminent pas nécessairement leur sensibilisation aux enjeux environnementaux ; c'est plutôt le contenu des programmes qui peut jouer un rôle important. Les élèves qui présentent un niveau élevé de connaissances et de compréhension, et qui peuvent résoudre des problèmes scientifiques complexes en utilisant leurs connaissances, sont susceptibles d'avoir acquis une

meilleure compréhension des enjeux environnementaux, ce qui peut par la suite conduire à une plus grande prise de conscience des problèmes environnementaux.

Dans l'ensemble des pays de l'UE et de l'OCDE, une différence d'un écart-type sur le score en résolution collaborative de problèmes est associée à une différence de 39 % environ d'un écart-type quant à la sensibilisation aux problèmes environnementaux. Toutefois, on n'observe pas de différence entre les élèves présentant des caractéristiques contextuelles analogues. En revanche, une différence d'un écart-type sur l'indice relatif à l'importance accordée aux relations est associée à une différence d'environ 24 % d'un écart-type quant à la sensibilisation aux problèmes environnementaux, avant que les caractéristiques contextuelles des élèves soient prises en compte, et de 18 % après. Enfin, une différence d'un écart-type sur l'indice relatif au travail en équipe est associée à une différence de 2.5 % d'un écart-type quant à la sensibilisation aux problèmes environnementaux, avant que les caractéristiques contextuelles des élèves soient prises en compte, et de 6 % après.

Les élèves de niveau avancé dans tous les domaines de compétence liés à la durabilité environnementale se déclarent davantage confiants dans leur capacité à utiliser les TIC et se disent plus intéressés par les TIC que les autres élèves. Par exemple, en moyenne dans les pays de l'UE, les élèves de 15 ans de niveau avancé dans tous les domaines enregistrent un niveau de compétence en TIC qui s'écarte de la moyenne de l'OCDE de l'équivalent de 23 % environ d'un écart-type à la hausse. À l'inverse, les élèves qui n'atteignent pas ce niveau avancé dans tous les domaines enregistrent un niveau de compétence en TIC inférieur à la moyenne de l'OCDE. De nombreux élèves dans les pays de l'UE et de l'OCDE montrent un faible intérêt pour les outils numériques et un manque d'efficacité et de maîtrise dans leur utilisation. Ainsi, les différences de degré d'intérêt pour les TIC et de confiance en soi dans leur utilisation et leur maîtrise semblent être très prononcées selon que les élèves déclarent être d'accord ou tout à fait d'accord avec l'idée qu'il est important pour eux de se soucier de l'environnement. En moyenne, dans les pays de l'UE et de l'OCDE, les élèves ayant déclaré que le respect de l'environnement était important pour eux dépassent leurs camarades qui ne jugent pas important de se soucier de l'environnement de l'équivalent de 20 % d'un écart-type sur l'indice d'évaluation de la crédibilité, de plus de 25 % d'un écart-type quant au niveau de compétence perçu dans l'utilisation des TIC et de près de 30 % d'un écart-type quant au niveau d'autonomie perçu.

Les élèves ayant une bonne culture financière affichent des niveaux plus élevés de sensibilisation, d'intérêt et d'efficacité personnelle en matière d'environnement. Ainsi, pour tous les pays de l'UE et de l'OCDE inclus dans l'analyse, les élèves dont le niveau de culture financière est égal ou supérieur à 2 (élèves de référence) font état de niveaux plus élevés de sensibilisation, d'intérêt et d'efficacité personnelle en matière d'environnement que ceux dont le niveau est inférieur au niveau de base. Toutefois, dans tous les pays sauf trois, ils sont moins susceptibles de faire état de comportements écofavorables que leurs camarades. Les élèves qui signalent un intérêt familial pour les questions financières et qui abordent des sujets d'ordre financier en classe semblent plus enclins à adopter des comportements écofavorables.

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1 What competences do young people need to contribute to a green future?

Probleme kann man niemals mit derselben Denkweise lösen, durch die sie entstanden sind. (We cannot solve problems by using the same kind of thinking we used when we created them).

Albert Einstein

1. Climate change and the depletion of natural resources require urgent action. In the face of today's climate and environmental emergency, many countries have committed to ambitious reform initiatives aimed at protecting the environment by reducing global warming, deforestation, loss of biodiversity and pollution. For example, the European Union (EU) has committed to reaching zero net emissions of greenhouse gases (GHG) by 2050 (European Parliament and Council, 2021^[2]). Among others, Costa Rica shares the same target in its National Decarbonisation Plan (Government of Costa Rica, 2019^[3]). Similarly, the United States have committed to reducing net GHG emissions by 50-52% below 2005 levels by 2030 (U.S. Congressional Research Service, 2021^[4]). At global level, after the 2021 United Nations Climate Change Conference (COP26) in Glasgow, the countries now covered by net-zero commitments represent over 90% of the world's GDP and around 90% of global emissions (COP26, 2021^[5]).
2. The transition to a green economy is one of the main policy underpinnings of many economic plans that countries are developing to recover from the socio-economic consequences of COVID-19. For example, in its New Deal, Korea's recovery plan from the pandemic, the country supports the transition to a green economy, with a focus on promoting renewable energy and reducing carbon footprint through the decarbonisation of heavy industries (Government of Korea, 2020^[6]). To support the country's economic recovery, Colombia's National Policy on Sustainable Recovery aims to promote, among others, clean energy transition, responses to climate change, reforestation and access to environmental information (Government of Colombia, 2020^[7]). As the European Commission's Annual Sustainable Growth Survey 2022 acknowledges, 'it is essential to ensure that the economic recovery goes hand in hand with the fast-forwarding of the green transition and to put the economy on track to deliver on the EU's commitment to becoming the first climate-neutral continent by 2050' (European Commission, 2021, p. 5^[8]). The EU Recovery and Resilience Facility has been designed to tackle the socio-economic consequences of the COVID-19 crisis (European Parliament and Council, 2021^[9]) by providing incentives towards investment supporting the transition to a green (and digital) economy.
3. From a human-capital perspective, the green transition requires significant investments in upskilling and reskilling to ensure that individuals have the skill sets needed to master green technologies, to find innovative production methods to reduce the footprint of economic activities but also reduce the environmental footprint of everyday life. Educating citizens on sustainability is increasingly recognised by education curricula around the world. The OECD Learning Framework 2030 indicates that 'children entering school in 2018 will need to abandon the notion that resources are limitless and are there to be exploited; they will need to value common prosperity, sustainability and well-being. They will need to be

responsible and empowered, placing collaboration above division and sustainability above short-term gain' (OECD, 2018, p. 3_[10]). The need for children to be able to take personal and social responsibility is also a cornerstone of the Assessment and Teaching of 21st Century Skills (ATC21S) framework (Griffin, McGaw and Care, 2012_[11]). A similar role is played by the ability to act autonomously having a big-picture perspective in the Definition and Selection of Competencies (DeSeCo) framework (Rychen and Salganik, 2003_[12]). Several countries – such as Australia, Denmark, Estonia, Hungary, Poland, Portugal and Sweden – prioritise the promotion of environmental awareness and sustainability among their educational goals. In student profiles set out in curricula by some education systems, concerns for environmental sustainability are also included. For example, Norway highlights the 'respect for nature and environmental awareness' and Denmark stresses the need for students to understand 'the interrelationship between humans and the environment'. Finland focuses on the need to develop a sustainable way of living and promote student understanding of climate change (OECD, 2020_[13]). While equipping children with the scientific skills that will be needed to tackle environmental challenges is crucial, sustainability skills involve much more than science literacy and knowledge about socio-ecological problems (OECD, 2020_[14]). A competence-based education, which instils sustainability skills based on knowledge and sustainability attitudes, can help learners embrace responsibility towards the planet and determine their willingness to take or demand action at local, national and global levels. To make progress on this front, in 2019-2020 several European Commission policy frameworks (such as the European Green Deal¹, the European Skills Agenda² and the European Education Area³) called for the development of a competence framework on sustainability, which was then published in January 2022 (Bianchi et al., 2022_[15]).

4. Against this policy background, this paper considers whether today's children developed emotional, cognitive, behavioural and attitudinal dimensions of environmental sustainability competence as well as whether they complemented these with additional key competences such as collaborative problem-solving, familiarity with and interest in digital devices and financial literacy. Students who have acquired the full environmental sustainability toolbox and complemented it with these additional competences have a solid foundation upon which to contribute to green and inclusive economic growth. Findings from this paper will help policy makers understand how young people approach environmental issues and how education systems can contribute to forming environmentally aware citizens and workers.

¹ Communication from the Commission – The European Green Deal. COM/2019/640 final. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1576150542719&uri=COM%3A2019%3A640%3AFIN>.

² Communication from the Commission – European Skills Agenda for sustainable competitiveness, social fairness and resilience. COM/2020/274 final. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0274>.

³ Communication from the Commission on achieving the European Education Area by 2025. COM/2020/625 final. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0625>.

2 Who are the environmental leaders of the future and the pro-environmental actors of today?

2.1. Introduction

5. This section combines a developmental perspective with a subjective child-centred view to examine environmental sustainability competence. The adoption of a developmental perspective emphasises the instrumental value that environmental sustainability competence acquired by age 15 has for the future of children and their societies (Borgonovi and Pál, 2016^[16]; Settersten, McClelland and Miao, 2014^[17]). By contrast, adopting a children-centred view means that 15-year-old students are viewed as current citizens, whose behaviours, actions and thoughts influence their everyday life and their societies in the present (Bronfenbrenner, 1979^[18]).

6. Both perspectives are important and valuable: the actions of teenagers can contribute to exacerbating environmental problems or, by contrast, can reduce their environmental impact. At the same time, their competences at age 15 can shape their future environmental impact in various respects. They can influence their occupational choices and/or create environmentally sustainable habits or behaviours that will guide their actions as adults. In many countries, the age of 15 corresponds to the period when students and families make decisions about further education or work (Stephens, Warren and Harner, 2015^[19]). At this age, students begin to develop occupational values, interests and preferences (Johnson, 2021^[20]; Schulenberg, Vondracek and Kim, 1993^[21]) as well as an understanding of the demands of different occupations (Hartung, Porfeli and Vondracek, 2005^[22]). Therefore, what happens at age 15 can determine children's educational and occupational choices, with possible long-term repercussions on the availability of talent for jobs that are key to achieving net-zero targets and the green transition (Motta, 2018^[23]).

7. Borgonovi et al. (2022^[1]) identify four key areas characterising environmental sustainability competence: embodying sustainability values, embracing complexity in sustainability, envisioning sustainable futures and acting for sustainability. The paper also reveals which 15-year-old students possess such competences, considering differences between both countries and population groups. Crucially, Borgonovi et al. (2022^[1]) consider the four areas of environmental sustainability competence in isolation. This section first takes into account relations between the four areas to identify which students are equipped with the wide range of cognitive, affective and behavioural competences to be able to play a positive role in shaping the future of the environment. If environmental sustainability competence is a tool children have at their disposal to fix environmental problems, which children have the entire toolbox at their disposal? Having the entire toolbox means having attained a given level of proficiency across all competence areas. Students who possess the entire toolbox in environmental sustainability competence are classified in this section as either baseline all-rounders or as advanced all-rounders, depending on their level of science proficiency. This section also considers the relationship between being 'top

performers', i.e. performing at proficiency level 5 and above in science, or reading or mathematics, and environmental awareness. Secondly, the section considers what drives students to take action to protect the environment in the present and the role played by the emotional, cognitive and attitudinal areas of environmental sustainability competence in shaping this propensity.

2.2. Students who are the future environmental leaders and environmentally thoughtful consumers

8. Figure 2.1 and Figure 2.2 illustrate the distribution of 15-year-old students who, in 2018, had acquired the full range of cognitive, affective and behavioural dimensions of environmental sustainability to be able to exert positive change in the future: i.e. students who were 'environmental competence all-rounders'. Environmental competence all-rounders are students who, by age 15, have acquired the four key competence areas that characterise environmental sustainability. They include achieving certain benchmarks in science literacy, displaying an awareness of key environmental problems, having the agency to take action, caring for the environment and having the willingness to act to protect the environment.

9. Two groups of all-rounders can be identified depending on their level of proficiency in science (see Box 2.1). **Baseline all-rounders** are students who, on top of fulfilling the other environmental competence areas, performed at least at the PISA baseline level of science proficiency (PISA level 2, see Section 1 in Borgonovi et al. (2022_[1]) for a description). Baseline all-rounders can be expected to have acquired the level of skills that will enable them to become thoughtful citizens, to be engaged in protecting the environment through their consumption decisions and lifestyle choices and who will have the emotional, cognitive and behavioural mindset to be able to consider the environmental consequence of their actions. The second group is that of **advanced all-rounders**, students who mastered the science skills needed to have a strong performance in PISA (defined as achieving at least proficiency level 4) and who, in the future, could engage more directly to shape the green economy by developing new technologies, innovating in the use of existing technologies in environmentally sound ways or by developing new solutions to reduce the environmental footprint associated with producing goods and services.

Box 2.1. All-rounders

Baseline all-rounders are students who, on top of fulfilling the other environmental competence areas, performed at least the PISA baseline level of science proficiency. Students are categorised as baseline all-rounders if all of the following apply:

- awareness. Students report either 'I know something about this and could explain the general issue' or 'I am familiar with this and I would be able to explain this well' about the environmental issues of climate change and global warming; and a minimum science proficiency at level 2;
- caring for the environment. Students agree or strongly agree that looking after the environment is important to them;
- science self-efficacy. 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 (for the tasks, see Box 1.5 in Borgonovi et al. (2022_[1]));
- environmental behaviour. Engagement in either energy saving or in collective action to protect the environment.

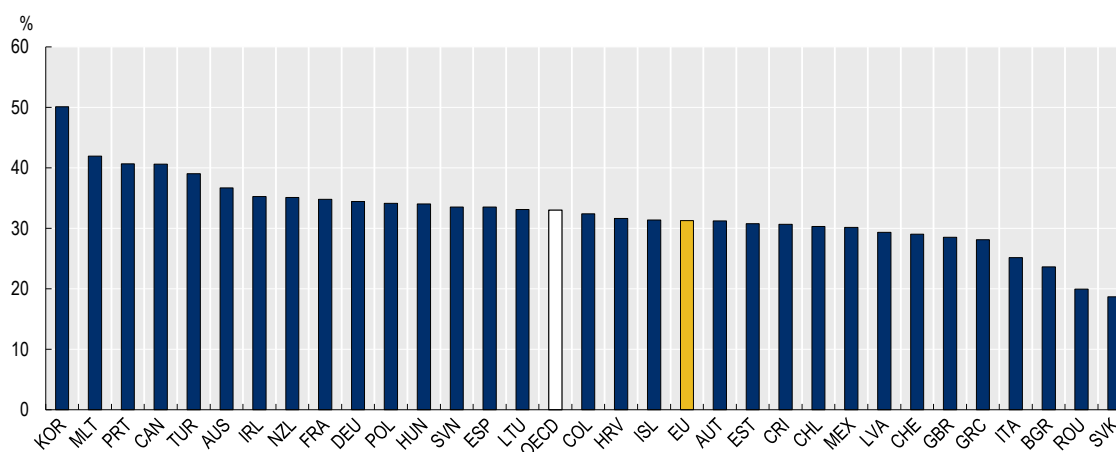
The second group is that of **advanced all-rounders**, students who mastered the science skills needed to have a strong performance in PISA, meaning – as opposed to baseline all-rounders – they need to achieve science proficiency level 4 as a minimum.

10. Figure 2.1 illustrates the percentage of 15-year-old students who, in 2018, were baseline all-rounders. On average throughout EU countries, 31% of 15-year-old students were baseline all-rounders (33% throughout OECD countries). These students achieved at least PISA baseline levels in science, they reported being aware of climate change and global warming, they felt confident about discussing or explaining environmental problems to others, they reported that caring for the environment was important to them and engaged in pro-environmental behaviour by either saving energy or participating in environmental groups. In Korea, one in two 15-year-old students in 2018 was a baseline all-rounder, the largest share throughout all EU and OECD countries with available data. In Malta, Portugal and Canada, over 40% of 15-year-olds were baseline all-rounders. By contrast, in Italy, Bulgaria, Romania and the Slovak Republic only one in four 15-year-old students or less was a baseline all-rounder.

11. In general, results presented in Figure 2.1 indicate that, on average throughout EU and OECD countries, only around one in three students, by age 15, mastered the emotional, cognitive and behavioural areas of environmental sustainability competence that represent a solid foundation upon which to build their future and the future of the planet. In other words, the vast majority of 15-year-old students in 2018 failed to acquire the entire environmental competence toolbox.

Figure 2.1. Distribution of baseline all-rounders, by country (PISA 2018)

Percentage of 15-year-old students who achieved at least baseline levels in the four environmental sustainability competence areas



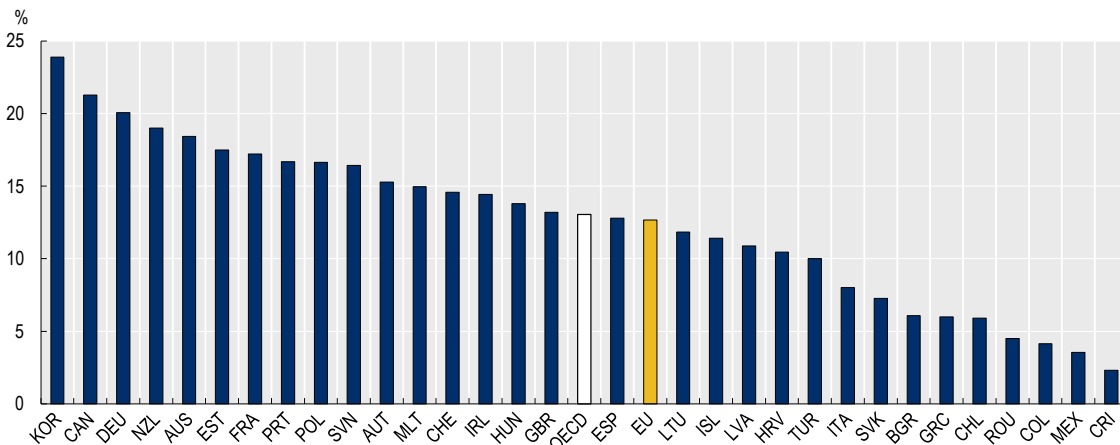
Note: Countries are sorted in descending order of the percentage of students who are baseline all-rounders. Results were obtained from the subsample of students with valid information on all areas. The figure presents the percentage of students who reported that looking after the environment was important to them; who achieved at least the baseline proficiency level 2 in the PISA science assessment; who indicated being aware of climate change and global warming; who reported high levels of environmental self-efficacy (see Section 1 in Borgonovi et al. (2022)⁽¹⁾ for a full description); and who reported either reducing energy consumption for environmental reasons or participating in activities in favour of environmental protection.

Source: Calculations based on OECD (2018⁽²⁴⁾), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

12. Figure 2.2 illustrates the distribution of 15-year-old students who, in 2018, were advanced all-rounders. It indicates that, on average throughout EU and OECD countries 13% of 15-year-old students in 2018 were advanced all-rounders, meaning that they were strong performers in the PISA science test, achieving at least proficiency level 4, as well as reporting that looking after the environment was important to them, being aware of climate change and global warming, having high environmental self-efficacy and engaging in pro-environmental behaviours. Only in Korea, Canada and Germany did at least one in five students satisfy all conditions to be considered advanced all-rounders, reflecting the high number of students who, at age 15, achieved only baseline proficiency levels in science. In nine countries – Italy, the Slovak Republic, Bulgaria, Greece, Chile, Romania, Colombia, Mexico and Costa Rica – less than one in ten students was an advanced all-rounder. This is despite the fact that in order to ensure an economy-wide effort to meet ambitious climate targets, EU and OECD economies will have to reorient production to satisfy net-zero requirements, and such reorientation requires labour market reallocation towards jobs in the green economy. Such jobs require strong technical skills, which most children in EU and OECD countries lack.

Figure 2.2. Distribution of advanced all-rounders, by country (PISA 2018)

Percentage of 15-year-old students who achieved high levels in the four environmental sustainability competence areas



Note: Countries are sorted in descending order of the percentage of students who are advanced all-rounders. Results were obtained from the subsample of students with valid information in all areas. The figure presents the percentage of students who reported that looking after the environment was important to them; who achieved at least the baseline proficiency level 4 in the PISA science assessment; who indicated being aware of climate change and global warming; who reported high levels of environmental self-efficacy (see Section 1 in Borgonovi et al. (2022_[11]) for a full description); and who reported either reducing energy consumption for environmental reasons or participating in activities in favour of environmental protection.

Source: Calculations based on OECD (2018_[24]), “PISA 2018 Database”, <https://www.oecd.org/pisa/data/2018database/>.

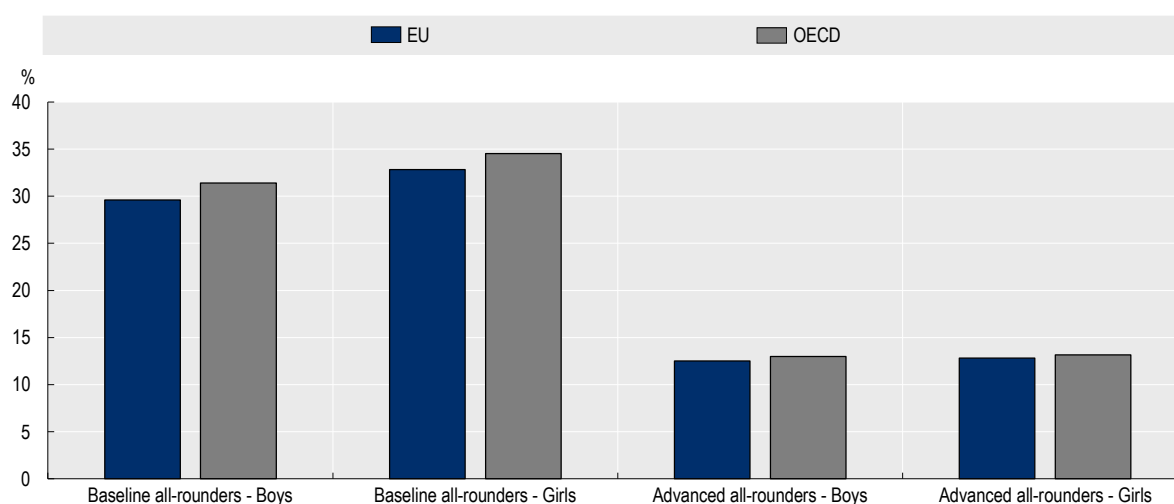
2.3. Disparities in environmental sustainability all-rounders

13. Figure 2.3 shows, for the EU and OECD average, the percentage of boys and girls who were baseline all-rounders and who were advanced all-rounders. Results indicate that in 2018 more girls than boys were baseline all-rounders: 33% of girls but 30% of boys were baseline all-rounders throughout EU countries and 35% of girls but 31% of boys were baseline all-rounders throughout OECD countries. Detailed country analyses reveal that gender differences in favour of girls were especially pronounced in

Korea, Lithuania and Poland, where the gender gap was 7 percentage points; Bulgaria and Malta, where the gap was 8 percentage points; and Turkey, where the gender gap was 9 percentage points. By contrast, Figure 2.3 shows that in 2018, there was no gender difference in the percentage of boys and girls who were advanced all-rounders: 13% of boys and girls throughout EU and OECD countries could be classified as advanced all-rounders. Country-specific analyses reveal that in Korea and Estonia, girls were considerably more likely than boys to be classified as advanced all-rounders (in Estonia 19% of girls but 16% of boys, and in Korea, 25% of girls but 23% of boys).

Figure 2.3. Distribution of baseline and advanced all-rounders, by gender, EU and OECD averages (PISA 2018)

Percentage of 15-year-old boys and girls who achieved baseline and high levels in the four environmental sustainability competence areas



Note: The figure presents the percentage of boys and girls who reported that looking after the environment was important to them; who achieved at least the baseline proficiency level 2 (baseline all-rounders) and level 4 (advanced all-rounders) in the PISA science assessment; who indicated being aware of climate change and global warming; who reported high levels of environmental self-efficacy (see Section 1 in Borgonovi et al. (2022^[1]) for a full description); and who reported either reducing energy consumption for environmental reasons or participating in activities in favour of environmental protection.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

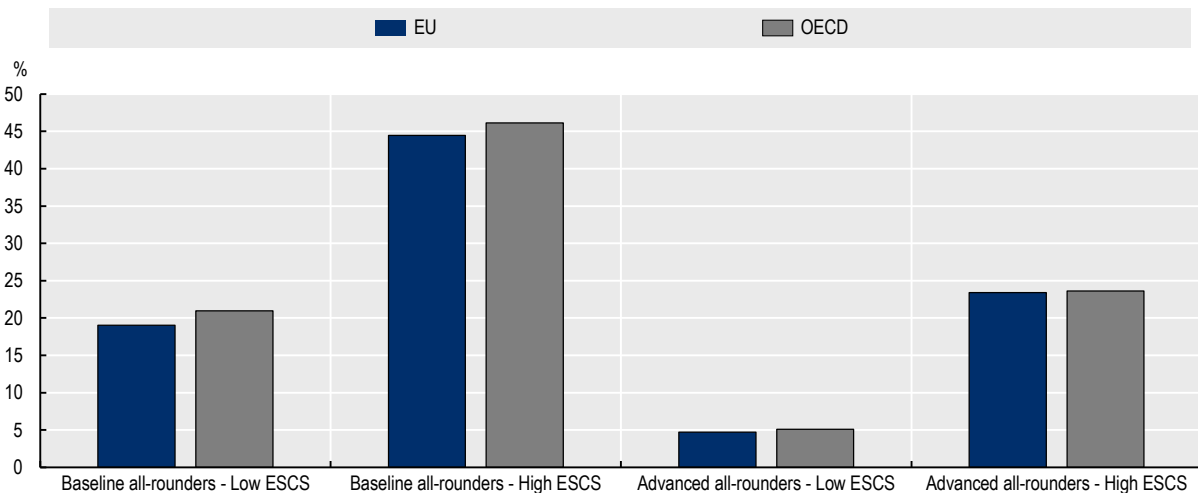
14. Figure 2.4 shows, for the EU and OECD average, the percentage of socio-economically disadvantaged and advantaged students who were baseline all-rounders and who were advanced all-rounders. Socio-economically disadvantaged students are students in the bottom quartile of the national distribution of the PISA index of economic, social and cultural status (ESCS). Socio-economically advantaged students are students in the top quartile of the national distribution of ESCS. On average throughout EU countries, 19% of socio-economically disadvantaged but 44% of socio-economically advantaged students were baseline all-rounders, a difference of 25 percentage points. Similarly, on average throughout OECD countries, 21% of socio-economically disadvantaged but 46% of socio-economically advantaged students were baseline all-rounders, a difference of 25 percentage points. Country-specific analyses reveal that socio-economic disparities in the percentage of baseline all-rounders were larger than 30 percentage points in Hungary, Portugal and Bulgaria and were below 20 percentage points only in Italy (16 percentage-point difference) and Turkey (17 percentage-point difference).

15. Figure 2.4 also shows that there are large differences per socio-economic status in the likelihood that 15-year-old students will be advanced all-rounders. On average throughout EU countries, 5% of socio-economically disadvantaged but 23% of socio-economically advantaged students were advanced

all-rounders, a difference of 19 percentage points. Similarly, on average throughout OECD countries, 5% of socio-economically disadvantaged but 24% of socio-economically advantaged students were advanced all-rounders, a difference of 19 percentage points. Country-specific analyses reveal that socio-economic disparities in the percentage of advanced all-rounders were larger than 25 percentage points in Switzerland, Germany, France, New Zealand and Portugal. These results are especially concerning because PISA reveals that students with a socio-economically disadvantaged background are less likely than their more advantaged counterparts to expect to continue their studies (OECD, 2021^[25]), and individuals from disadvantaged backgrounds are more likely to work in jobs that are likely to be displaced by the twin digital and green transition. These results suggest that initial education systems are currently failing to equip many youngsters, and socio-economically disadvantaged youngsters in particular, with the foundation skills and mindset that they will need to find employment in the new green economy.

Figure 2.4. Distribution of baseline and advanced all-rounders, by socio-economic status, EU and OECD averages (PISA 2018)

Percentage of socio-economically advantaged and disadvantaged 15-year-old students who achieved baseline and high levels in the four environmental sustainability competence areas



Note: The figure presents the percentage of socio-economically advantaged and disadvantaged students who reported that looking after the environment was important to them; who achieved at least the baseline proficiency level 2 (baseline all-rounders) and level 4 (advanced all-rounders) in the PISA science assessment; who indicated being aware of climate change and global warming; who reported high levels of environmental self-efficacy (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, see Box 1.5 in Borgonovi et al. (2022^[11]) for a full description); and who reported either reducing energy consumption for environmental reasons or participating in activities in favour of environmental protection. Socio-economically disadvantaged students are students in the bottom quartile of the national distribution of the PISA index of Economic, Social and Cultural status (ESCS). Socio-economically advantaged students are students in the top quartile of the national distribution of ESCS.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

2.4. Are all top-performing students aware of environmental problems?

16. The literature highlights a positive correlation between overall science achievement and students' environmental awareness, although the strength of this association differs between countries (Oliver and Adkins, 2020^[26]). Scientific competences allow students to interpret information based on sound evidence, a process that could translate into higher levels of awareness (Rychen and Salganik, 2003^[12]). Moreover, through scientific studies, students may become more interested in topics important to today's and

tomorrow's global challenges, such as the sustainability of natural environments, and subsequently develop environmental awareness.

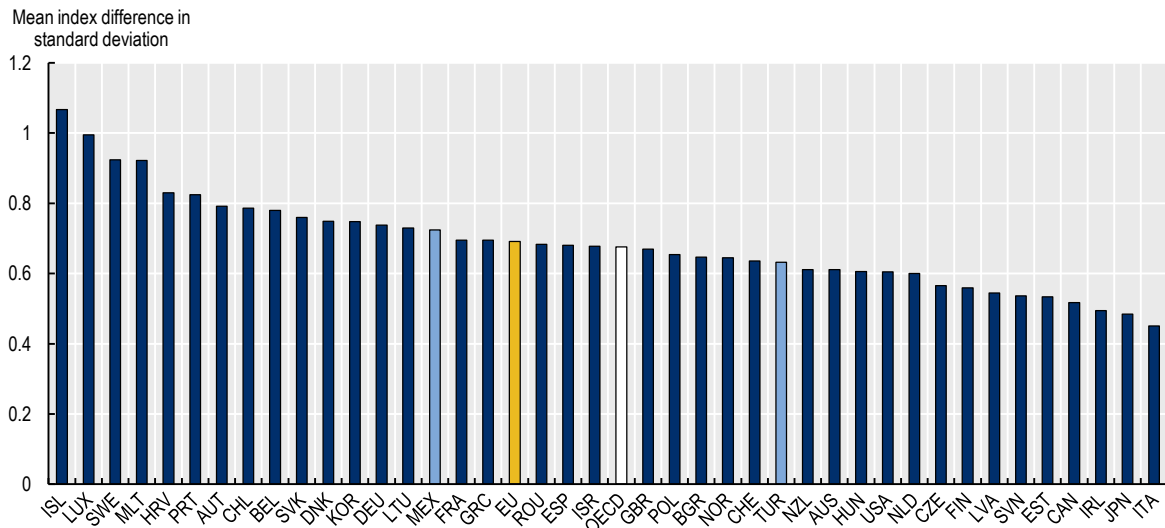
17. This section focuses on top performers in scientific fields. These are students who achieved PISA proficiency level 5 or above in science-related topics. Top performers can creatively and autonomously apply their knowledge to a wide variety of situations (OECD, 2019^[27]). Thus, they own the skills to develop a critical awareness of environmental issues that, in turn, make them potentially more environmentally oriented than other students. A study on students aged 9-15 years old from Eastern Anatolia, Turkey, revealed that top performers in science and mathematics reported higher awareness scores on environmental education concepts compared to other students (Mutlu, Nacaroglu and Doğan, 2021^[28]). Similarly, science top performers in Korean elementary schools showed levels of environmental knowledge higher than the average (Jung, 2012^[29]). Finally, in a study of high school students in the United States, Maker and Zimmerman (2020^[30]) indicated that top students in STEM subjects were more likely to develop critical and systemic thinking about environmental changes.

18. The scientific literature is not conclusive in defining a link between top-performing students and pro-environmental behaviours. For instance, using a sample of engineering and psychology students from north-western Mexico, Giannetti et al. (2021^[31]) highlighted that students with better academic results engaged to the same extent as other students in environmental sustainability behaviours. On the other hand, using a sample of secondary school students in Turkey aged 13 or 14, Saricam and Sahin (2015^[32]) showed that top performers reported higher levels of both environmental awareness and environmental behaviours compared to other students.

19. Figure 2.5 illustrates the mean index difference in environmental awareness between top performers and non-top performers in science in PISA 2015. On average throughout EU and OECD countries, top performers in science reported a level of awareness that was almost 70% of a SD higher compared to other students. This finding was consistent throughout countries and varied between 45% of a SD in Italy and 107% of a SD in Iceland. Estimates were significantly different from zero for all of the countries analysed, with the only exceptions being Mexico and Turkey – countries with a small overall number of top performers in science.

Figure 2.5. Mean difference in environmental awareness between top performers and non-top performers in science, by country (PISA 2015)

Standard deviation difference in the index of environmental awareness between top performers and non-top performers



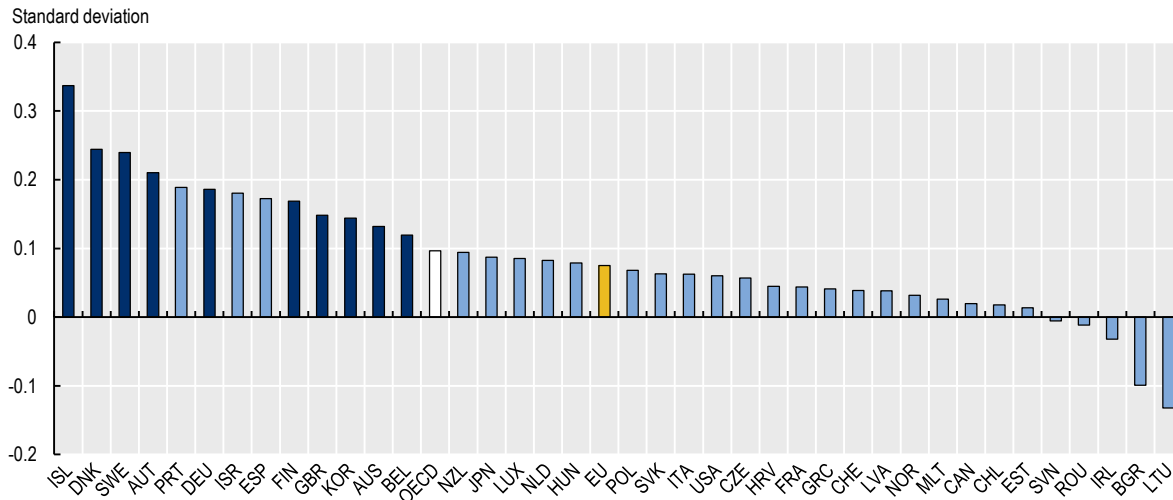
Note: The figure shows the mean index difference between 15-year-old top performers and non-top performers who reported to know about ('I know something about this and could explain the general issue') or to be familiar ('I am familiar with this and I would be able to explain this well') with the following environmental topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortages, the increase in greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Top performers in science are students with proficiency levels ≥ 5 . Light colours denote that shares are not significantly different between top and non-top performers at a 5 per-cent significance level. Countries are sorted in descending order based on the standard deviation difference in environmental awareness between top performers and non-top performers for available EU and OECD countries.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

20. Figure 2.6 presents differences in levels of environmental awareness between top performers and other students after accounting for differences between the two groups in other characteristics as well as their achievement in mathematics and reading. Differences in levels of awareness between the two groups are greatly reduced, although in several countries top performers reported higher levels of environmental awareness, and in countries where differences were in favour of non-top performers, estimated differences could not be considered to be different from zero with a high degree of confidence. On average throughout EU countries, top performers reported levels of awareness of environmental problems that were 8% of a SD higher than otherwise similar non-top performers. Throughout OECD countries, this difference corresponded to 10% of a SD. Differences were greatest in Iceland (34% of a SD), Denmark and Sweden (24% of a SD).

Figure 2.6. Mean difference in environmental awareness between top performers and non-top performers in science after controlling for students' background characteristics, by country (PISA 2015)

Estimated effect of being a top performer in science on environmental awareness expressed in standard deviation units



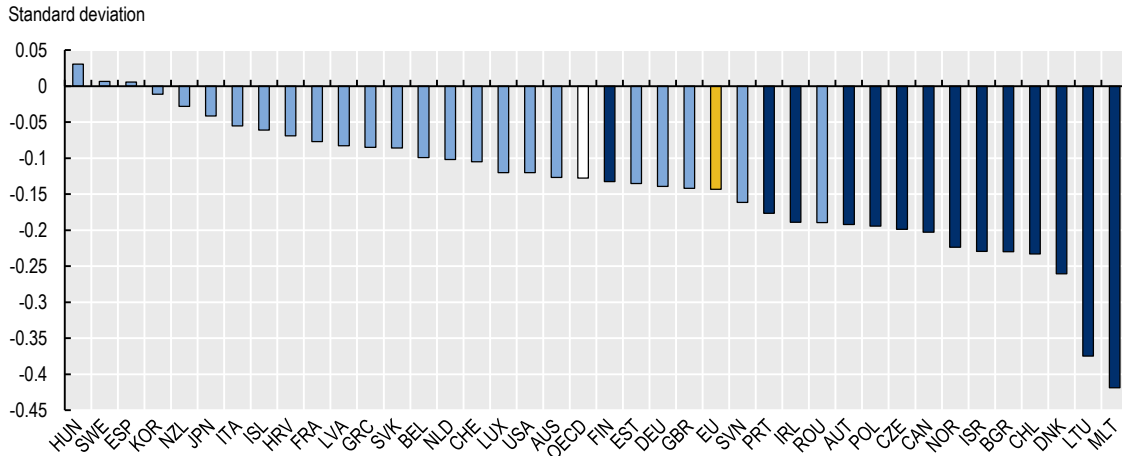
Note: The figure shows the mean index difference in environmental awareness between being a top performer in science and not being a top performer in science. Environmental awareness reflects awareness of the following environmental topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortages, the increase in greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Top performers in science are students who performed at proficiency levels 5 or above in the PISA science test. Results are obtained controlling for students' gender, students' individual PISA index of economic, social, and cultural status (ESCS), the mean ESCS of the school attended by the student, immigrant background, language spoken at home and reading and mathematics achievement. Light colours denote differences that are not significantly different from zero at the 5 per-cent significance level. Countries are sorted in descending order of mean index difference for available EU and OECD countries.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

21. The consistency of a positive relationship between being a top performer in science and reporting high levels of environmental awareness (even when controlling for students' achievement in other academic domains) suggests that science education plays a central role in the formation of environmental awareness. This is further supported by the fact that top performers in reading and top performers in mathematics are not more likely to report high levels of environmental awareness than students who perform at lower levels in those domains. In fact, Figure 2.7 and Figure 2.8 reveal that top performers in reading and mathematics reported lower levels of environmental awareness after controlling for other background characteristics.

Figure 2.7. Mean difference in environmental awareness between top performers and non-top performers in reading after controlling for students' background characteristics, by country (PISA 2015)

Estimated effect of being a top performer in reading on environmental awareness expressed in standard deviation points

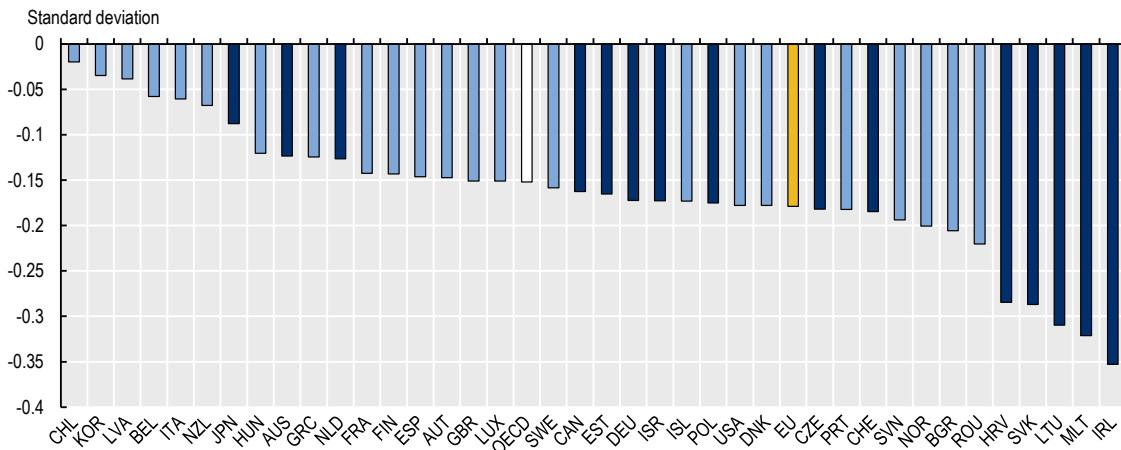


Note: The figure shows the mean index difference in environmental awareness between top performers in reading and non-top performers in science. Environmental awareness reflects awareness of the following environmental topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortages, the increase in greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Top performers in science are students who performed at proficiency level 5 or above in the PISA science test. Results are obtained by controlling for students' gender, students' individual PISA index of economic, social, and cultural status (ESCS), the mean ESCS of the school attended by the student, immigrant background, language spoken at home, and science and mathematics achievement. Light colours denote differences that are not significantly different from zero at the 5 per-cent significance level. Countries are sorted in descending order of mean index difference for available EU and OECD countries.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

Figure 2.8. Mean difference in environmental awareness between top performers and non-top performers in mathematics after controlling for students' background characteristics, by country (PISA 2015)

Estimated effect of being a top performer in mathematics on environmental awareness expressed in standard deviation points



Note: The figure shows the mean index difference in environmental awareness between being a top performer in reading and not being a top performer in science. Environmental awareness reflects awareness of the following environmental topics: air pollution, the extinction of plants and animals, the consequences of clearing forests for land use, water shortages, the increase in greenhouse gases in the atmosphere, nuclear waste and the use of genetically modified organisms. Top performers in science are students who performed at proficiency level 5 or above in the PISA science test. Results are obtained by controlling for students' gender, students' individual PISA index of economic, social, and cultural status (ESCS), the mean ESCS of the school attended by the student, immigrant background, language spoken at home and science and reading achievement. Light colours denote differences that are not significantly different from zero at the 5 per-cent significance level. Countries are sorted in descending order of mean index difference for available EU and OECD countries.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

2.5. Which environmental sustainability competence areas predict pro-environmental behaviours among 15-year-old students?

22. Previous sections considered students' engagement in pro-environmental behaviours as representing their willingness to act for sustainability in the future. However, students' actions at present are key to environmental welfare and, as such, describe 15-year-old students' present contribution to environmental sustainability. Figure 2.5 and Figure 2.6 consider how students' current engagement in individual and collective forms of pro-environmental behaviours depends on emotional, attitudinal and cognitive areas of environmental sustainability competence. The figures illustrate the percentage-point difference in the probability that 15-year-old students report reducing energy consumption for environmental reasons and participation in environmental groups that is associated with a one-unit change in emotional, attitudinal and cognitive dimensions of environmental sustainability competence. Percentage-point differences represented in the figure compare students with similar gender, socio-economic status, language and migration status and attending schools with a similar socio-economic intake. Furthermore, they were estimated when comparing students with similar levels of sustainability competence on the other dimensions.

Box 2.2. Top and strong performers

Section 1.4 focuses on the environmental awareness of top performers, who are students achieving a PISA proficiency level equal to or above 5. The advanced all-rounders described in this section instead consider strong performers in science, who are defined as students with a proficiency level equal to or above 4. The adoption of a wider threshold in the definition of advanced all-rounders allow a significant share of students to be considered, which would not be possible if referring only to top performers with all of the key competences of environmental sustainability.

Indeed, throughout EU countries, the mean share of science top performers was only 5.9% in 2018 and 7.4% in 2015; while throughout OECD countries, the 2018 and 2015 averages were 6.7% and 7.4%, respectively. The values were heterogeneous throughout countries and were even close to zero in some cases. For instance, Mexico, the country with the lowest share of top performers in science, reported a share of only 0.3% in 2018. The share of strong performers with science proficiency level 4 and above in 2015 throughout OECD countries was 18.6%, and 21% throughout EU countries.

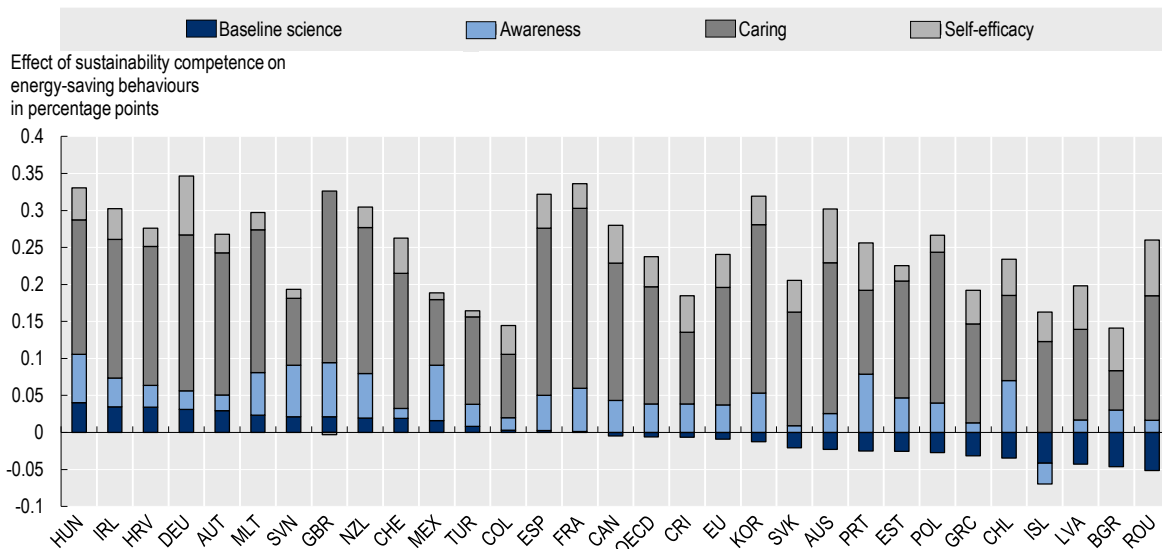
The mean share of reading top performers in 2015 was 7% throughout OECD countries and 7.5% throughout EU countries. Meanwhile, among strong performers (reading level 4 and above), the mean share of students was 20% throughout OECD countries and 21% throughout EU countries. In mathematics, the mean share of top performers in 2015 was 8.1% throughout OECD countries and 8.5% throughout EU countries. For the share of strong performers (mathematics level 4 and above), the average share is 18.1% throughout OECD and 19.2% throughout EU countries.

Even if top and strong performers partially refer to the same students, they could present several differences. Compared to strong performers, top performers in science generally show greater intention to cultivate their scientific interests by pursuing further scientific studies or by working in a science-related field. Besides, top performers in science are generally found to report higher levels of enjoyment in science compared to strong achievers (see OECD (2009^[34])).

23. Results reported in Figure 2.9 indicate that, on average throughout OECD and EU countries with available data, students who agreed or strongly agreed that looking after the global environment was important to them were 16 percentage points more likely to save energy than those who disagreed or strongly disagreed with the statement. In particular, in Germany, Spain, France, the United Kingdom, Australia, Poland and Korea, the difference in the percentage of 15-year-old students who reported engaging in energy-saving behaviours between those who reported caring about the environment and those who did not was larger than 20 percentage points. Differences were smallest and corresponded to less than 5 percentage points in Bulgaria and Lithuania.

24. Figure 2.9 also suggests that a high level of environmental self-efficacy is strongly associated with engagement in saving energy. On average, throughout EU and OECD countries with available data, students who reported high levels of environmental self-efficacy were 4 percentage points more likely to report saving energy because of environmental reasons than students with low levels of environmental self-efficacy. The difference in the propensity to engage in energy-saving behaviour between students with high and low levels of environmental self-efficacy was highest in Romania, Germany and Lithuania (greater than 7 percentage points). The difference in energy-saving behaviour between students who achieved at least baseline proficiency levels in the PISA science test (i.e. achieved proficiency level 2) and those who did not was negative but quantitatively small. On average throughout EU and OECD countries students who achieved at least at baseline proficiency levels in science were 1 percentage point less likely to engage in energy-saving behaviours than other similar students. In Italy, the difference was larger and corresponded to 7 percentage points, and in Romania and Bulgaria, corresponded to 5 percentage points. Finally, students who reported being aware of environmental problems were 4 percentage points more likely, on average throughout EU and OECD countries, to engage in energy-saving behaviours than students who reported low levels of environmental awareness.

Figure 2.9. The association between sustainability competence areas and energy-saving behaviours, by country (PISA 2018)



Notes: Countries are sorted in descending order of the percentage-point difference in energy saving associated with students being top performers in science. Results were obtained by estimating whether a respondent reported as a function of the four dimensions of sustainability competence, as well as gender, individual socio-economic status measured using the PISA index of Economic, Social and Cultural Status, an indicator of whether the respondent spoke, at home, the same language of the PISA test and whether they or their parents were born outside of the country in which they sat the PISA test; as well as the school average socio-economic status.

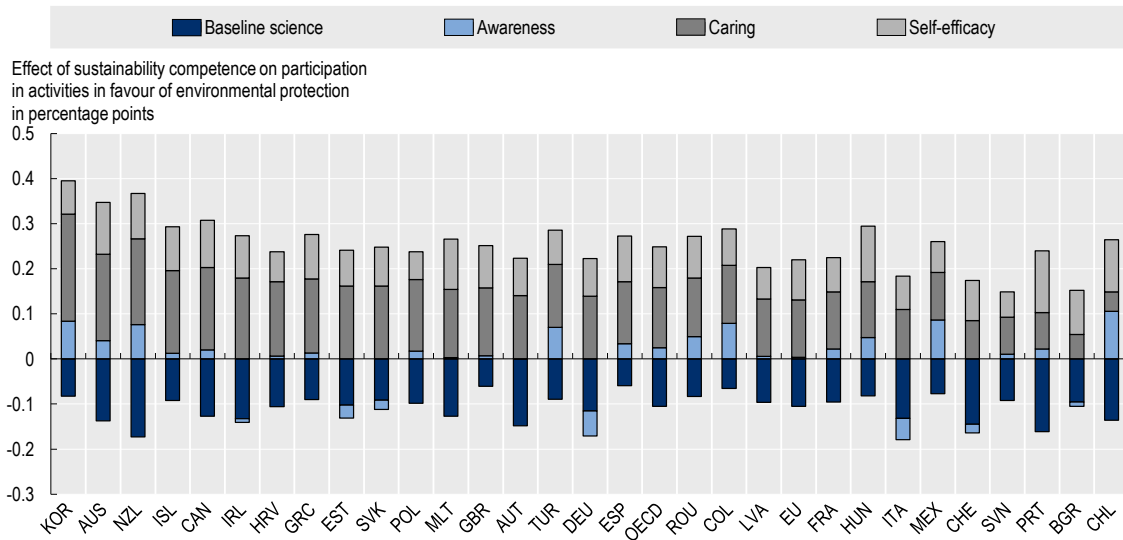
Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

25. Figure 2.10 illustrates associations with participation in activities in favour of environmental protection. In line with energy-saving behaviour, participation in activities in favour of environmental protection varies markedly depending on whether or not students report caring about the environment and depending on their level of environmental self-efficacy. Data from 2018 reveal that 15-year-old students who reported caring about the environment and who had high levels of environmental self-efficacy were more likely to participate in activities in favour of environmental protection. By contrast, in most countries, participation in activities in favour of environmental protection was lower among students who achieved at least baseline levels in science and similar irrespective of any reported awareness of environmental issues.

26. On average throughout EU and OECD countries with available data, students who reported high levels of environmental self-efficacy were 9 percentage points more likely to report participating in activities in favour of environmental protection than students with low levels of environmental self-efficacy. The difference in the propensity to participate in activities in favour of environmental protection between students with high and low levels of environmental self-efficacy was highest in Portugal, Hungary and Chile. Similarly, students who reported caring about the environment were 13 percentage points more likely to have participated in activities in favour of environmental protection throughout EU and OECD countries. The difference was largest in Korea – 24 percentage points – and smallest in Lithuania, where it was 3 percentage points and not statistically significantly different from no difference. The difference in participation in activities in favour of environmental protection between students who achieved at least baseline performance levels in science and those who did not was strong and negative. Other things being equal, throughout EU countries, students who achieved at least baseline levels of science proficiency were 10 percentage points less likely to have participated in activities (11 percentage points throughout OECD countries). Finally, throughout OECD countries, students who reported being aware of environmental problems were 3 percentage points more likely to report participating in activities in favour of environmental

protection than students who did not. On average, no difference could be observed between students in EU countries.

Figure 2.10. The association between sustainability competence and participation in activities in favour of environmental protection (PISA 2018)



Note: Countries are sorted in descending order of the percentage-point difference in activities in favour of environmental protection associated with students who achieved baseline levels of science performance. Results were obtained by estimating whether a respondent reported as a function of the four areas of sustainability competence, as well as gender, individual socio-economic status measured using the PISA index of Economic, Social and Cultural Status, an indicator of whether the respondent spoke, at home, the same language of the PISA test and whether they or their parents were born outside of the country in which they sat the PISA test; as well as the school average socio-economic status. Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

3 Do children know how to work together to achieve a green future?

3.1. Introduction

27. Many of the environmental problems we face today are the result not only of profound failures of free-market mechanisms (Stern, 2008^[35]) but also of the absence of effective governance arrangements on an appropriate scale to tackle these (Bennett and Satterfield, 2018^[36]; Bodin, Mancilla García and Robins, 2020^[37]; Vatn, 2018^[38]). Environmental problems such as air pollution, inefficient use of natural resources (e.g. water and land), over-consumption of goods resulting in excess amounts of waste and adding to carbon emissions require, by their very nature, collaboration between different stakeholders. Achieving successful collaboration to solve complex environmental challenges that cross geographic scales and national boundaries requires an alignment of wills and objectives, the awareness of the effects of human activities on the environment but also the creation of institutional arrangements, regulatory frameworks and working practices that rely on collaboration.

28. From global to local level, tackling climate change and promoting environmentally sustainable growth relies on individuals working with others to achieve change. Doing so effectively hinges on the willingness and ability of individuals and communities to reach out to others with different interests, values and expertise. Although, by its nature, environmental governance requires collaboration, studies have repeatedly shown that stakeholders often lack the willingness or the ability to deliberate and contribute to jointly negotiated solutions to common environmental problems.

29. Collaboration usually means a joint effort by group members to solve a task or a series of tasks. The effort is characterised by two crucial features: **task focus and collective orientation** (Webster and Walker, 2016^[39]). Task focus means that (a) there are objective standards to assess whether the group has successfully solved the task or failed to do so; and (b) group members care about succeeding in the task and, consequently, tend to act in a way that maximises the chances of the group's success in solving it. Collective orientation, in turn, means that group members are expected to take into account one another's suggestions and propositions about how to go about solving the problem. In other words, if the task at hand is a group task, group members have to act collectively, in accord with one another. The group would not do a good job if each of its members acted on their own. All in all, successful collaboration means that collective goals and interest are given primacy over the individual ones.

30. Thus, collaboration often involves tension between individual and collective motivations. This tension is also inherent in many social dilemmas, including environmental ones. In social dilemmas, individuals face a choice between **cooperation**, or a behaviour that is beneficial to the group, and **defection**, or a self-interested behaviour that benefits the individual. Individuals who fail to cooperate are not necessarily driven purely or primarily by self-interest. Sometimes, they simply recognise that other members of the community benefit from their cooperative behaviour and, consequently, refuse to cooperate not to be exploited by others. Thus, to protect themselves from defection motivated by **greed** (i.e. the temptation to free-ride on others' contributions) or **fear** (i.e. reluctance to be exploited by others (Kuwabara, 2005^[40]; Simpson, 2003^[41]), communities often develop institutional solutions to social

dilemmas which make defection more costly, compared to cooperation (Habyarimana et al., 2009^[42]; Ostrom, 2010^[43]; Simpson and Willer, 2015^[44]).

31. Promoting sustainability requires different forms of collaboration to facilitate effective decision-making and co-ordination. Many environmental problems require careful negotiation during the decision-making process so that a solution is reached despite the fact that different stakeholders hold different interests and suffer different costs and benefits from taking action. For example, a major industrial plant may be reluctant to modernise its production system in order to minimise its footprint on the local environment, arguing that the owners of the plant will be the only ones to pay the cost of the modernisation, while its benefits accrue to the whole community. They might thus demand that the community contributes to the cost of modernisation, to which the local authorities might respond that the owners do not have the right to pollute the environment (and need to bear the costs for restoring it). Other problems require the building up of a consensus for action when different stakeholders may hold different views and opinions and where reaching successful solutions requires making the most of such diversity to avoid ‘group thinking’. For example, city authorities, businesses, organisations and citizens can debate whether the city’s budget should be allocated to private car transport or rather increasing the green and blue infrastructure of the city in an effort to mitigate the consequences of global warming and extreme heat events. It is important that all parties can present their points of view and voice their concerns.

32. Finally, other types of problems still require different groups to pool information and their unique abilities because no group or individual has the range of expertise or can gather all of the information required to fully understand the problem and achieve a solution. Failure to secure the participation of all stakeholders with relevant skills or information can jeopardise appreciating all aspects of the problem and finding effective solutions. For instance, if authorities of a community proposed the construction of a hydropower plant to reduce carbon dioxide emissions and increase the share of renewable energy in the community’s energy mix, experts and activists could point to the fact that the construction of the power plant might have an adverse impact on biodiversity and pose a threat to fish and other species living in or by the river which would drive the plant. In this case, the exchange of information between the authorities, experts, activists, etc. might lead to finding a more sustainable alternative to the hydropower plant.

33. This section maps the extent to which today’s generation of children has developed the mindset that is required to effectively tackle climate change, i.e. if young people have – alongside key environmental sustainability competences as described in Borgonovi et al. (2022^[1]) – the willingness and ability to collaborate with others to solve such problems. As a matter of fact, both collaborative dispositions and sustainability competence are often listed as 21st century skills (Bianchi, 2020^[45]; Tang, Liu and Wen, 2021^[46]). Data used in this section come from the PISA 2015 assessment in which students were probed about their attitudes to collaboration and assessed on their collaborative problem-solving skills. Collaborative problem-solving was defined as ‘the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution’ (OECD, 2017^[47]).

3.2. Collaborative dispositions

34. The objective of this section is to examine students’ attitudes towards and the ability to work collectively with others on a common task using data from 15-year-old students who took part in the computer-based assessment in PISA 2015. Three measures related to collaborative dispositions and skills are considered: (a) how much students **value teamwork**; (b) how much students **value relationships**; and (c) **collaborative problem-solving skills (CPS)** (OECD, 2017^[47]).

Box 3.1. How students' collaborative dispositions are measured

Students participating in PISA 2015 were asked in the background questionnaire to report how much they agreed, using a four-point scale ranging from strongly disagree to strongly agree, with the following statements:

- I prefer working as part of a team to working alone;
- I find that teams make better decisions than individuals;
- I find that teamwork raises my own efficiency;
- I enjoy co-operating with peers.

An index of valuing teamwork 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 for valuing teamwork than the average student throughout OECD countries and positive values indicate higher levels for valuing teamwork than the average student throughout OECD countries.

Students participating in PISA 2015 were also asked to report how much they agreed, using a four-point scale ranging from strongly disagree to strongly agree, with the following statements:

- I am a good listener;
- I enjoy seeing my classmates be successful;
- I take into account what others are interested in;
- I enjoy considering different perspectives.

An index of valuing relationships 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).

The items which make up the index of valuing relationships do not mention teamwork or collaboration explicitly. Maintaining good relationships with others is certainly important in collaboration, but it may also be important in situations that are neither task-focused nor require collective orientation. Put in another way, while the items which make up the index of valuing teamwork are more concerned with the outcome of interaction among group members (e.g. teams making better decisions or being more efficient than individuals working alone), the items making up the index of valuing relationships are more about the interaction itself.

The third measure of collaborative dispositions comes from a test of collaborative problem-solving (CPS), a task-based assessment of students' ability to work collectively and collaboratively on a common task. Rather than their knowledge in some substantive domain, the test was designed to capture students' readiness to take others' suggestions into account when solving the task at hand to arrive at a common solution as a group. In other words, of possible ways to approach the task, some were more collaborative and group-oriented, whereas others were more competitive and self-oriented. Students received higher scores for pursuing the former approach (see OECD (2017)^[47] for more details). Like other task-based assessments in PISA, the scores on the CPS test are scaled to have a mean of 500 and a standard deviation of 100 among all participating countries. Not all countries and economies participating in the 2015 cycle of PISA administered the test: only 54 out of the 79 countries and economies participating in PISA in 2015 did.

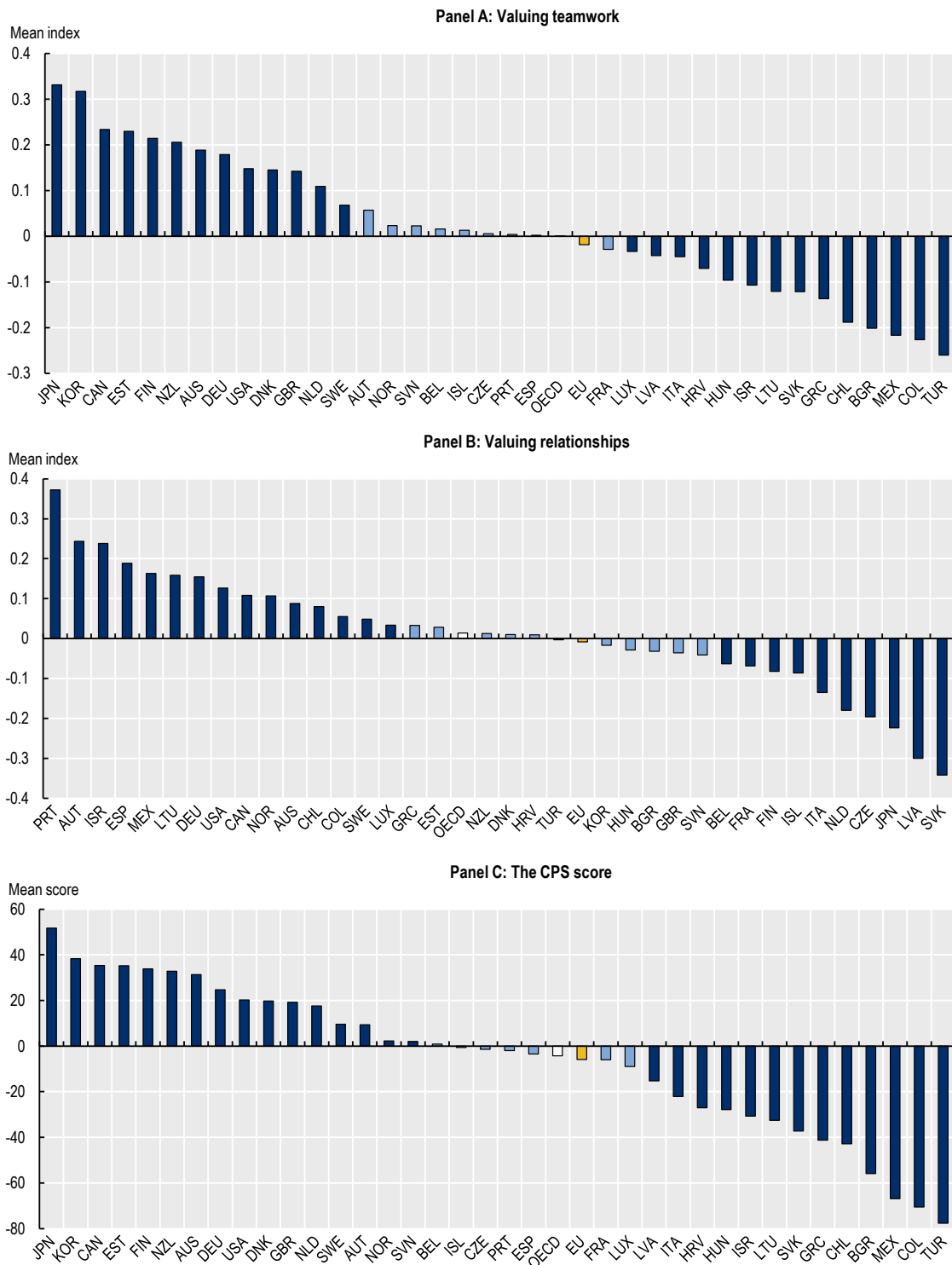
35. Panel A of Figure 3.1 shows the mean values of the index of valuing teamwork in EU and OECD countries. In 2015, there were considerable between-country differences in average levels of the index. In northern European countries (such as the Netherlands, Norway, Finland, Iceland, Sweden and Denmark) and some eastern European countries (such as Latvia, the Slovak Republic or Estonia), students were, on average, less oriented towards teamwork than an average student in OECD countries. In turn, in countries such as Lithuania, Portugal, Colombia, Mexico or Chile, students expressed valuing teamwork at a higher level than the average student throughout OECD countries. Finally, in Italy, Slovenia, Australia, the Czech Republic, Luxembourg, Canada, Hungary and Japan, students expressed levels of valuing teamwork in line with the OECD average.

36. Panel B of Figure 3.1 also indicates that there were large differences between countries in the extent to which students reported valuing relationships. The difference between Portugal, the country with the highest average value of the index, and the Slovak Republic, the country with the lowest average, was around 70% of a standard deviation. Students in Austria, Israel, Spain, Mexico, Lithuania and Germany reported valuing relationships considerably more than the average student in OECD countries, while students in Latvia, Japan, the Czech Republic, the Netherlands and Italy reported valuing them less than the average student. The indices of valuing relationships and valuing teamwork are well correlated. As shown in Figure 3.2, countries where students reported valuing teamwork the most tended to be countries where students reported valuing relationships the most, and vice versa.

37. Finally, Panel C Figure 3.1 indicates that in 2015 there were significant differences in average levels of collaborative problem-solving skills. For example, on average, Japanese students in 2015 had scores on the collaborative problem-solving test that were 52 points above the OECD average, corresponding to around half of a standard deviation. By contrast, Turkish students had an average score of 422 points, i.e. 78 points below the OECD average. In Turkey, Colombia and Mexico, the average score on the CPS test is more than half a standard deviation below the OECD average, while in Australia, New Zealand, Finland, Estonia, Canada, Korea and Japan, in turn, mean performance was significantly above the OECD average.

Figure 3.1. Collaborative problem-solving skills and dispositions, by country (PISA 2015)

Average value of the three measures of collaborative dispositions among 15-year-old students



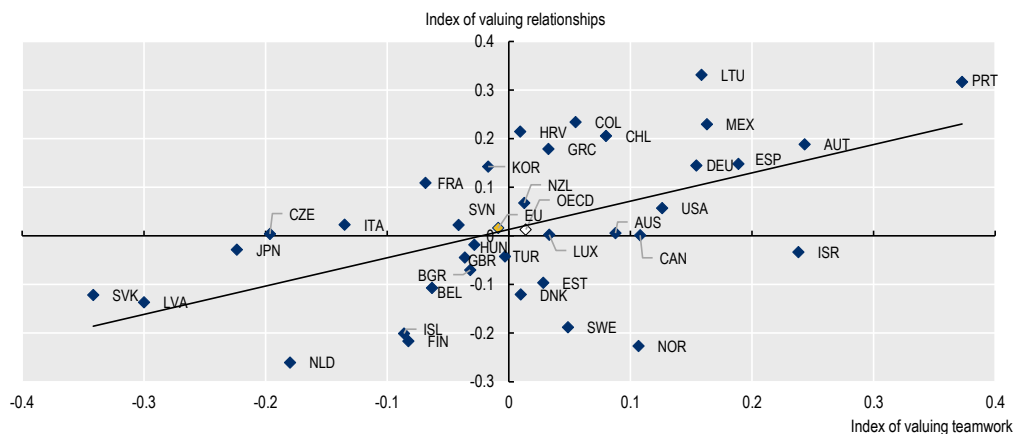
Note: In each panel, countries are ordered in an increasing order by the mean value of the given measure of collaborative dispositions. For individual countries, bars coloured with a darker shade indicate a statistically significant difference from the EU average. See Box 4.1 for more information on how students' collaborative dispositions were measured in PISA 2015.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

38. Figure 3.2 suggests that countries where students reported that, on average, they valued teamwork more were also the same countries where students reported valuing relationships more, suggesting that different aspects of collaborative dispositions were positively correlated at the system level. At the same time, in some countries students appeared to report considerably higher levels in one disposition based on what would be expected given their preferences for the other dispositions, and vice versa. For example, students in Croatia reported levels on the index of valuing relationships that were 20% of a standard deviation above the mean levels of the average OECD student but were similar to the OECD average student in terms of valuing teamwork. By contrast, on average, students in Israel reported average levels for valuing relationships but comparatively high levels for valuing teamwork.

Figure 3.2. Correlation of the average values of the valuing teamwork and valuing relationships indices (PISA 2015)

Country-level means of the index of valuing relationships plotted against means of the index of valuing teamwork among 15-year-olds



Note: Points on the chart represent country-level means of the valuing teamwork and valuing relationships indices. The black solid line shows the linear trend in the association between both indices. See Box 8.1 for more information on how the indices were constructed in PISA 2015.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

3.3. Are girls more collaborative than boys?

39. An increasingly large literature across the social sciences assesses gender differences in preference of collaboration and competition in work and everyday life (Croson and Gneezy, 2009^[48]; Falk and Hermle, 2018^[49]; Vugt, Cremer and Janssen, 2007^[50]). Such literature generally relies on task experiments and identifies women as being more likely to engage in positive social reciprocity and less likely to engage in negative social reciprocity (e.g. (Andreoni and Vesterlund, 2001^[51]; Eagly and Wood, 1991^[52]; Falk and Hermle, 2018^[49]); responding less positively to competitive environments (Niederle and Vesterlund, 2007^[53]); being less aggressive (Eagly and Steffen, 1986^[54]); and being more empathic, an important pre-requisite of successful collaboration (Christov-Moore et al., 2014^[55]). At the same time, gender differences can differ greatly depending on context: for instance, women are found to be more cooperative than men in mixed-gender groups, but in same-gender groups it is men who are found to be more cooperative (Balliet et al., 2011^[56]). Furthermore, research on social dilemmas finds that men fail to cooperate due to greed (i.e. the temptation to take advantage of others), whereas women fail to co-operate

because of the fear of being exploited by others (Kuwabara, 2005^[40]; Simpson, 2003^[41]). In task groups, women are more likely to accept influence from men (Ridgeway and Bourg, 2004^[57]).

40. Figure 3.3 shows gender differences in the attitudinal and cognitive dimensions of collaboration. For each measure, the graph shows the difference between the average value for boys and the average value for girls. In general, results suggest that in 2015 boys tended to report valuing teamwork to a greater extent than girls, while girls tended to report valuing relationships more than boys and to perform at a higher level in the collaborative problem-solving test. Japan was the only country where boys reported statistically significantly higher levels for valuing teamwork than girls, while the gender gap in favour of girls was most pronounced in Sweden, Canada and the United States.

41. By contrast, the gender gap in the index of valuing relationships was in favour of girls in all countries included in the analysis. The gender gap was the widest in Austria, Norway, Croatia, Portugal and Israel, and narrowest in Korea, Iceland, the United States, the Netherlands and the Slovak Republic. The gender gap was also in favour of girls and present in all countries when collaborative problem-solving skills are examined in the bottom panel of Figure 3.3. The gender gap was widest in Finland where girls outperform boys by 48 points and is greater than 40 points in Sweden, Australia, New Zealand and Latvia. The gender gap in collaborative problem-solving skills in favour of girls was smallest in Colombia (8 points), Mexico (14 points), Chile (14 points) and Portugal (19 points).

Figure 3.3. Gender gaps in collaborative dispositions, by country (PISA 2015)

Differences between 15-year-old boys and girls with respect to average values of the measures of collaborative dispositions



Note: In each panel, bars represent the size of the difference between the mean value of the given measure of collaborative dispositions among boys and among girls. For individual countries, bars coloured with a darker shade indicate statistically significant differences between boys and girls, whereas those coloured with a lighter shade indicate statistically insignificant differences. See Box 8.1 for more information on how the indices were constructed in PISA 2015.

Source: Calculations based on OECD (2015_[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

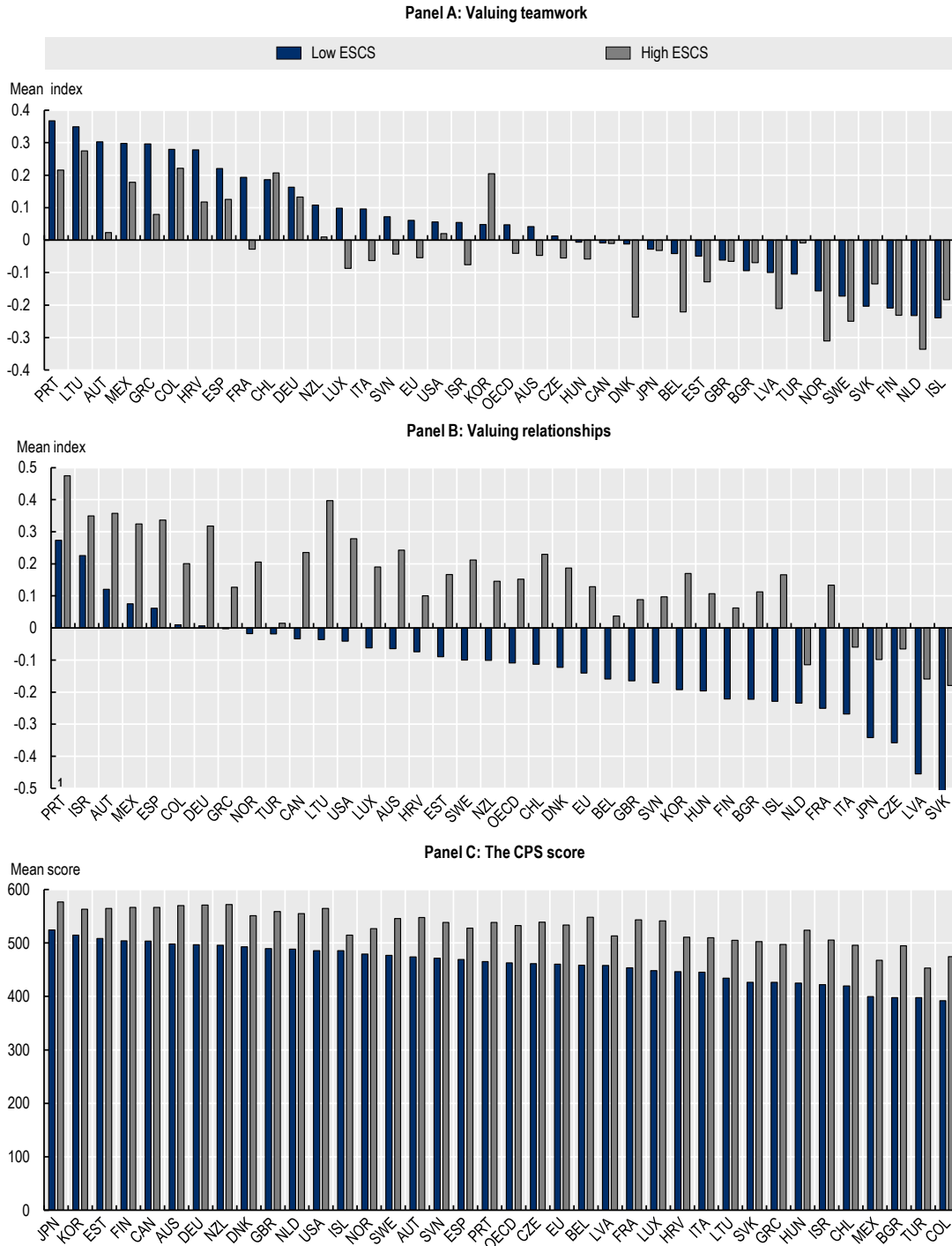
3.4. Socio-economic differences in collaborative dispositions

42. Figure 3.4 shows differences in collaborative dispositions and skills of students in the top and bottom quartile of the national distribution of the PISA ESCS index (see Section 2 in Borgonovi et al. (2022_[1]) for an explanation of how this index is built).

43. The top panel of Figure 3.4 indicates that advantaged students tended to express lower values for teamwork than socio-economically disadvantaged students. By contrast, socio-economically advantaged students tended to value relationships more and to have higher collaborative problem-solving skills. For example, on average throughout EU countries, socio-economically advantaged students had values on the index of valuing teamwork of -0.05 and values on the index of valuing relationships of 0.13 , and socio-economically disadvantaged students of 0.06 and 0.14 , respectively. The socio-economic gap in collaborative problem-solving skills was widest in Hungary, Bulgaria and Luxembourg (around 100 points, or one standard deviation) and smallest in Iceland (29 points).

Figure 3.4. Socio-economic gaps in collaborative dispositions, by country (PISA 2015)

Average values of the measures of collaborative dispositions among 15-year-old students in the low and high ESCS categories



Notes: In each panel, bars represent average values of the given measure of collaborative dispositions among 15-year-old students from high (grey bars) and low (navy blue bars) ESCS categories. Countries are ordered in descending order according to the value in the low ESCS category. See Box 8.1 for more information on how the indices were constructed in PISA 2015 and Section 2 in Borgonovi et al. (2022^[1]) for an explanation of how the ESCS index is built.

Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

3.5. Appreciating complexity in sustainability

44. As detailed in Section 1 in Borgonovi et al. (2022_[1]), students' self-reported awareness about key environmental challenges is an important indicator of students' ability to appreciate complexity in environmental sustainability. In 2015, the measure reflected how informed students felt about 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, extinction of plants and animals and water shortage (see Box 1.2 in Section 1 in Borgonovi et al. (2022_[1]) for more information about how the environmental awareness index was built in PISA 2015).

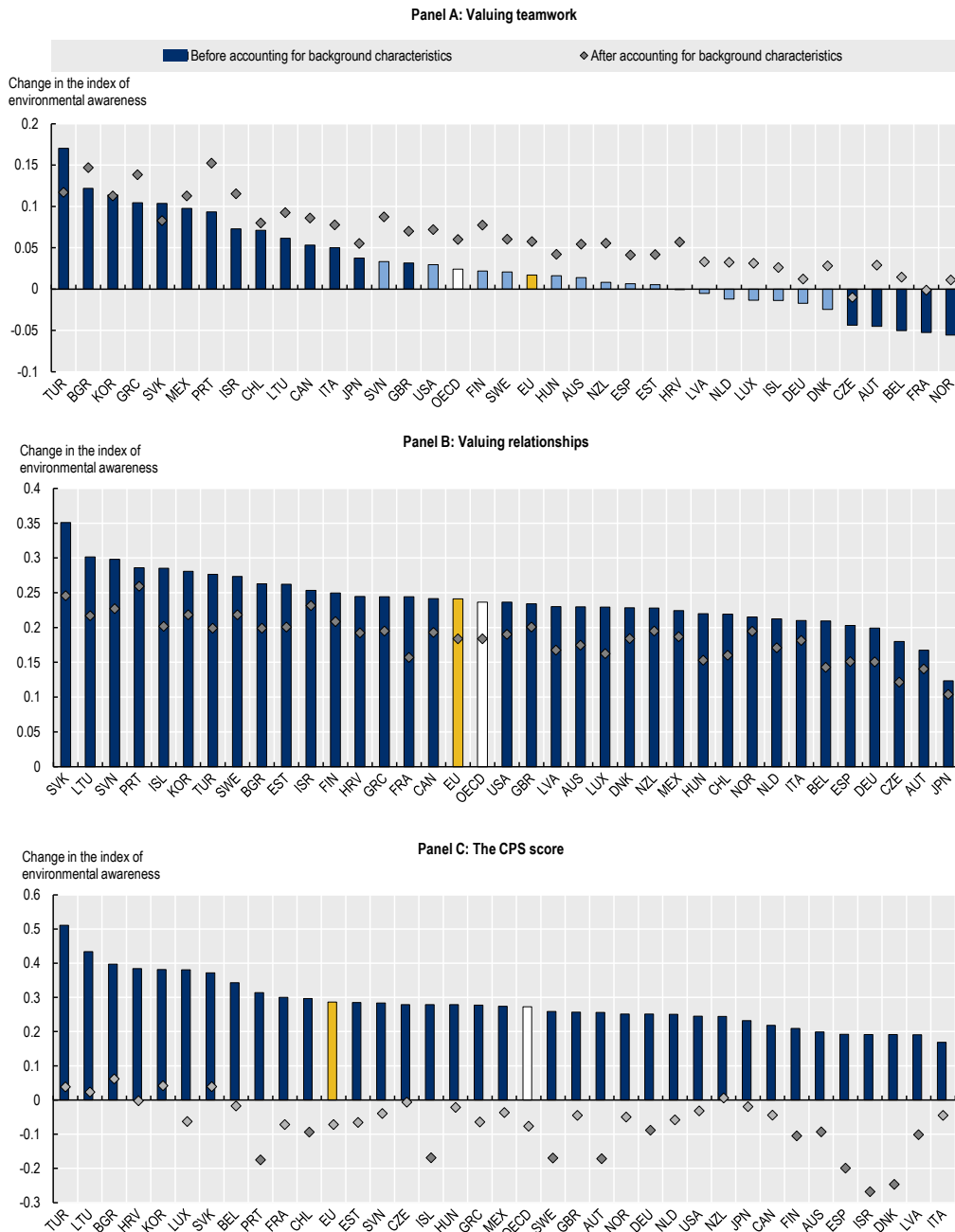
45. Figure 3.5 illustrates the **difference** in environmental awareness between students who differed in terms of collaborative dispositions before and after controlling for other background characteristics. The background characteristics include gender, migrant status, language spoken at home (or, more specifically, whether the language spoken at home was the same as the language of the PISA test), socio-economic status (as measured by ESCS), socio-economic status of the school that the student attends and students' scores in the PISA science test. Figure 3.5 reveals that in 2015, in all countries included in the analysis, the relationship between environmental awareness and the index of valuing relationships was statistically significant and positive – both before and after controlling for background characteristics. This implies that students who valued relationships more were also more environmentally aware. Throughout OECD countries, a change of one standard deviation in the index of valuing relationships was associated with a difference of around 24% of a standard deviation in environmental awareness before controlling for background characteristics and 18% of a standard deviation when differences in background characteristics between students were accounted for. The strength of the association varied markedly between countries: it ranged from 0.13 in Japan to 0.35 in the Slovak Republic, before background characteristics were taken into account, and from 0.10 in Japan to 0.26 in Portugal after they were accounted for.

46. By contrast, the association between environmental awareness and collaborative problem-solving skills was strong and positive: for example, throughout EU countries, students who differed by one standard deviation in collaborative problem-solving scores differed by around 39% of a standard deviation in environmental awareness. However, no difference existed when students with similar background characteristics were compared. In fact, in some countries, when students with similar background characteristics were compared, the association between collaborative problem-solving skills and environmental awareness was negative, quantitatively meaningful and statistically significant. For example, in Denmark a positive difference of 100 scores in the collaborative problem-solving test was associated with 20% of a standard deviation positive difference in environmental awareness before controlling for background characteristics, but 20% of a standard deviation negative difference when students with similar background characteristics were compared.

47. Finally, the top panel of Figure 3.5 reveals that the association between the index of valuing teamwork and environmental awareness was generally weak and positive but in many countries was not statistically significant before controlling for background characteristics; however, the relationship becomes stronger and statistically significant after controlling for students' background characteristics. For example, throughout OECD countries, a difference of one unit (i.e. one standard deviation) in the index of teamwork was associated with a difference of 2.5% of a standard deviation in environmental awareness before background characteristics were controlled for and a difference of 6% after controlling for background characteristics.

Figure 3.5. The association between environmental awareness and collaborative dispositions, by country (PISA 2015)

Effects of the measures of collaborative dispositions on environmental awareness among 15-year-old students



Note: In each panel, countries are ordered in descending order by the strength of the overall association between a given measure of collaborative dispositions and the index of environmental awareness. The bars refer to overall differences in environmental awareness between students who differed in their collaborative dispositions, with the darker shade of the colour representing statistically significant differences and the lighter shade statistically insignificant ones. The diamonds, in turn, represent only the part of the difference that cannot be attributed to the background characteristics (i.e. gender, migrant status, language spoken at home, student's ESCS, school's ESCS and student's score on the PISA science test). Again, a darker shade of the colour is used to mark statistically significant differences and a lighter shade to indicate statistically insignificant ones. See Box 3.1 for more information about how collaborative dispositions were measured in PISA 2015. See Section 1 [see Box 1.2 in Borgonovi et al. (2022)^[11]] for an explanation on how the index of environmental awareness was built in PISA 2015. Source: Calculations based on OECD (2015^[33]), PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

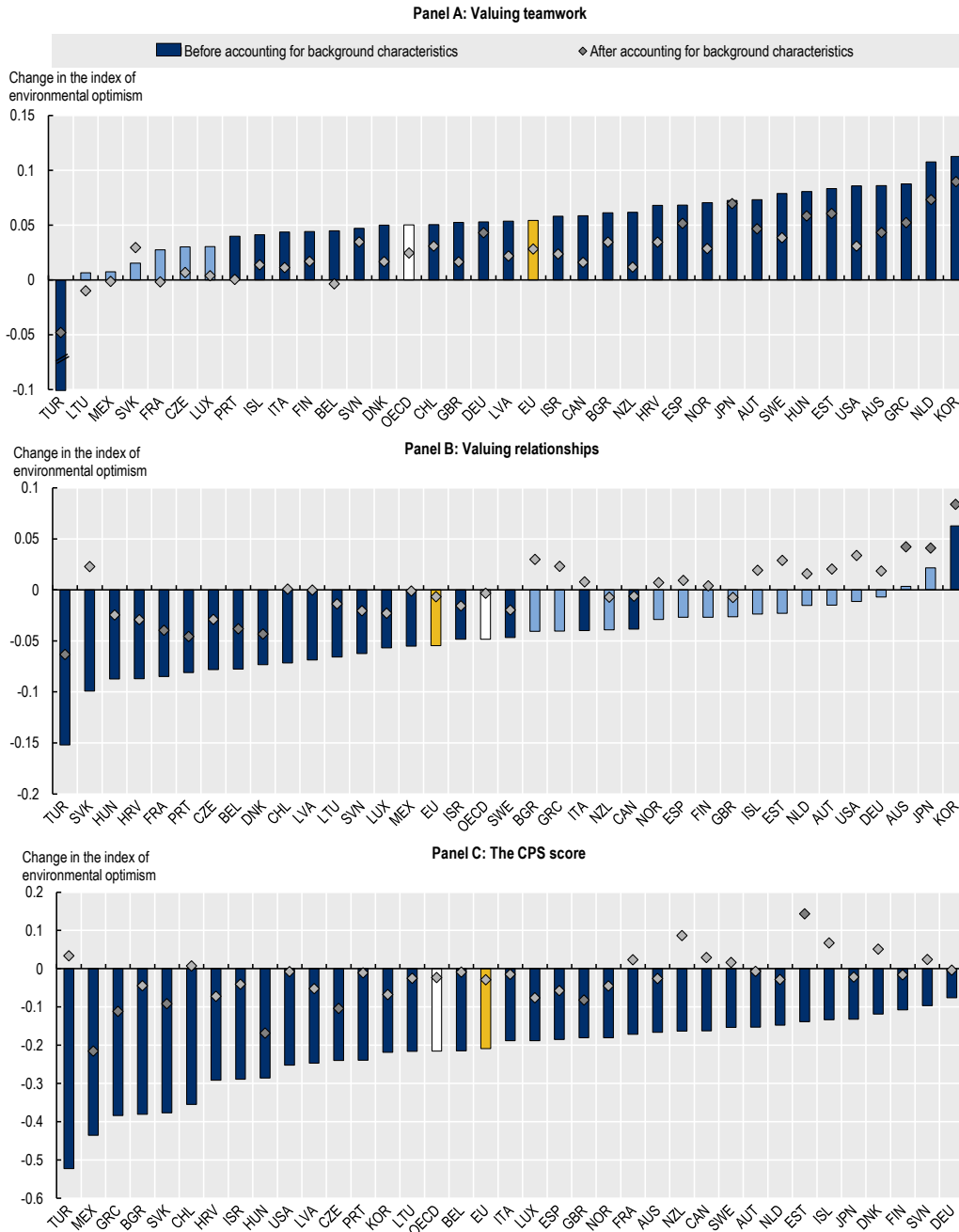
3.6. Envisioning environmentally sustainable futures

48. This section considers whether students who were more collaboratively oriented were more optimistic about the future state of the natural environment and had a greater sense of self-efficacy about understanding and explaining scientific problems with relevance to the betterment of the environment.

49. Figure 3.6 indicates that before accounting for background characteristics, students with greater collaborative problem-solving skills in 2015 reported to be less optimistic about the future state of the environment. However, such relationship was statistically insignificant and quantitatively close to zero in most countries. On average throughout EU countries, a difference of 100 points in collaborative problem-solving was associated with a negative difference of 21% of a standard deviation in environmental optimism (22% throughout OECD countries). Similarly, throughout EU countries, a difference of one standard deviation in the index of valuing relationships was associated with a negative difference of 5% of a standard deviation in environmental optimism before controlling for background characteristics and less than 1% after accounting for background characteristics (4% and 0.3%, respectively, throughout OECD countries). By contrast, environmental optimism was generally positively associated with the index of valuing teamwork, although the association was weaker and, in many countries, cannot be considered to be different from zero with a high level of confidence.

Figure 3.6. The association between environmental optimism and collaborative dispositions, by country (PISA 2015)

Effects of the measures of collaborative dispositions on environmental awareness among 15-year-old students



Note: In each panel, countries are ordered in descending order by the strength of the overall association between a given measure of collaborative dispositions and the index of environmental optimism. The bars refer to overall differences in environmental optimism between students who differed in their collaborative dispositions, with the darker shade of the colour representing statistically significant differences and the lighter shade statistically insignificant ones. The diamonds, in turn, represent only the part of the difference that cannot be attributed to the background characteristics (i.e. gender, migrant status, language spoken at home, student’s ESCS, school’s ESCS and student’s score on the PISA science test). Again, a darker shade of the colour is used to mark statistically significant differences and a lighter shade to indicate statistically insignificant ones. See Box 4.1 for more information about how collaborative dispositions were measured in PISA 2015 (see Box 1.4 in Borgonovi et al. (2022)^[11] for an explanation about how the index of environmental awareness was built in PISA 2015).

Source: Calculations based on OECD (2015)^[33], PISA 2015 Database, <https://www.oecd.org/pisa/data/2015database/>.

4 Are youngsters ready for the twin digital and green transition?

4.1. Introduction

50. All over the world, countries and economies are pushing for a transformation of their growth and development strategies. For instance, the European Commission has made sustainable development, as well as the digital agenda, the main component of its overall growth strategy for the current decade. The European Green Deal represents an ambitious innovation-led strategy for Europe and sets out the direction for the EU to become climate-neutral by 2050, which will mobilise more than EUR 1 trillion from both public and private investments for a twin green and digital transition (McCann and Soete, 2020^[58]). Digital transformations have an important role to play as enablers of green growth (Demirel, Kesidou and Danisman, 2022^[59]). Although it is predicted that virtually all jobs in the future will require having at least some digital skills and that digital skills will be necessary to participate in further education and training, on average, two in five Europeans aged 16-74 are lacking these skills.⁴

51. Enabling competences are competences that are not directly related to environmental sustainability competence per se but allow environmental sustainability competence to be developed and effectively used in the labour market and society. Among this set of enabling competences, digital skills can play a major role in promoting young people's acquisition of environmental sustainability competence and engagement in a green economy. For instance, digital skills could contribute to establishing circular economies and cleaner production processes (Montresor and Quatraro, 2019^[60]; Santoalha, Consoli and Castellacci, 2021^[61]). For instance, the 3R practice (Reduce, Reuse, Recycle) is a prime example of how the use of digital technologies for industrial symbiosis, i.e. outgoing flows from one manufacturing facility are used by another, can help reduce and, potentially replace, reliance on virgin raw materials. Digital efficacy, and the ability to manage digital systems and processes, are also considered essential to facilitate the decoupling of economic growth and climate change, as many of these green technologies rely and are enhanced by digital ones (Cenamor, Parida and Wincent, 2019^[62]; Gurbaxani and Dunkle, 2019^[63]).

52. Among the set of digital skills that can promote the acquisition of environmental sustainability competence, digital literacy has the potential to facilitate knowledge codification and diffusion, which is pivotal to environmental sustainability competence (Frenken, Izquierdo and Zeppini, 2012^[64]). Furthermore, digital skills can potentially increase adaptability and flexibility, which are key for environmental sustainability competence. The benefits go beyond immediate ones, such as higher efficiency in gathering, organising and interpreting information. Digital skills also facilitate the hybridisation – merging of different or even competing competences – of traditional competences (such as mother tongue literacy, numeracy, science) with non-traditional ones (such as learning to learn, self-expression, social competences) to increase the capacity for researching, communicating, planning and organising (Anderson-Levitt and Gardinier, 2021^[65]; Cook and Weaving, 2012^[66]; Rychen, 2004^[67]). As digital media

⁴ Digital Economy and Society Index (DESI): <https://digital-agenda-data.eu/charts/analyse-one-indicator-and-compare-countries>.

are so diverse and widespread, they call for appropriate skills to successfully master an expanded spectrum of options (Gareis et al., 2014^[68]). These so-called ‘e-skills’, which may be defined as capabilities required for researching, developing and designing, managing, producing, consulting, marketing and selling, integrating, installing and administrating, maintaining, supporting and servicing digital systems, while important for both green and non-green domains, are plausibly more important for green competences (Faucheux and Nicolai, 2011^[69]).

53. Digital literacy is crucial to address the digital skills gap, which is exacerbated by the digital divide (Chetty et al., 2018^[70]). Effectively, digital literacy encompasses more than the basic skills required to work with digital technologies and operate digital devices, but extends to a set of capabilities linked to the attitudes and knowledge needed to achieve valued outputs (Eshet, 2004^[71]; Goodfellow, 2011^[72]). Put differently, digital literacy should be seen as a gateway to improve individuals' skills required in modern digital life (UNESCO, 2011^[73]).

54. Examples of the intrinsic relationship between digital and green skills abound. For instance, in the energy sector, digital skills are used to improve efficiency by maximising quality while minimising energy use, thus contributing to the green energy transition. According to the IEA (2017^[74]), digitally enabled tasks (such as data processing, modelling, simulation and optimisation) have been pivotal for the energy sector since the 1970s and have progressively acquired prominence in other environmentally sensitive domains such as transport, buildings and industry. The cases of the photovoltaics and biofuel regional clusters in Wales, United Kingdom, and of the Cleantech platform in central Israel provide other relevant illustrations of regions in which pre-existing specialisations and digital capabilities have facilitated the development of new green specialisations (Cooke, 2010^[75]).

55. In addition, an important characteristic of digital technology is its multi-modality, i.e. the ability to include texts, images, animations, sound and even haptic feedback to create rich and engaging experiences through a steadily growing supply of interactive applications. In particular, the ability of digital tools to allow users to envision potential futures, using Augmented or Virtual Reality, is principally a key opportunity, as these skills are essential for sustainability competences. For instance, digital tools could allow people to visit places that are inaccessible, far away, no longer exist or never even existed. By enabling users to visualise something that would otherwise be invisible to them, such as their carbon footprint, digital technologies make it possible to engage with the environmental issues in a more engaging way, which is especially crucial when those users are youngsters. In short, the promotion of digital literacy by using tools such as Augmented/Virtual Reality could represent an efficient way to promote environmental literacy (Fauville, Queiroz and Bailenson, 2020^[76]).

56. To some extent, digitalisation may accelerate the transition towards a greener economy and digital competences could play a prominent role for green ones (Cecere et al., 2014^[77]). Research, for example, reveals that the use of digital media such as Science, Camera, Action! (SCA) facilitates children's constructive climate change engagement by combining educational activities with digital photography to facilitate children's individual and collaborative climate change action (Trott and Weinberg, 2020^[78]). Similarly, digital storytelling has been successfully used to raise children's environmental attitudes (Theodorou et al., 2018^[79]). In fact, students' exposure to digital social stories through the web application 'Pixton' with the aim of educating them on the process of recycling, reusing and reducing influenced not only children's environmental knowledge but also their willingness to change their behaviour. A sustainability app has been shown to have a positive effect on environmental awareness and users' pro-environmental behaviours (D'Arco and Marino, 2022^[80]). Digital technologies have also been used in buildings to encourage occupants to engage in pro-environmental behaviours when prompted to do so by their computers (Khashe et al., 2017^[81]). Such smart digital monitoring tools led to high levels of engagement and compliance. 'Digital nudging' has been identified as effective in guiding people's behaviour in a digital choice environment and promoting individual pro-environmental behaviour (Henkel et al., 2019^[82]). Digital nudging can support individuals' pro-environmental behaviour and lead to changes in individual behaviours, such as using energy more efficiently, consuming less water or increasing the use

of renewable energy sources. Thus, digital nudging holds the potential to prevent further environmental damage and provide a cost-effective way to encourage pro-environmental behaviour at both macro--(society and organisations) and micro-level (individuals).

Box 4.1. Twin green and digital transition

The European Union is resetting its growth strategy, based on sustainability, with green and digital transitions as its transformative drivers. The green and digital transition – the 'twin transition' – is at the top of the EU political agenda, and will shape Europe and its future. On the one hand, the European Green Deal aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy in which there are no net emissions of greenhouse gases by 2050 and economic growth is decoupled from resource use. On the other hand, the EU's digital transformation aims to empower businesses and people in a human-centred, sustainable and more prosperous digital future. Both processes are taking place in parallel and influence each other. Or as the European Commission highlights: 'This twin challenge of a green and digital transformation has to go hand-in-hand' (European Commission, 2020, p. 1).

To achieve the EU's objectives of becoming a greener, digitally fit and fairer Europe, the European Commission has adopted several initiatives and set clear targets to identify both green and digital interlinkages and synergies as well as tension points to ensure that the two transitions can reinforce each other (e.g. e-waste, digital carbon footprint). Such initiatives entail, for instance:

- identifying and addressing (re-/up-)skilling and (re-)training needs stemming from new, green or digital products, services or technologies;
- fostering social acceptance and/or behavioural changes for more sustainable business models, consumption patterns and/or modes of transport;
- investing in education and training, enhancing skills and equipping people for new green and digital jobs;
- digital and green readiness to build, reinforce and strengthen digital and green capacity and digital tools;
- raising awareness of the opportunities and challenges related to the green and digital transitions and contributions to their social acceptance.

4.2. Students' interest in information and communication technology (ICT) and self-belief in their competence in using ICT

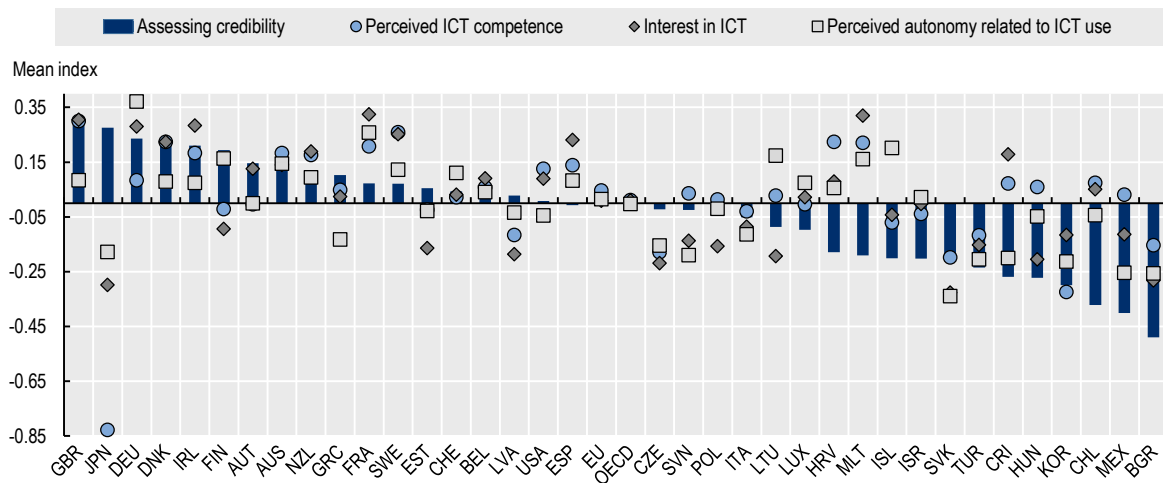
57. Although the PISA 2018 study did not contain a direct assessment of students' digital literacy, participating students were asked to report how interested they were in information and communication technology (ICT) use, as well as their level of perceived competence in using ICT. Students were also asked to report which strategies they felt were appropriate to assess the credibility of digital information and their responses were compared against expert ratings. Lastly, students were asked to report how often they were involved in digital reading activities to communicate (such as reading emails, chatting, taking part in online group discussions or forums) but also to find and locate information (such as searching for information on a particular topic and reading online news). Student responses can be used to map how confident students throughout EU and OECD participating countries feel about using ICT and how frequently they engage in digital reading activities.

58. Figure 4.1 illustrates, for each country that administered the optional ICT questionnaire in PISA in 2018, how 15-year-old students perceived their level of competence in using ICT as well as their attitudes

towards ICT use. Results reveal that, at country level, students' interest in ICT, perceived competence and autonomy in ICT and perceived ability to assess the credibility of digital information is positively associated, but also that in some countries there are significant differences between these indicators. For example, 15-year-old students in the United Kingdom reported having comparatively high levels of competence in being able to assess the credibility of an email they received as well as high levels of ICT competence and interest in ICT. By contrast, they reported average levels of autonomy related to ICT use. Students in Japan also reported having comparatively high levels of competence in being able to assess the credibility of an email they received but very low levels of interest in ICT, competence in ICT and autonomy related to ICT use.

Figure 4.1. Students' interest and self-belief in their competence in ICT, by country (PISA 2018)

Mean index of 15-year-old students' perceived ability to assess the credibility of digital information, perceived ICT competence, interest in ICT and perceived autonomy related to ICT use



Note: The figure shows the mean indices of students' perceived ability to assess the credibility of digital information, perceived ICT competence, interest in ICT and perceived autonomy related to ICT use. Countries are ranked in descending order by the mean index of assessing the credibility of digital sources.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

Box 4.2. Indicators of students' interest in ICT and self-belief in their competence in using ICT in PISA 2018

In 2018, students in countries that administered the optional ICT questionnaire 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 ICT:

- I forget about time when I'm using digital devices.
- The Internet is a great resource for obtaining information I am interested in (e.g. news, sports, dictionary).
- It is very useful to have social networks on the Internet.
- I am really excited discovering new digital devices or applications.
- I really feel bad if no Internet connection is possible.
- I like using digital devices.

Student responses were combined into an **index of interest in ICT**, standardised in such a way that the index would have a mean of 0 and a standard deviation of 1 throughout OECD countries.

Using the same Likert scale, they were also asked to report on their perceived competence in using ICT through the following sets of questions:

- I feel comfortable using digital devices that I am less familiar with.
- If my friends and relatives want to buy new digital devices or applications, I can give them advice.
- I feel comfortable using my digital devices at home.
- When I come across problems with digital devices, I think I can solve them.
- If my friends and relatives have a problem with digital devices, I can help them.

Student responses were combined into an **index of competence in ICT**, standardised in such a way that the index would have a mean of 0 and a standard deviation of 1 throughout OECD countries.

Using the same Likert scale, they were also asked to report how autonomous they felt using ICT through the following sets of questions:

- If I need new software, I install it by myself.
- I read information about digital devices to be independent.
- I use digital devices as I want to use them.
- If I have a problem with digital devices I start to solve it on my own.
- If I need a new application, I choose it by myself.

Student responses were combined into an **index of perceived autonomy in ICT use**, standardised in such a way that the index would have a mean of 0 and a standard deviation of 1 throughout OECD countries.

As part of the main student questionnaire, students were also asked to imagine a situation in which they received a message in their inbox from a well-known mobile phone operator telling them that they were one of the winners of a smartphone. They were told that the sender asked them to click on a link to fill out a form with their data so they could send them the smartphone. Students were asked to rate how useful they felt a series of strategies would be in response to this situation. Students could indicate the

appropriateness of a series of strategies using a 6-point scale, ranging from not appropriate at all to very appropriate. Strategies considered were:

- Answer the email and ask for more information about the smartphone.
- Check the sender's email address.
- Click on the link to fill out the form as soon as possible.
- Delete the email without clicking on the link.
- Check the website of the mobile phone operator to see whether the smartphone offer is mentioned.

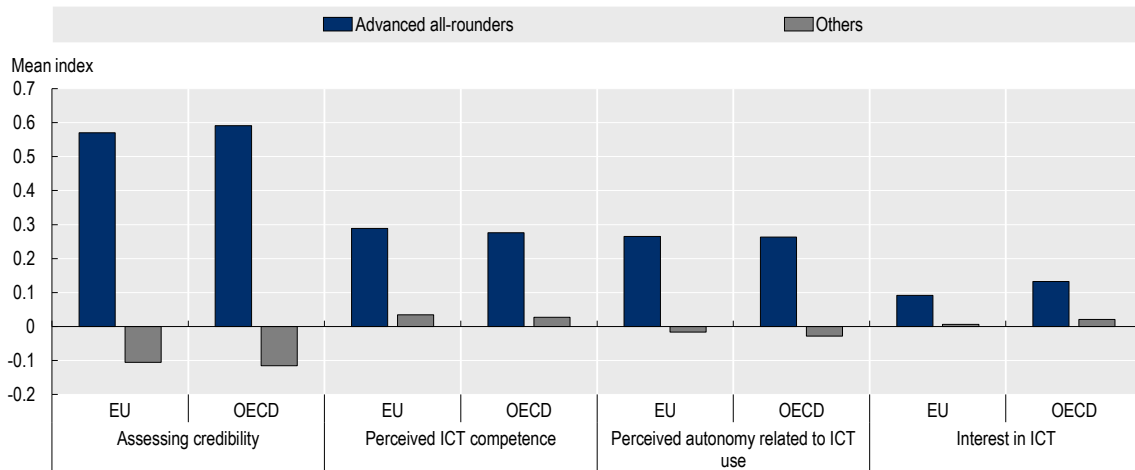
Student responses were mapped onto the opinions of experts and used to construct an **index of proficiency in assessing credibility**, standardised in such a way that the index would have a mean of 0 and a standard deviation of 1 throughout OECD countries.

4.3. The relationship between environmental sustainability competence and students' interest in ICT and self-belief in their competence in using ICT

59. Analyses reveal that, in general, students who have acquired environmental sustainability competence also tend to be more at ease with digital devices and ICT equipment than other students. Figure 4.2 suggests that **advanced all-rounders** in environmental sustainability reported more positive self-belief in their competence in using ICT as well as a higher level of interest in ICT than other students. For example, on average throughout EU countries, 15-year-old advanced all-rounders reported levels of ICT competence that were around 23% of a standard deviation higher than the average student throughout OECD countries. By contrast, students who were not advanced all-rounders reported levels of ICT competence that were lower than those reported by the average OECD student. Similarly, on average throughout OECD countries, 15-year-old advanced all-rounders reported levels of ICT competence that were around 21% of a standard deviation higher than the average student throughout OECD countries, while students who were not all-rounders reported levels of ICT competence that were lower than those reported by the average OECD student. Differences were even more pronounced when students were asked to identify their own ability to assess the credibility of online information: on average throughout EU and OECD countries, advanced all-rounders assessed their ability to be 23% of a SD higher than the assessment provided by the average student in OECD countries, while non all-rounders assessed their ability to be 12% and 15% of a SD lower than the assessment provided by the average student in OECD countries.

Figure 4.2. Interest in ICT and self-belief in competence in ICT use of advanced all-rounders and other students, EU and OECD averages (PISA 2018)

Mean index in levels of 15-year-old students' perceived ability to assess the credibility of digital information, perceived ICT competence, perceived autonomy related to ICT use and interest in ICT based on whether or not they were advanced all-rounders



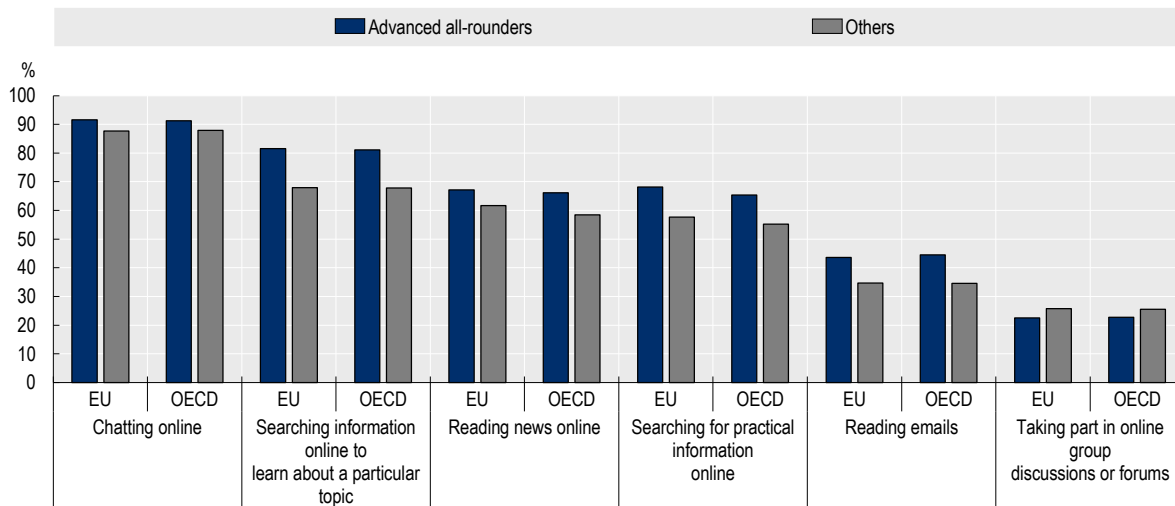
Note: The figure shows the mean index in levels of advanced all-rounders and other students' perceived ability to assess the credibility of digital information, perceived ICT competence, perceived autonomy related to ICT use and interest in ICT. Topics are sorted in descending order of EU average values for advanced all-rounders.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

60. Figure 4.3 also indicates that, on average throughout EU and OECD countries, advanced all-rounders were more likely to engage in digital reading activities than students who had not displayed the same level of proficiency across environmental sustainability competence areas. In particular, advanced all-rounders engaged more in activities aimed at gathering information. For example, on average throughout EU and OECD countries, 82% and 81% of advanced all-rounders and 68% and 69% of other students, respectively, in 2018 reported searching for information online to learn about a particular topic. Similarly, 68% of advanced all-rounders throughout EU countries and 65% of all-rounders throughout OECD countries reported searching for practical information online. By contrast, 58% of non-advanced all-rounders throughout EU countries and 55% of non-advanced all-rounders throughout OECD countries did so.

Figure 4.3. Digital reading behaviours of advanced all-rounders and other students, EU and OECD averages (PISA 2018)

Percentage of 15-year-old students who reported engaging in the following digital reading behaviour based on whether or not they were advanced all-rounders



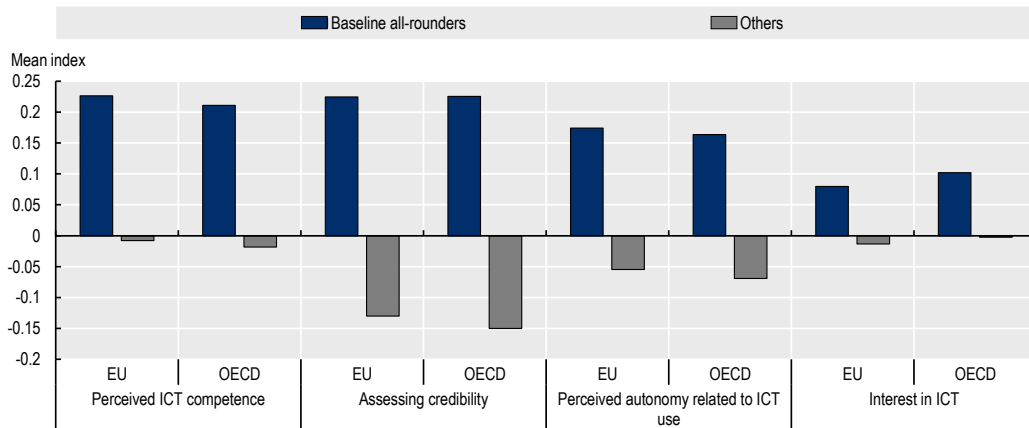
Note: The figure shows the percentage of advanced all-rounders and other students who reported engaging in the following digital reading activities: chatting online; searching information online to learn about a particular topic; reading news online; searching for practical information online; reading emails; taking part in online group discussions or forums. Topics are sorted in descending order based on EU average values for advanced all-rounders.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

61. Differences in attitudes towards ICT and levels of engagement in digital reading activities are also pronounced when comparing students who are classified as baseline all-rounders and other students. For example, Figure 4.4 reveals that, on average throughout EU and OECD countries, baseline all-rounders reported perceived levels of competence in using ICT that were at least 20% of a SD above the value reported by the average student throughout OECD countries, while students who did not meet baseline levels of proficiency across all environmental sustainability areas reported perceived levels of competence in using ICT that were below those reported by the average student throughout OECD countries. Similarly, on average throughout EU countries, baseline all-rounders reported levels of interest in ICT that were 7% of a SD higher than levels reported by the average student throughout the OECD countries (the corresponding value throughout OECD countries was 10% of a SD). Baseline all-rounders also reported a higher level of autonomy in using ICT and use of appropriate strategies when having to assess the credibility of digital information.

Figure 4.4. Interest in ICT and self-belief in competence in ICT use of baseline all-rounders and other students, EU and OECD averages (PISA 2018)

Mean index in levels of 15-year-old students' perceived ability to assess the credibility of digital information, perceived ICT competence, perceived autonomy related to ICT use and interest in ICT based on whether or not they were baseline all-rounders



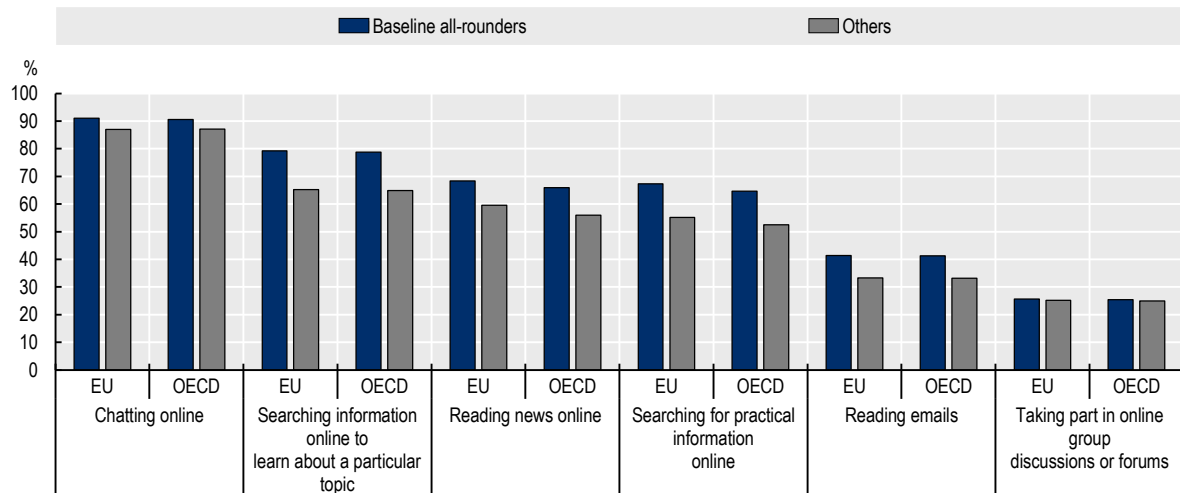
Note: The figure shows the mean index in levels of baseline all-rounders and other students' perceived ability to assess the credibility of digital information, perceived ICT competence, perceived autonomy related to ICT use and interest in ICT. Topics are sorted in descending order of EU average values for baseline all-rounders.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

62. Baseline all-rounders were also more likely to engage in digital reading activities than students who had not displayed the same level of proficiency across environmental sustainability competence areas. In line with results presented in Figure 4.3, results presented in Figure 4.5 suggest that baseline all-rounders engaged more in activities aimed at gathering information such as searching for information online to learn about a particular topic, searching for practical information online and reading news on line.

Figure 4.5. Differences in Digital reading behaviours between baseline all-rounders and other students, EU and OECD averages (PISA 2018)

Percentage of 15-year-old baseline all-rounders and other students who reported engaging in the following digital behaviours, depending on whether or not they were baseline all-rounders



Note: The figure shows the percentage of baseline all-rounders and other students who reported engaging in the following digital reading activities: chatting online; searching information online to learn about a particular topic; reading news online; searching for practical information online; reading emails; taking part in online group discussions or forums. Topics are sorted in descending order based on EU average values for baseline all-rounders.

Source: Calculations based on OECD (2018^[24]), "PISA 2018 Database", <https://www.oecd.org/pisa/data/2018database/>.

63. Figure 4.6 reveals how students' interest in ICT and self-belief in their use of ICT vary depending on whether or not 15-year-old students in 2018 reported engaging in pro-environmental behaviours, reported agreeing or strongly agreeing that caring about the environment was important to them, reported being aware about climate change and global warming and reported feeling confident about being able to explain or discuss a series of environmental problems. Compared to results presented in Figure 4.2 to Figure 4.5 results presented in Figure 4.6 compare students in terms of one environmental sustainability competence area at a time, rather than depending on whether or not they were all-rounders.

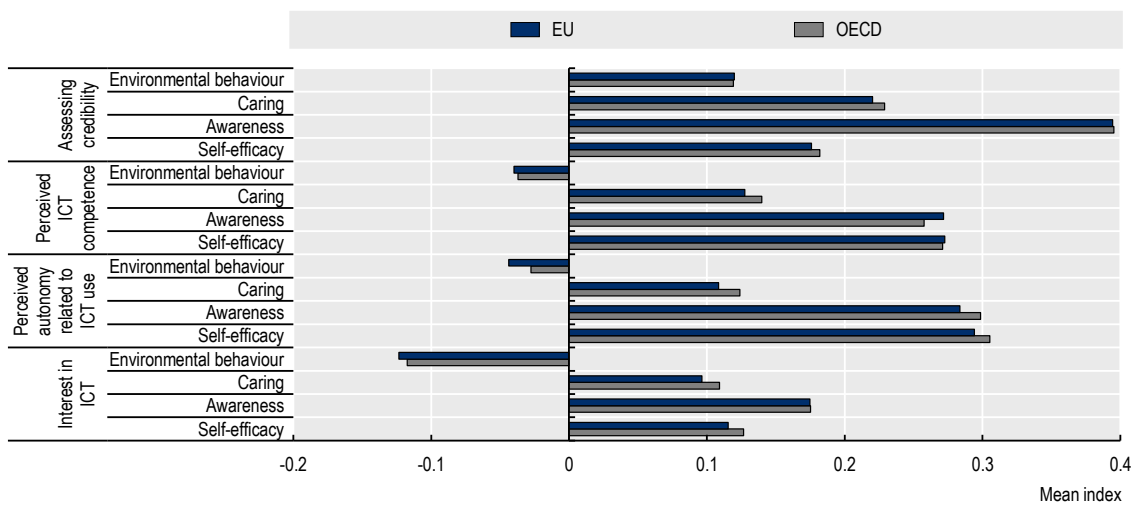
64. Figure 4.6 reveals that students who reported being aware of climate change and global warming had considerably higher values in terms of ability to assess the credibility of digital information, interest in ICT, perceived autonomy in ICT, perceived competence in ICT than students who reported not being aware of climate change and global warming. For example, on average throughout EU and OECD countries, students who reported being aware of climate change and global warming had values on the assessing credibility index that were 40% of a SD above those reported by students with lower levels of environmental awareness. Similarly, they expressed levels of perceived competence in ICT use that were over 25% of a SD higher and levels of perceived autonomy that were over 30% of a SD above those of students with lower levels of environmental awareness.

65. Differences in levels of interest in ICT and self-belief in ICT use and competence are also very pronounced depending on whether students reported agreeing or strongly agreeing that caring about the environment was important to them. For example, on average throughout EU and OECD countries, students who reported that caring about the environment was important to them had values on the assessing credibility index that were 20% of a SD above those reported by students who did not, expressed levels of perceived competence in ICT use that were over 25% of a SD higher and levels of perceived autonomy that were almost 30% of a SD higher than those who did not.

66. Interestingly, Figure 4.6 reveals that although students who engaged in pro-environmental behaviours, on average, reported higher levels of ability to assess the credibility of sources than students who did not engage in pro-environmental behaviours, they reported lower levels of interest in ICT, lower levels of perceived autonomy in the use of ICT and lower levels of ICT competence. In particular, differences in levels of interest in ICT between students who engaged in pro-environmental behaviours and those who did not was over 10% of a SD on average throughout EU and OECD countries.

Figure 4.6. Students’ interest in ICT and self-belief in their competence in using ICT, by environmental sustainability competence area, EU and OECD averages (PISA 2018)

Mean index in levels of 15-year-old students’ perceived ability to assess the credibility of digital information, perceived ICT competence, perceived autonomy related to ICT use and interest in ICT by environmental sustainability competence area



Note: The figure shows the mean index in levels of students’ perceived ability to assess the credibility of digital information, perceived ICT competence, perceived autonomy related to ICT use and interest in ICT by environmental sustainability competence area (environmental behaviour, caring for the environment, environmental awareness and environmental self-efficacy).

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

4.4. School instruction on how to deal with digital information

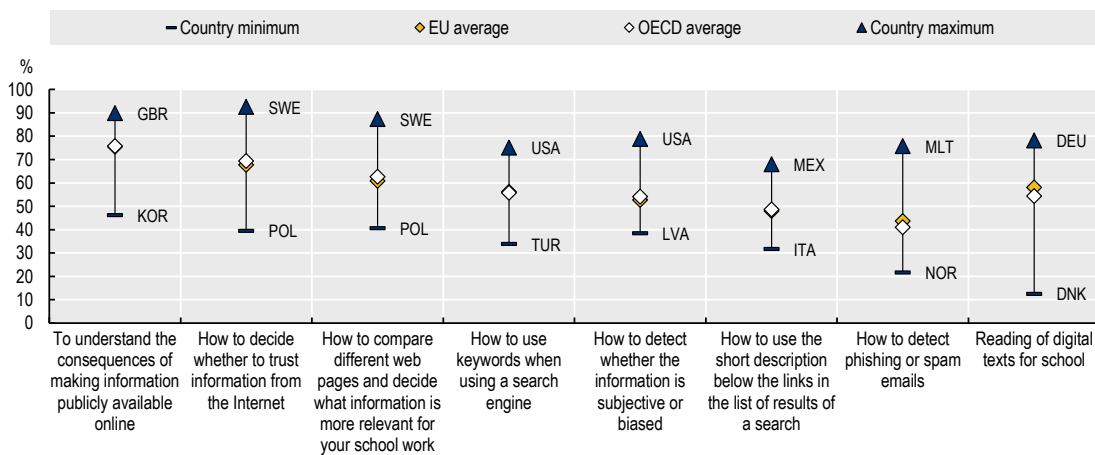
67. Schools have a key role to play in equipping youngsters with the skills needed to engage with digital technologies meaningfully and successfully. Figure 4.7 illustrates the percentage of 15-year-old students in EU and OECD countries who, in 2018, reported having been taught at school a range of strategies to deal with digital information. These strategies are crucial to be able to make the most of the information potential available on the internet and be thoughtful users of digital information content. Although young generations are often referred to as digital natives, being able to make the most of digital resources and being mindful of the possible threats and biases of online information requires concerted cultivation. While some families may be able to guide their children, schools are increasingly active in equipping young people with digital literacy. On average throughout EU and OECD countries, 78% of students reported having been taught in school the consequences of making information publicly available online; 70% reported having been taught how to decide whether to trust information from the internet; 60% reported having been taught how to compare different web pages and decide what information is more relevant for schoolwork; 60% reported having been taught how to read digital texts for school; 60% reported having been taught how to use keywords when using a search engine; 55% reported having been taught

how to detect whether information posted online is subjective or biased; 50% reported having been taught how to use the description below links in the list of search results; and only a minority of students, 40%, reported having been taught how to detect phishing or spam emails.

68. Figure 4.7 also reveals large differences in digital literacy instruction between countries. For example, 80% of students in Germany reported having been taught how to read digital texts, while in Denmark, only 12% did – a difference of over 50 percentage points. Similarly, over 90% of students in Sweden reported having been taught how to decide whether to trust information on the internet, while only 40% of students in Poland did.

Figure 4.7. Students’ acquisition of strategies to deal with digital information, EU and OECD averages (PISA 2018)

Percentage of 15-year-old students who reported being taught the different strategies to deal with digital information and the percentage of students reading digital texts in school



Note: The figure illustrates the percentage of students who reported having been taught at school different strategies to deal with digital information. Strategies considered include: how to use keywords when using a search engine; how to decide whether to trust information from the internet; how to compare different web pages and decide what information is more relevant for your schoolwork; to understand the consequences of making information publicly available online on ‘Facebook ©’, ‘Instagram ©’, etc.; how to use the short description below the links in the list of results of a search; how to detect whether the information is subjective or biased; how to detect phishing or spam emails. The figure also illustrates the percentage of students who reported reading digital texts including links for school (in the classroom or for homework) two or three times a week or more often. Strategies are sorted in descending order of EU average values.

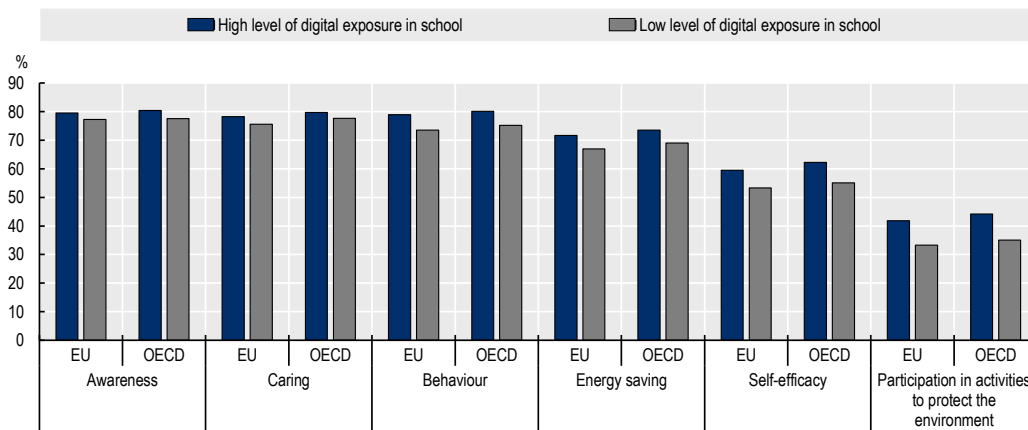
Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

69. Figure 4.8 illustrates differences in the percentage of 15-year-old students who, in 2018, reported having acquired high levels of emotional, cognitive, attitudinal and behavioural dimensions of environmental sustainability depending on whether they were taught at school a wide range of strategies to deal with digital information or reported having been taught only several strategies depending on students’ proficiency in different environmental sustainability competence areas. Results indicate that, generally, students who reported having been taught a wide range of strategies to deal with digital information at school were more likely to report agreeing or strongly agreeing that caring for the environment was important to them; were more likely to report being familiar with climate change and global warming; were more likely to report engaging in energy-saving behaviours because of environmental reasons, participate in groups with the aim of protecting the environment, or both; and were more likely to report feeling confident about discussing or understanding key environmental problems. For example, on average throughout EU and OECD countries, 42% and 44% of students who were taught how

to deal with at least five out of eight strategies (high level of exposure) to deal with digital information considered as critical by international experts participated in activities to promote the environment, while 33% and 35% of students who received less extensive instruction on the use of strategies to deal with digital texts participated in such activities.

Figure 4.8. Students' digital exposure at school, by environmental sustainability competence area, EU and OECD averages (PISA 2018)

Share of 15-year-old students with environmental sustainability competence by level of digital exposure at school



Note: The figure illustrates the share of students' environmental sustainability competence by high and low levels of digital exposure. Students with low levels of digital exposure are those who reported having been taught at school four different strategies to deal with digital information or less, and those with high exposure are students who reported having been taught at school five different strategies or more to deal with digital information. Strategies considered include: how to use keywords when using a search engine; how to decide whether to trust information from the internet; how to compare different web pages and decide what information is more relevant for your schoolwork; to understand the consequences of making information publicly available online on 'Facebook ©', 'Instagram ©', etc.; how to use the short description below the links in the list of results of a search; how to detect whether the information is subjective or biased; how to detect phishing or spam emails. The environmental sustainability competence areas are environmental awareness; caring for the environment; environmental behaviour (which includes energy saving and participation in activities to protect the environment); and environmental self-efficacy. Borgonovi et al. (2022^[11]) provide a detailed description of these areas and how they are assessed in PISA. In the figure, environmental competence areas are sorted in descending order for high levels of digital exposure in school values.

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

5 Financially literate and environmentally competent – Meet tomorrow's green entrepreneurs

5.1. Introduction

This section looks at the relationship between financial literacy and environmental sustainability competence. The OECD defines financial literacy as:

[The] knowledge and understanding of financial concepts and risks, and the skills, motivation and confidence to apply such knowledge and understanding in order to make effective decisions across a range of financial contexts, to improve the financial well-being of individuals and society, and to enable participation in economic life (OECD, 2020^[83]).

70. Such a definition is broad and covers different aspects: from the understanding and identification of risks to knowledge of specific financial concepts and instruments, including the ability to use such knowledge, and the related skills, in real-life situations.

71. Similar to other PISA domains (reading, mathematics and science), financial literacy has two parts. The first refers to the kinds of thinking and behaviour that characterise the specific domain. The second part refers to the importance of developing the particular literacy. As such, the definition incorporates students' ability to use financial knowledge and skills to meet challenges in the future. It is worth mentioning that in PISA, 'literacy' refers not only to the capacity of 15-year-old students to apply knowledge and skills in key subject areas, but also to students' ability to analyse, reason and communicate effectively as they pose, solve and interpret problems in a variety of situations.

72. The objective to increase financial literacy across the entire population has been high on the policy agenda of many countries for quite some years. The underlying hypothesis is that individuals, and young cohorts, will increasingly need to become financial literate to be able to make sound personal and economic decisions (e.g. savings decisions, portfolio allocation, etc.) that will enable them to fully participate to economic and social life. In the case of students, relevant examples could be the evaluation of a student loan, the opening of a bank account, the use of a credit card, the purchasing of an app and the selection of a mobile phone plan.

73. Indeed, environmental sustainability competence and financial literacy share some relevant methodological and content aspects (Steinberg et al., 2009^[84]), such as: identifying and quantifying risks connected to a given activity; the clear understanding of intertemporal trade-offs⁵ and the discounting of future costs and benefits using present value techniques (Frederick et al., 2002); future orientation; and the intergenerational transfers of resources.

⁵ In fact, the very concept of sustainability is based on the notion of intertemporal trade-offs (WCED, 1987^[89]).

74. Consequently, financial literacy is increasingly perceived as a means to both empower individuals and allow them to be aware of the future consequences associated with their actions (Grohmann, Klühs and Menkhoff, 2018^[85]). As a matter of fact, White Jr, McCoy and Watkins (2018^[86]) show that individuals with higher positive financial attitudes, behaviours and intentions are also those with more pro-environmental attitudes and behaviours, suggesting that attitudes and behaviours carry over from one area to the other.

75. Furthermore, financial literacy implies a broad range of various skills, knowledge, attitudes and behaviour for taking the right decisions, which may be critical to sustainable development. For instance, budgeters are considered long-term planners who understand that their financial decisions today impact their consumption tomorrow, a skill that can be transposed to take the appropriate decisions when managing scarce environmental resources (Muske and Winter, 2001^[87]).

76. From a different angle, a successful green transition will need 'green' entrepreneurs (e.g. seeking to develop more efficient solar panels or to patent a new filter reducing car emissions). However, even the most skilled and knowledgeable scientist (or science students of today) would have a hard time succeeding in their entrepreneurial effort in the absence of a sufficient level of financial literacy: a well-designed and credible business plan is an essential element of any successful entrepreneurial effort.

77. In a nutshell, financial literacy is increasingly perceived as a means to both empower individuals and allow them to be aware of the future consequences associated with their actions (Grohmann, Klühs and Menkhoff, 2018^[85]). Thus, financial literacy is progressively seen as an element contributing to the achievement of a more environmentally sustainable future (Castro, Enríquez-Díaz and García, 2021^[88]), in which the needs of current generations are met without compromising the ability of the next generations to meet their own (WCED, 1987^[89]).

5.2. Financial literacy, environmental awareness and pro-environmental behaviour

78. Financial literacy demands key competences, such as the ability to conduct research before making decisions, weighing alternatives, understanding intertemporal trade-offs and identifying opportunities as they arise, all of which are important to environmentally friendly choices (Świecka et al., 2021^[90]). In fact, financial literacy plays a significant role in improving individuals' understanding of environmental sustainability (Kumari and Harikrishnan, 2021^[91]) and in empowering individuals when taking decisions and actions that involve risk, intertemporal trade-offs and discounting.

79. For instance, using a sample of women from rural Indonesia, Lee and Huruta (2022^[92]) show that improved financial literacy empowers women through their inclusion in green microfinance initiatives for sustainable farming projects. Such an impact is due to the fact that participating women were able to understand the financial products and services offered in the green microfinance sector and the implications for environmental sustainability.

80. Similarly, Mavlutova et al. (2021^[93]) use a sample from Latvia to show that individuals with higher levels of financial literacy are more likely to inquire about and evaluate the environmental sustainability of companies before investing. The authors provide further evidence on how financial literacy can contribute to achieving sustainable development.

81. In the same vein, using a sample of Polish students aged 15 and older, Świecka et al. (2021^[90]) show that students with higher levels of financial knowledge are more likely to understand how using cashless payment contributes to environmental protection, although their decision to use it is not necessarily environmentally motivated – a finding that resembles that of a pro-environmental attitude being an imperfect predictor of pro-environmental behaviour (Kristensson, Wästlund and Söderlund, 2017^[94]).

82. Financial literacy has been shown to be an important factor to ensure entrepreneurs' success in running business ventures (Šubic, Braje and Žagi, 2019^[95]), and this is particularly true for sustainable development projects (Rahmandoust et al., 2011^[96]). Conversely, the lack of financial self-efficacy (or financial illiteracy) is associated with higher rates of nascent-business failures, in spite of higher levels of environmental self-efficacy (Pushkarskaya and Usher, 2020^[97]). Indeed, financial literacy is key to understanding the future implications of financial decisions as well as the importance of rational decision-making based on objective criteria and metrics (Hilgert, Hogarth and Beverly, 2003^[98]). In addition, financial literacy instils future orientation, embracing complexity and the ability to adapt to emerging situations, all key to environmental sustainability competence (Bianchi et al., 2022^[15]). In fact, an increasing number of empirical micro-level studies are converging towards this idea that financial literacy goes hand-in-hand with environmental sustainability competence.

83. Using a sample of Polish high school students aged 15, Swiecka et al. (2020^[99]) show that financial literacy plays an important role in students' knowledge about sustainable economic development, although high levels of financial knowledge do not necessarily translate into the proper behaviour. However, when supplemented with the experience of the parents, family and the closest environment, financial knowledge brings positive results in terms of sustainable behaviour, motivated by the desire to protect and ensure one's livelihood and future. The authors also show that the appropriate way for students to acquire financial knowledge that will translate into proper behaviour is through financial education. It is thus paramount to ensure that financial literacy is an integral part of schools' curricula.

84. Similarly, using survey data from 622 households in Mexico, González-Hernández, Meijles and Vanclay (2019^[100]) show that financial knowledge and self-efficacy greatly influence household-level pro-environmental behaviour. The results highlight both the importance of financial literacy but also how collective involvement in financial matters is a determinant for climate change mitigation and adaptation actions.

85. More generally, financial literacy has become a necessity in the age of green investments (Anderson and Robinson, 2021^[101]). Many financial institutions are offering their clients options to add green investments to their portfolios or to apply green screening of their current investments. Recently, the European Commission has released an EU taxonomy for sustainable activities⁶, creating a common language for investors wishing to engage in sustainable finance. Such initiatives are crucial, as evidence shows that even pro-environmental households are not more likely to invest in pro-environmental portfolios, mainly due to low financial literacy and informational hurdles (Anderson and Robinson, 2021^[101]). As a consequence, raising individuals' environmental awareness without ensuring their financial literacy may lead to a missed opportunity where pro-environmental attitudes are not translated into financial practices in favour of environmental sustainability (White Jr, McCoy and Watkins, 2018^[86]).

⁶https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en.

Box 5.1. What is financial literacy?

The PISA 2018 assessment of financial literacy amongst 15-year-old students was conducted in 20 countries, including:

- 13 OECD countries – Australia, Canada, Chile, Estonia, Finland, Italy, Latvia, Lithuania, Poland, Portugal, the Slovak Republic, Spain and the United States,
- 7 partner (non-OECD) countries – Brazil, Bulgaria, Georgia, Indonesia, Peru, Russia and Serbia.

In this section, only 13 EU and/or OECD countries are considered: Bulgaria, Canada, Chile, Estonia, Finland, Italy, Latvia, Lithuania, Poland, Portugal, the Slovak Republic, Spain and the United States.

The assessment of students' financial knowledge and skills provides a rich set of cross-country comparative data that shed light on questions such as 'How experienced are 15-year-old students with digital financial services and transactions?' and 'What differentiates financially literate students from those who struggle to understand?'

The financial literacy assessment primarily focuses on measuring students' proficiency in applying the knowledge and skills that they have learned in and outside of school. Like other PISA domains, financial literacy is assessed using an instrument designed to provide data that are valid, reliable and interpretable.

Around 117 000 students were assessed in financial literacy in 2018, representing about 13.5 million 15-year-olds in the schools of the 20 participating countries and economies.

In countries that conducted the financial literacy assessment, students in sampled schools were divided into two groups. One group was assessed in financial literacy, mathematics and reading, and the other group was assessed in the core PISA subjects (science, mathematics and reading). Both groups were assessed for a total of 120 minutes. The 2018 financial literacy assessment consisted of a 1-hour, computer-based test using items drawn from a set of 43 questions. As in other domains, financial literacy items were grouped into units, where one or more items shared a common stimulus. The selection included financially focussed stimulus material in diverse formats, including prose, diagrams, tables, charts and illustrations.

Students who sat the financial literacy assessment also answered the PISA student questionnaire about themselves, their homes, their school and learning experiences and attitudes. They also answered questions about their experiences with money matters, which were included at the end of the financial literacy test booklets. School principals received a questionnaire with questions about school policies and the learning environment, with no particular emphasis on financial education.

The PISA 2018 financial literacy assessment covered content related to 'planning and managing finances', 'money and transactions', 'risk and reward' and 'financial landscape'. In addition, some questions covered the financial process areas of 'analysing information in a financial context', 'evaluating financial issues' and 'applying financial knowledge and understanding'; and the process related to 'identifying financial information'. Around half of the items were set in the 'individual' context, under a third were items in the 'home and family' context; the remaining items divided between the 'education and work' and 'societal' context.

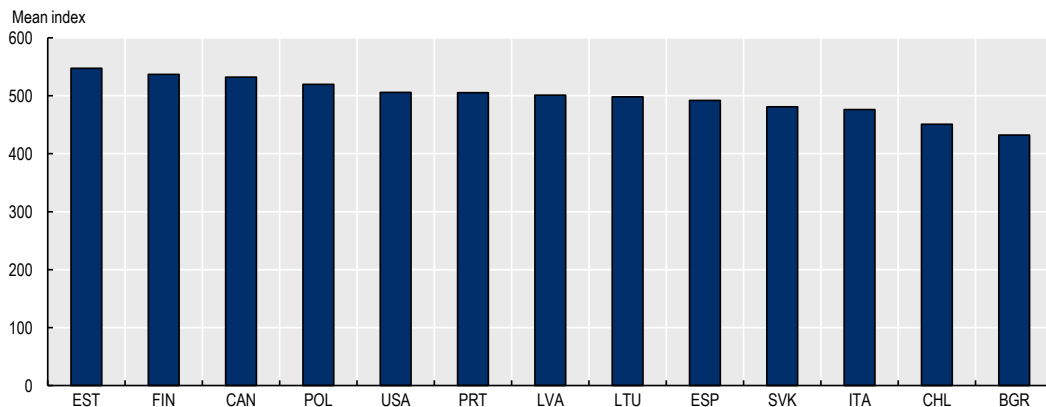
5.3. Financial literacy measures in PISA 2018

86. In PISA 2018, financial proficiency was assessed using various test items, which combined content, processes and context aspects in order to provide a comprehensive measure of the understanding of (and ability to apply) financial concepts (see Box 5.1). Students who sat the financial proficiency test in 2018 were also asked to reply to a questionnaire intended to capture and measure not only their familiarity with financial concepts, products and services, their confidence in understanding and explaining financial information and issues, but also the context in which financial knowledge and skills are applied and/or acquired, such as family, community and school. The answers to such a questionnaire can provide insights into the drivers of students' financial proficiency.

87. Figure 5.1 illustrates, for all EU and OECD countries that participated in the financial literacy assessment in PISA in 2018, how 15-year-old students performed on average in the financial proficiency test. Results reveal that students in all EU and OECD countries achieved an average level of financial proficiency above 400 (proficiency level 2, see OECD (2020_[83])), which implies that they possessed basic knowledge of common financial products and concepts. On average, students in Estonia scored the highest (547), while those in Bulgaria recorded the lowest score (432) among participating countries.

Figure 5.1. Students' financial proficiency, by country (PISA 2018)

Mean index of 15-year-old students' financial proficiency



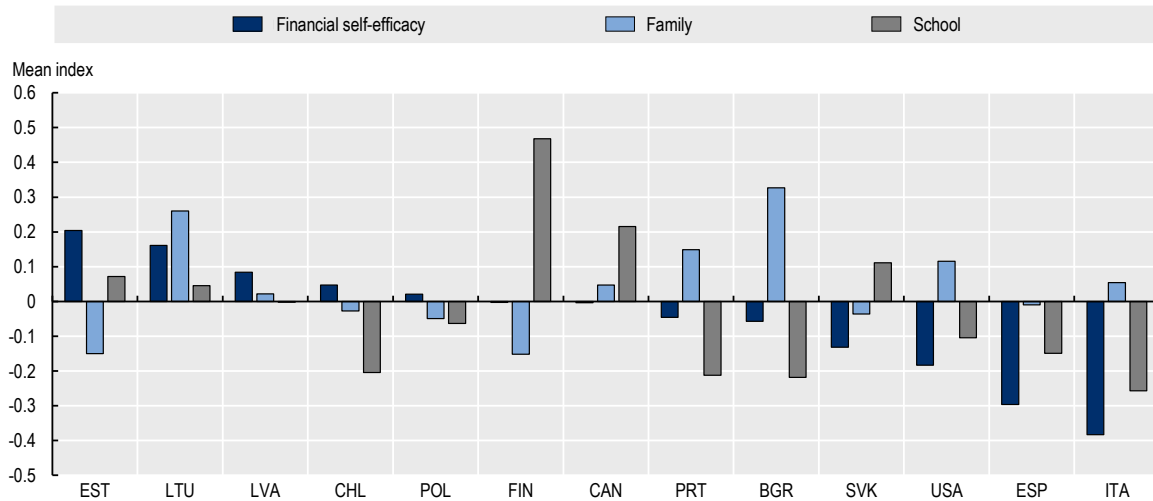
Note: The figure shows the mean index of 15-year-old students' financial proficiency. Countries are ranked in descending order by the mean index of financial proficiency. See Box 9.1 for a description of the indices.

Source: Calculations based on OECD (2018_[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

88. For the same 13 EU and OECD countries, Figure 5.2 uses the information provided in the accompanying questionnaire and shows the average values for three variables that are potentially important when addressing financial proficiency: confidence in financial matters (financial self-efficacy), parental and family involvement in financial matters, as well as exposure to financial topics at school. The scores are calculated using weighted likelihood estimation (WLE), then standardised so that the mean of the index values is zero and the standard deviation is one, with countries given equal weighting in the standardisation process (see OECD (2020_[83])). Students in Estonia scored highest in terms of confidence in financial matters, while those from Italy had the lowest score. Italian students also reported the lowest level of exposure to financial topics at school, while Finnish students reported the highest value. Conversely, students from Finland reported the lowest scores in terms of family involvement in financial matters, while those from Bulgaria showed the highest levels for the same variable.

Figure 5.2. Students' financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, by country (PISA 2018)

Mean index of 15-year-old students' financial self-efficacy, family involvement in financial matters and exposure to financial topics at school



Note: The figure shows the mean index of 15-year-old students' financial self-efficacy, family involvement in financial matters and exposure to financial topics at school. Countries are ranked in descending order by the mean index of financial self-efficacy. Indices are calculated using weighted likelihood estimation (WLE).

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

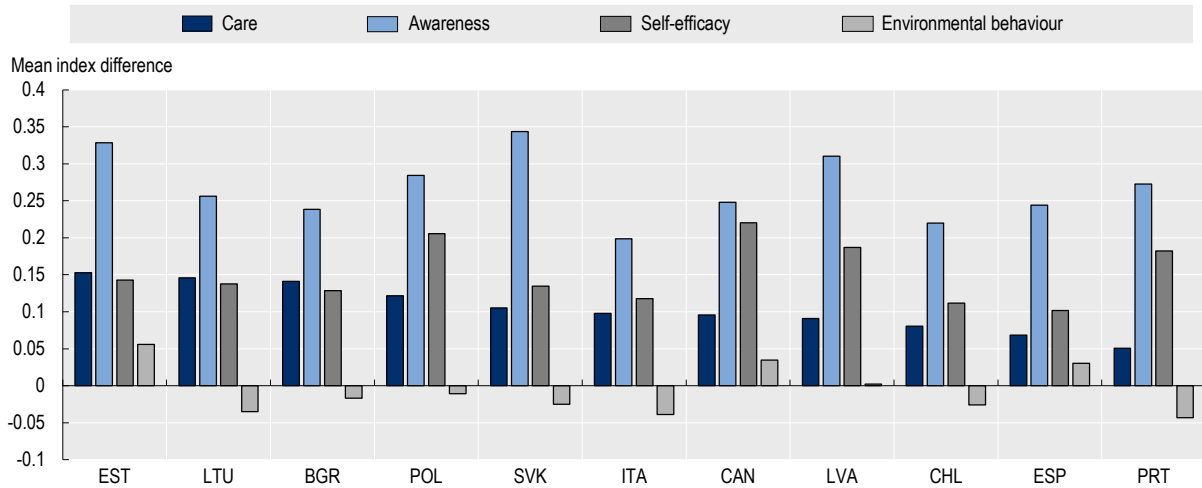
5.4. Financial proficiency and environmental sustainability competence – evidence from PISA 2018

89. Research suggests that financial literacy and environmental sustainability competence are highly correlated, given their common drivers in intertemporal trade-offs and future orientation. Figure 5.3 shows that for all of the 13 EU and OECD countries considered here, on average, students with a financial proficiency level of 2 and above (baseline performers) reported higher levels of environmental awareness, environmental care and environmental self-efficacy, compared to students with less-than-basic proficiency. However, on average, in 10 countries (exceptions are Estonia, Canada and Spain), students with a financial proficiency level of 2 or above reported lower levels of pro-environmental behaviour, compared to students with level 1 proficiency or below.

90. Similarly, Figure 5.4 shows that students with advanced financial proficiency (level 4 and above) reported higher levels of environmental awareness and environmental care, as well as much higher levels of environmental self-efficacy, which may be due to the higher levels of confidence in their abilities. Interestingly, students with a financial proficiency level 4 or above also reported higher levels of pro-environmental behaviour (compared to students with proficiency level 3 or below) in all countries except Poland and the Slovak Republic.

Figure 5.3. Difference in environmental sustainability competence between baseline performers in financial proficiency and other students, by country (PISA 2018)

Mean index difference of 15-year-old students' environmental sustainability competence, depending on whether or not they were baseline performers in financial proficiency

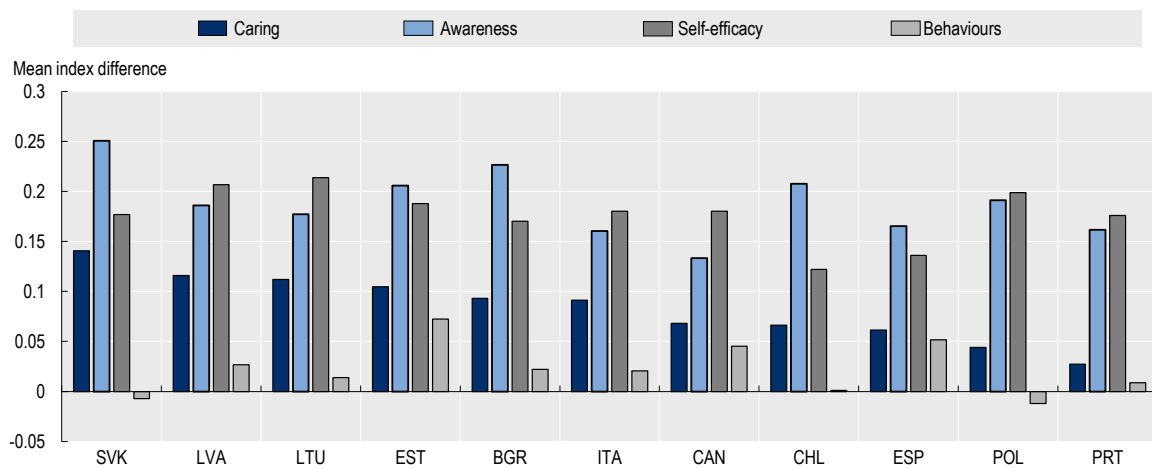


Note: The figure shows the mean index difference of 15-year-old students' environmental sustainability competence, depending on whether or not they were baseline performers in financial proficiency.

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

Figure 5.4. Difference in environmental sustainability competence between strong performers in financial proficiency and other students, by country (PISA 2018)

Mean difference of 15-year-old students' environmental sustainability competence, depending on whether or not they were strong performers in financial proficiency



Note: The figure shows the mean index difference of 15-year-old students' environmental sustainability competence, depending on whether or not they were strong performers in financial proficiency.

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

5.5. Financial literacy measures and environmental sustainability competence – evidence from PISA 2018

91. The personal and societal contexts in which financial knowledge and skills are acquired and/or applied are key to youths' financial proficiency (OECD, 2020). Indeed, the home, family, community and school play an important role in students' financial education. Figure 5.5 to Figure 5.8 represent various areas of financial literacy (proficiency, self-efficacy, parental involvement and exposure to financial issues at school) of students with high levels of environmental sustainability competence compared to students who displayed lower levels of environmental sustainability competence.

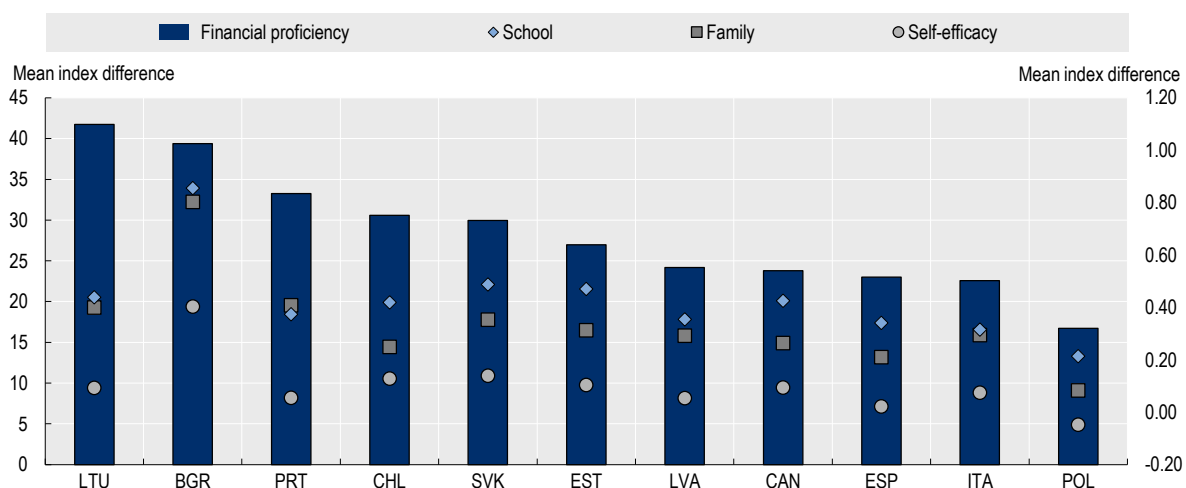
92. Figure 5.5 shows that students with higher levels of environmental care performed much better (compared to students with lower levels of environmental care) in the financial proficiency test throughout all 13 EU and OECD countries considered here. Lithuania displayed the highest average difference, while students from Poland showed the smallest difference.

93. Throughout all 13 EU and OECD countries, students' self-efficacy in financial matters was also higher for those with higher levels of environmental care, with little disparity between countries' average scores.

94. Both family involvement in financial matters and exposure to financial issues at school were notably higher for students who reported to care about environmental issues (compared to students who declared not to care). The highest values of the mean difference were found in Bulgaria, while the smallest were recorded in Poland.

Figure 5.5. Difference in students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, based on the level of environmental care, by country (PISA 2018)

Mean index difference of 15-year-old students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of care of the environment



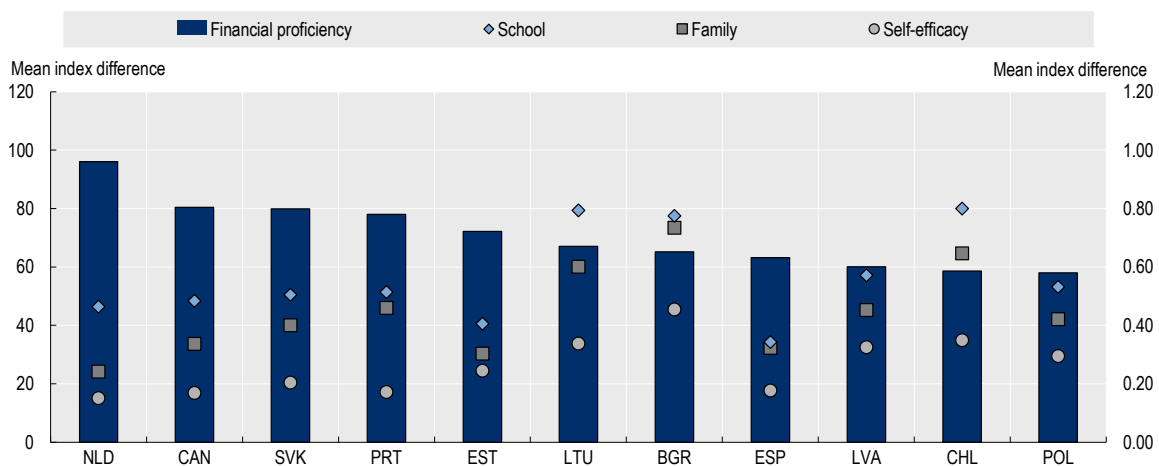
Note: The figure shows the mean index difference of 15-year-old students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of care of the environment. Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

95. Figure 5.6 projects a similar story to Figure 5.5, with students with higher levels of environmental awareness also reporting higher levels in all four areas of financial literacy considered here. The highest average difference in terms of financial proficiency was found in the Netherlands, while the highest mean index difference in terms of self-efficacy was recorded in Bulgaria (in both cases compared to students who have lower levels of environmental awareness). Bulgaria also scored highly in terms of the difference in family involvement in financial matters, while Lithuania showed the greatest positive difference in terms of exposure to financial issues at school (again compared to students who had lower levels of environmental awareness).

96. Similarly, as shown in Figure 5.4, students from Lithuania with high levels of environmental self-efficacy were also those who displayed the largest positive difference in terms of exposure to financial topics at school (compared to students with low levels of environmental self-efficacy). Throughout the remaining financial literacy measures, Figure 5.7 shows that students from all EU and OECD countries who reported higher levels of environmental self-efficacy systematically reported a higher level of financial literacy.

Figure 5.6. Difference in students’ financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, based on the level of environmental awareness, by country (PISA 2018)

Mean index difference of 15-year-old students’ financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of awareness of environment issues

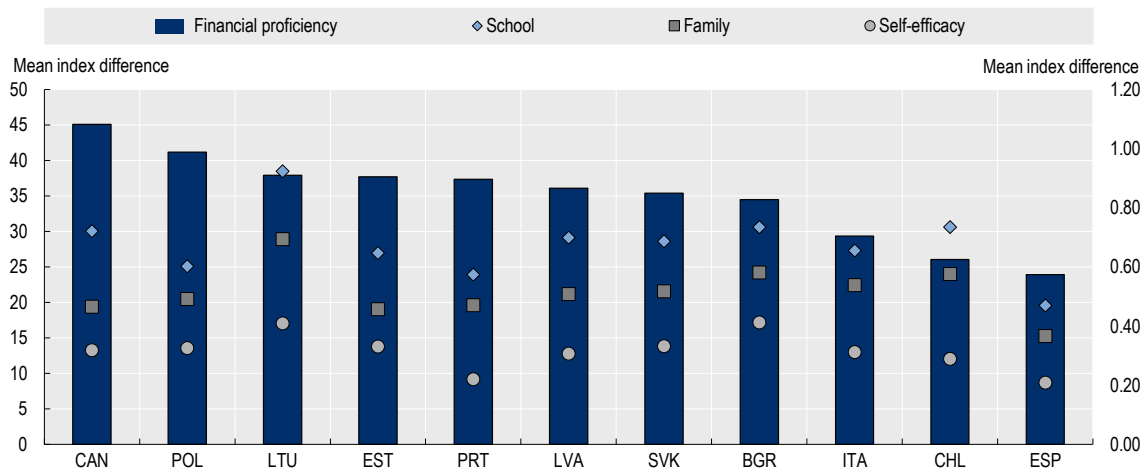


Note: The figure shows the mean index difference of 15-year-old students’ financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of awareness of environment issues.

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

Figure 5.7. Difference in students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, based on the level of environmental self-efficacy, by country (PISA 2018)

Mean index difference of 15-year-old students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of environmental self-efficacy



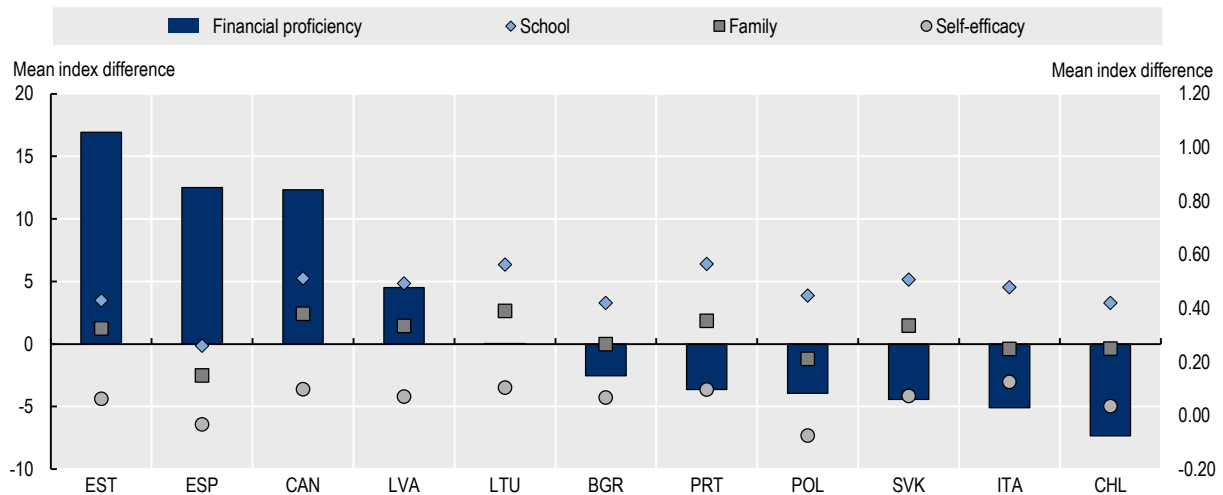
Note: The figure shows the mean index difference of 15-year-old students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of environmental self-efficacy
Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

97. Of all four environmental competence areas analysed, pro-environmental behaviour is the only one where higher levels are not systematically associated with greater financial literacy measures. Figure 5.8 indicates that students with higher levels of pro-environmental behaviour also reported lower levels of environmental self-efficacy (compared to students who reported lower levels of pro-environmental behaviour) in all 13 EU and OECD countries considered. Similarly, higher levels of pro-environmental behaviour were associated with lower levels of financial proficiency, with the exception of students from Estonia, Spain and Canada.

98. By contrast, family involvement in financial matters and exposure to financial topics at school were associated with higher levels of environmental behaviour in all participating countries. These results may reflect that financial proficiency and self-efficacy, which are personal characteristics, are less of a determinant for pro-environmental action, while family and school, which are collective and social by nature, may be key to inducing pro-environmental behaviour.

Figure 5.8. Difference in students' financial proficiency, financial self-efficacy, family involvement in financial matters and exposure to financial topics at school, based on the level of pro-environmental behaviour, by country (PISA 2018)

Mean index difference of 15-year-old students' financial proficiency, self-efficacy, family involvement in financial matters and exposure to financial topics at school, depending on whether or not they reported a high level of pro-environmental behaviour



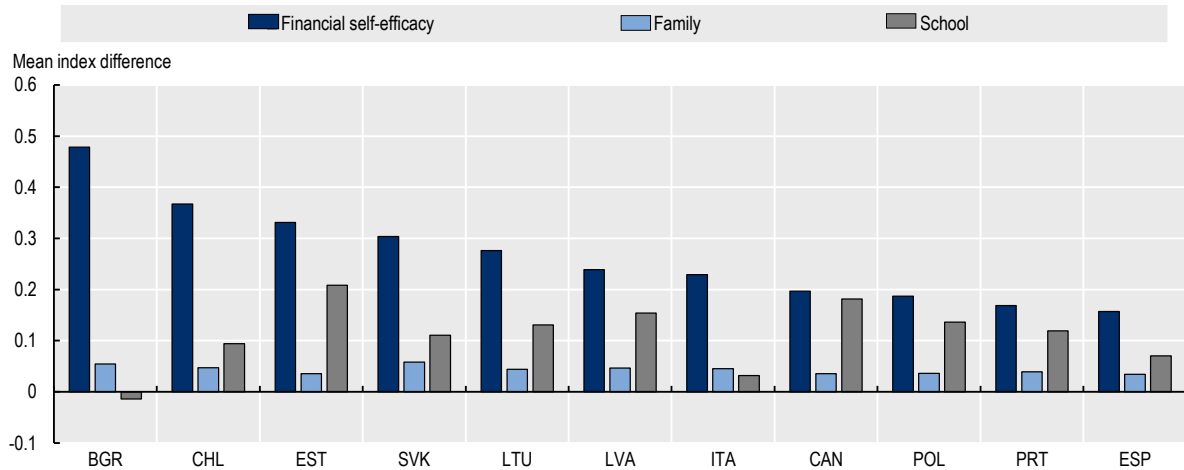
Note: The figure shows the mean index difference of 15-year-old students' financial literacy competence areas, depending on whether or not they reported a high level of pro-environmental behaviour.

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

99. Figure 5.9 shows how baseline all-rounders fare in terms of three financial literacy measures (financial self-efficacy, family involvement in financial matters and exposure to financial topics at school). Baseline all-rounders are those students who possess a level of financial proficiency of 2 or above and report high levels of environmental sustainability competence (care, awareness, self-efficacy and behaviour). All-rounders reported a higher level of financial self-efficacy throughout all 13 EU and OECD countries and, to a lesser extent, family involvement in financial matters. In all countries, except Bulgaria, all-rounders also reported a higher index of exposure to financial topics at school compared to non-all-rounders.

Figure 5.9. Financial self-efficacy, family involvement in financial matters and exposure to financial topics at school of baseline all-rounders and other students, by country (PISA 2018)

Mean index difference of 15-year-old students' financial self-efficacy, family involvement in financial matters and exposure to financial topics at school based on whether or not they were baseline all-rounders



Note: The figure shows the mean index in difference of baseline all-rounders and other students' financial self-efficacy, family involvement in financial matters and exposure to financial topics at school.

Source: Calculations based on OECD (2018^[24]), PISA 2018 Database, <https://www.oecd.org/pisa/data/2018database/>.

6 Conclusions and policy implications

I used to think that the top environmental problems were biodiversity loss, ecosystem collapse and climate change. I thought that with 30 years of good science we could address those problems, but I was wrong. The top environmental problems are selfishness, greed and apathy and to deal with those we need a spiritual and cultural transformation. And we scientists don't know how to do that.

Gus Speth⁷

100. Investing in equipping youngsters with the full environmental sustainability competence toolbox is not enough. In particular, it is widely believed that digital technologies have the potential to support sustainable and inclusive economic growth and help countries fulfil the green transition. Many analysts consider the green transition and the digital transition as two faces of the same coin or as twin economic and policy objectives that reinforce and accelerate each other. Digital innovations can be key enablers for the economy's green transition, while the greening of digital technologies is a critical success factor for the digital transformation.

101. Digital innovations can support the green transition. Digital technologies are key to monitoring, with precision, the state of the environment and assessing the impact of policies and interventions with the aim of identifying good practices and bringing such practices to scale. For example, satellites allow for real-time collection of data on greenhouse gas emissions and deforestation, allowing for greater transparency in countries' commitments to reach global environmental agreements. Technology also has a key role to play in enabling reductions in emissions. For example, digital technologies can help the housing sector reduce energy and water consumption. Smart technologies can enable the integration of renewable energy sources into the grid and advanced management systems can improve efficiency in energy and water use. Real-time traffic information and connected devices in logistics and lighting can reduce the environmental impact related to the transportation of people and goods. Digital technologies can also reduce the need to transport people through virtual conferencing, allowing effective virtual communication. Finally, digital technologies can improve agricultural productivity, reducing the water footprint of food production and food waste.

102. However, many technological innovations have contributed and continue to contribute to the creation of greenhouse gases and other environmental problems. Equipping future generations with proficiency across all environmental sustainability competence areas, including emotional, attitudinal and behavioural dimensions, is key to unleashing the potential of the twin transition towards a green and digital future. Yet results presented in this paper indicate that many students who do have good levels of environmental sustainability competence do not have similar levels of digital competence and vice versa. While PISA did not contain direct measures of proficiency in using digital tools, many students throughout OECD and EU countries reported low levels of interest in digital tools, a lack of self-efficacy when using digital tools and low levels of self-reported digital competence.

103. Combining strong environmental sustainability competence with solid digital skills is key to the profound rethinking and retooling that is necessary to adapt the energy, urban, transport, housing, agriculture and clothing industries – to name just a few – so that they reach climate change goals.

⁷ Gus Speth is an American environmental lawyer and co-founder of the Natural Resources Defense Council.

Supporting the environmental and digital transformation should not be dealt with separately but jointly if the economy is to reach a sustainable growth model with the necessary speed to avert environmental collapse.

104. Education and training policies and investments geared towards inclusive green and digital transitions hold the key to a sustainable and resilient future economy. Initiatives such as Erasmus+ and European Solidarity Corps programmes can serve as examples to emulate for education to become both greener and more digital. Virtual and blended mobility could complement physical mobility. Green and digital topics should take precedence in cooperation projects with their forward-looking and strategic character. Such programmes would streamline the digital dimension within the mobility and cooperation actions and intend to support climate-friendly means of cooperation and project execution. Further initiatives like incentives to carbon-friendly physical mobility travel could complement the measures. Interestingly, the European Commission envisages placing digital education beyond a mere science, technology, engineering and mathematics (STEM) approach and towards an ethical perspective. ‘High quality and inclusive digital education, which respects the protection of personal data and ethics, needs to be a strategic goal of all bodies and agencies active in education and training’ (European Commission, 2020, p. 8_[102]). This is also where the green dimension of digital skills becomes relevant, showcasing the European Commission’s intention to link the ideas of skill acquisition, digital transformation and sustainable development on any possible occasion (Symeonidis, Francesconi and Agostini, 2021_[103]).

105. Experts’ contribution at COP26 highlighted the urgent need for education initiatives that offer a more holistic and balanced perspective on the opportunities for technology-based solutions but also communicated the realities of the negative impact from e-waste and the shifting of the problem to poorer emerging nations. Indeed, while the reality is that digital technology is an integral component of global efforts to get to net-zero emissions, its adoption, however, requires pragmatic trade-offs as we transition from current behaviours to a more climate-friendly society (Dwivedi et al., 2022_[104]).

106. Other key competences that education systems should foster to promote the green transition are collaborative problem-solving and financial literacy. Solving many of the most pressing environmental challenges requires collaboration between different stakeholders. Achieving successful collaboration to solve complex environmental challenges that transcend national boundaries requires the alignment of wills and objectives, the awareness of the effects of human activities on the environment but also the creation of institutional arrangements, regulatory frameworks and working practices that rely on collaboration. From global to local level, tackling climate change and promoting sustainable growth rely on individuals working with others to achieve change. Doing so effectively hinges on the willingness and ability of individuals and communities to reach out to others with different interests, values and expertise.

107. Financial literacy entails key competences, such as the ability to conduct research before making decisions, weighing alternatives, understanding intertemporal trade-offs and identifying opportunities as they arise, all of which are important for sustainability. At the same time, financial knowledge and decision-making are also based on a set of objective criteria and metrics where emotions should play a minimal role. This contrast is conceivably reflected in the results presented in this report. In fact, while students who show higher levels of financial literacy demonstrate higher levels of environmental awareness, care and self-efficacy, they are also those less likely to exhibit pro-environmental behaviour compared to their peers. Interestingly, students who reported higher levels of family involvement in financial matters and inclusion of financial topics at school seem to be more prone to exhibit pro-environmental behaviour. These results are consistent with the literature on green behaviours, as environmental attitudes are an imperfect predictor of pro-environmental behaviour (Kristensson, Wästlund and Söderlund, 2017_[94]). The results also imply that since students with higher levels of financial literacy are also those with heightened environmental awareness and environmental self-efficacy, the fact that they are less likely to take pro-environmental actions is perhaps less critical. Indeed, by collaborating with others and spotting sustainable action opportunities, these upcoming adults could turn out to be the next generation of environmental venturers and entrepreneurs. As such, ensuring that students who have these

financial competences are also equipped with adequate environmental knowledge is key to achieving such profiles.

108. The paper also highlights that being a top performer in some fields is not sufficient to develop greater awareness of environmental problems. Findings reveal that for the science domain only (i.e. not for reading or mathematics), being a top performer is associated with greater awareness of environmental problems, compared to students with lower levels of achievement. These findings suggest that it is not students' general high educational performance, and the factors that generally accompany high achievement, that determine environmental awareness but, rather, that the content of the educational curriculum matters. Students who have high levels of science knowledge and understanding, and who can solve complex scientific problems using such knowledge, are likely to have acquired a greater understanding of environmental and sustainability issues which, in turn, equips them with greater environmental awareness.

109. Global environmental problems have become more complex and will affect economies and societies in the coming decades. While it is the responsibility of today's society to leave behind a better environmental future for today's younger generations, it will be today's younger generation that will shape future environmental policies. To move forward and ensure that all students are equipped with environmental sustainability competence needed to be actors in promoting the green transition and shaping a more sustainable future, education systems should consider the following policy pointers, which have been developed also based on the analysis carried out in Borgonovi et al. (2022^[11]).

- **Prepare children for the twin digital and green transition.** Education systems must look at digital and climate action together, rather than separate policy areas. Too often, education systems consider them in isolation. The reality is that we cannot achieve one without the other.
- **Develop programmes early.** The appreciation and protection of our environment should be taught and nurtured from an early age. Given the key role played by emotional, attitudinal and behavioural dimensions of environmental sustainability competence, and the fact that these dimensions can be acquired through repeated exposure to role models and long-term socialisation, environmental protection should be made a shared cultural and social norm. This requires whole-of-society efforts between the education system, parents and other social institutions. The education system can promote early childhood education and care programmes that aim at teaching children environmental sustainability competence from the early years. At the same time, environmental sustainability competence can be promoted within the family.
- **Early programmes are important but environmental sustainability should be promoted throughout the lifecycle.** The understanding of the impact of human actions on the environment, of key environmental phenomena and possibilities to promote environmental protection have evolved dramatically in the recent past. Comprehensive systems should be developed to capitalise on the success of early interventions and ensure that individuals continue to develop pro-environmental actions throughout their life. Furthermore, as environmental degradation has worsened, many individuals who were sceptic about the urgency of climate action have realised the need to develop and sustain initiatives to protect the environment. New generations who are working towards protecting the environment can be powerful agents of change, mobilising prior generations and help them establish a new environmental consciousness and awareness.
- **Embed environmental sustainability competence throughout the curriculum.** The acquisition of environmental sustainability competence should be promoted through an integrated and cross-curricular approach. Learning about the environment and acquiring environmental sustainability competences requires an interdisciplinary approach.
- **Prepare teachers and schools to promote students' acquisition of environmental sustainability competence.** Incorporating environmental and climate change education in

curricula is critical and should be accompanied by solid elective and extracurricular activities and professional development opportunities for all teachers.

- **Organise early and comprehensive career advice and educational orientation programmes.** Having acquired environmental sustainability competence is a precondition for students to be able to work in the green jobs of tomorrow. But promoting early and comprehensive career advice and educational orientation is critical to ensure that children will make choices that will enable them to make the most of this competence. Such programmes should be regularly updated to integrate information on emerging educational and career opportunities, adequately staffed and resourced.
- **Reduce socio-economic disparities in environmental sustainability competence.** Education systems should promote more equitable learning of environmental sustainability competence for all students, ensuring that today's marked socio-economic divide in environmental sustainability competence between students with a high and low ESCS can be mitigated. Education systems can promote interventions at school, community and system levels to mitigate this socio-economic divide in environmental sustainability competence. Among others, these include promoting policies and interventions aimed at increasing the share of science top performers among disadvantaged students. In addition, it is equally important that all schools, including the disadvantaged, use teaching methods that can enhance students' environmental sustainability competence, including teacher-directed instruction, perceived feedback, adaptive instruction, enquiry-based science instruction.
- **Tackle stereotypes and biases that create gender segregation by science area.** Gender stereotypes and biases can affect the way students perform at school and build their educational and professional aspirations, particularly in STEM disciplines. Together with parents, teachers and schools play an important role in passing down gender stereotypes and biases to students and reinforcing them. Therefore, education systems should be equipped with the means to mitigate gender stereotypes and biases in STEM by, among others, preparing teachers and the school staff to promote learning environments free of biases and stereotypes. What happens at home is equally important. Thus, education systems should also support parents and families in learning how their stereotypes and biases can affect their children's identity development as well as their educational and professional choices and outcomes.
- **Focus on how best to develop interventions.** A 'whole-school approach', encompassing teaching and learning, active participation from both students and their parents, as well as partnerships with local communities, can be a transformative strategy to support the acquisition of environmental sustainability competence.
- **Monitor and evaluate programmes and interventions aimed at promoting students' environmental sustainability competences throughout all areas.** System-wide policies and school-level interventions should be regularly monitored and evaluated to assess their progress and support the development of new programmes. Ongoing monitoring and final evaluation of interventions implemented can, among others, support the upscaling of effective interventions. Monitoring and evaluation can also strengthen stakeholder engagement and coordination to systematise the promotion of environmental sustainability competence for all students.

References

- Anderson, A. and D. Robinson (2021), *Financial literacy in the age of green investment. Swedish House of Finance Research Paper*, 19–6. [101]
- Anderson-Levitt, K. and M. Gardinier (2021), “Introduction contextualising global flows of competency-based education: polysemy, hybridity and silences”, *Comparative Education*, Vol. 57/1, pp. 1-18, <https://doi.org/10.1080/03050068.2020.1852719>. [65]
- Andreoni, J. and L. Vesterlund (2001), “Which is the Fair Sex? Gender Differences in Altruism”, *The Quarterly Journal of Economics*, Vol. 116/1, pp. 293-312, <https://doi.org/10.1162/003355301556419>. [51]
- Balliet, D. et al. (2011), “Sex differences in cooperation: A meta-analytic review of social dilemmas.”, *Psychological Bulletin*, Vol. 137/6, pp. 881-909, <https://doi.org/10.1037/a0025354>. [56]
- Ben-Arieh, A. et al. (eds.) (2014), *Child well-being and the life course*, Springer. [17]
- Bennett, N. and T. Satterfield (2018), “Environmental governance: A practical framework to guide design, evaluation, and analysis”, *Conservation Letters*, Vol. 11/6, p. e12600, <https://doi.org/10.1111/conl.12600>. [36]
- Bianchi, G. (2020), *Sustainability competences*, Publications Office of the European Union, <https://publications.jrc.ec.europa.eu/repository/handle/JRC123624> (accessed on 7 June 2022). [45]
- Bianchi, G. et al. (2022), *GreenComp: The European Sustainability Competence Framework*, Publications Office of the European Union. Available at, <https://publications.jrc.ec.europa.eu/re> (accessed on 7 June 2022). [15]
- Bodin, Ö., M. Mancilla García and G. Robins (2020), “Reconciling Conflict and Cooperation in Environmental Governance: A Social Network Perspective”, *Annual Review of Environment and Resources*, Vol. 45/1, pp. 471-495, <https://doi.org/10.1146/annurev-environ-011020-064352>. [37]
- Borgonovi et al. (2022), “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, OECD Publishing, Paris, <https://doi.org/10.1787/1097a78c-en>. [1]

- Borgonovi, F. and J. Pál (2016), “A Framework for the Analysis of Student Well-Being in the PISA 2015 Study: Being 15 In 2015”, *OECD Education Working Papers*, No. 140, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5jlpszwghvvh-en>. [16]
- Bronfenbrenner, U. (1979), *The Ecology of Human Development*, Harvard University Press. [18]
- Cecere, G. et al. (2014), “Technological pervasiveness and variety of innovators in Green ICT: A patent-based analysis”, *Research Policy*, Vol. 43/10, pp. 1827-1839, <https://doi.org/10.1016/j.respol.2014.06.004>. [77]
- Cenamor, J., V. Parida and J. Wincent (2019), “How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity”, *Journal of Business Research*, Vol. 100, pp. 196-206, <https://doi.org/10.1016/j.jbusres.2019.03.035>. [62]
- Chetty, K. et al. (2018), “Bridging the digital divide: measuring digital literacy”, *Economics*, Vol. 12/1, <https://doi.org/10.5018/economics-ejournal.ja.2018-23>. [70]
- Christov-Moore, L. et al. (2014), “Empathy: Gender effects in brain and behavior”, *Neuroscience & Biobehavioral Reviews*, Vol. 46, pp. 604-627, <https://doi.org/10.1016/j.neubiorev.2014.09.001>. [55]
- Cooke, P. (2010), “Regional innovation systems: development opportunities from the ‘green turn’”, *Technology Analysis & Strategic Management*, Vol. 22/7, pp. 831-844, <https://doi.org/10.1080/09537325.2010.511156>. [75]
- Cook, R. and H. Weaving (2012), *Key Competence Development in School Education in Europe: KeyCoNet’s review of the literature*, KeyCoNet, http://keyconet.eun.org/c/document_library/get_file?uuid=3a7a093c-4c8f-473c-8702-f38ed86bb730&groupId=11028 (accessed on 8 June 2022). [66]
- COP26 (2021), *COP26: The Glasgow Climate Pact*, <https://ukcop26.org/wp-content/uploads/2021/11/COP26-Presidency-Outcomes-The-Climax-Pact.pdf> (accessed on 7 June 2022). [5]
- Croson, R. and U. Gneezy (2009), “Gender Differences in Preferences”, *Journal of Economic Literature*, Vol. 47/2, pp. 448-474, <https://doi.org/10.1257/jel.47.2.448>. [48]
- D’Arco, M. and V. Marino (2022), “Environmental citizenship behavior and sustainability apps: an empirical investigation”, *Transforming Government: People, Process and Policy*, Vol. 16/2, pp. 185-202, <https://doi.org/10.1108/tg-07-2021-0118>. [80]
- Demirel, P., E. Kesidou and G. Danisman (2022), *Paper to be presented at DRUID22 Copenhagen Business School, Copenhagen, Denmark June 13-15, 2022*. [59]
- Dwivedi, Y. et al. (2022), “Climate change and COP26: Are digital technologies and information management part of the problem or the solution? An editorial reflection and call to action”, *International Journal of Information Management*, Vol. 63, p. 102456, <https://doi.org/10.1016/j.ijinfomgt.2021.102456>. [104]
- Eagly, A., A. Beall and R. Sternberg (eds.) (2004), *Gender as Status: An Expectation States Theory Approach*, The Guilford Press. [57]

- Eagly, A. and V. Steffen (1986), "Gender and aggressive behavior: A meta-analytic review of the social psychological literature.", *Psychological Bulletin*, Vol. 100/3, pp. 309-330, <https://doi.org/10.1037/0033-2909.100.3.309>. [54]
- Eagly, A. and W. Wood (1991), "Explaining Sex Differences in Social Behavior: A Meta-Analytic Perspective", *Personality and Social Psychology Bulletin*, Vol. 17/3, pp. 306-315, <https://doi.org/10.1177/0146167291173011>. [52]
- Enríquez-Díaz, J., L. Castro-Santos and F. Puime-Guillén (eds.) (2021), *The role of financial education in the path towards sustainable development: A practical experience with students of secondary education*, <https://doi.org/10.4018/978-1-7998-7634-2.ch001>. [88]
- Eshet, Y. (2004), "Digital literacy: A conceptual framework for survival skills in the digital era", *Journal of Educational Multimedia and Hypermedia*, Vol. 13/1, pp. 93-106. [71]
- European Commission (2021), *Communication from the Commission: Annual Sustainable Growth Survey 2022. COM/2021/740 Final.*, https://ec.europa.eu/info/system/files/economy-finance/2022_european_semester_annual_sustainable_growth_survey.pdf (accessed on 7 June 2022). [8]
- European Commission (2020), *Digital Education Action Plan 2021-2027*, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0624> (accessed on 9 June 2022). [102]
- European Parliament and Council (2021), *Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')*, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1119> (accessed on 7 June 2022). [2]
- European Parliament and Council (2021), *Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility*, [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021R0241) (accessed on 7 June 2022). [9]
- Falk, A. and J. Hermle (2018), "Relationship of gender differences in preferences to economic development and gender equality", *Science*, Vol. 362/6412, <https://doi.org/10.1126/science.aas9899>. [49]
- Faucheux, S. and I. Nicolăi (2011), "IT for green and green IT: A proposed typology of eco-innovation", *Ecological Economics*, Vol. 70/11, pp. 2020-2027. [69]
- Fauville, G., A. Queiroz and J. Bailenson (2020), "Virtual reality as a promising tool to promote climate change awareness", in *Technology and Health*, Elsevier, <https://doi.org/10.1016/b978-0-12-816958-2.00005-8>. [76]
- Frenken, K., L. Izquierdo and P. Zeppini (2012), "Branching innovation, recombinant innovation, and endogenous technological transitions", *Environmental Innovation and Societal Transitions*, Vol. 4, pp. 25-35, <https://doi.org/10.1016/j.eist.2012.06.001>. [64]
- Gareis, K. et al. (2014), *E-skills for jobs in Europe: Measuring progress and moving ahead. Prepared for European Commission*. [68]

- Giannetti, B. et al. (2021), “Individual-level characteristics of environmental sustainability among students in a higher education institution: the role of happiness and academic performance”, *International Journal of Sustainability in Higher Education*, Vol. 22/7, pp. 1664-1690, <https://doi.org/10.1108/ijshe-10-2020-0368>. [31]
- González-Hernández, D., E. Meijles and F. Vanclay (2019), “Factors that Influence Climate Change Mitigation and Adaptation Action: A Household Study in the Nuevo Leon Region, Mexico”, *Climate*, Vol. 7/6, p. 74, <https://doi.org/10.3390/cli7060074>. [100]
- Goodfellow, R. (2011), “Literacy, literacies and the digital in higher education”, *Teaching in Higher Education*, Vol. 16/1, pp. 131-144, <https://doi.org/10.1080/13562517.2011.544125>. [72]
- Government of Colombia (2020), *Colombia’s National Policy on Sustainable Recovery (CONPES No. 4023)*, <https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/4023.pdf> (accessed on 24 March 2022). [7]
- Government of Costa Rica (2019), *National Decarbonization Plan 2018-2050*, <https://unfccc.int/sites/default/files/resource/NationalDecarbonizationPlan.pdf> (accessed on 24 March 2022). [3]
- Government of Korea (2020), *Korean New Deal: National Strategy for a Great Transformation*, <https://english.moef.go.kr/pc/selectTbPressCenterDtl.do?boardCd=N0001&seq=4948> (accessed on 24 March 2022). [6]
- Griffin, P., B. McGaw and E. Care (eds.) (2012), *Assessment and Teaching of 21st Century Skills*, Springer Netherlands, Dordrecht, <https://doi.org/10.1007/978-94-007-2324-5>. [11]
- Grohmann, A., T. Klühs and L. Menkhoff (2018), “Does financial literacy improve financial inclusion? Cross country evidence”, *World Development*, Vol. 111, pp. 84-96, <https://doi.org/10.1016/j.worlddev.2018.06.020>. [85]
- Gurbaxani, V. and D. Dunkle (2019), “Gearing up for successful digital transformation”, *MIS Quarterly Executive*, Vol. 18/3. [63]
- Habyarimana, J. et al. (2009), *Coethnicity: Diversity and the Dilemmas of Collective Action. The Russel Sage Foundation Series on Trust.*, Russel Sage Foundation. [42]
- Hartung, P., E. Porfeli and F. Vondracek (2005), “Child vocational development: A review and reconsideration”, *Journal of Vocational Behavior*, Vol. 66/3, pp. 385-419, <https://doi.org/10.1016/j.jvb.2004.05.006>. [22]
- Henkel, C. et al. (2019), *How to Nudge Pro-Environmental behaviour: An Experimental Study*, ECIS. [82]
- Hilgert, M., J. Hogarth and S. Beverly (2003), *Household financial management: The connection between knowledge and behavior*. [98]
- IEA (2017), *Digitalisation and Energy*, IEA, <https://www.iea.org/reports/digitalisation-and-energy> (accessed on 8 June 2022). [74]
- Johnson, M. (2021), “Job values in the young adult transition: Stability and change with age”, *Social Psychology Quarterly*, Vol. 64/4, pp. 297–317. [20]

- Jung, J. (2012), “Gifted elementary students’ understandings about earth systems and environmental problems”, *Journal of the Korean Earth Science Society*, Vol. 33/7, pp. 672-682. [29]
- Khashe, S. et al. (2017), “Buildings with persona: Towards effective building-occupant communication”, *Computers in Human Behavior*, Vol. 75, pp. 607-618, <https://doi.org/10.1016/j.chb.2017.05.040>. [81]
- Kristensson, P., E. Wästlund and M. Söderlund (2017), “Influencing consumers to choose environment friendly offerings: Evidence from field experiments”, *Journal of Business Research*, Vol. 76, pp. 89-97, <https://doi.org/10.1016/j.jbusres.2017.03.003>. [94]
- Kumari, S. and A. Harikrishnan (2021), “Importance of Financial literacy For Sustainable Future Environment: A Research Among People In Rural Areas With Special Reference To Mandi District,Himachal Pradesh”, *International Journal of Engineering, Science and Information Technology*, Vol. 1/1, pp. 15-19, <https://doi.org/10.52088/ijesty.v1i1.36>. [91]
- Kuwabara, K. (2005), “Nothing to Fear But Fear Itself: Fear of Fear, Fear of Greed and Gender Effects in Two-Person Asymmetric Social Dilemmas”, *Social Forces*, Vol. 84/2, pp. 1257-1272, <https://doi.org/10.1353/sof.2006.0020>. [40]
- Lee, C. and A. Huruta (2022), “Green Microfinance and Women’s Empowerment: Why Does Financial Literacy Matter?”, *Sustainability*, Vol. 14/5, p. 3130, <https://doi.org/10.3390/su14053130>. [92]
- Maker, C. and R. Zimmerman (2020), “Concept maps as assessments of expertise: Understanding of the complexity and interrelationships of concepts in science”, *Journal of Advanced Academics*, Vol. 31/3, pp. 254-297, <https://doi.org/10.1177%2F1932202X20921770>. [30]
- Mavlutova, I. et al. (2021), “Opportunities to increase financial well-being by investing in environmental, social and governance with respect to improving financial literacy under COVID-19: The case of Latvia”, Vol. 14/1, p. 339. [93]
- McCann, P. and L. Soete (2020), *Place-based innovation for sustainability*, Publications Office of the European Union, <http://dx.doi.org/10.2760/250023>. [58]
- Montesor, S. and F. Quatraro (2019), “Green technologies and Smart Specialisation Strategies: a European patent-based analysis of the intertwining of technological relatedness and key enabling technologies”, *Regional Studies*, Vol. 54/10, pp. 1354-1365, <https://doi.org/10.1080/00343404.2019.1648784>. [60]
- Motta, M. (2018), “The enduring effect of scientific interest on trust in climate scientists in the United States”, *Nature Climate Change*, Vol. 8/6, pp. 485-488, <https://doi.org/10.1038/s41558-018-0126-9>. [23]
- Muske, G. and M. Winter (2001), “An in-depth look at family cash-flow management practices”, *Journal of Family and Economic Issues*, Vol. 22/4, pp. 353–372. [87]
- Mutlu, F., O. Nacaroglu and M. Doğan (2021), “Awareness of the Gifted Students and Their Normally Developing Peers about Environmental Education Concept”, *Acta Didactica Napocensia*, Vol. 14/1, pp. 2-16, <https://doi.org/10.24193/adn.14.1.1>. [28]

- Niederle, M. and L. Vesterlund (2007), "Do Women Shy Away From Competition? Do Men Compete Too Much?", *The Quarterly Journal of Economics*, Vol. 122/3, pp. 1067-1101, <https://doi.org/10.1162/qjec.122.3.1067>. [53]
- OECD (2021), *OECD Skills Outlook 2021: Learning for Life*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/0ae365b4-en>. [25]
- OECD (2020), *PISA 2018 Results (Volume IV): Are Students Smart about Money?*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/48ebd1ba-en>. [83]
- OECD (2020), *PISA 2018 Results (Volume VI): Are Students Ready to Thrive in an Interconnected World?*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/d5f68679-en>. [14]
- OECD (2020), *What Students Learn Matters: Towards a 21st Century Curriculum*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/d86d4d9a-en>. [13]
- OECD (2019), *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/5f07c754-en>. [27]
- OECD (2018), *PISA 2018 Database*, <https://www.oecd.org/pisa/data/2018database/> (accessed on 9 August 2022). [24]
- OECD (2018), *The future we want. OECD Education 2030 position paper*, OECD Publishing, [https://www.oecd.org/education/2030-project/contact/E2030%20Position%20Paper%20\(05.04.2018\).pdf](https://www.oecd.org/education/2030-project/contact/E2030%20Position%20Paper%20(05.04.2018).pdf) (accessed on 7 June 2022). [10]
- OECD (2017), *PISA 2015 Results (Volume V): Collaborative Problem Solving*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264285521-en>. [47]
- OECD (2015), *PISA 2015 Database*, <https://www.oecd.org/pisa/data/2015database/> (accessed on 10 August 2022). [33]
- OECD (2009), "What are the top performers' attitudes and motivations for science in PISA 2006?", in *Education at a Glance 2009: OECD Indicators*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/eag-2009-9-en>. [34]
- Oliver, M. and M. Adkins (2020), "'Hot-headed' students? Scientific literacy, perceptions and awareness of climate change in 15-year olds across 54 countries", *Energy Research & Social Science*, Vol. 70, p. 101641, <https://doi.org/10.1016/j.erss.2020.101641>. [26]
- Ostrom, E. (2010), "Analyzing collective action", *Agricultural Economics*, Vol. 41, pp. 155-166, <https://doi.org/10.1111/j.1574-0862.2010.00497.x>. [43]
- Pushkarskaya, H. and E. Usher (2020), "Self-efficacy for resolving environmental uncertainties: Implications for entrepreneurial educational and support programs", *Journal of Extension*, Vol. 48/1, pp. 1–10. [97]
- Rahmandoust, M. et al. (2011), "Teaching financial literacy to entrepreneurs for sustainable development", *OIDA International Journal of Sustainable Development*, Vol. 2/12, pp. 61-66. [96]
- Rychen, D. (2004), *An overarching conceptual framework for assessing key competences in an international context. Lessons from an interdisciplinary and policy-oriented approach*. [67]

- Rychen, D. and L. Salganik (eds.) (2003), *Key competencies for a successful life and a well-functioning society*, Hogrefe & Huber Publishers. [12]
- Santoalha, A., D. Consoli and F. Castellacci (2021), "Digital skills, relatedness and green diversification: A study of European regions", *Research Policy*, Vol. 50/9, p. 104340, <https://doi.org/10.1016/j.respol.2021.104340>. [61]
- Saricam, H. and S. Sahin (2015), "The Relationship between the Environmental Awareness, Environmental Attitude, Curiosity and Exploration in Highly Gifted Students: Structural Equation Modelling", *Educational Process: International Journal*, Vol. 4/1-2, pp. 7-17, <http://dx.doi.org/10.12973/edupij.2015.412.1>. [32]
- Schulenberg, J., F. Vondracek and J. Kim (1993), "Career certainty and short-term changes in work values during adolescence", *The Career Development Quarterly*, Vol. 41/3, pp. 268-284. [21]
- Simpson, B. (2003), "Sex, Fear, and Greed: A Social Dilemma Analysis of Gender and Cooperation", Vol. 82, pp. 35-52. [41]
- Simpson, B. and R. Willer (2015), "Beyond Altruism: Sociological Foundations of Cooperation and Prosocial Behavior", *Annual Review of Sociology*, Vol. 41/1, pp. 43-63, <https://doi.org/10.1146/annurev-soc-073014-112242>. [44]
- Steinberg, L. et al. (2009), "Age Differences in Future Orientation and Delay Discounting", *Child Development*, Vol. 80/1, pp. 28-44, <https://doi.org/10.1111/j.1467-8624.2008.01244.x>. [84]
- Stephens, M., L. Warren and A. Harner (2015), *Comparative Indicators of Education in the United States and Other G-20 Countries: 2015*, National Center for Education Statistics. [19]
- Stern, N. (2008), "The Economics of Climate Change", *American Economic Review*, Vol. 98/2, pp. 1-37, <https://doi.org/10.1257/aer.98.2.1>. [35]
- Šubic, R., I. Braje and K. Žagi (2019), *Family Background And Financial Literacy As A Prerequisite For Entrepreneurial Intention Of University Students*. [95]
- Świecka, B. et al. (2021), "Consumer Financial Knowledge and Cashless Payment Behavior for Sustainable Development in Poland. Sustainability", Vol. 13/11. [90]
- Swiecka, B. et al. (2020), "Financial Literacy: The Case of Poland", *Sustainability*, Vol. 12/2, p. 700, <https://doi.org/10.3390/su12020700>. [99]
- Symeonidis, V., D. Francesconi and E. Agostini (2021), "The EU's education policy response to the Covid-19 pandemic: A discourse and content analysis", *CEPS Journal*, Vol. 11/Special issue, pp. 89–115. [103]
- Tang, P., H. Liu and H. Wen (2021), "Factors Predicting Collaborative Problem Solving: Based on the Data From PISA 2015", *Frontiers in Education*, Vol. 6, <https://doi.org/10.3389/educ.2021.619450>. [46]
- Theodorou, P. et al. (2018), *Recycling and education through digital storytelling in the age group "8-12" in Greece*. [79]
- Trott, C. and A. Weinberg (2020), "Science Education for Sustainability: Strengthening Children's Science Engagement through Climate Change Learning and Action", *Sustainability*, Vol. 12/16, p. 6400, <https://doi.org/10.3390/su12166400>. [78]

- U.S. Congressional Research Service (2021), *U.S. Climate Change Policy*, [4]
<https://crsreports.congress.gov/product/pdf/R/R46947#:~:text=Examples%20of%20enacted%20legislation%20involving%2ccarbon%20capture%20and%20sequestration%20efforts.&text=President%20Bid> (accessed on 24 March 2022).
- UNESCO (2011), *Digital Literacy in Education*. [73]
- Vatn, A. (2018), “Environmental Governance – From Public to Private?”, *Ecological Economics*, [38]
Vol. 148, pp. 170-177, <https://doi.org/10.1016/j.ecolecon.2018.01.010>.
- Vugt, M., D. Cremer and D. Janssen (2007), “Gender Differences in Cooperation and [50]
Competition”, *Psychological Science*, Vol. 18/1, pp. 19-23, <https://doi.org/10.1111/j.1467-9280.2007.01842.x>.
- WCED (1987), *World Commission on Environment and Development: Our Common Future*. [89]
- Webster, M. and L. Walker (2016), “The Theories of Status Characteristics and Expectation [39]
States”, in *Handbooks of Sociology and Social Research, Handbook of Contemporary Sociological Theory*, Springer International Publishing, Cham, https://doi.org/10.1007/978-3-319-32250-6_16.
- White Jr, K., M. McCoy and K. Watkins (2018), “Exploring the Relationship Between [86]
Sustainability and Personal Finance Practices”, *The Forum Journal*, Vol. 22/1.

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/Environmental-sustainability-competence-toolbox-data-tables.xlsx>