Publication

PISA 2022 Results

Learning Strategies and Attitudes for Life

Volume V

OECD
BETTER POLICIES FOR BETTER LIVES

PISA 2022 Results (Volume V)

LEARNING STRATEGIES AND ATTITUDES FOR LIFE

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Preface

In 2022, as countries were still dealing with the lingering impacts of the COVID-19 pandemic, nearly 700 000 students from 81 OECD Member and partner economies, representing 29 million across the world, took the Programme for International Student Assessment (PISA) test.

It makes 2022 PISA the first large-scale study to collect data on student performance, well-being, and equity in education before and after the COVID-19 disruptions. The report finds that, in spite of the challenging circumstances, 24 countries and economies managed to maintain their performance at the same level as PISA 2018. Among these, Singapore, Japan, Korea, Switzerland, and Australia* maintained or further raised already high levels of student performance, with scores ranging from 487 to 575 points (OECD average 472). These systems showed common features including shorter school closures, fewer obstacles to remote learning, and continuing teachers' and parental support. These offer insights and indications of broader best practices to address future crises.

Many countries also made significant progress towards universal secondary education, key to enabling equality of opportunity and full participation in the economy. Among them, Cambodia, Colombia, Costa Rica, Indonesia, Morocco, Paraguay and Romania have rapidly expanded education to previously marginalised populations over the past decade.

Ten countries and economies saw a large share of all 15-year-olds gain basic proficiency in maths, reading and science, and achieve high levels of socio-economic fairness: Canada*, Denmark*, Finland, Hong Kong (China)*, Ireland*, Japan, Korea, Latvia*, Macao (China) and the United Kingdom*. While socio-economic status remains a significant predictor of performance in these and other OECD countries and economies, education in these countries can be considered highly equitable.

At the same time, on average, the PISA 2022 assessment saw an unprecedented drop in performance across the OECD. Compared to 2018, mean performance fell by ten score points in reading and by almost 15 score points in mathematics, which is equivalent to three-quarters of a year's worth of learning. The decline in mathematics performance is three times greater than any previous consecutive change. In fact, one in four 15-year-olds is now considered a low performer in mathematics, reading, and science on average across OECD countries. This means they can struggle to do tasks such as use basic algorithms or interpret simple texts. This trend is more pronounced in 18 countries and economies, where more than 60% of 15-year-olds are falling behind.

Yet the decline can only partially be attributed to the COVID-19 pandemic. Scores in reading and science had already been falling prior to the pandemic. For example, negative trends in mathematics performance were already apparent prior to 2018 in Belgium, Canada*, Czechia, Finland, France, Hungary, Iceland, the Netherlands*, New Zealand*, and the Slovak Republic.

The relationship between pandemic-induced school closures, often cited as the main cause of performance decline, is not so direct. Across the OECD, around half of the students experienced closures for more than three months. However, PISA results show no clear difference in performance trends between education systems with limited school closures such as Iceland, Sweden and Chinese Taipei, and systems that experienced longer school closures, such as Brazil, Ireland* and Jamaica*.

School closures also drove a global conversion to digitally-enabled remote learning, adding to long-term challenges that had already emerged, such as the use of technology in classrooms. How education systems grapple with technological change and whether policymakers find the right balance between risks and opportunities, will be a defining feature of effective education systems.

According to our results, on average across OECD countries, around three-quarters of students reported being confident using various technologies, including learning-management systems, school learning platforms and video communication programmes. Students who spent up to one hour per day on digital devices for learning activities in school scored 14 points higher in mathematics than students who spent no time, and this positive relationship is observed in over half (46 countries and economies) of all systems with available data. Yet technology used for leisure rather than instruction, such as mobile phones, often seems to be associated with poorer results. Students who reported that they become distracted by other students who are using digital devices in at least some mathematics lessons scored 15 points lower than students who reported that this never or almost never happens, after accounting for students' and schools' socio-economic profile.

PISA data show that teacher support is particularly important in times of disruption, including by providing extra pedagogical and motivational support to students. The availability of teachers to help students in need had the strongest relationship to mathematics performance across the OECD, compared to other experiences linked to COVID-19 school closure. Mathematics scores were 15 points higher on average where students agreed they had good access to teacher help. These students were also more confident than their peers to learn autonomously and remotely. Despite this, only one in five students overall reported that they received extra help from teachers in some lessons in 2022. Around eight percent never or almost never received additional support.

Overall, education systems with positive trends in parental engagement in student learning between 2018 and 2022 showed greater stability or improvement in mathematics performance. This was particularly true for disadvantaged students. These figures, which consider students' and schools' socio-economic profile, show that the level of active support that parents offer their children might have a decisive effect. Yet parental involvement in students' learning at school decreased substantially between 2018 and 2022. On average across OECD countries, the share of students in schools where most parents independently initiated discussions about their child's progress with a teacher dropped by ten percentage points.

Finally, we see a positive relationship between investment in education and average performance up to a threshold of USD 75 000 in cumulative spending per student from ages 6 to 15. For many OECD countries that spend more per student, there is no relationship between extra investment and student performance. Countries like Korea and Singapore have demonstrated that it is possible to establish a top-tier education system even when starting from a relatively low income level, by prioritising the quality of teaching over the size of classes and funding mechanisms that align resources with needs.

To strengthen the role of education in empowering young people to succeed and ensuring merit-based equality of opportunity, the resilience of our education systems will be critical not only to improve learning outcomes measured through PISA, but to their long-term effectiveness. I'm pleased to share the 2022 PISA report with you, to provide policymakers across OECD Members and partner economies with evidence-based policy advice to design resilient and effective education systems that will help give our children and adolescents the best possible future.

Mathias Cormann,

OECD Secretary-General

Foreword

The OECD's latest PISA results assess not just academic performance but also the ability of students to learn continuously, adapt to new circumstances, and apply knowledge in diverse and often unpredictable contexts. Education systems are facing an unprecedented challenge: preparing students to thrive in the face of profound environmental, social, and economic uncertainties.

The good news is that all countries and economies have it within their reach to inculcate the values, attitudes and practices necessary to create resilient, lifelong learners in and beyond the classroom. Some countries, like Korea, have seen remarkable reversals in mathematic anxiety, even amid a shift to remote learning during the COVID-19 pandemic. Others, like Portugal, are outstanding in critical thinking and perspective-taking. In Costa Rica and the United States, more low performers can easily judge the quality of online information. But many other students across PISA countries and economies are struggling with motivation, anxiety and self-directed learning. Unless countries do more, we will leave a generation of learners unprepared to deal with the challenges of today and tomorrow.

At the heart of lifelong learning is the ability to regulate and sustain one's own learning over time. The PISA 2022 results reveal that students' strategies for learning – such as asking questions when in doubt, applying prior knowledge and being able to consider different perspectives than one's own – are far from universal. For example, fewer than half of students in OECD countries reported trying to relate new material to what they had already learned. Even among students that perform well in PISA, only a slight majority regularly engage in such proactive learning behaviours. This suggests significant room for improvement in equipping students with the tools they need for continuous, self-directed learning.

Motivation is another key driver of lifelong learning. PISA data show that students who are intrinsically motivated – those who enjoy learning for its own sake – are more likely to adopt effective learning strategies and engage in critical thinking. However, motivation is not evenly distributed across socio-economic or gender lines. Girls, for instance, often report being more intrinsically motivated than boys but also experience greater anxiety about mathematics, even when their performance is similar to that of their male peers. Disparities also exist between socio-economically advantaged and disadvantaged students. These findings underscore the need for targeted interventions to foster motivation and resilience among all students, regardless of their background.

Self-confidence, or belief in one's own abilities, plays a crucial role in a student's willingness to take on challenges and persevere through setbacks. Students with higher self-efficacy are more likely to employ learning strategies that foster deep understanding and problem-solving. Yet, the PISA 2022 results show that confidence varies significantly among countries and economies and between student groups. In some high-performing education systems, we see the widest gaps in mathematics self-efficacy between low- and high-achieving students. More needs to be done to support the confidence and self-belief of students who struggle.

The report also highlights the importance of self-directed learning, particularly in an age of rapid technological change. While a majority of students express confidence in their ability to find information online, fewer are comfortable assessing the quality and reliability of that information easily. This is a crucial skill for navigating an increasingly digital world, where the ability to discern credible sources from unreliable ones can shape not just academic success, but informed citizenship. Alarmingly, about 60% of low-performing students on average across

OECD countries cannot easily judge the quality of online information, compared to just over half of their higher-performing peers.

Socio-economic disparities further complicate the picture. Students from disadvantaged backgrounds, particularly those facing food insecurity or economic hardship, are less likely to report using effective learning strategies and more likely to exhibit passive learning behaviours. This suggests that socio-economic factors are not only related to academic performance but also to the attitudes and strategies students adopt towards learning. Encouragingly, the PISA 2022 data show that students who engage frequently with their parents or receive support from their teachers are more likely to adopt proactive learning strategies and exhibit higher levels of motivation. These findings highlight the critical role of family and school environments in shaping students' learning behaviours and attitudes.

Education systems can, and must, play a role in fostering lifelong learning by promoting not only academic excellence but also the development of the skills, strategies, and mindsets that underpin continuous learning. One of the most significant findings from PISA 2022 is the relationship between teaching practices and students' confidence in their 21st-century mathematics skills. For instance, students who reported being exposed to tasks requiring thinking about how to solve mathematical problems are more likely to feel confident in their ability to interpret mathematical solutions in a real-life situation. Education systems that incorporate cognitive activation – teaching practices that encourage students to reflect on their problem-solving processes – are better equipped to foster lifelong learners who can adapt to new challenges.

As this report shows, learning strategies, motivation, and self-belief tend to go hand-in-hand. Low-performing students face a double challenge: they struggle with both academic achievement and a lack of confidence in their ability to learn. Meanwhile, even high-performing students are not always well-prepared for lifelong learning. Identifying and building on students' strengths – whether in terms of learning strategies, motivation, or self-belief – can create multiple pathways to success.

Policymakers should take note of these findings. Creating education systems that foster lifelong learning requires a holistic approach – one that recognises the interplay between academic performance, learning strategies, and socio-emotional development. By understanding how students learn, and what motivates them, education systems can better prepare young people not just for the challenges of today's world, but for the uncertainties of tomorrow. This volume of PISA 2022 provides valuable insights that can inform policies aimed at creating resilient, motivated, and self-directed learners, capable of navigating an increasingly complex and dynamic world.

Andreas Schleicher

Director for Education and Skills

Special Advisor on Education Policy

to the Secretary-General

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This report is the product of a collaborative effort between the countries and economies participating in PISA, the national and international experts and institutions working within the framework of the PISA Consortium, and the OECD Secretariat.

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The development of the report was steered by the PISA Governing Board, chaired by Michele Bruniges (Australia), with Peggy Carr (United States), Akiko Ono (Japan) and Carmen Tovar Sánchez (Spain) as vice chairs. Annex C of this volume lists the members of the various PISA bodies, including Governing Board members and National Project Managers in participating countries and economies, the PISA Consortium and the individual experts and consultants who have contributed to PISA 2022.

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PISA in the context of the COVID-19 pandemic

This edition of PISA was originally planned to take place in 2021 but was delayed by one year due to the COVID-19 pandemic. The exceptional circumstances throughout this period, including lockdowns and school closures in many places, led to occasional difficulties in collecting some data. While the vast majority of countries and economies met PISA's technical standards (available online), a small number did not. In prior PISA rounds, countries and economies that failed to comply with the standards, and which the PISA Adjudication Group judged to be consequential, could face exclusion from the main part of reporting. However, given the unprecedented situation caused by the pandemic, PISA 2022 results include data from all participating education systems, including those where there were issues such as low response rates (see Annexes A2 and A4). The next section explains the potential limitations of data from countries not meeting specific technical standards. Readers are alerted to these limitations throughout the volume wherever appropriate.

It is important to note that the limitations and implications were assessed by the PISA Adjudication Group in June 2023. There may be a need for subsequent adjustments as new evidence on the quality and comparability of the data emerges. PISA will return to the standard ways of reporting for the 2025 assessment.

Adjudicated entities not meeting the sampling standards

The results of 12 adjudicated entities (i.e. countries, economies and regions within countries), listed below, will be reported with annotations in this volume. Caution is required when interpreting estimates for these countries/economies because one or more PISA sampling standards listed below were not met.

- **Overall exclusion rate. Standard 1.7**: The PISA Defined Target Population covers 95% or more of the PISA Desired Target Population. That is, school-level exclusions and within-school exclusions combined do not exceed 5%.
- **School response rate. Standard 1.11**: The final weighted school response rate is at least 85% of sampled schools. If a response rate is below 85% then an acceptable response rate can still be achieved through agreed-upon use of replacement schools.
- **Student response rate. Standard 1.12**: The student response rate is at least 80% of all sampled students across responding schools.

The 12 entities can be grouped into two categories:

(i) Entities that submitted technically strong analyses, which indicated that more than minimal bias was most likely introduced in the estimates due to low response rates (falling below PISA standards): Canada, Ireland, New Zealand, the United Kingdom and Scotland.

(ii) Entities that did not meet one or more PISA sampling standards and it is not possible to exclude the possibility of more than minimal bias based on the information available at the time of data adjudication: Australia, Denmark, Hong Kong (China), Jamaica, Latvia, the Netherlands and Panama.

The Adjudication Group also noted that the bias associated with trend and cross-country comparisons might be smaller, if past data or data for other countries are biased in the same direction. Therefore, the deviations from the standards in PISA 2022 are compared with those in PISA 2018 where necessary.

(i) Entities that submitted technically strong analyses, which indicated that more than minimal bias was most likely introduced in the estimates due to low response rates (falling below PISA standards)

Canada

- **Overall exclusion rate: 5.8%.** Exclusions exceeded the acceptable rate by less than one percentage point; at the same time, the exclusion rates observed in 2022 remained relatively close to exclusion rates observed in 2018 (6.9%).
- **Student response rate: 77%. School response rates: 81% before replacement, 86% after replacement.** Student response rates decreased from 84% with respect to PISA 2018, and fell short of the target in 7 out of 10 provinces (all but New Brunswick, Prince Edward Island and Saskatchewan). A thorough non-response bias analysis was submitted, with analyses conducted separately for each province, using students' academic achievement data as auxiliary information. School response rates also fell short of the target, driven by low participation rates in two provinces (Alberta and Quebec). For these provinces, non-response bias was also examined at the school level. The analyses clearly indicate that school nonresponse has not led to any appreciable bias, but student nonresponse has given rise to a small upwards bias.

Ireland

- **Student response rate: 77%.** Student response rates decreased from 86% with respect to PISA 2018. A thorough non-response bias analysis was submitted, using external achievement data at the student level as auxiliary information. The analysis provided evidence to suggest a residual upwards bias of about 0.1 standard deviations, after non-response adjustments are taken into account. On the PISA scale, considering that the standard deviation in Ireland ranged (in 2018) from 78 score points in mathematics to 91 score points in reading, this could translate in an estimated upwards bias of approximately 8 or 9 points.

New Zealand

- **Overall exclusion rate: 5.8%.** Exclusions exceeded the acceptable rate by less than one percentage point; at the same time, the exclusion rates observed in 2022 remained relatively close to exclusion rates observed in 2018 (6.8%).
- **Student response rate: 72%. School response rate: 61% before replacement, 72% after replacement.** Student response rates decreased from 83% with respect to PISA 2018. School response rates also fell short of the target. A thorough and detailed non-response bias analysis was submitted, using external achievement data at the student level, but also information on chronic absenteeism, as auxiliary information, along with demographic characteristics. The analysis provided evidence to suggest a residual upwards bias of about 0.1 standard deviations, after non-response adjustments are taken into account, driven entirely by student non-response (school non-participation did not result in significant bias, in contrast). The analysis also suggested that chronically absent students are over-represented among non-respondents in PISA. On the PISA scale, considering that the standard deviation in New Zealand ranged (in 2018) from 93 score points in mathematics to 106 score points in reading, this could translate in an estimated upwards bias of approximately 10 points. The Adjudication Group also noted that the bias associated with trend and cross-country comparisons might be smaller, if past data or data for other countries are biased in the same direction. For more information, see the educationcounts.govt.nz website.

The United Kingdom

The United Kingdom (excluding Scotland)

- **Student response rate: 75%. School response rates: 66% before replacement, 80% after replacement.** Student response rates decreased from 83% with respect to PISA 2018. School response rates also fell short of the target. An informative non-response bias analysis was submitted, using external achievement data at the student level as auxiliary information, along with demographic characteristics; the analysis was limited to England as the largest subnational entity within the United Kingdom (excluding Scotland), and thus covered over 90% of the intended sample. The analysis provided evidence to suggest a small residual upwards bias of about 0.07 standard deviations for reading and 0.09 standard deviations for mathematics, after non-response adjustments are taken into account, driven entirely by student non-response (school non-participation did not result in significant bias, in contrast). On the PISA scale, considering that the standard deviation in England (in 2018) was about 101 score points in reading and 93 score points in mathematics, this could translate in an estimated upwards bias of approximately 7 or 8 points.

Scotland

- **Overall exclusion rate: 6.6%.** Exclusions exceeded the acceptable rate by a small margin; at the same time, the exclusion rates observed in 2022 remained relatively close to exclusion rates observed in 2018 (5.4%).
- **Student response rate: 79%.** Student response rates missed the standard by a small margin, but were otherwise similar to response rates in PISA 2018 (81%). A thorough non-response bias analysis was submitted, using several external achievement variables at the student level as auxiliary information, along with demographic characteristics. The analysis provided evidence to suggest a residual upwards bias of about 0.1 standard deviations, after non-response adjustments are taken into account. On the PISA scale, considering that the standard deviation in Scotland (in 2018) was about 95 score points in reading and mathematics, this could translate in an estimated upwards bias of approximately 9 or 10 points. Given the similarity of response rates between 2018 and 2022, it cannot be excluded that a similar bias might be present in 2018 as well, and in many PISA 2022 participants whose response rates were similarly close to the target. For this reason, data were deemed to be comparable to previous cycles.

(ii) Entities that did not meet one or more PISA sampling standards and it is not possible to exclude the possibility of more than minimal bias based on the information available at the time of data adjudication.

Australia

- **Overall exclusion rate: 6.9%.** Exclusions exceeded the acceptable rate by a small margin; at the same time, the exclusion rates observed in 2022 remained relatively close to exclusion rates observed in 2018 (5.7%).
- **Student response rate: 76%.** Student response rates decreased from 85% with respect to PISA 2018. A technically sound non-response bias analysis was submitted; however, the strength of the evidence was limited by the fact that no external student-level achievement variables could be used in the analysis. Based on the available evidence, and on the experience of other countries participating in PISA, the Adjudication Group considered that while non-response adjustments likely limited the severity of non-response biases, a small residual upward bias could not be excluded.

Denmark

- **Overall exclusion rate**: 11.6%. Exclusions exceeded the acceptable rate by a large margin and showed a marked increase, with respect to 2018 (5.7%). The Adjudication Group noted that high levels of student exclusions may bias performance results upwards. In Denmark, a major cause behind the rise appears to be the increased share of students with diagnosed dyslexia, and the fact that more of these students are using electronic assistive devices to help them read on the screen, including during exams. The lack of such an accommodation for students with diagnosed dyslexia in the PISA assessment led schools to exclude many of these students. In order to reduce exclusion rates in the future, PISA may need to further accommodate dyslexic students, allowing the use of assistive devices.

Hong Kong (China)

- **Student response rate: 75%. School response rates: 60% before replacement, 80% after replacement.** Student response rates decreased from 85% with respect to PISA 2018. School response rates also fell short of the target (as they did in 2018). At the school level, the fact that a raw, but direct measure of school performance is used to assign schools to sampling strata (and therefore, differential non-response across strata is unlikely to cause bias), limits the risk of bias due to non-response. A non-response bias analysis was submitted; however, the strength of the evidence was limited by the fact that no external student-level achievement variables could be used in the analysis (only student grade information, already used in non-response adjustments, was available). The proxies for school and student achievement (school size and student grade) that were used in the analyses showed no or very limited relationship with participation rates. Nevertheless, based on the available evidence, and on the experience of other countries participating in PISA, the Adjudication Group considered that while non-response adjustments likely limited the severity of non-response biases, a small residual upward bias could not be excluded.

Jamaica

- **Student response rate: 68%.** Student response rates were substantially below the standard. A simple non-response bias analysis was submitted, analysing student response rates by school characteristics: this showed in particular lower response rates in rural schools and regions. A limited non-response bias analysis was also prepared by the Core C contractor, to compare respondent characteristics (both before and after nonresponse adjustment) to characteristics of the full eligible sample of students. This suggested that non-response was also related to students' grade level and gender (both variables are used in non-response adjustments). Based on the available information, it is not possible to exclude the possibility of bias; considering the analyses on student non-response conducted in other countries, the residual bias after non-response adjustments are taken into account is likely to correspond to an upward bias. The Adjudication Group also noted that a number of issues encountered during the main survey data collection could have been prevented, had Jamaica been able to do a full field trial. This was not possible because of COVID-related disruptions to schooling in 2021. In particular, enrolment information available to the national centre for school-level sampling often turned out to be imprecise; and low student participation rates could have been anticipated, had a regular field trial been conducted. As a result of inaccurate sampling frames and low student response rates, the achieved sample size for the main survey was well below target, and sampling errors for Jamaica are larger than desired. The Adjudication Group noted that apart from the challenges around sampling operations, the quality of the data met expectations for reporting.

Latvia

- **Overall exclusion rate: 7.9%.** Exclusions exceeded the acceptable rate by a large margin and showed a marked increase, with respect to 2018 (4.3%). Most of these students were excluded because they were attending school in remote or virtual mode. The Adjudication Group noted that high levels of student exclusions may bias performance results upwards.

The Netherlands

- **Overall exclusion rate: 8.4%.** Exclusions exceeded the acceptable rate by a large margin and showed a marked increase, with respect to 2018 (6.2%). Most of these students were excluded because they had a physical or intellectual disability and no adaptation was available for them. The Adjudication Group noted that high levels of student exclusions may bias performance results upwards.
- **School response rates: 66% before replacement, 90% after replacement.** A non-response bias analysis was submitted, analysing differences in performance and in other characteristics between responding schools and the total population of schools, as well as differences between replacement schools and originally

sampled, but non-responding schools. This supported the case that no large bias would result from non-response; furthermore, given the available evidence, there is no clear indication about the direction of any residual bias.

Panama

- **Student response rate: 77%.** In the challenging circumstances surrounding schooling in Panama in 2022 (teacher strikes, road blockades and student absenteeism), student response rates decreased from 90% with respect to PISA 2018. No non-response bias analysis was submitted; the PISA national centre explained that non-response was potentially related to the agitated school climate the students found themselves when returning to their schools after the strikes. A limited non-response bias analysis was prepared by the Core C contractor, to compare respondent characteristics (both before and after nonresponse adjustment) to characteristics of the full eligible sample of students. This analysis suggested that (before non-response adjustments were taken into account), non-response was related to students' grade level, and to special needs status. Based on the available information, it is not possible to exclude the possibility of bias; considering the analyses on student non-response conducted in other countries, the residual bias after non-response adjustments are taken into account is likely to correspond to an upward bias.

Adjudication entity not reaching a strong level of comparability

The ability to compare PISA results with those of other countries, and over time, depends on the use of common test items and of standardised test-administration procedures. In addition, the common items must consistently indicate high, medium or low proficiency, regardless of the country/economy or of the language of the test. When this condition is met, a common set of (international) parameters is used to convert students' correct, partially correct or incorrect responses into an estimated score on the PISA scale.

The PISA Technical Advisory Group issued a memo in December 2021 stating that, in each country and economy, over two-thirds of items are expected to use the international item parameters to ensure strong comparability of PISA scores across countries and economies. Where the proportion is lower, greater uncertainty (beyond the uncertainty of estimates reflected in standard errors) is associated with cross-country comparisons.

During the review of PISA 2022 results, invariance of item parameters with respect to the international ones was examined for each major language of assessment within a participating country/economy. For Albania and the Dominican Republic, around 50% of the items were assigned unique parameters in creative thinking (16 and 17 out of 32 items, respectively). For both Albania and the Dominican Republic, results are therefore reported in this volume with an annotation indicating that a strong linkage to the international PISA scale could not be established.

Data underlying the figures

The data referred to in this volume are presented in Annex B and, in greater detail, including additional tables, on the PISA website (www.oecd.org/pisa). Two symbols are used to denote missing data:

- c There were too few observations to provide reliable estimates (i.e. there were fewer than 30 students or fewer than 5 schools with valid data).
- m Data are not available. There was no observation in the sample; these data were not collected by the country or economy; or these data were collected but subsequently removed from the publication for technical reasons.

Coverage

PISA 2022 was implemented in 81 countries and economies, including all OECD Member countries except Luxembourg and 44 non-OECD Member countries and economies (see map of PISA countries and economies in “What is PISA?”).

The designation “Ukrainian regions (18 of 27)” refers to the 18 PISA-participating jurisdictions of Ukraine: Cherkasy Oblast, Kirovohrad Oblast, Poltava Oblast, Vinnytsia Oblast, Chernihiv Oblast, Kyiv Oblast, Sumy Oblast, the City of Kyiv, Zhytomyr Oblast, Odesa Oblast, Chernivtsi Oblast, Ivano-Frankivsk Oblast, Khmelnytskyi Oblast, Lviv Oblast, Rivne Oblast, Ternopil Oblast, Volyn Oblast and Zakarpattia Oblast. Due to Russia’s large-scale aggression against Ukraine, the following nine jurisdictions were not covered: Dnipropetrovsk Oblast, Donetsk Oblast, Kharkiv Oblast, Luhansk Oblast, Zaporizhzhia Oblast, Kherson Oblast, Mykolaiv Oblast, the Autonomous Republic of Crimea and the city of Sevastopol.

Note on Kosovo:

This designation is without prejudice to positions on status, and is in line with United Nations Security Council Resolution 1244/99 and the Advisory Opinion of the International Court of Justice on Kosovo’s declaration of independence.

Following OECD data regulations, a visual separation between countries and territories has been used in all charts to reduce the risk of data misinterpretation.

International averages

The OECD average corresponds to the arithmetic mean of the respective country estimates. It was calculated for most indicators presented in this report.

In this publication, the OECD average is generally used when the focus is on comparing performance across education systems. In the case of some countries, data may not be available for specific indicators, or specific categories may not apply. Readers should, therefore, keep in mind that the term “OECD average” refers to the OECD Member countries included in the respective comparisons. In cases where data are not available or do not apply for all sub-categories of a given population or indicator, the “OECD average” is not necessarily computed on a consistent set of countries across all columns of a table.

In analyses involving data from multiple years, the OECD average is always reported on consistent sets of OECD Member countries, and several averages may be reported in the same table. For instance, the “OECD average-36” includes only 36 OECD Member countries that have non-missing values across all the assessments for which this average itself is non-missing. This restriction allows for valid comparisons of the OECD average over time. The number in the label used in figures and tables indicates the number of countries included in the average:

- OECD average: Arithmetic mean across all OECD Member countries except Luxembourg.
- OECD average-36: Arithmetic mean across all OECD Member countries excluding Israel and Luxembourg.

Rounding figures

Because of rounding, some figures in tables may not add up exactly to the totals. Totals, differences and averages are always calculated on the basis of exact numbers and are rounded only after calculation.

All standard errors in this publication have been rounded to one or two decimal places. Where the value 0.0 or 0.00 is shown, this does not imply that the standard error is zero, but that it is smaller than 0.05 or 0.005, respectively.

Reporting student data

The report uses "15-year-olds" as shorthand for the PISA target population. PISA covers students who are aged between 15 years 3 months and 16 years 2 months at the time of assessment and who are enrolled in school and have completed at least 6 years of formal schooling, regardless of the type of institution in which they are enrolled, and whether they are in full-time or part-time education, whether they attend academic or vocational programmes, and whether they attend public or private schools or foreign schools within the country.

Reporting school data

The principals of the schools in which students were assessed provided information on their schools' characteristics by completing a school questionnaire. Where responses from school principals are presented in this publication, they are weighted so that they are proportionate to the number of 15-year-olds enrolled in the school.

Focusing on statistically significant differences

This volume discusses only statistically significant differences or changes. These are denoted in darker colours in figures and in bold font in tables. Unless otherwise specified, the significance level is set to 5%. See Annex A3 for further information.

Abbreviations used in this report

ESCS	PISA index of economic, social, and cultural status
ICT	Information and communications technology
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
Score dif.	Score-point difference
S.D.	Standard deviation
S.E.	Standard error
% dif.	Percentage-point difference

Box 1. Interpreting differences in PISA scores

PISA scores do not have a substantive meaning as they are not physical units such as metres or grams. Instead, they are set in relation to the variation in results observed across all test participants. For the PISA assessments of mathematics, reading and science there is, theoretically, no minimum or maximum score in PISA; rather, the results are scaled to fit approximately normal distributions (i.e. means around 500 score points, standard deviations around 100 score points). In statistical terms, a one-point difference on the PISA scale therefore corresponds to an effect size (Cohen's d) of 0.01; and a 10-point difference to an effect size of 0.10.

The creative thinking data are summarised according to a different PISA scale than the assessments of mathematics, reading and science, with which readers may be more familiar. The creative thinking scale is a bounded scale between 0 and 60 score points, where 60 score points represents the total number of points available across all 32 items within the creative thinking test-item pool. Scores on the creative thinking scale therefore represent students' estimated scores (i.e. the sum of partial and full credit responses) if they were to sit a hypothetical test containing all 32 items from the test-item pool. This bounded, two-digit scale addresses the relatively lower measurement precision of the creative thinking test compared to the PISA assessments of mathematics, reading and science, given the smaller number of items in the creative thinking item pool (see Annex A5). In statistical terms, a one-point difference on the PISA creative thinking scale signals about 10% of a standard deviation of proficiency. This approach to scaling the PISA creative thinking data also means that results will differ more where there is more information available in the test (i.e. where there are more items that correspond to a given proficiency level).

Interpreting large differences in scores: Proficiency levels

PISA scales are divided into proficiency levels. For example, for PISA 2022, the range of difficulty of creative thinking items is represented by six described levels of creative thinking proficiency: the simplest items correspond to Level 1, with Levels 2, 3, 4, 5 and 6 corresponding to increasingly difficult items. Individuals who are proficient within the range of Level 1 are likely to be able to complete Level 1 items but are unlikely to be able to complete items at higher levels. See Chapter 1 for a detailed description of the proficiency levels in creative thinking.

In creative thinking, each proficiency level corresponds to a range of between seven and nine score points. Hence, score-point differences of that magnitude can be interpreted as the difference in described skills and knowledge between successive proficiency levels in creative thinking.

Interpreting small differences in scores: Statistical significance

Smaller differences in PISA scores cannot be expressed in terms of the difference in skills and knowledge between proficiency levels. However, they can still be compared with each other by means of verifying their "statistical significance".

A difference is called "statistically significant" if it is unlikely that such a difference can be observed in the estimates based on samples when, in fact, no true difference exists in the populations from which the samples are drawn. The results of the PISA assessments are "estimates" because they are obtained from samples of students rather than from a census of all students (i.e. which introduces a "sampling error"), and because they are obtained using a limited set of assessment tasks rather than the universe of all possible assessment tasks (i.e. which introduces a "measurement error").

It is possible to determine the magnitude of the uncertainty associated with the estimate and to represent it as a "confidence interval", i.e. a range defined in such a way that if the true value lies above its upper bound or below its lower bound, an estimate different from the reported estimate would be observed only with a small probability (typically less than 5%). The confidence interval needs to be taken into account when making comparisons between estimates so that differences that may arise simply due to the sampling error and measurement error are not interpreted as real differences.

Interpreting differences in scores on the creative thinking scale

In this report, a difference of three score points is considered to be a "large" change in creative thinking performance. Typically, in the PISA core domain assessments of mathematics, reading and science, a "large" difference is defined as a change of 20 score points or more. This is approximately equivalent to the typical annual learning gain by students around the age of 15 and is around one-fifth of the OECD standard deviation in performance. Given the broader grain size of the creative thinking scale (i.e. the bounded, two-digit scale), a change of three score points is approximately equivalent to one-quarter of the OECD standard deviation in creative thinking performance.

A "small" change in creative thinking performance is defined as a change of one score point. Changes of up to one score point correspond to just under one-tenth of the OECD standard deviation in creative thinking performance. Consequently, score changes of between one and three points can thus be considered "moderate" differences in creative thinking performance.

Further documentation

For further information on the PISA assessment instruments and the methods used in PISA, see the *PISA 2022 Assessment and Analytical Framework* (OECD, 2023[1]) and *PISA 2022 Technical Report* (OECD, 2024[2]).

StatLink

This report has StatLinks for tables and graphs at the end of each chapter. To download the matching Excel® spreadsheet, just type the link into your Internet browser, starting with the https://doi.org prefix, or click on the link from the e-book version.

References

OECD (2024), *PISA 2022 Technical Report*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/01820d6d-en. [2]

OECD (2023), *PISA 2022 Assessment and Analytical Framework*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/dfe0bf9c-en. [1]

Executive Summary

The COVID-19 pandemic taught us that education systems must prepare students for a future marked by profound environmental, social and economic changes. It forced education systems to adapt quickly to constraints imposed by the virus. Schools did their best but PISA 2022 revealed significant learning gaps. We must rethink teaching and learning to better equip students for an uncertain future.

Building young people's resilience in a changing world requires an aptitude for lifelong learning. PISA provides important insights into how well 15-year-olds are prepared for learning beyond compulsory schooling. The data shed light on how students adopt and use key learning strategies; how motivated they are to learn; and how confident they are that they can acquire, synthesise and employ new knowledge through study and effort.

How students do with key learning strategies

- Asking questions is key to learning. But less than half of students (47%) ask questions often when they do not understand something being taught in mathematics class, on average across the OECD. Only in Iceland, do more than 60% of students ask questions more than half of the time when they are not sure of something being taught. In Macao (China), Poland, Chinese Taipei and Thailand, fewer than one in three students do.
- Critical thinking or perspective-taking is another important learning strategy. This involves considering other people's perspectives before forming one's own opinions and viewing issues from different angles. Less than 60% of students employ critical-thinking strategies, on average. And, top performers show more flexible critical thinking.
- Helping students develop the habit of proactively connecting something new they have just learned to something they already know is crucial. Yet, less than half of students reported that they do this in mathematics lessons more than half of the time.
- Students who regularly use these learning strategies tend to outperform those who do not, even after accounting for students' and schools' socio-economic profile.
- Girls and socio-economically advantaged students in most education systems consistently reported using learning strategies more often than boys and socio-economically disadvantaged students.

Motivation and predispositions encourage the uptake of learning strategies

- Intrinsic motivation like enjoying learning new things in school consistently predicts the uptake of learning strategies, even after accounting for students' and schools' socio-economic profile. But, only around a half or less of students in OECD countries reported being intrinsically motivated. In Guatemala, Peru and Viet Nam, over 85% of students enjoy learning new things at school but less than a third do in Czechia and Poland.
- Growth mindsets are strongly linked to positive learning strategies, attitudes, and outcomes. While 58% of students said they have a general growth mindset, only 35% of students reported a mathematics-specific growth mindset.
- Co-operation is the social and emotional skill most strongly related to critical-thinking attitudes. This relationship is particularly strong in top-performing Hong Kong (China)*, Korea, Singapore and Chinese Taipei.

- The anxiety students say they experience doing mathematics has grown since 2012, the last time mathematics was PISA's focus subject. This can impact their well-being and readiness for lifelong learning. But systems can work against this trend: anxiety levels fell in Singapore and Thailand, and, most significantly, in Korea between 2012 and 2022.
- Gender stereotypes about learning mathematics continue. Boys are more likely to report a growth mindset in mathematics than girls by an average of 7 percentage points. Girls also reported higher levels of mathematics anxiety than boys, even among top-performing students.

The role of autonomy in sustained lifelong learning

- Fifteen-year-olds feel most confident finding resources online on their own. More than 85% of students in Italy and Croatia are confident they can find the online information they need while in Japan, less than half are (OECD average 73%).
- However, being able to easily judge the quality of online information is a major challenge (OECD average 51%). This is especially so among low performers: 60% cannot easily gauge the quality of online information. Among skilled performers, 57% can do this easily, on average.
- The connection between finding online information and looking for reliable verification of the accuracy of such information is not straightforward: less than 50% of students, on average, discuss the accuracy of online information with their teachers or in class.
- Students who check the quality, credibility and accuracy of online information are more likely to be meticulous, critical thinkers, and proactive learners who make connections between what they learn and what they know. They are also more likely to be intrinsically and instrumentally motivated to learn.

Learning for the 21st century and the future

- Students who are proactive learners that make connections between new material and what they have learned before; who always make sure they have understood what is being taught; and who say they are cognitively activated in the classroom are most likely to be confident in their 21st-century mathematics skills.
- Only about a third of students are exposed to 21st-century mathematics tasks like frequently extracting mathematical information from diagrams or graphs and one in five to applying mathematical solutions to real-life situations.
- Cognitive activation practices such as encouraging students to think about different ways of solving problems and explaining their reasoning are strongly associated with confidence in 21st-century mathematics.
- Proactive students who link what they are learning to what they already know are particularly confident representing, extracting and interpreting mathematical information, even in real-life situations.

Students' family and learning environments matter

- Students who interact with their parents on an ordinary, everyday basis and have conversations with them about learning and school employ more learning strategies and are more motivated to learn, even after accounting for students' and schools' socio-economic profile.
- Students who are well-supported by their teachers are often more proactive in learning mathematics. They also use critical-thinking skills more, take control of their learning and have more motivation to learn.
- Students suffering from food insecurity are less likely to use self-regulated learning strategies and, generally, are more passive learners.
- Students holding part-time jobs tend to feel more positive and motivated about learning.

Table V.1. Snapshot of learning strategies

- [blue] Countries/economies with values **above** the OECD average
- [white] Countries/economies with values **not significantly different** from the OECD average
- [grey] Countries/economies with values **below** the OECD average

Percentage of students reporting:

	Controlling one's own learning			Critical thinking (perspective-taking)		Proactive learning	Cognitive activation	
	More than half of the time, students…	Students agree or strongly agree…		Students agree or strongly agree…	Students disagree or strongly disagree…	More than half of the time, students…	More than half of the lessons…	
	…ask questions when they do not understand the mathematics material	…they like to make sure there are no mistakes	…they carefully check homework before turning it in	…they try to consider everybody's perspective before they take a position	…there is only one correct position in a disagreement	…try to connect new material to what they have learned in previous mathematics lessons	…the teacher asks students to explain their reasoning when solving a mathematics problem	…the teacher asks students to think about how new and old mathematics topics are related
	%	%	%	%	%	%	%	%
OECD average	46.8	64.2	44.3	58.9	45.8	45.6	46.1	31.2
Iceland	61.6	63.2	46.7	42.9	36.7	48.4	28.3	20.6
Albania	59.3	74.8	67.7	55.0	21.8	60.8	53.4	47.5
Uzbekistan	59.1	75.8	76.5	73.0	22.2	58.7	48.3	49.5
Costa Rica	57.2	77.0	74.0	66.6	25.0	52.5	41.0	34.7
Israel	57.2	m	m	m	m	50.1	48.6	33.1
Denmark*	56.6	58.5	42.8	56.9	50.2	42.8	39.5	21.1
Guatemala	55.5	74.6	74.7	m	m	58.0	44.9	49.0
Sweden	55.1	m	m	m	m	48.6	52.3	26.2
United Arab Emirates	54.7	70.9	65.6	64.1	30.2	53.0	51.1	40.6
Canada*	54.6	62.1	45.5	62.0	48.1	53.8	55.4	35.3
Paraguay	54.6	73.3	70.9	m	m	48.0	31.7	35.3
Singapore	54.6	64.0	42.5	72.3	56.6	48.8	51.4	43.8
Australia*	54.4	57.3	36.1	61.5	44.4	49.7	54.6	32.7
Colombia	53.0	72.4	70.4	69.7	27.4	55.6	46.5	46.5
United States*	52.5	m	m	m	m	53.2	56.0	33.7
Dominican Republic	52.4	71.6	70.8	65.9	28.4	51.3	48.4	47.4
Uruguay	52.2	63.5	55.7	56.9	36.1	49.6	46.3	34.3
Kazakhstan	52.0	63.6	60.2	56.2	40.5	54.2	51.6	42.9
Austria	51.7	59.0	38.5	56.1	57.1	53.0	48.2	32.2
New Zealand*	51.5	52.4	45.4	56.7	43.5	42.1	53.1	24.0
Switzerland	50.7	60.5	34.6	57.6	52.8	45.9	48.3	32.4
Jamaica*	50.6	70.1	64.3	61.9	34.0	47.8	54.4	41.4
Chile	50.6	69.4	59.1	62.9	29.3	53.1	45.8	41.1
Spain	50.3	70.4	42.8	56.3	46.7	46.8	46.4	28.0
Germany	50.3	62.3	37.3	57.8	55.1	47.4	54.2	36.2
Qatar	50.1	65.0	54.6	57.5	29.2	50.4	46.8	39.9
Panama*	49.8	70.5	72.4	68.5	24.5	57.5	45.9	44.9
El Salvador	49.8	70.1	71.8	66.0	25.1	52.0	40.2	43.1
United Kingdom*	49.4	55.7	32.9	53.0	42.4	44.9	59.6	34.7
Netherlands*	49.0	65.5	27.4	42.7	51.9	39.9	41.6	18.7
Malta	48.2	59.7	36.8	62.3	40.0	49.6	56.3	30.9
Ireland*	48.2	56.2	36.3	58.4	57.8	46.0	57.0	30.1
Georgia	47.4	66.9	55.2	56.3	37.3	50.2	54.3	41.0
Italy	47.2	70.6	48.0	59.4	37.3	39.9	57.3	32.7
Belgium	46.7	64.1	41.7	52.8	52.3	38.5	46.3	28.2
Norway	46.6	m	m	m	m	43.2	52.3	28.8
Mongolia	46.6	86.9	52.2	74.7	28.6	43.0	33.6	38.4
North Macedonia	46.6	69.4	55.1	56.0	26.2	51.4	41.5	35.9
Peru	46.4	71.0	71.6	71.1	25.7	54.2	53.9	52.3
Indonesia	46.4	85.2	77.2	55.8	18.3	42.3	34.3	35.2
Portugal	46.1	72.1	49.4	80.1	65.2	48.5	55.9	41.0
Jordan	45.5	67.2	61.1	43.5	23.3	48.9	26.8	31.0
Morocco	45.4	71.6	66.4	61.3	29.8	41.1	34.3	34.0

Table V.1. Snapshot of learning strategies [2/2]

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students reporting:

	Controlling one's own learning			Critical thinking (perspective-taking)		Proactive learning	Cognitive activation	
	More than half of the time, students…	Students agree or strongly agree…		Students agree or strongly agree…	Students disagree or strongly disagree…	More than half of the time, students…	More than half of the lessons…	
	…ask questions when they do not understand the mathematics material	…they like to make sure there are no mistakes	…they carefully check homework before turning it in	…they try to consider everybody's perspective before they take a position	…there is only one correct position in a disagreement	…try to connect new material to what they have learned in previous mathematics lessons	…the teacher asks students to explain their reasoning when solving a mathematics problem	…the teacher asks students to think about how new and old mathematics topics are related
	%	%	%	%	%	%	%	%
OECD average	46.8	64.2	44.3	58.9	45.8	45.6	46.1	31.2
Moldova	45.0	70.8	54.7	58.9	31.5	46.1	33.3	33.9
Saudi Arabia	45.0	78.4	71.9	66.6	23.6	45.2	37.1	33.2
Lithuania	44.9	55.1	40.9	52.5	34.1	46.5	34.9	34.6
Greece	44.1	70.3	52.3	63.8	55.7	49.3	53.3	23.9
Argentina	43.1	62.0	59.6	53.2	30.7	39.7	41.9	37.4
Türkiye	43.0	66.4	69.8	75.2	47.4	49.2	39.6	29.7
Latvia*	42.8	59.0	28.9	53.9	49.8	43.2	43.5	33.9
Slovak Republic	42.7	67.9	49.2	57.4	54.0	44.4	39.6	34.6
Hungary	42.7	54.5	34.2	62.2	48.6	43.2	49.4	27.6
Bulgaria	41.7	62.1	43.4	63.9	40.8	47.3	46.6	44.5
Malaysia	41.7	66.4	63.6	56.0	25.7	35.6	30.8	32.5
Mexico	41.2	68.0	65.5	70.4	22.4	51.3	48.0	44.6
Serbia	41.1	68.3	45.0	60.7	30.3	47.8	36.4	36.2
Viet Nam	40.5	77.0	74.6	m	m	59.2	42.2	48.1
Estonia	40.3	53.4	36.0	63.5	49.0	41.4	38.7	24.5
France	39.7	65.8	50.0	63.9	47.8	36.1	54.9	36.4
Finland	39.7	59.6	23.9	48.5	53.8	41.2	34.9	20.4
Brazil	39.6	69.9	59.1	62.1	38.9	41.5	36.0	33.4
Montenegro	39.4	64.7	51.4	55.0	26.5	48.7	34.1	36.8
Philippines	39.4	60.8	71.7	62.3	24.6	39.4	46.5	40.8
Cambodia	39.4	67.1	78.5	m	m	32.8	37.4	43.2
Brunei Darussalam	39.1	61.9	52.9	56.7	21.4	36.2	43.6	31.8
Japan	37.7	m	m	m	m	27.2	51.8	42.8
Croatia	37.7	50.5	38.1	57.4	32.0	47.6	34.2	38.2
Czechia	36.7	62.4	35.4	48.9	43.4	42.9	37.4	26.9
Romania	35.8	70.2	43.6	59.3	30.4	45.8	35.5	36.7
Slovenia	35.1	60.6	30.5	58.0	44.5	47.4	34.5	30.4
Korea	33.8	89.6	58.9	68.7	45.5	43.0	25.5	24.6
Thailand	29.8	72.9	63.8	65.0	19.4	31.9	29.1	27.7
Poland	26.8	72.6	34.0	43.6	46.5	35.9	32.3	28.6
Baku (Azerbaijan)	56.2	64.6	52.1	50.5	28.1	57.8	51.6	49.0
Cyprus	49.1	60.0	39.0	55.3	46.9	49.3	50.4	33.4
Kosovo	47.4	75.8	66.5	43.6	26.0	50.8	38.1	36.5
Palestinian Authority	43.0	72.2	64.6	49.1	22.5	47.7	31.2	37.9
Ukrainian regions (18 of 27)	36.4	59.5	40.9	56.0	34.7	39.5	45.7	41.9
Hong Kong (China)*	34.9	52.1	37.0	64.1	41.6	35.5	39.0	32.9
Macao (China)	31.0	50.2	40.0	64.9	42.5	31.1	40.7	33.0
Chinese Taipei	23.5	62.2	38.0	65.9	49.5	29.5	30.7	27.1

* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
Countries and economies are ranked in descending order of the percentage of students who "asked questions when they did not understand the mathematics material" more than half of the time.
Source: OECD, PISA 2022 Database, Tables V.B1.2.2, V.B1.2.4, V.B1.2.6, V.B1.2.10, V.B1.2.14, V.B1.2.21, V.B1.3.24 and V.B1.3.26.
The StatLink URL of this table is available below Snapshot Table V.7.

Table V.2. Snapshot of motivations and growth mindset

- Countries/economies with values **above** the OECD average
- Countries/economies with values **not significantly different** from the OECD average
- Countries/economies with values **below** the OECD average

	Percentage of students reporting:							
	Intrinsic motivation		Instrumental motivation		Growth mindset			
	Students agree or strongly agree…				Students disagree or strongly disagree…			
	…they love learning new things in school	…they like school work that is challenging	…school has taught them things which could be useful in a job	…they want to do well in their mathematics class	…your intelligence is something about you that you cannot change very much		…some people are just not good at mathematics, no matter how hard they study	
					All students	Gender difference (boys – girls)	All students	Gender difference (boys – girls)
	%	%	%	%	%	% dif.	%	% dif.
OECD average	50.1	46.9	67.4	89.3	57.8	**-0.6**	34.5	**6.6**
Guatemala	87.2	m	m	m	m	m	m	m
Viet Nam	87.2	m	m	m	m	m	m	m
Peru	85.4	72.6	84.0	92.5	43.6	**6.9**	53.4	**3.2**
Colombia	84.8	80.1	82.8	88.8	42.6	**2.9**	41.4	**7.0**
Mongolia	84.2	62.5	72.0	88.9	45.3	0.0	28.9	**7.3**
Morocco	82.4	71.0	69.3	82.7	48.5	**6.1**	30.8	**11.4**
Uzbekistan	81.7	69.7	72.0	82.0	52.3	**4.2**	40.6	**5.4**
Paraguay	80.8	m	m	m	m	m	m	m
Mexico	80.5	74.2	82.4	89.3	41.6	**3.1**	39.3	**5.8**
Philippines	78.3	71.1	80.6	80.2	35.3	**3.9**	38.8	**4.3**
Dominican Republic	78.1	69.6	71.9	80.5	38.2	**10.4**	38.5	**11.3**
El Salvador	77.9	77.3	78.7	86.1	35.8	**5.9**	40.0	**5.7**
Panama*	77.7	77.0	78.0	90.0	39.5	**5.9**	36.1	**4.7**
Cambodia	77.6	m	m	m	m	m	m	m
Indonesia	76.1	51.7	84.7	81.4	35.4	**3.7**	40.9	1.6
Albania	74.9	80.7	75.7	82.2	30.7	**5.8**	24.6	**12.1**
Costa Rica	73.6	63.8	83.3	94.9	53.9	0.8	43.1	**5.6**
Portugal	72.7	64.3	75.2	91.0	54.2	**-5.1**	29.4	**6.1**
Jamaica*	72.7	42.0	81.1	92.5	35.1	**7.7**	29.9	**10.5**
Türkiye	70.7	35.3	64.7	86.7	48.1	1.6	40.5	**6.6**
Kazakhstan	70.7	54.7	70.9	82.8	66.9	1.8	38.3	**10.1**
Uruguay	69.7	69.4	70.9	88.6	52.1	**9.1**	39.2	**9.5**
Chile	68.5	56.2	74.4	91.4	61.2	0.2	45.3	**7.3**
Malaysia	68.2	47.3	80.9	85.1	38.1	**4.3**	32.1	**6.8**
Romania	68.0	63.9	65.1	74.1	42.8	**-2.8**	27.9	**7.1**
Georgia	68.0	51.0	64.3	80.2	56.8	1.0	68.3	-2.1
Brazil	66.8	52.6	78.2	89.9	61.1	0.0	49.8	**8.8**
Thailand	66.8	56.2	73.6	72.1	48.2	**4.3**	37.0	**10.2**
Greece	66.6	58.9	65.4	85.2	40.7	**-3.1**	30.8	**8.9**
Argentina	66.4	57.1	76.2	88.9	48.3	2.5	48.9	**4.7**
Jordan	66.2	69.9	66.2	75.8	49.1	**5.7**	31.8	**15.9**
Saudi Arabia	65.7	69.5	74.6	86.3	40.8	**2.9**	41.9	**3.7**
Moldova	63.9	59.9	70.9	82.0	34.0	**7.0**	26.6	**9.7**
United Arab Emirates	61.5	63.7	70.5	86.9	49.6	**3.5**	48.3	**2.4**
Brunei Darussalam	61.4	39.9	81.7	94.0	45.4	0.4	45.4	**3.9**
Korea	59.9	47.8	64.3	90.1	54.5	**2.9**	30.9	**2.7**
Bulgaria	58.7	56.9	66.2	76.3	59.0	-0.2	32.8	**11.5**
Montenegro	58.3	68.3	66.8	74.7	47.5	0.9	27.9	**7.1**
Qatar	57.1	59.9	68.5	85.9	45.2	**8.0**	40.3	**13.1**
North Macedonia	57.1	73.7	73.4	77.8	40.0	**4.5**	26.7	**8.8**
Singapore	56.7	49.5	76.2	96.8	60.9	-2.1	57.3	0.4
Slovak Republic	51.5	38.8	65.5	86.2	56.1	-0.5	23.6	**10.7**
Malta	51.5	44.5	67.1	92.2	49.5	-3.1	28.1	**8.0**
France	51.4	25.9	70.4	89.3	45.9	**-4.1**	27.0	**6.2**
Serbia	51.0	55.8	65.4	79.5	51.3	**-4.0**	25.5	**8.2**
Italy	50.9	62.9	68.8	92.6	49.8	**-3.9**	40.8	1.9

Table V.2. Snapshot of motivations and growth mindset [2/2]

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students reporting:

	Intrinsic motivation		Instrumental motivation		Growth mindset			
	Students agree or strongly agree...				Students disagree or strongly disagree...			
	...they love learning new things in school	...they like school work that is challenging	...school has taught them things which could be useful in a job	...they want to do well in their mathematics class	...your intelligence is something about you that you cannot change very much: All students	...your intelligence is something about you that you cannot change very much: Gender difference (boys – girls)	...some people are just not good at mathematics, no matter how hard they study: All students	...some people are just not good at mathematics, no matter how hard they study: Gender difference (boys – girls)
	%	%	%	%	%	% dif.	%	% dif.
OECD average	50.1	46.9	67.4	89.3	57.8	**-0.6**	34.5	**6.6**
Spain	50.5	56.2	67.5	90.5	52.9	**-1.6**	30.7	**3.9**
Hungary	50.5	53.5	60.3	87.2	56.8	-0.9	22.9	**8.3**
Switzerland	49.3	41.5	66.6	89.4	61.1	**-6.8**	34.1	**4.6**
Ireland*	46.7	41.9	66.6	94.3	72.9	0.2	36.6	**7.3**
Canada*	46.6	51.0	71.5	92.5	62.5	-1.9	38.8	**4.0**
Australia*	46.4	49.1	70.8	91.4	65.7	0.5	47.9	**6.7**
New Zealand*	45.9	48.6	67.8	91.4	65.1	1.7	51.4	**4.7**
Belgium	45.4	45.4	65.1	90.9	52.6	**-2.7**	22.5	**6.1**
Iceland	45.0	49.4	63.5	88.5	56.9	**3.8**	43.0	**7.3**
Latvia*	44.2	28.0	72.3	89.7	58.8	1.4	26.8	**9.8**
Croatia	44.0	48.7	66.9	86.4	54.2	-2.3	25.5	**7.0**
Austria	44.0	37.1	60.0	85.9	71.5	-1.8	36.6	**5.1**
Denmark*	42.5	50.8	70.1	93.8	62.6	-2.0	49.9	**4.9**
Norway	42.0	42.3	56.6	89.4	58.7	**-2.5**	41.6	**3.9**
Slovenia	41.4	26.1	67.2	81.0	52.1	1.0	19.6	**8.6**
United Kingdom*	40.0	48.3	63.7	95.6	63.6	2.6	45.5	**7.6**
Lithuania	38.4	35.9	70.6	91.7	57.5	2.3	25.2	**10.1**
Estonia	37.9	40.0	69.7	90.9	73.9	**-4.7**	33.3	**8.6**
Germany	37.6	38.1	41.2	91.2	72.1	**-5.2**	35.6	**5.3**
Finland	35.8	37.0	76.4	69.9	59.2	**-6.3**	33.6	**8.1**
Netherlands*	35.2	36.6	64.0	83.4	41.1	2.2	23.3	**6.8**
Czechia	31.1	43.1	65.6	89.4	50.3	2.7	19.5	**10.4**
Poland	26.3	38.9	50.7	82.6	53.4	-1.5	18.4	**8.1**
Israel	m	47.2	m	92.2	m	m	m	m
Japan	m	m	71.7	91.4	71.0	**3.9**	18.8	**7.8**
Sweden	m	m	65.1	89.5	70.4	-1.3	52.0	**2.6**
United States*	m	m	65.9	94.1	69.8	1.7	43.5	**9.9**
Kosovo	79.2	76.8	71.6	79.8	33.9	**4.5**	25.3	**10.8**
Palestinian Authority	68.9	71.9	71.4	75.8	40.5	**5.4**	28.4	**17.1**
Baku (Azerbaijan)	62.3	59.2	69.9	82.1	43.2	**3.1**	25.6	**8.3**
Hong Kong (China)*	55.5	50.6	64.6	85.1	40.0	**6.1**	36.1	**5.1**
Chinese Taipei	53.0	46.7	70.8	83.4	54.9	**3.8**	41.8	2.2
Macao (China)	52.4	41.3	63.8	84.5	40.8	**5.1**	36.5	**4.5**
Ukrainian regions (18 of 27)	47.8	69.2	66.3	67.5	59.2	-2.5	32.5	**11.3**
Cyprus	45.0	43.6	62.3	83.2	47.1	0.9	32.7	**9.5**

* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
Note: Values that are statistically significant are marked in bold (see Annex A3).
Countries and economies are ranked in descending order of the percentage of students who reported "they love learning new things in school".
Source: OECD, PISA 2022 Database, Tables V.B1.3.3, V.B1.3.8, V.B1.3.13, V.B1.3.17, V.B1.3.40 and V.B1.3.42.
The StatLink URL of this table is available below Snapshot Table V.7.

Table V.3. Snapshot of students' predispositions to learning

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students reporting:

	More than half of the time they ask questions when they do not understand the mathematics material		Agreeing or strongly agreeing they love learning new things		More than half of the time they try to connect new material to what they have learned in previous mathematics lessons		Agreeing or strongly agreeing they like schoolwork that is challenging	
	More self-efficacy[1]	Difference between more and less self-efficacy[1]	More self-efficacy[1]	Difference between more and less self-efficacy[1]	More anxiety[2]	Difference between more and less anxiety[2]	More anxiety[2]	Difference between more and less anxiety[2]
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	61.8	**29.5**	62.1	**23.9**	39.3	**-15.9**	36.9	**-21.5**
Iceland	86.4	**44.3**	63.4	**35.3**	42.7	**-20.9**	34.8	**-27.5**
Albania	80.4	**43.2**	88.1	**25.2**	46.9	**-29.3**	73.5	**-16.5**
Uzbekistan	80.1	**39.8**	85.4	**14.1**	42.6	**-34.0**	59.7	**-20.2**
Denmark*	75.8	**37.6**	61.7	**34.9**	33.3	**-27.0**	37.5	**-27.7**
United Arab Emirates	74.3	**39.5**	74.3	**26.9**	40.7	**-29.1**	50.3	**-26.3**
Sweden	72.5	**36.4**	m	m	40.7	**-19.2**	m	m
Israel	70.8	**29.2**	m	m	m	m	m	m
Dominican Republic	69.4	**31.1**	87.7	**20.8**	40.6	**-23.5**	60.1	**-17.3**
Mongolia	69.0	**43.8**	87.9	**10.9**	31.5	**-29.3**	48.1	**-27.5**
Australia*	68.9	**32.3**	65.4	**39.8**	40.9	**-20.1**	36.0	**-25.3**
Qatar	68.6	**37.8**	76.8	**32.7**	41.1	**-26.4**	45.9	**-29.0**
Georgia	68.4	**38.4**	73.7	**13.9**	41.5	**-18.5**	41.9	**-20.1**
Jordan	67.8	**38.6**	75.6	**17.0**	35.6	**-27.2**	61.4	**-18.9**
Canada*	67.5	**27.1**	61.5	**30.6**	47.1	**-17.0**	40.7	**-24.6**
Chile	67.4	**29.3**	79.0	**21.2**	51.3	**-11.7**	48.5	**-19.2**
Norway	67.3	**42.4**	60.3	**32.8**	32.2	**-26.2**	28.2	**-32.8**
Uruguay	67.1	**30.3**	75.9	**17.2**	45.9	**-13.0**	65.5	**-7.5**
New Zealand*	67.0	**30.3**	64.0	**35.4**	35.0	**-15.6**	36.0	**-23.0**
Singapore	66.4	**25.5**	69.5	**27.3**	41.2	**-19.3**	36.2	**-30.7**
Paraguay	66.2	**27.7**	85.9	**14.6**	38.7	**-18.1**	m	m
Costa Rica	65.9	**17.7**	80.2	**12.3**	50.4	**-7.1**	52.0	**-23.6**
Germany	65.3	**30.4**	50.1	**26.2**	40.1	**-17.5**	25.0	**-28.6**
Guatemala	65.3	**19.2**	89.8	**6.8**	52.5	**-16.5**	m	m
Colombia	65.1	**24.4**	87.8	**8.4**	50.3	**-13.1**	77.0	**-6.0**
Saudi Arabia	65.1	**39.3**	76.1	**26.1**	32.6	**-30.5**	59.3	**-19.6**
Jamaica*	64.9	**31.0**	80.1	**12.7**	44.6	**-14.9**	26.3	**-32.2**
Morocco	64.8	**35.6**	88.4	**14.3**	26.5	**-31.5**	67.1	**-9.7**
United States*	64.7	**27.3**	m	m	47.5	**-12.9**	m	m
Portugal	64.7	**37.3**	84.2	**22.6**	38.0	**-20.3**	60.2	**-12.2**
Panama*	64.5	**27.3**	82.6	**9.6**	58.3	-1.1	68.9	**-13.3**
Ireland*	64.4	**28.8**	61.7	**31.2**	39.9	**-12.9**	28.3	**-26.7**
Spain	64.0	**27.0**	61.0	**20.0**	44.8	**-7.6**	51.3	**-11.1**
Malta	63.9	**34.2**	65.3	**25.5**	41.1	**-24.2**	29.2	**-28.9**
North Macedonia	63.4	**32.4**	64.4	**13.9**	35.6	**-31.6**	64.5	**-14.9**
Switzerland	63.2	**26.3**	61.9	**25.1**	42.2	**-11.3**	33.6	**-20.8**
Peru	63.1	**29.0**	92.8	**14.5**	44.3	**-20.7**	62.6	**-19.6**
Austria	63.1	**21.4**	56.6	**22.5**	51.2	**-7.0**	25.3	**-27.8**
Greece	62.6	**36.8**	73.2	**15.6**	39.3	**-23.9**	54.1	**-11.2**
Moldova	62.6	**36.7**	70.4	**14.3**	38.7	**-18.6**	52.5	**-12.2**
United Kingdom*	61.7	**28.2**	55.6	**29.3**	38.2	**-15.1**	34.2	**-29.8**
Lithuania	61.5	**35.6**	49.9	**22.6**	39.0	**-16.6**	23.4	**-28.4**
Netherlands*	61.4	**23.6**	45.1	**18.7**	33.4	**-14.3**	30.3	**-14.0**
Malaysia	61.1	**37.8**	79.3	**23.9**	31.6	**-11.7**	33.2	**-28.0**
Slovak Republic	60.7	**29.4**	63.2	**20.5**	36.7	**-18.1**	27.7	**-22.8**

Table V.3. Snapshot of students' predispositions to learning [2/2]

- Countries/economies with values **above** the OECD average
- Countries/economies with values **not significantly different** from the OECD average
- Countries/economies with values **below** the OECD average

Percentage of students reporting:

	More than half of the time they ask questions when they do not understand the mathematics material		Agreeing or strongly agreeing they love learning new things		More than half of the time they try to connect new material to what they have learned in previous mathematics lessons		Agreeing or strongly agreeing they like schoolwork that is challenging	
	More self-efficacy[1]	Difference between more and less self-efficacy[1]	More self-efficacy[1]	Difference between more and less self-efficacy[1]	More anxiety[2]	Difference between more and less anxiety[2]	More anxiety[2]	Difference between more and less anxiety[2]
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	61.8	**29.5**	62.1	**23.9**	39.3	**-15.9**	36.9	**-21.5**
Türkiye	60.5	**34.0**	75.3	**15.6**	39.1	**-21.6**	20.0	**-31.6**
Latvia*	60.3	**32.3**	53.2	**21.0**	39.3	**-13.2**	12.9	**-32.4**
Bulgaria	59.0	**33.5**	68.0	**19.6**	34.9	**-31.0**	46.7	**-18.6**
Serbia	58.5	**34.2**	61.1	**19.7**	38.1	**-19.2**	51.0	**-7.7**
Italy	57.9	**20.3**	62.4	**20.8**	34.3	**-11.5**	59.6	**-6.4**
Mexico	57.3	**29.7**	83.6	**12.5**	46.3	**-14.5**	68.9	**-10.8**
Hungary	57.1	**30.3**	59.7	**20.8**	36.7	**-16.9**	44.1	**-20.8**
Argentina	57.0	**29.7**	74.5	**19.3**	33.6	**-15.1**	47.2	**-17.9**
Belgium	56.9	**21.0**	53.7	**14.1**	36.2	**-8.1**	41.8	**-9.7**
France	56.5	**32.0**	61.4	**19.4**	32.6	**-11.4**	18.3	**-20.2**
Cambodia	56.3	**27.9**	84.2	**16.3**	27.1	**-15.3**	m	m
Montenegro	55.9	**29.6**	65.3	**13.3**	37.7	**-24.9**	60.4	**-16.2**
Korea	55.4	**43.0**	76.1	**29.8**	33.9	**-23.6**	36.6	**-24.2**
Viet Nam	54.9	**21.7**	89.8	**8.0**	50.0	**-21.5**	m	m
Brazil	54.4	**26.8**	75.8	**19.9**	35.6	**-14.9**	43.4	**-16.3**
Finland	53.7	**28.5**	53.6	**35.1**	32.5	**-22.0**	22.0	**-35.1**
Estonia	52.9	**24.9**	53.8	**30.5**	36.9	**-13.1**	28.5	**-23.0**
Czechia	50.9	**26.4**	44.1	**24.2**	37.5	**-14.9**	34.3	**-16.3**
Philippines	50.7	**23.9**	87.4	**18.1**	m	m	m	m
Romania	50.7	**29.8**	74.4	**15.7**	40.1	**-13.9**	58.3	**-8.2**
Croatia	50.2	**21.8**	54.8	**20.6**	39.8	**-17.7**	39.8	**-18.1**
Brunei Darussalam	50.0	**22.8**	71.4	**19.1**	36.7	-2.7	28.1	**-19.1**
Japan	48.4	**19.9**	m	m	21.2	**-17.5**	m	m
Slovenia	45.9	**22.8**	51.8	**21.8**	41.3	**-20.0**	17.3	**-15.5**
Poland	40.1	**21.8**	35.7	**19.5**	34.7	**-9.1**	28.5	**-21.4**
El Salvador	m	m	m	m	44.4	**-20.2**	69.3	**-13.0**
Kazakhstan	m	m	m	m	42.5	**-21.0**	44.3	**-20.4**
Indonesia	m	m	m	m	m	m	m	m
Thailand	m	m	m	m	m	m	m	m
Baku (Azerbaijan)	76.9	**42.1**	71.2	**17.9**	42.0	**-32.7**	47.6	**-26.1**
Cyprus	68.8	**38.4**	58.5	**22.3**	40.8	**-23.3**	33.7	**-18.7**
Kosovo	65.4	**33.3**	84.8	**8.4**	43.2	**-17.8**	69.6	**-14.5**
Palestinian Authority	59.1	**32.9**	77.1	**16.5**	36.1	**-23.1**	62.5	**-15.9**
Ukrainian regions (18 of 27)	56.9	**35.6**	59.3	**29.3**	32.5	**-17.5**	61.5	**-11.7**
Hong Kong (China)*	48.5	**29.8**	71.8	**34.3**	26.8	**-22.9**	37.1	**-32.1**
Macao (China)	45.1	**27.8**	65.8	**31.3**	22.0	**-23.7**	25.6	**-35.9**
Chinese Taipei	39.4	**28.4**	65.9	**27.4**	20.0	**-23.7**	34.0	**-27.9**

* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
1. Students who reported more (less) self-efficacy in mathematics are those in the top (bottom) quarter of the index of self-efficacy in mathematics in their own country/economy.
2. Students who reported more (less) anxiety in mathematics are those in the top (bottom) quarter of the index of mathematics anxiety in their own country/economy.
Note: Values that are statistically significant are marked in bold (see Annex A3).
Countries and economies are ranked in descending order of the percentage of students reporting asking questions when they do not understand the mathematics material among students with more mathematics self-efficacy.
Source: OECD, PISA 2022 Database, Tables V.B1.4.7, V.B1.4.8, V.B1.4.18 and V.B1.4.19.
The StatLink URL of this table is available below Snapshot Table V.7.

Table V.4. Snapshot of students' autonomy and 21st-century mathematics skills

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students reporting:

	Extracting mathematical information from diagrams, graphs, or simulations frequently	Interpreting mathematical solutions in the context of a real-life challenge frequently	Confidence extracting mathematical information from diagrams, graphs, or simulations	Confidence interpreting mathematical solutions in the context of a real-life challenge	Trying to connect new material to what they have learned in previous mathematics lessons more than half of the time: More confidence in 21st-century mathematics skills[1]	Trying to connect new material to what they have learned in previous mathematics lessons more than half of the time: Difference between more and less confidence in 21st-century mathematics skills[1]	Confidence finding learning resources online on their own, if schools close again in the future	They can easily assess the quality of information they find online
	%	%	%	%	%	% dif.	%	%
OECD average	34.6	19.7	64.5	52.5	62.6	**32.0**	72.7	51.0
Singapore	53.2	33.7	75.2	59.1	68.2	**36.3**	m	64.0
Denmark*	49.5	26.3	72.9	56.8	64.7	**41.4**	m	60.4
Kazakhstan	48.8	34.0	63.2	60.8	73.7	**41.2**	77.9	53.9
United Kingdom*	48.5	20.9	72.7	58.7	65.6	**37.0**	72.6	59.0
Netherlands*	47.7	15.1	73.9	50.0	54.3	**26.9**	74.6	m
Canada*	47.5	26.3	73.4	65.1	69.3	**33.6**	74.6	m
Albania	47.2	38.1	60.5	62.9	84.5	**45.9**	68.0	42.9
Ireland*	47.0	20.2	76.8	54.4	63.7	**32.0**	72.1	61.8
Austria	46.3	27.8	74.7	55.7	70.7	**30.7**	73.1	43.6
Uzbekistan	45.4	43.3	58.3	64.6	79.5	**43.2**	67.6	m
United Arab Emirates	45.2	31.8	68.8	61.3	74.3	**42.5**	79.2	m
France	44.9	26.5	79.4	69.1	52.8	**30.0**	82.9	m
Malta	44.7	21.5	66.9	53.9	71.9	**42.5**	68.0	58.0
United States*	44.5	19.2	69.3	58.6	69.6	**34.9**	73.5	62.7
Australia*	43.6	22.9	72.0	62.9	70.3	**42.4**	77.7	61.8
Saudi Arabia	43.6	33.4	63.7	57.4	64.9	**40.1**	69.0	34.4
Qatar	43.0	29.4	65.3	56.3	72.0	**39.2**	72.9	m
Hungary	42.9	16.0	74.1	37.3	56.9	**27.7**	79.3	48.9
Brazil	42.4	36.2	47.7	48.4	52.7	**24.4**	52.8	39.2
New Zealand*	42.2	19.7	68.0	55.3	61.3	**36.7**	73.4	m
Germany	41.7	21.6	77.6	56.2	64.8	**31.7**	77.3	47.4
Brunei Darussalam	41.6	15.7	46.8	29.3	53.0	**26.9**	54.6	40.5
Portugal	40.3	19.7	69.6	62.9	67.1	**37.2**	73.2	m
Georgia	40.2	28.3	44.2	44.9	73.4	**43.2**	63.6	44.4
Dominican Republic	39.7	37.0	47.1	51.4	70.7	**36.6**	63.1	40.4
Jamaica*	38.8	23.3	60.1	47.0	67.6	**32.2**	65.2	m
Colombia	37.9	29.4	67.8	68.3	68.7	**32.4**	81.4	m
Belgium	37.4	21.1	73.0	52.9	53.9	**27.1**	64.7	48.5
Malaysia	36.3	20.6	47.1	37.3	58.0	**36.6**	60.1	34.5
Sweden	35.8	26.3	67.0	58.7	70.0	**40.1**	71.5	48.0
Peru	35.7	35.5	61.8	60.3	72.2	**36.0**	72.2	m
Indonesia	35.5	30.9	47.0	47.9	60.7	**33.5**	58.7	m
Switzerland	35.2	19.8	75.1	63.3	61.0	**29.5**	76.5	48.3
Japan	34.5	15.3	43.9	30.0	44.7	**30.6**	32.6	39.0
Jordan	34.0	28.4	47.6	46.6	67.0	**37.2**	59.7	32.6
Uruguay	34.0	20.1	65.1	60.7	64.5	**29.0**	66.4	44.0
El Salvador	33.8	30.6	56.8	56.4	70.2	**33.1**	72.4	m
Cambodia	33.7	25.8	m	m	m	m	54.7	m
Philippines	33.6	25.9	47.6	49.5	53.6	**26.2**	61.1	m
Spain	33.4	20.8	63.6	57.8	61.2	**25.5**	77.5	52.2
Chile	33.4	28.9	55.9	54.8	69.1	**28.8**	70.8	50.1
Israel	32.9	13.3	57.0	39.4	68.3	**32.8**	61.6	41.0
Bulgaria	32.6	23.1	50.6	44.6	70.1	**37.3**	66.2	40.1
Argentina	32.5	27.6	47.5	50.9	52.2	**26.3**	67.6	36.7

Table V.4. Snapshot of students' autonomy and 21st-century mathematics skills [2/2]

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students reporting:

	Extracting mathematical information from diagrams, graphs, or simulations frequently	Interpreting mathematical solutions in the context of a real-life challenge frequently	Confidence extracting mathematical information from diagrams, graphs, or simulations	Confidence interpreting mathematical solutions in the context of a real-life challenge	Trying to connect new material to what they have learned in previous mathematics lessons more than half of the time: More confidence in 21st-century mathematics skills[1]	Trying to connect new material to what they have learned in previous mathematics lessons more than half of the time: Difference between more and less confidence in 21st-century mathematics skills[1]	Confidence finding learning resources online on their own, if schools close again in the future	They can easily assess the quality of information they find online
	%	%	%	%	%	% dif.	%	%
OECD average	34.6	19.7	64.5	52.5	62.6	**32.0**	72.7	51.0
Slovak Republic	31.5	21.0	60.2	52.2	56.2	**22.4**	69.5	44.2
Romania	31.4	18.5	60.4	54.3	64.7	**35.8**	68.5	43.6
Morocco	31.3	27.9	42.9	44.3	60.2	**34.1**	53.6	30.5
Lithuania	31.2	14.2	68.3	49.2	60.7	**31.1**	82.4	54.5
Latvia*	31.2	18.7	55.9	36.3	60.3	**25.6**	75.1	52.8
Montenegro	31.1	23.0	42.7	43.8	65.9	**28.9**	57.8	m
North Macedonia	30.6	24.8	54.3	52.9	69.1	**38.5**	68.2	m
Paraguay	30.6	28.2	m	m	m	m	70.6	m
Moldova	30.2	20.4	44.3	44.5	67.3	**38.9**	67.6	m
Guatemala	30.2	29.8	m	m	m	m	69.7	m
Greece	30.0	16.1	48.9	42.8	70.1	**37.1**	56.0	45.2
Norway	29.9	18.6	58.6	48.3	65.7	**38.4**	m	m
Serbia	29.9	21.0	51.1	43.7	67.0	**35.2**	61.8	m
Mongolia	28.8	16.9	50.6	39.7	62.8	**37.6**	67.6	m
Türkiye	28.4	19.3	60.6	51.9	66.7	**38.3**	70.4	58.5
Croatia	27.2	22.6	70.9	63.2	63.6	**34.5**	87.1	44.2
Mexico	27.0	24.4	56.5	53.5	71.6	**37.3**	72.2	m
Costa Rica	26.0	26.8	51.1	55.4	65.5	**26.3**	69.6	58.2
Italy	25.5	16.1	64.7	51.7	57.2	**32.0**	86.5	51.9
Panama*	25.1	21.5	54.6	60.8	71.6	**29.4**	80.6	43.7
Poland	24.9	11.3	56.6	41.3	48.1	**18.9**	71.2	44.9
Iceland	23.9	16.4	62.6	55.8	69.3	**37.9**	79.9	57.4
Finland	23.6	14.6	63.2	59.0	61.0	**38.0**	79.8	51.6
Estonia	22.3	14.9	63.9	43.8	55.7	**25.8**	80.8	42.2
Korea	21.8	10.8	48.2	38.1	66.8	**42.6**	64.9	55.8
Viet Nam	20.2	17.3	m	m	m	m	69.6	m
Thailand	20.1	18.1	36.0	33.4	52.5	**33.7**	56.3	44.9
Slovenia	18.6	17.3	62.3	52.5	56.7	**21.6**	73.0	43.1
Czechia	18.3	11.3	47.2	41.8	55.9	**20.3**	m	46.6
Kosovo	42.5	31.9	45.9	44.6	65.8	**29.4**	61.9	m
Cyprus	38.5	22.0	59.8	51.5	68.2	**34.4**	65.2	m
Palestinian Authority	35.7	29.8	51.3	50.5	67.3	**39.4**	59.0	m
Baku (Azerbaijan)	35.6	26.9	58.7	57.1	79.3	**44.9**	67.6	m
Ukrainian regions (18 of 27)	35.0	19.5	44.4	39.9	60.9	**34.5**	76.5	46.2
Chinese Taipei	30.1	16.0	63.7	43.1	53.8	**41.3**	67.6	50.7
Macao (China)	29.2	11.3	59.9	46.2	50.6	**35.3**	65.8	47.7
Hong Kong (China)*	24.5	11.2	59.1	46.8	56.3	**37.1**	69.6	50.9

* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
1. Students who reported more (less) confidence in 21st-century mathematics skills are those in the top (bottom) quarter of the index of confidence in 21st-century mathematics skills in their own country/economy.
Note: Values that are statistically significant are marked in bold (see Annex A3).
Countries and economies are ranked in descending order of the percentage of students who reported "Extracting mathematical information from diagrams, graphs, or simulations" frequently.
Source: OECD, PISA 2022 Database, Tables V.B1.8.1, V.B1.8.10, V.B1.8.28, V.B1.8.29, V.B1.9.2 and V.B1.10.15.
The StatLink URL of this table is available below Snapshot Table V.7.

Table V.5. Snapshot of students' attitudes about the future

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students reporting:

	Extracting mathematical information from diagrams, graphs, or simulations frequently	Interpreting mathematical solutions in the context of a real-life challenge frequently	Confidence extracting mathematical information from diagrams, graphs, or simulations	Confidence interpreting mathematical solutions in the context of a real-life challenge	Trying to connect new material to what they have learned in previous mathematics lessons more than half of the time: More confidence in 21st-century mathematics skills[1]	Trying to connect new material to what they have learned in previous mathematics lessons more than half of the time: Difference between more and less confidence in 21st-century mathematics skills[1]	Confidence finding learning resources online on their own, if schools close again in the future	They can easily assess the quality of information they find online
	%	%	%	%	%	% dif.	%	%
OECD average	34.6	19.7	64.5	52.5	62.6	**32.0**	72.7	51.0
Slovak Republic	31.5	21.0	60.2	52.2	56.2	**22.4**	69.5	44.2
Romania	31.4	18.5	60.4	54.3	64.7	**35.8**	68.5	43.6
Morocco	31.3	27.9	42.9	44.3	60.2	**34.1**	53.6	30.5
Lithuania	31.2	14.2	68.3	49.2	60.7	**31.1**	82.4	54.5
Latvia*	31.2	18.7	55.9	36.3	60.3	**25.6**	75.1	52.8
Montenegro	31.1	23.0	42.7	43.8	65.9	**28.9**	57.8	m
North Macedonia	30.6	24.8	54.3	52.9	69.1	**38.5**	68.2	m
Paraguay	30.6	28.2	m	m	m	m	70.6	m
Moldova	30.2	20.4	44.3	44.5	67.3	**38.9**	67.6	m
Guatemala	30.2	29.8	m	m	m	m	69.7	m
Greece	30.0	16.1	48.9	42.8	70.1	**37.1**	56.0	45.2
Norway	29.9	18.6	58.6	48.3	65.7	**38.4**	m	m
Serbia	29.9	21.0	51.1	43.7	67.0	**35.2**	61.8	m
Mongolia	28.8	16.9	50.6	39.7	62.8	**37.6**	67.6	m
Türkiye	28.4	19.3	60.6	51.9	66.7	**38.3**	70.4	58.5
Croatia	27.2	22.6	70.9	63.2	63.6	**34.5**	87.1	44.2
Mexico	27.0	24.4	56.5	53.5	71.6	**37.3**	72.2	m
Costa Rica	26.0	26.8	51.1	55.4	65.5	**26.3**	69.6	58.2
Italy	25.5	16.1	64.7	51.7	57.2	**32.0**	86.5	51.9
Panama*	25.1	21.5	54.6	60.8	71.6	**29.4**	80.6	43.7
Poland	24.9	11.3	56.6	41.3	48.1	**18.9**	71.2	44.9
Iceland	23.9	16.4	62.6	55.8	69.3	**37.9**	79.9	57.4
Finland	23.6	14.6	63.2	59.0	61.0	**38.0**	79.8	51.6
Estonia	22.3	14.9	63.9	43.8	55.7	**25.8**	80.8	42.2
Korea	21.8	10.8	48.2	38.1	66.8	**42.6**	64.9	55.8
Viet Nam	20.2	17.3	m	m	m	m	69.6	m
Thailand	20.1	18.1	36.0	33.4	52.5	**33.7**	56.3	44.9
Slovenia	18.6	17.3	62.3	52.5	56.7	**21.6**	73.0	43.1
Czechia	18.3	11.3	47.2	41.8	55.9	**20.3**	m	46.6
Kosovo	42.5	31.9	45.9	44.6	65.8	**29.4**	61.9	m
Cyprus	38.5	22.0	59.8	51.5	68.2	**34.4**	65.2	m
Palestinian Authority	35.7	29.8	51.3	50.5	67.3	**39.4**	59.0	m
Baku (Azerbaijan)	35.6	26.9	58.7	57.1	79.3	**44.9**	67.6	m
Ukrainian regions (18 of 27)	35.0	19.5	44.4	39.9	60.9	**34.5**	76.5	46.2
Chinese Taipei	30.1	16.0	63.7	43.1	53.8	**41.3**	67.6	50.7
Macao (China)	29.2	11.3	59.9	46.2	50.6	**35.3**	65.8	47.7
Hong Kong (China)*	24.5	11.2	59.1	46.8	56.3	**37.1**	69.6	50.9

Table V.5. Snapshot of students' attitudes about the future [2/2]

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students agreeing or strongly agreeing…

	…they try to consider everybody's perspective before they take a position		…they love learning new things		…they like to make sure there are no mistakes…		…they love learning new things…	
	More information research[1]	Difference between more and less information research[1]	More information research[1]	Difference between more and less information research[1]	…when they have a clear idea about their future job[2]	Difference between students with a clear idea about their future job and those without[2]	…when they have a clear idea about their future job[2]	Difference between students with a clear idea about their future job and those without[2]
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	61.7	**8.7**	52.2	**8.1**	65.9	**5.5**	52.4	7.7
Argentina	58.5	**5.3**	68.0	**8.9**	63.9	**6.8**	67.0	**8.7**
Georgia	58.5	**8.0**	70.6	5.4	70.7	**5.8**	73.6	**8.3**
Indonesia	58.4	**6.2**	77.5	**5.9**	86.2	1.3	78.2	**4.0**
Albania	58.0	2.4	77.3	-0.6	77.2	4.7	76.8	0.1
Denmark*	57.4	**7.3**	43.9	5.7	58.1	-4.0	47.5	**10.8**
Lithuania	56.8	**12.3**	40.8	**13.2**	59.1	**7.7**	40.6	**8.4**
Switzerland	56.1	0.2	49.8	0.7	61.7	**7.2**	51.0	3.9
Latvia*	56.0	**12.1**	45.1	**9.1**	60.8	**8.3**	46.7	**6.7**
Belgium	55.8	**9.3**	45.5	**8.5**	62.5	5.3	44.5	8.5
United Kingdom*	53.9	**6.1**	42.5	**11.0**	57.9	**7.6**	41.6	4.1
Czechia	53.8	**12.1**	31.5	**6.0**	63.6	1.0	32.7	3.6
Finland	50.9	**6.5**	36.9	**7.2**	61.4	**5.4**	38.9	**6.3**
Poland	46.7	**8.7**	27.3	**8.0**	73.8	-0.6	29.5	**10.9**
Iceland	46.4	**13.7**	47.7	**10.0**	63.8	1.5	48.3	**13.7**
Netherlands*	45.9	**8.9**	35.6	**9.0**	67.8	**5.5**	37.6	**5.5**
Jordan	44.3	-2.7	67.3	-4.4	73.1	m	71.3	-1.7
Viet Nam	m	m	m	m	78.1	**3.9**	88.3	**5.5**
Guatemala	m	m	m	m	74.7	5.3	87.6	3.8
Paraguay	m	m	m	m	74.4	**8.1**	81.4	**6.4**
Spain	m	m	m	m	72.3	**4.2**	52.9	**8.5**
Cambodia	m	m	m	m	68.1	2.5	79.7	3.3
France	m	m	m	m	68.0	4.4	54.6	**9.3**
Singapore	m	m	m	m	65.2	**6.1**	59.7	**14.7**
Germany	m	m	m	m	62.8	**5.8**	39.4	**10.3**
Ireland*	m	m	m	m	57.8	**7.4**	49.2	**13.0**
Norway	m	m	44.5	**6.2**	m	m	43.5	2.0
Israel	m	m	m	m	m	m	m	m
Japan	m	m	m	m	m	m	m	m
Sweden	m	m	m	m	m	m	m	m
United States*	m	m	m	m	m	m	m	m
Hong Kong (China)*	68.8	**16.1**	57.8	**12.4**	55.2	5.0	60.6	**13.7**
Macao (China)	68.6	**11.9**	54.7	**13.0**	51.0	**8.9**	54.1	**10.0**
Chinese Taipei	68.2	**10.9**	55.3	**13.1**	64.0	5.4	55.5	**10.7**
Ukrainian regions (18 of 27)	59.8	**10.1**	49.6	**12.3**	62.0	7.9	50.6	**9.8**
Cyprus	58.4	1.0	48.2	5.2	64.7	-0.3	50.3	**11.7**
Baku (Azerbaijan)	52.6	5.0	67.2	**10.2**	65.8	-0.9	63.0	4.3
Palestinian Authority	48.8	**-4.8**	71.0	0.3	77.1	**7.5**	74.6	1.4
Kosovo	44.8	2.1	79.3	-4.4	77.6	m	81.2	m

* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
1. Students who reported more (less) information research are those in the top (bottom) quarter of the index of information-seeking regarding future career in their own country/economy.
2. For this column, Belgium's data represent only the French-speaking and German-speaking communities.
Note: Values that are statistically significant are marked in bold (see Annex A3).
Countries and economies are ranked in descending order of the percentage of students who reported "they try to consider everybody's perspective before they take a position" among students in the top quarter of index of information-seeking at national level.
Source: OECD, PISA 2022 Database, Tables V.B1.6.4, V.B1.6.5, V.B1.6.11 and V.B1.6.12.
The StatLink URL of this table is available below Snapshot Table V.7.

Table V.6. Snapshot of experiences of food insecurity and working for pay and the use of learning strategies

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students agreeing or strongly agreeing…

	...they like to make sure there are no mistakes, among those who...				...they try to consider everybody's perspective before they take a position, among those who...			
	...experienced food insecurity at least once in the past 30 days prior to the PISA test	Difference between students who experienced food insecurity at least once and those who did not	...work for pay before or after school at least once in a typical school week	Difference between students who work for pay before or after school at least once in a typical school week and those who do not	...experienced food insecurity at least once in the past 30 days prior to the PISA test	Difference between students who experienced food insecurity at least once and those who did not	...work for pay before or after school at least once in a typical school week	Difference between students who work for pay before or after school at least once in a typical school week and those who do not
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	54.3	**-10.0**	59.6	**-6.1**	52.8	**-6.4**	54.7	**-5.8**
Korea	86.7	-3.1	76.3	**-14.2**	62.7	-6.3	65.1	-3.8
Indonesia	80.2	**-6.3**	81.2	**-6.4**	49.4	**-8.0**	51.5	**-6.8**
Mongolia	79.4	**-8.6**	81.6	**-7.2**	68.5	**-7.1**	67.4	**-9.5**
Viet Nam	74.5	**-3.1**	72.7	**-4.9**	m	m	m	m
Guatemala	73.9	-1.2	74.5	-0.7	m	m	m	m
Albania	70.9	**-5.5**	60.2	**-20.1**	47.0	**-10.8**	47.9	**-10.1**
Mexico	70.6	3.0	66.3	**-4.0**	70.0	-0.5	68.9	**-3.6**
Jamaica*	69.8	-0.6	69.1	-1.3	61.4	-1.4	57.3	-6.2
Portugal	69.7	-2.6	64.9	**-8.7**	65.6	**-15.0**	69.1	**-13.1**
Romania	69.1	-1.5	66.1	**-5.8**	62.1	3.0	58.3	-1.4
Saudi Arabia	68.9	**-11.0**	67.4	**-14.8**	57.3	**-10.9**	55.8	**-14.8**
Paraguay	68.5	**-5.4**	70.3	**-4.9**	m	m	m	m
El Salvador	67.8	-2.8	68.1	**-6.0**	56.3	**-11.6**	64.3	**-5.7**
Cambodia	67.7	1.3	66.9	-0.4	m	m	m	m
Thailand	67.1	**-8.1**	68.8	**-7.1**	59.8	**-7.1**	61.7	**-5.8**
Panama*	66.8	-4.6	68.5	-4.0	62.7	**-7.1**	66.3	**-5.0**
Colombia	66.7	**-6.4**	70.9	**-3.3**	65.3	-5.2	67.0	**-5.7**
Uzbekistan	66.1	**-13.2**	68.0	**-11.5**	66.4	**-9.0**	66.3	**-10.2**
Chile	65.4	-4.8	67.0	**-4.9**	61.4	-2.2	58.7	**-8.0**
Peru	65.0	**-7.1**	69.5	**-3.9**	66.7	**-5.3**	69.3	**-4.1**
Morocco	64.4	**-9.7**	62.8	**-13.9**	55.9	**-7.4**	50.0	**-17.1**
North Macedonia	63.2	**-7.8**	55.0	**-17.7**	51.3	**-6.1**	47.4	**-11.0**
Türkiye	62.6	**-4.8**	59.2	**-8.7**	72.8	-3.0	62.0	**-15.8**
Serbia	62.3	**-6.6**	59.4	**-10.7**	56.2	-4.7	56.2	**-5.4**
Brazil	61.7	**-8.9**	66.1	**-5.4**	57.6	-4.9	55.5	**-9.2**
Brunei Darussalam	61.5	-0.7	60.1	-2.2	47.5	**-12.2**	46.0	**-12.9**
Iceland	60.8	-2.3	63.3	0.2	32.1	-11.3	39.2	**-6.6**
France	60.7	-5.6	65.8	-0.2	59.5	-5.3	60.3	**-4.6**
Georgia	60.5	**-8.1**	53.0	**-17.9**	55.7	-0.6	52.3	-4.9
Moldova	60.3	**-11.6**	64.3	**-9.2**	49.0	**-10.8**	53.2	**-8.2**
Malaysia	60.0	**-8.3**	62.6	**-5.5**	50.2	**-7.6**	48.6	**-11.2**
Singapore	58.8	**-5.9**	52.1	**-12.8**	69.0	-3.8	62.0	**-11.1**
Dominican Republic	58.6	**-15.3**	70.6	**-4.2**	51.5	**-17.1**	64.0	**-5.8**
Kazakhstan	57.6	**-6.8**	58.8	**-6.6**	51.4	**-5.5**	52.1	**-5.7**
United Arab Emirates	57.4	**-16.4**	59.2	**-15.7**	53.3	**-13.0**	54.0	**-13.8**
Uruguay	55.2	**-9.1**	60.8	**-4.1**	51.7	-5.6	51.9	**-7.4**
Bulgaria	54.8	**-9.3**	48.3	**-18.3**	53.4	**-13.0**	48.5	**-20.2**
Poland	54.5	**-19.3**	54.7	**-21.7**	29.0	**-15.6**	36.7	**-8.5**
Finland	54.4	-5.3	54.1	**-7.2**	41.5	-7.3	46.4	-2.8
Jordan	53.4	**-18.8**	48.0	**-29.2**	40.3	**-4.4**	35.5	**-11.9**
Slovenia	53.0	**-8.5**	57.4	-4.0	53.7	-4.6	49.4	**-10.7**
Czechia	52.9	**-10.5**	58.8	**-5.0**	43.6	**-5.8**	45.1	**-5.3**
Philippines	52.0	**-14.1**	55.8	**-8.4**	52.0	**-16.6**	53.2	**-15.6**
Lithuania	50.5	**-5.4**	49.6	**-7.9**	48.9	-4.3	49.5	**-4.3**
Qatar	50.2	**-18.1**	50.9	**-18.8**	45.5	**-14.7**	41.3	**-20.9**

Table V.6. Snapshot of experiences of food insecurity and working for pay and the use of learning strategies

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

Percentage of students agreeing or strongly agreeing…

	...they like to make sure there are no mistakes, among those who...				...they try to consider everybody's perspective before they take a position, among those who...			
	...experienced food insecurity at least once in the past 30 days prior to the PISA test	Difference between students who experienced food insecurity at least once and those who did not	...work for pay before or after school at least once in a typical school week	Difference between students who work for pay before or after school at least once in a typical school week and those who do not	...experienced food insecurity at least once in the past 30 days prior to the PISA test	Difference between students who experienced food insecurity at least once and those who did not	...work for pay before or after school at least once in a typical school week	Difference between students who work for pay before or after school at least once in a typical school week and those who do not
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	54.3	**-10.0**	59.6	**-6.1**	52.8	**-6.4**	54.7	**-5.8**
Canada*	50.1	**-13.2**	59.2	**-4.9**	54.5	**-8.3**	59.2	**-4.8**
Switzerland	49.5	**-11.9**	59.1	-2.0	49.0	**-9.0**	55.9	-2.6
Netherlands*	47.3	**-18.8**	63.7	**-5.6**	37.9	-5.0	40.5	**-7.9**
Slovak Republic	46.9	**-22.2**	56.5	**-15.4**	45.7	**-12.2**	50.6	**-9.6**
Latvia*	46.5	**-13.8**	51.3	**-9.3**	58.1	4.1	53.9	-0.2
Hungary	46.5	-8.5	48.7	**-7.0**	60.1	-2.2	55.7	**-7.9**
Malta	45.6	**-15.5**	55.4	-5.4	50.5	**-13.2**	56.4	**-7.2**
United Kingdom*	45.0	**-11.9**	50.7	**-6.8**	49.8	-3.5	50.5	-3.3
Denmark*	43.5	**-16.1**	58.7	0.4	45.8	**-11.7**	58.6	3.9
Estonia	42.9	**-11.4**	45.4	**-10.2**	58.1	-6.0	58.2	**-6.8**
Croatia	42.2	**-8.7**	46.9	-4.2	45.3	**-12.6**	46.7	**-12.7**
New Zealand*	38.5	**-16.4**	53.1	0.9	50.1	**-7.9**	55.4	-2.2
Ireland*	38.2	**-19.4**	53.4	**-4.3**	53.0	-5.9	54.6	**-5.6**
Costa Rica	m	m	76.3	-1.0	m	m	66.7	-0.3
Italy	m	m	67.3	**-4.1**	m	m	53.4	**-7.4**
Greece	m	m	64.3	**-7.2**	m	m	53.0	**-12.9**
Spain	m	m	62.6	**-9.7**	m	m	47.3	**-11.1**
Belgium	m	m	61.0	**-4.5**	m	m	51.7	-1.3
Germany	m	m	59.6	-3.8	m	m	55.3	**-3.6**
Argentina	m	m	57.3	**-6.7**	m	m	49.0	**-6.2**
Australia*	m	m	55.6	**-3.6**	m	m	60.4	-2.4
Austria	m	m	53.3	**-7.5**	m	m	51.4	**-6.0**
Montenegro	m	m	50.2	**-17.4**	m	m	45.6	**-11.4**
Israel	m	m	m	m	m	m	m	m
Japan	m	m	m	m	m	m	m	m
Norway	m	m	m	m	m	m	m	m
Sweden	m	m	m	m	m	m	m	m
United States*	m	m	m	m	m	m	m	m
Kosovo	71.6	**-5.9**	58.9	**-21.8**	40.3	**-4.4**	38.4	**-6.7**
Palestinian Authority	62.4	**-13.2**	57.0	**-22.3**	45.7	**-4.3**	40.3	**-13.1**
Baku (Azerbaijan)	59.5	**-8.5**	48.9	**-19.6**	51.2	0.9	43.3	**-8.9**
Chinese Taipei	55.5	**-7.5**	57.6	-5.2	61.7	-4.7	58.8	**-8.0**
Ukrainian regions (18 of 27)	49.0	**-11.5**	53.4	**-9.3**	45.6	**-11.5**	49.3	**-10.0**
Hong Kong (China)*	45.6	**-7.6**	45.2	**-8.0**	56.1	**-9.5**	54.6	**-11.0**
Cyprus	45.2	**-16.8**	49.3	**-14.8**	46.4	**-10.0**	48.6	**-9.3**
Macao (China)	40.6	**-11.2**	52.1	2.0	61.8	-3.6	58.8	**-6.8**

* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
Note: Values that are statistically significant are marked in bold (see Annex A3).
Countries and economies are ranked in descending order of the percentage of students who reported "they like to make sure there are no mistakes" among students who experienced food insecurity at least once in the past 30 days prior to the PISA test.
Source: OECD, PISA 2022 Database, Tables V.B1.7.5, V.B1.7.7, V.B1.7.19 and V.B1.7.21.
The StatLink URL of this table is available below Snapshot Table V.7.

Table V.7. Snapshot of students' proactive learning with parental and teacher support

Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

	Percentage of students reporting trying to connect new material to what they have learned in previous mathematics lessons, when their:				Percentage of students reporting the following, when the teacher shows an interest in every student's learning:			
	Parents spend time just talking with them		Parents take an interest in what they are learning at school		Try to connect new material to what they have learned in previous mathematics lessons		Make time to learn the material for mathematics class	
	Students with more frequent parental interactions[1]	Difference between students with more frequent interactions and those with less	Students with more frequent parental interactions[1]	Difference between students with more frequent interactions and those with less	Students with more frequent teacher support[2]	Difference between students with more frequent support and those with less	Students with more frequent teacher support[2]	Difference between students with more frequent support and those with less
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	48.1	12.1	50.0	13.5	49.8	11.9	52.9	12.0
Albania	68.3	25.2	69.1	29.4	62.2	6.1	50.0	-2.2
Panama*	66.4	9.9	68.3	26.6	60.8	12.9	62.0	14.5
Viet Nam	65.7	16.2	66.8	20.8	63.8	19.6	59.7	25.9
Uzbekistan	63.8	15.9	64.6	24.7	60.5	8.4	60.2	9.5
Guatemala	62.8	12.0	62.7	17.9	59.3	11.3	69.4	16.2
North Macedonia	59.5	22.3	59.2	23.6	55.5	14.0	50.7	9.9
Kazakhstan	59.5	18.8	62.2	23.4	58.7	19.5	57.9	18.1
Peru	59.1	11.2	62.3	17.8	57.9	17.9	60.9	17.3
Mexico	59.0	17.1	59.3	22.0	55.3	16.8	57.4	12.0
Chile	58.4	13.2	58.0	13.2	56.4	14.1	63.9	16.7
Jordan	58.0	17.4	54.8	15.1	49.4	1.2	48.0	2.9
Canada*	57.8	18.2	58.9	14.2	m	m	m	m
El Salvador	57.8	11.4	57.0	13.4	53.8	8.7	56.9	11.2
Colombia	57.7	6.9	58.1	16.7	58.3	14.3	62.5	14.3
Dominican Republic	57.6	14.9	59.6	21.4	51.9	2.1	55.2	0.5
United Arab Emirates	57.3	17.7	59.6	21.1	56.4	11.8	57.9	9.1
United States*	57.3	12.7	62.4	17.6	57.4	14.4	62.8	15.4
Austria	56.2	11.0	58.2	12.3	57.0	8.4	52.8	3.2
Greece	55.4	20.2	53.3	15.6	52.6	5.7	50.4	10.7
Qatar	55.3	14.6	56.5	17.2	52.5	7.9	54.2	6.6
Slovenia	54.4	16.8	52.7	12.8	53.5	12.7	47.6	5.6
Paraguay	53.8	15.5	54.5	18.5	49.7	12.0	61.6	15.5
Montenegro	53.6	16.9	53.8	13.4	52.1	9.1	46.9	5.9
Australia*	53.2	13.8	55.9	15.8	54.6	15.8	59.2	16.9
Jamaica*	53.1	11.1	52.3	12.9	51.8	14.8	58.0	16.8
Bulgaria	52.6	16.4	52.7	16.8	51.6	12.1	47.1	12.7
Georgia	52.5	8.8	54.9	18.7	52.4	9.5	52.1	15.0
Sweden	52.2	11.4	52.5	11.5	51.9	12.1	53.8	9.8
Uruguay	52.1	14.8	52.3	13.5	53.3	11.4	57.6	9.3
Türkiye	51.8	10.1	55.2	10.3	56.0	16.1	56.2	14.8
Malta	50.9	8.5	54.8	15.8	53.0	10.4	63.8	17.4
Iceland	50.7	7.5	53.0	10.9	50.2	6.0	57.0	9.0
Slovak Republic	50.5	14.3	48.2	9.2	48.1	9.6	44.2	7.7
Singapore	50.4	7.3	55.9	14.9	52.4	14.9	64.3	18.0
Serbia	50.3	14.0	55.0	13.7	51.8	9.1	50.7	11.2
Saudi Arabia	50.1	11.3	50.3	13.3	45.7	2.1	45.1	7.9
Moldova	49.7	12.6	52.9	20.1	49.3	10.3	49.8	11.7
Mongolia	49.7	13.8	49.6	15.5	48.5	12.7	53.0	12.7
Germany	49.5	13.8	52.7	14.5	52.9	13.6	45.5	5.7
Croatia	49.4	16.0	53.8	17.2	51.3	10.8	47.9	6.3
Portugal	49.0	16.7	54.0	16.5	52.5	14.6	65.1	19.1
Romania	49.0	13.9	50.4	10.7	50.0	9.8	43.0	11.2
Spain	48.8	10.1	53.4	13.8	50.5	11.7	58.4	10.0

Table V.7. Snapshot of students' proactive learning with parental and teacher support

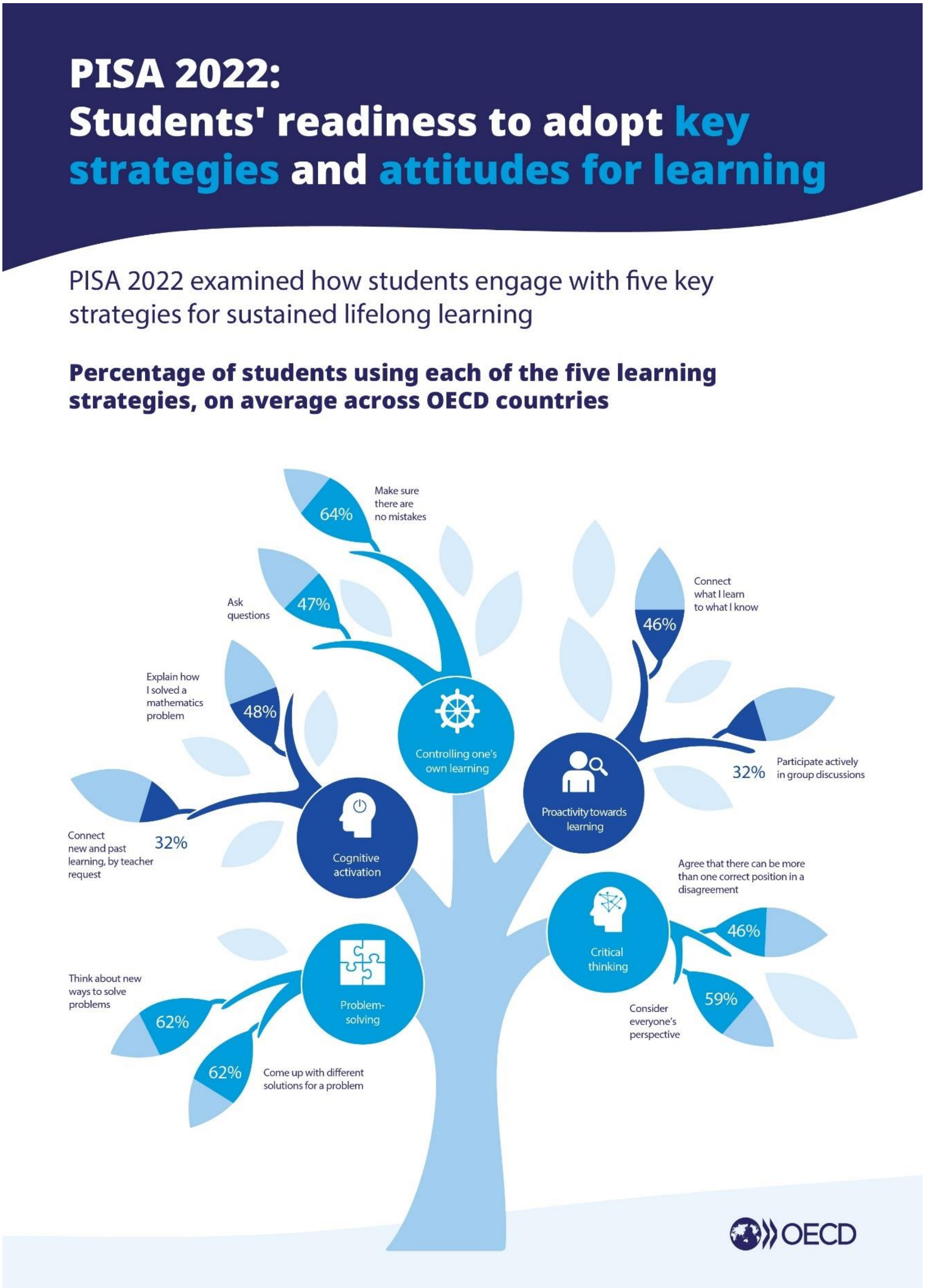
Countries/economies with values **above** the OECD average
Countries/economies with values **not significantly different** from the OECD average
Countries/economies with values **below** the OECD average

	Percentage of students reporting trying to connect new material to what they have learned in previous mathematics lessons, when their:				Percentage of students reporting the following, when the teacher shows an interest in every student's learning:			
	Parents spend time just talking with them		Parents take an interest in what they are learning at school		Try to connect new material to what they have learned in previous mathematics lessons		Make time to learn the material for mathematics class	
	Students with more frequent parental interactions[1]	Difference between students with more frequent interactions and those with less	Students with more frequent parental interactions[1]	Difference between students with more frequent interactions and those with less	Students with more frequent teacher support[2]	Difference between students with more frequent support and those with less	Students with more frequent teacher support[2]	Difference between students with more frequent support and those with less
	%	% dif.	%	% dif.	%	% dif.	%	% dif.
OECD average	48.1	**12.1**	50.0	**13.5**	49.8	**11.9**	52.9	**12.0**
Lithuania	48.4	**14.6**	53.0	**20.7**	51.8	**10.4**	57.3	**8.7**
Switzerland	48.1	**11.8**	48.1	**10.3**	50.4	**10.9**	50.3	**10.0**
Brazil	48.1	**13.7**	48.1	**13.0**	43.0	**5.2**	35.2	**4.8**
Philippines	47.7	**17.0**	50.6	**22.1**	41.8	**11.1**	44.9	**13.6**
Latvia*	47.4	**13.6**	47.7	**10.3**	50.0	**13.5**	39.5	**10.9**
Indonesia	47.1	**12.1**	52.7	**23.7**	45.9	**8.6**	42.4	**7.3**
Ireland*	46.9	**14.2**	50.9	**16.1**	49.7	**10.5**	54.5	**16.3**
Korea	46.6	**18.9**	50.7	**18.6**	46.5	**12.8**	58.3	**16.2**
Denmark*	46.5	**10.3**	48.6	**14.8**	48.3	**15.4**	64.1	**17.5**
Norway	46.0	**8.8**	45.9	**11.4**	48.2	**12.8**	41.8	**13.0**
Czechia	44.7	**12.4**	46.3	**13.0**	48.2	**10.0**	47.4	**7.8**
New Zealand*	44.7	**14.4**	43.8	**11.6**	46.1	**11.2**	52.0	**17.6**
United Kingdom*	44.7	6.3	51.7	**13.7**	49.9	**17.3**	52.1	**19.0**
Hungary	44.6	**13.4**	45.8	**16.8**	47.3	**10.5**	49.7	**6.4**
Morocco	44.6	**9.4**	46.3	**10.8**	41.9	2.2	46.2	2.2
Argentina	44.5	**12.6**	47.8	**14.7**	40.9	**7.5**	33.8	**6.9**
Finland	44.2	**11.5**	43.7	**11.9**	46.6	**13.4**	39.5	**13.3**
Estonia	42.9	**10.6**	46.2	**13.1**	46.5	**10.4**	50.3	**9.1**
Malaysia	42.2	**16.1**	43.3	**15.8**	38.8	**10.5**	43.5	**14.9**
Italy	41.7	**8.2**	45.6	**13.2**	43.7	**10.1**	62.6	**24.7**
Brunei Darussalam	40.4	**12.3**	39.8	**5.8**	40.6	**12.6**	39.1	**12.4**
Netherlands*	40.0	6.8	42.8	**7.8**	46.0	**12.9**	52.1	**12.2**
Poland	38.9	**13.5**	39.9	**12.9**	41.5	**10.4**	42.8	**12.5**
Belgium	37.9	3.0	40.3	**9.1**	43.5	**11.0**	55.9	**10.2**
Thailand	36.3	**14.0**	42.2	**20.8**	32.8	**4.2**	29.8	2.8
Cambodia	36.3	**8.5**	39.9	**16.8**	35.2	**9.1**	38.7	**10.2**
France	35.8	**10.6**	40.5	**12.0**	41.7	**11.7**	44.8	**10.6**
Japan	31.2	**6.0**	31.2	**7.5**	30.6	**12.7**	45.7	**9.9**
Israel	m	m	m	m	55.4	**7.1**	50.7	**7.2**
Costa Rica	m	m	m	m	53.9	**8.8**	56.7	**7.8**
Baku (Azerbaijan)	63.7	**23.1**	64.4	**22.1**	59.8	**8.2**	62.3	**14.2**
Kosovo	57.3	**18.3**	59.4	**21.5**	52.8	**5.4**	45.3	-0.3
Palestinian Authority	55.3	**19.5**	57.5	**23.2**	49.4	**5.9**	46.7	**5.0**
Cyprus	53.7	**15.9**	53.6	**15.2**	52.9	**8.5**	55.9	**4.6**
Ukrainian regions (18 of 27)	47.5	**22.3**	46.3	**16.2**	42.7	**9.2**	44.2	**13.8**
Hong Kong (China)*	37.3	**5.6**	39.8	**9.8**	38.5	**10.0**	31.0	**6.8**
Macao (China)	33.6	**10.0**	38.0	**8.2**	34.3	**9.5**	26.1	**4.5**
Chinese Taipei	32.7	**9.4**	32.3	**9.1**	33.2	**13.0**	29.1	**7.4**

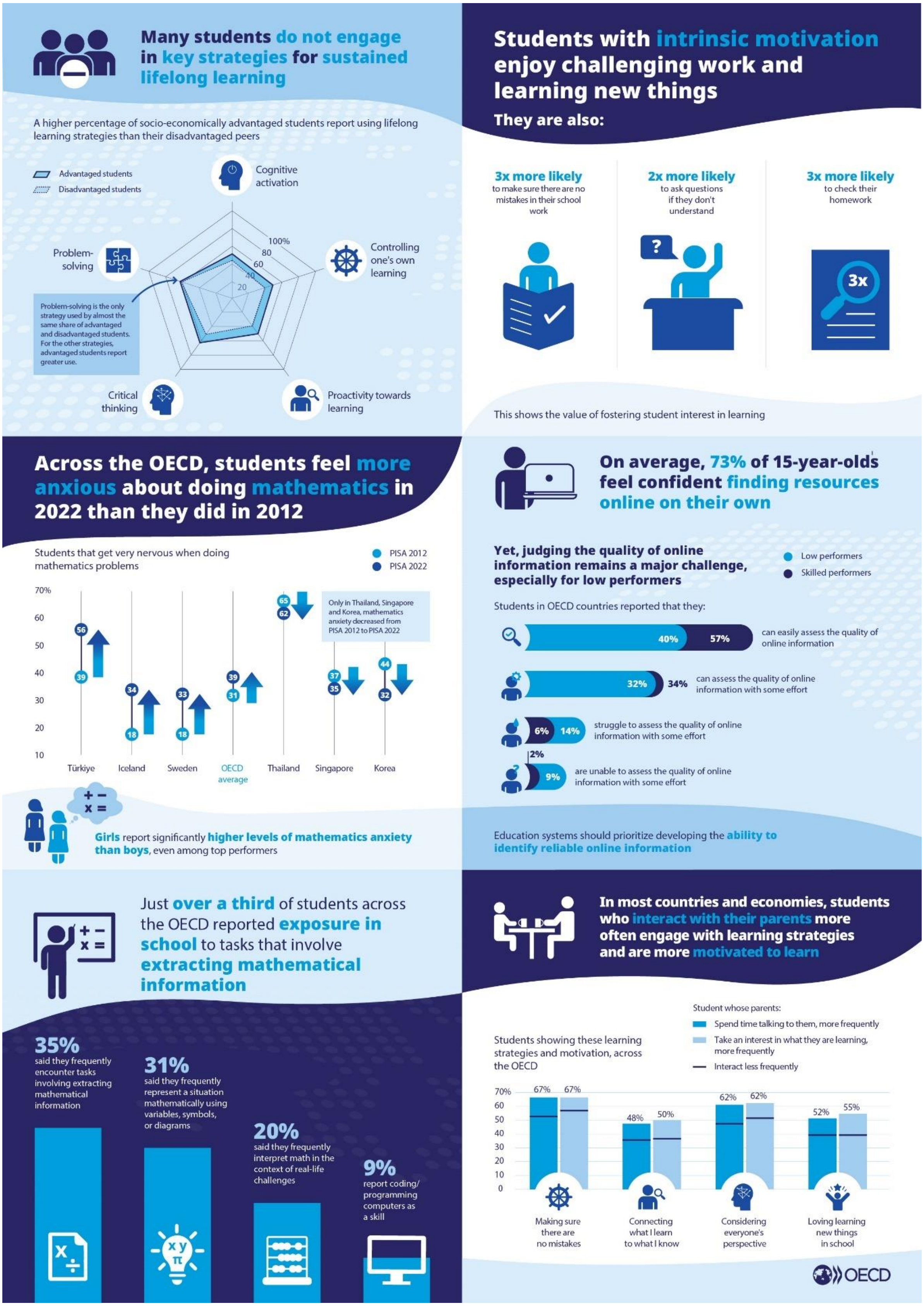
* Caution is required when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).
1. Students who reported more (less) frequent parental interactions are those responding this activity occurred about once or twice a week or every day or almost every day (never or almost never to about once or twice a month).
2. Students who reported more (less) frequent teacher support are those responding this activity occurred in most lessons to every lesson (never or almost never to some lessons).
Note: Percentage-point differences that are statistically significant are marked in bold (see Annex A3).
Countries and economies are ranked in descending order of the percentage of students reporting trying to connect new material to what they have learned in previous mathematics lessons when their parents spend more time with them.
Source: OECD, PISA 2022 Database, Annex B1, Table V.B1.5.19, Table V.B1.5.73, Table V.B1.5.81.

StatLink https://stat.link/xndp9b

Infographic 1. Students' readiness to adopt key strategies and attitudes for learning



Infographic 2. PISA 2022 findings on lifelong learning



What is PISA?

OECD's Programme for International Student Assessment (PISA)

What should citizens know and be able to do? In response to that question and to the need for internationally comparable evidence on student performance, the Organisation for Economic Co-operation and Development (OECD) launched the Programme for International Student Assessment (PISA) in 1997 and the first assessment was conducted in 2000.

PISA is a triennial survey of 15-year-old students around the world that assesses the extent to which they have acquired key knowledge and skills essential for full participation in social and economic life. PISA assessments do not just ascertain whether students near the end of their compulsory education can reproduce what they have learned; they also examine how well students can extrapolate from what they have learned and apply their knowledge in unfamiliar settings, both in and outside of school.

While the eighth assessment was originally planned for 2021, the PISA Governing Board postponed the assessment to 2022 because of the many difficulties education systems faced due to the COVID-19 pandemic.

What is unique about PISA?

PISA is unique because of its:

- **policy orientation**, which links data on student learning outcomes with data on students' backgrounds and attitudes towards learning, and with key aspects that shape their learning, in and outside of school; by doing so, PISA can highlight differences in performance and identify the characteristics of students, schools and education systems that perform well
- **innovative concept of student competency**, which refers to students' capacity to apply their knowledge and skills in key areas, and to analyse, reason and communicate effectively as they identify, interpret and solve problems in a variety of situations
- **relevance to lifelong learning**, as PISA asks students to report on their motivation to learn, their beliefs about themselves, and their learning strategies
- **regularity**, which enables countries to monitor their progress in meeting key learning objectives
- **breadth of coverage**, which, in PISA 2022, encompassed 37 OECD countries and 44 partner countries and economies.

Which countries and economies participate in PISA?

PISA is used as an assessment tool in many regions around the world. It was implemented in 43 countries and economies in the first assessment (32 in 2000 and 11 in 2002), 41 in the second assessment (2003), 57 in the third assessment (2006), 75 in the fourth assessment (65 in 2009 and 10 in 2010), 65 in the fifth assessment (2012), 72 in the sixth assessment (2015) and 79 in the seventh assessment (2018). In 2022, 81 countries and economies participated in PISA.

Figure V.1. Map of PISA countries and economies

OECD member countries in PISA 2022

Australia
Austria
Belgium
Canada
Chile
Colombia
Costa Rica
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Japan
Korea
Latvia
Lithuania
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
Türkiye
United Kingdom
United States

Partner countries and economies in PISA 2022

Albania
Argentina
Baku (Azerbaijan)
Brazil
Brunei Darussalam
Bulgaria
Cambodia
Croatia
Cyprus
Dominican Republic
El Salvador
Georgia
Guatemala
Hong Kong (China)
Indonesia
Jamaica
Jordan
Kazakhstan
Kosovo
Macao (China)
Malaysia
Malta
Republic of Moldova
Mongolia
Montenegro
Morocco
North Macedonia
Palestinian Authority
Panama
Paraguay
Peru
Philippines
Qatar
Romania
Saudi Arabia
Serbia
Singapore
Chinese Taipei
Thailand
Ukraine
United Arab Emirates
Uruguay
Uzbekistan
Viet Nam

Countries and economies in previous cycles

Algeria
Azerbaijan
Beijing (China)
Belarus
Bosnia and Herzegovina
Guangdong (China)
Himachal Pradesh (India)
Jiangsu (China)
Kyrgyzstan
Lebanon
Liechtenstein
Luxembourg
Mauritius
Miranda (Venezuela)
Russian Federation
Shanghai (China)
Tamil Nadu (India)
Trinidad and Tobago
Tunisia
Zhejiang (China)

First-time participants include Cambodia, El Salvador, Guatemala, Jamaica, Mongolia, the Palestinian Authority, Paraguay and Uzbekistan, while Cambodia, Guatemala and Paraguay participated in the PISA for Development programme. Chinese provinces/municipalities (Beijing, Shanghai, Jiangsu and Zhejiang) and Lebanon are participants in PISA 2022 but were unable to collect data because schools were closed during the intended data collection period.

Key features of PISA 2022

The content

The PISA 2022 survey focused on mathematics, with reading, science and creative thinking as minor areas of assessment. In each round of PISA, one subject is tested in detail, taking up nearly half of the total testing time. The main subject in 2022 was mathematics, as it was in 2012 and 2003. Reading was the main subject in 2000, 2009 and 2018, science was the main subject in 2006 and 2015.

With this alternating schedule, a thorough analysis of achievement in each of the three core subjects is presented every nine (or 10) years; and an analysis of trends is offered every three (or four) years. As this cycle was postponed from 2021 to 2022 due to the COVID-19 pandemic, this cycle offers results one year later than previous cycles.

Creative thinking was assessed as an innovative domain for the first time in PISA 2022.

The *PISA 2022 Assessment and Analytical Framework* (OECD, 2023[1]) presents definitions and more detailed descriptions of the subjects assessed in PISA 2022:

- Mathematics is defined as students' capacity to reason mathematically and to formulate, employ and interpret mathematics to solve problems in a variety of real-world contexts. It includes concepts, procedures, facts and tools to describe, explain and predict phenomena. It helps individuals make well-founded judgements and decisions, and become constructive, engaged and reflective 21st-century citizens.
- Reading is defined as students' capacity to understand, use, evaluate, reflect on and engage with texts in order to achieve one's goals, develop one's knowledge and potential, and participate in society.
- Science literacy is defined as students' ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires the competencies to explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically.
- Creative thinking is defined as students' ability to engage productively in the generation, evaluation and improvement of ideas that can result in original and effective solutions, advances in knowledge and impactful expressions of imagination.

PISA 2022 also included an assessment of young people's financial literacy, which was optional for countries and economies.

The students

Some 690 000 students took the assessment in 2022, representing about 29 million 15-year-olds in the schools of the 81 countries and economies.

PISA students are aged between 15 years 3 months and 16 years 2 months at the time of the assessment, and they have completed at least 6 years of formal schooling. Using this age across countries and over time allows PISA to consistently compare the knowledge and skills of individuals born in the same year who are still in school at age 15, despite the diversity of their education histories in and outside of school. They can be enrolled in any type of institution, participate in full-time or part-time education, in academic or vocational programmes, and attend public or private schools or foreign schools within the country.

The population of PISA-participating students is defined by the PISA Technical Standards as are the students who are excluded from participating (see Annex A2). The overall exclusion rate within a country is required to be below 5% to ensure that, under reasonable assumptions, any distortions in national mean scores would remain within plus or minus five score points, i.e. typically within the order of magnitude of two standard errors of sampling. Exclusion could take place either through the schools that participated or the students who participated within schools. There are several reasons why a school or a student could be excluded from PISA. Schools might be excluded because they are situated in remote regions and are inaccessible, because they are very small, or because of organisational or operational factors that precluded participation. Students might be excluded because of intellectual disability or limited proficiency in the language of the assessment.

The assessment

As was done in 2015 and 2018, computer-based tests were used in most countries and economies in PISA 2022, with assessments lasting a total of two hours for each student. In mathematics and reading, a multi-stage adaptive approach was applied in computer-based tests whereby students were assigned a block of test items based on their performance in preceding blocks.

Test items were a mixture of multiple-choice questions and questions requiring students to construct their own responses. The items were organised in groups based on a passage setting out a real-life situation. More than 15 hours of test items for reading, mathematics, science and creative thinking were covered, with different students taking different combinations of test items.

There were six different kinds of test forms representing various combinations of two of the four domains (i.e. the three core domains, plus the innovative domain). Typically, within each country/economy, 94% of students received test forms covering 60 minutes of mathematics as the major domain, and another 60 minutes of one of the three minor or innovative domains (reading, science or creative thinking). In addition, 6% of students received test forms composed of two minor domains. Each test form was completed by enough students to allow for estimations of proficiency and psychometric analyses of all items by students in each country/economy and in relevant subgroups within a country/economy, such as boys and girls, or students from different social and economic backgrounds.

In addition, PISA 2022 retained a paper-based version of the assessment that included only trend items that had been used in prior paper-based assessments. This paper-based assessment was implemented in four countries: Cambodia, Guatemala, Paraguay and Viet Nam.

The assessment of financial literacy was offered again in PISA 2022 as an optional computer-based test. It was based on a revised framework based on the PISA 2022 updated framework. The cognitive instruments included trend items and a set of new interactive items that were developed specifically for PISA 2022.

The questionnaires

Students answered a background questionnaire, which took about 35 minutes to complete. The questionnaire sought information about the students' attitudes, dispositions and beliefs, their homes, and their school and learning experiences. School principals completed a questionnaire that covered school management and organisation, and the learning environment. Both students and schools responded to items in the Global Crises Module in their respective questionnaires. These items aimed to elicit their perspectives on how learning was organised when schools were closed because of the COVID-19 pandemic.

Some countries/economies also distributed additional questionnaires to elicit more information. These included: a questionnaire for teachers asking about themselves and their teaching practices; and a questionnaire for parents asking them to provide information about their perceptions of and involvement in their child's school and learning.

Countries/economies could also choose to distribute two other optional questionnaires for students: a questionnaire about students' familiarity with computers and a questionnaire about students' well-being. A financial literacy questionnaire was also distributed to the students in the countries/economies that conducted the optional financial literacy assessment.

Where can you find the results?

The initial PISA 2022 results are released in five volumes:

- **Volume I: The State of Learning and Equity in Education** (OECD, 2023[2]) presents two of the main education outcomes: performance and equity. The volume examines countries' and economies' performance in mathematics, reading and science and how performance has changed over time. In addition, equity in education is analysed from the perspectives of inclusion and fairness, focusing on students' gender, socio-economic status and immigrant background.
- **Volume II: Learning During – and From – Disruption** (OECD, 2023[3]) examines various student-, school-, and system-level characteristics, and analyses how these are related to student outcomes, such as performance, equity and student well-being. The volume also presents data on how learning was organised when schools were closed because of COVID-19. These results can assist countries in building resilience in their education systems, schools and students so they are all better able to withstand disruptions in teaching and learning.
- **Volume III: Creative Minds, Creative Schools** (OECD, 2024[4]) is on creative thinking. This volume examines students' capacity to generate original and diverse ideas in the 66 countries and economies that participated in the innovative domain assessment for the PISA 2022 cycle. It explores how student performance and attitudes associated with creative thinking vary across and within countries, and with different student- and school-level characteristics. The volume also offers an insight into students' participation in creative activities, how opportunities to engage in creative thinking vary across schools and socio-demographic factors, and how these are associated with different student outcomes.
- **Volume IV: How Financially Literate Are Students?** (OECD, 2024[5])is on financial literacy. This volume examines 15-year-old students' understanding about money matters in the 23 countries and economies that participated in this optional assessment. The volume explores how the financial literacy of 15-year-old students is associated with their competencies in other subjects and how it varies across socio-demographic factors. It also offers an overview of students' experiences with money, of their financial behavior and attitudes, and of exposure to financial literacy in school.
- **Volume V: Learning Strategies and Attitudes for Life** on students' readiness for lifelong learning. This volume presents key aspects of students' preparedness to continue learning throughout their lives. These include students' attitudes towards mathematics, their social and emotional skills, and their aspirations for future education and a career.

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1 What does PISA 2022 tell us about lifelong learning?

This chapter describes the relevance of lifelong learning in the context of the challenges that today's 15-year-olds will face in a highly uncertain future. It identifies a set of skills and attitudes that are key for sustained lifelong learning and maps them to the PISA 2022 data. It sets out the analytical framework of the report and describes the dimensions that are explored in the various chapters that follow.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

With profound environmental, social and economic changes sweeping through our societies, education, too, is changing. Not only must education prepare us for the future, it must prepare us to navigate a highly uncertain one.

Nothing makes this clearer than the near-boundless quantity of information technology has made available to us. The counterpart to this information revolution, however, is building the skills to manage it. Education curricula has been addressing this challenge and there is a plethora of formal and informal learning opportunities designed to close skills gaps and help people keep up with technological evolution.

The COVID-19 pandemic was a further catalyst for abrupt changes in schooling. Education systems around the world did their best to maintain continuity with rapid solutions but these were often based on pre-existing education knowledge and experience. The significant learning gaps that are being revealed from this period will impact how we rethink teaching and learning.

Data from the Programme for International Student Assessment (PISA) in 2022 show that education systems that were the most resilient during this disruption share common features (OECD, 2023[1]). Among these is student confidence about autonomous learning. But, only a handful of resilient systems had students who confidently undertook their own learning. COVID-19 showed us that education systems need to better prepare students to learn on their own. The challenge now is to determine how much education is equipping students with the skills to not only cope with major disruptions but, most importantly, become autonomous learners.

Climate change and artificial intelligence are pushing us even further to rethink education as not just *what* but *how* we learn. Education's job now is to cultivate students' motivation and disposition to learn independently, and the self-regulatory skills to do so well. Students should be able to effectively manage and navigate learning environments; set clear goals, strategies and actions; and assess their own progress and motivations.

Education that is adaptable aligns with the learning objectives of the United Nations' Sustainable Development Goals (SDG) (UNESCO, 2017[2]). Central to these is the ability to learn autonomously outside traditional settings. This includes:

- employing abstract metacognitive strategies in how we learn,
- being proactive and decisive,
- identifying reliable sources of information,
- making informed decisions, and
- continuously updating one's skills independently.

Schools can teach students learning strategies early on. This lays the foundation for the confident and autonomous lifelong learning needed to keep pace with changes yet to be known.

The relevance of PISA data to lifelong learning

Developing resilience to uncertainties the future holds demands a new attitude about learning: that it is something we continue to do long after our traditional school years. Lifelong learning is not only essential for each person's personal and professional development, it helps us adjust to the shifting environmental, social and economic landscape.

Lifelong learning is a dynamic, multifaceted and continuous process whereby a person acquires skills and knowledge throughout their life (UNESCO, 2021[3]; OECD, 2021[4]). It cannot be confined to a single, specific phase of life or context and extends beyond traditional educational stages, ranging from formal settings such as schools and apprenticeship programmes to informal and non-formal learning settings (OECD, 2019[5]; UNESCO, 2006[6]). As a key element of the United Nations' Sustainable Development Goal 4, lifelong learning is essential to ensure good, inclusive and equitable education for all (United Nations, 2023[7]). Yet, important challenges remain. Data from the

Survey of Adult Skills, a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC) has found that about 60% of adults did not participate in adult learning in the 12 months prior to the survey. And, about half of those aged 25 to 65 across the OECD declared no interest in or availability to participate in learning activities available to them through their work (OECD, 2021[4]; OECD, 2019[8]).

Data from the European Union (EU) Adult Education Survey in 2022 are consistent with these findings. Slightly less than half of 25-64 year-olds have participated in formal or non-formal education and training in a given year (46%), on average across the OECD and accession counties participating in the survey. Of those who have not participated, more than two-thirds report that they do not need further education and training (OECD, 2024[9]).

What does PISA data tell us about lifelong learning? PISA cannot directly measure which approaches to learning individuals adopt after the age of 15 but it provides insights into students' *readiness* to adopt key learning strategies central to self-directed learning. It also measures learners' motivation to take control of one's "self-monitoring" and "self-management" processes to achieve specific learning outcomes (Garrison, 1997[10]). For example, PISA asks students whether they ask questions when they do not understand what is being taught, whether they make connections between what they are learning and what they have learned in the past, or how often they encounter cognitive activation practices in mathematics class (see Table V.1.2). Taking control of one's own learning is a key strategy in formal schooling.

The relevance of these factors has been pointed out by analyses with data from PIAAC. Evidence from this programme suggests that adults that reported a stronger drive to learn are more likely to engage in learning activities throughout adulthood (OECD, 2021[4]). What is most relevant for this report is that such analyses suggest that the desire to learn, master difficult subjects and seek additional information when needed develops gradually. They are attitudes towards lifelong learning that typically begin to form early in school.

Assuming agency in one's education is important for lifelong learning because individuals must be willing and able to pursue learning throughout their lives. Lifelong learning requires a fundamental change in mindset – from passively receiving knowledge to actively participating in one's own learning process (Candy, 1991[11]). Self-directed learning strategies, skills and competencies are the cornerstones of such a mindset (Zimmerman, 2001[12]; Dignath, Buettner and Langfeldt, 2008[13]; van Hout-Wolters, Simons and Volet, 2000[14]) and will likely guide students' learning throughout their lives.

To analyse the readiness of 15-year-olds to adopt key learning strategies for lifelong learning, it is essential to narrow down and conceptualise what make these strategies effective. The concept of "sustainable learning in education" is particularly useful as it encompasses strategies and skills that enable learners to upgrade their knowledge, inquire, and cope with circumstances that require continuous learning and relearning (Ben-Eliyahu, 2021[15]; Hays and Reinders, 2020[16]). By focusing on this concept, we can identify and analyse the strategies that empower students to continue learning effectively throughout their lives.

Strategies for sustained lifelong learning

PISA plays a central role in understanding the effectiveness of learning strategies around the world. Such effectiveness can be determined by different criteria. In this report, we have chosen to approach this from the perspective of "sustainable learning in education" (Ben-Eliyahu, 2021[15]; Forbes et al., 2023[17]). It identifies four key components of effective learning strategies for sustained learning: reinforcing learning and relearning; independent and collaborative learning; active learning; and transferability.

Table V.1.1 provides detailed descriptions of these components and how these can be approached in PISA.

Table V.1.1. Matching sustainable learning to PISA

Component	Definition	In PISA
Renewing and relearning	This concept encapsulates the dynamic process of continually updating and refreshing knowledge to maintain relevance and effectiveness in a rapidly changing world. Self-monitoring and understanding learning gaps are relevant components. Feedback from others, such as teachers, supervisors or peers, also plays a vital role, offering external evaluations that guide learners in updating their skills to meet evolving needs.	Specific classroom behaviours such as checking for mistakes and actively asking questions are examples of this approach to learning. Other critical thinking aspects like considering different perspectives before making a decision can also be considered. Such behaviours not only facilitate the correction and consolidation of students' understanding, but promote a flexible learning paradigm that can easily adapt to new information and challenges. These actions are essential for maintaining the accuracy and depth of learning.
Independent and collaborative learning	This involves mastering the ability to acquire knowledge autonomously and through interaction with others. Both are important in cultivating a sustainable learning environment that effectively balances individual learning autonomy with the benefits of collective intelligence and social support, making the learning experience both dynamic and inclusive. Independent or autonomous learning involves identifying learning needs and finding relevant sources, facilitated, for example, by online platforms. Collaborative learning, on the other hand, involves group efforts where responsibilities are shared, such as studying with classmates or working on team projects to achieve collective goals.	Social and emotional skills such as curiosity, persistence, emotional control, stress resistance, and co-operation are crucial for both independent and collaborative learning. Curiosity promotes self-directed learning while persistence helps learners to overcome challenges. Emotional control and stress resistance help manage frustration and maintain focus during individual and group tasks. Collaboration promotes effective teamwork by sharing tasks and integrating different skills. In addition, certain components of digital literacy are also critical for today's independent learners. In particular, the ability to assess the reliability of sources and information autonomously.
Active learning	This emphasises the need for learners to be actively and consciously involved in their educational process. This involves learners actively seeking information and continuously evaluating their progress through "feedback loops" (Ben-Eliyahu, 2021[16]). Learners use these insights to adjust their learning strategies and prepare for future challenges, incorporating "feedforward" mechanisms that focus on applying past learning to upcoming tasks (Ben-Eliyahu, 2021[16]). This forward-looking approach supports sustainable learning by preparing students to adapt to changing conditions and to proactively manage their future educational needs.	PISA identifies and underscores the importance of active learning strategies that involve students' proactive and deliberate engagement in their educational processes. These include behaviours such as participating in group discussions, integrating new material with previously acquired knowledge, and listening attentively to teachers. These practices not only enhance immediate understanding, but equip students for future learning opportunities by promoting a "feedforward" loop in which past learning is applied to new situations.
Transferability	As might be expected, this refers to the ability to apply learned skills, processes or strategies in different contexts or domains beyond those in which they were originally acquired. This is crucial for learners to navigate through different life stages and different educational or work environments. This versatility, which is fundamental to lifelong learning, enables learners to adapt their skills to different tasks and environments.	Several learning strategies can be said to be transferable but, here, we focus on the process that engages students in higher-order thinking tasks that require them to apply knowledge in new contexts, thereby strengthening their understanding and adaptability. Cognitive activation practices and teacher-prompted problem-solving tasks are interesting proxies for such transferability in education. Cognitive activation engages students deeply in learning through challenging tasks, encouraging active engagement rather than passive consumption of information. This approach enhances comprehension and retention and enables the transfer of strategies across contexts. Likewise, teacher-prompted problem-solving tasks encourage flexible thinking and the development of diverse problem-solving techniques applicable to different scenarios.

Source: Based on (Ben-Eliyahu, 2021[15]) and PISA 2022 student questionnaires.

The components described here are interrelated and should not be viewed as separate or isolated characteristics. Each one illustrates a key characteristic of strategies for sustained lifelong learning. Certain components overlap, facilitating, for instance, both knowledge renewal and relearning, and collaborative learning efforts. And, while one of the four components is transferability, all strategies should, in principle, be transferable. The overlap between these components reflects the complex and interrelated nature of how and why learning strategies are implemented.

In the PISA assessment, students reported on their learning behaviours and strategies as well as those their teachers use or encourage them to use. By examining these behaviours and strategies within the framework of the four learning components, this report assesses how effectively education systems are equipping students for sustained lifelong learning.

Mapping sustainable learning strategies to PISA data

Schooling is crucial for equipping students with learning strategies. It extends beyond the development of individual skills to structured learning environments in which teacher input and peer interaction shape students' acquisition and refinement of these strategies (OECD, 2023[1]). This report's analysis of 15-year-olds' learning strategies is based on the assumption that long-term exposure to schooling has profoundly shaped such strategies (OECD, 2010[18]).

This report focuses on learning strategies and dispositions measured in PISA. The components presented in Table V.1.1 were used to guide which learning strategies and student dispositions the report should focus on. These are listed in two of the following tables in this chapter.

Table V.1.2 presents learning strategies that students have taken the initiative to use themselves and those that their teachers have taught and encouraged them to use[1]. For the most part, these strategies encompass cognitive and metacognitive processes, and self-regulated learning techniques. Research shows that students proactively select and structure them to improve their educational outcomes, making these strategies important components of effective independent learning (Zimmerman, 2001[12]). For example, asking questions in class when students do not understand what is being taught is a key component of monitoring and understanding learning gaps. It is an active and conscious learning act that supports individual and group learning, and can be applied to most interactive learning situations and contexts.

Table V.1.2. Learning strategies

Domain	Concept	Concepts covered by PISA 2022 student questionnaire: Learner	Concepts covered by PISA 2022 student questionnaire: Teacher
Learning strategies	**Cognitive activation**		The teacher asked us to think about how new and old mathematics topics were related. The teacher asked us to explain our reasoning when solving a mathematics problem. The teacher encouraged us to think about how to solve mathematics problems in different ways than demonstrated in class.
	Controlling one's own learning	I like to make sure there are no mistakes. I carefully check homework before turning it in. I asked questions when I did not understand the mathematics material that was being taught.	
	Critical thinking	I try to consider everybody's perspective before I take a position. I can view almost all things from different angles. I think there is only one correct position in a disagreement.	
	Proactive towards learning	Connect new materials / information to prior learning: I tried to connect new material to what I have learned in previous mathematics lessons. I made time to learn the material for mathematics class. I actively participated in group discussions during mathematics class I started my work on mathematics assignments right away.	
	Problem-solving		The activities we do in my classes help me think about new ways to solve problems. My mathematics assignments require me to come up with different solutions for a problem. Interpreting mathematical solutions in the context of a real-life challenge. Identifying mathematical aspects of a real-world problem.

Note: The concepts listed here are intended to serve as examples of the strategies, attitudes and tasks that are analysed in this report. It is not an exhaustive list.
Source: Student questionnaire for PISA 2022 and based on (Artelt et al., 2003[19])

Certain learning strategies are used more than others and this is often related to how effective they are in helping students achieve academic goals, especially when it comes to school-based goals. This correlation has been extensively explored in the academic literature (Soderstrom and Bjork, 2015[20]).

The motivation to learn

While sustainable learning strategies are often the end-product of schooling, that is not where the story ends: they can spur individuals to continually renew their skills and knowledge long after they have left formal schooling. And, while it is important to assess the relationship between these strategies and students' academic performance, strong PISA performance alone does not define an effective lifelong learner. Neither does mere knowledge of learning strategies: students might know what the best learning strategies are but still not necessarily use them. The literature on self-regulated learning suggests that motivational processes bear closer attention in robust information-processing (Dignath, Buettner and Langfeldt, 2008[13]).

This is why this report looks further than the relationship between learning strategies and academic achievement to analyse students' motivations and readiness to learn. These analyses illustrate the significant link between motivation and learning outcomes. By examining the triangular relationship between learning strategies, motivation and self-belief, that is, the confidence learners have in themselves, the report provides insights into how to cultivate effective learning strategies, boost motivation and strengthen self-belief. It is important to recognise that these findings do not imply causality – for example, that increased motivation leads individuals to use effective learning strategies and improves performance. But, they do point to the interconnected and triangular nature of the relationship between motivation and the use of learning strategies, and a nuanced perspective on how motivation enhances sustained learning and, consequently, educational outcomes (Artelt et al., 2003[19]).

Table V.1.3 presents different approaches to learner motivation and self-perceptions of competence. Motivation is the main catalyst for learning efforts but self-belief is crucial too. In this report, self-belief encompasses three concepts: self-efficacy, self-concept and growth mindset. Self-efficacy refers to students' confidence in their ability to perform well even in difficult tasks while self-concept has to do with how capable they believe they are at learning new things. Lastly, growth mindset is the belief that intelligence and skills can be developed through work and effort rather than being fixed traits.

Table V.1.3. Motivation and self-beliefs

Domain	Concept	Concepts covered by PISA 2022 student questionnaire Learner
Motivation	**Intrinsic motivation (interest in learning)**	I like to ask questions. I love learning new things in school. I like to develop hypotheses and check them based on what I observe. I enjoy thinking about new ways to solve problems. I like schoolwork that is challenging.
	Instrumental (extrinsic) motivation	I want to do well in my mathematics class. School has taught me things which could be useful in a job.
Self-beliefs	**Growth mindset**	Your intelligence is something about you that you cannot change very much. Some people are just not good at mathematics, no matter how hard they study.
	Mathematical self-concept and anxiety	Mathematics is easy for me. I feel anxious about failing in mathematics.
	Mathematics self-efficacy	I feel confident about extracting mathematical information from diagrams, graphs, or simulations. I feel confident about understanding scientific tables presented in an article.

Note: The concepts listed here are intended to serve as examples of the strategies, attitudes and tasks that are analysed in this report. It is not an exhaustive list.
Source: Student questionnaire for PISA 2022 and based on (Artelt et al., 2003[19]).

The motivation and self-belief that are so crucial to sustained learning are, themselves, related to social and emotional skills such as curiosity and persistence. Intellectual curiosity and persistence indicate a learner's willingness to invest significant time and effort into understanding something (OECD, 2023[1]). Similarly, how co-operative a person is will influence what kind of learning strategies work best for them: collaborative or individual learning. Effective learners can learn both independently and in a group, and this is important in lifelong learning. Therefore, social and emotional skills including co-operation and emotional control or stress resistance, are highly relevant to students' autonomous learning and confidence in learning. Understanding the nuanced relationship between these skills and students' approaches to learning provides valuable insights into how these skills can be nurtured to support all students to reach their full potential for learning throughout their lives.

Table V.1.4 catalogues the social and emotional skills considered in these analyses and highlights how learners use them to regulate or enhance their learning (OECD, 2021[21]). [2]

Table V.1.4. Social and emotional skills

Domain	Concept	Concepts covered by PISA 2022 student questionnaire Learner
Social and emotional skills	Open-mindedness	Index of Curiosity
	Task performance	Index of Persistence
	Emotional regulation	Index of Emotional control Index of Stress resistance
	Collaboration	Index of Co-operation

Note: For further information on the construct of indices, consult the PISA 2022 Technical Report (OECD, 2024[22]).
Source: OECD, PISA 2022 database and based on (OECD, 2021[21]).

In summary, this report draws on PISA 2022 data to examine the triangular relationship between learning strategies, motivation and self-belief. These are the essential characteristics of sustained lifelong learning.

Notes

[1] The PISA 2022 student questionnaire explores these dimensions through various items. Some items are designed to elicit opinions (e.g. "Some people are just not good at mathematics, no matter how hard they study"). These items usually provide a four-point scale for response, from "strongly agree" to "strongly disagree", or another similar scale, such as level of confidence. Other items are phrased in terms of frequency (e.g. "I asked questions when I did not understand the mathematics material being taught"). Responses to these items generally provide a five-point scale ranging from "never or almost never" to "all or almost all of the time". Many of the questionnaire items are combined into a series of derived or index variables that represent broader underlying constructs. For example, the index of proactive mathematics study behaviour is derived from students' responses to eight items on the student questionnaire about the extent to which students engage in specific proactive behaviours in mathematics class or with mathematics class materials and tasks. In this report, indices and individual items will be considered, as shown in Tables V.1.2, V.1.3 and V.1.4.

[2] Indices representing teaching and learning strategies are of considerable interest here as well because they are more efficient for modelling. Although they are more abstract than observed variables, they encapsulate a greater amount of information on a single scale and are more consistent with model assumptions. However, analyses with individual items are also reported as they often provide clear and more direct descriptions of student behaviour.

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2 Learning strategies: Student approaches to learning

This chapter examines students' reports of three types of learning strategies: students' control or self-monitoring of their own work, their use of critical thinking (perspective-taking) skills, and their proactive learning behaviours. It outlines the importance of fostering these strategies and behaviours in all students in order to prepare them to take control of their own learning and to improve their learning outcomes, including readiness for lifelong learning. The chapter also analyses socio-economic inequalities in students' learning strategies and builds on the importance of improving access to resources, supporting disadvantaged students and fostering inclusive learning environments that promote lifelong learning for all students.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

This chapter explores how students use learning strategies for sustained learning. Special attention will be given to two types of students: those who did not attain baseline Level 2 in mathematics[1], referred to as "low performers", and students scoring at Level 3 and above, referred to here as "skilled performers". Starting at Level 3, students demonstrate computational, spatial, and interpretational abilities that are essential for lifelong learning (see Box V.2.1 for further details).

This chapter focuses on three learning strategies. They are strategies that encompass cognitive dimensions essential for processing and encoding information and metacognitive dimensions that demand self-awareness and active participation in one's own learning process (Schraw, Crippen and Hartley, 2006[1]). These three strategies are: (1) students' control over or self-monitoring of their own work and learning processes; (2) the application of critical-thinking (perspective-taking) skills in analysing problems from various perspectives and considering diverse opinions; and (3) proactive learning behaviours, such as connecting new information with previously acquired knowledge, diligently engaging in tasks, and efficiently managing workload (c.f. Table V.1.2 in Chapter 1).

Key findings

About two out of three students agreed that they are meticulous about their schoolwork, on average across OECD countries. Low performers are often less meticulous with their schoolwork compared to skilled performers. While about 54% of low performers agreed that they are meticulous about their schoolwork, 71% of skilled performers did.

Many students would benefit from learning environments where they feel confident enough to ask questions when they do not understand the material. Inquisitive classroom atmospheres foster better learning outcomes. And, enhancing students' ability to proactively build on prior knowledge is crucial as most students in OECD countries do not frequently connect new material to mathematics knowledge they already have. Students who reported frequent proactive behaviours tend to outperform those who reported less frequent use. In Korea we find the biggest gap between students (101 score-point gap) while the gap is the smallest (15 score-point gap) in Costa Rica, but differences remain significant.

Being able to weigh different pieces of information is essential for making well-informed decisions in complex scenarios throughout life. Low performers, in particular, would benefit from improved critical thinking and perspective-taking as many struggle to recognise multiple valid viewpoints in a disagreement. Portugal stands out for its large share of students reporting that they consistently consider everyone's perspectives before taking a position (80%) among both low (72%) and skilled performers (85%). It is the country with the biggest share of students challenging the notion that there is only one correct position in a disagreement (65%). Portugal also showed the smallest discrepancy (29%) in students considering everyone's perspective while still believing there is only one correct position in a disagreement.

Finally, across most systems, socio-economically advantaged students consistently reported higher engagement in error-checking, homework review, question-asking, proactive study behaviours, and critical thinking than their socio-economically disadvantaged peers.

Control or self-monitoring strategies

Students who monitor their own learning set aside time and resources to process and understand information. They also regulate how and what they learn (Paris and Paris, 2001[2]). They make informed decisions about their learning processes by checking their understanding as they progress and evaluating how they do against set objectives.

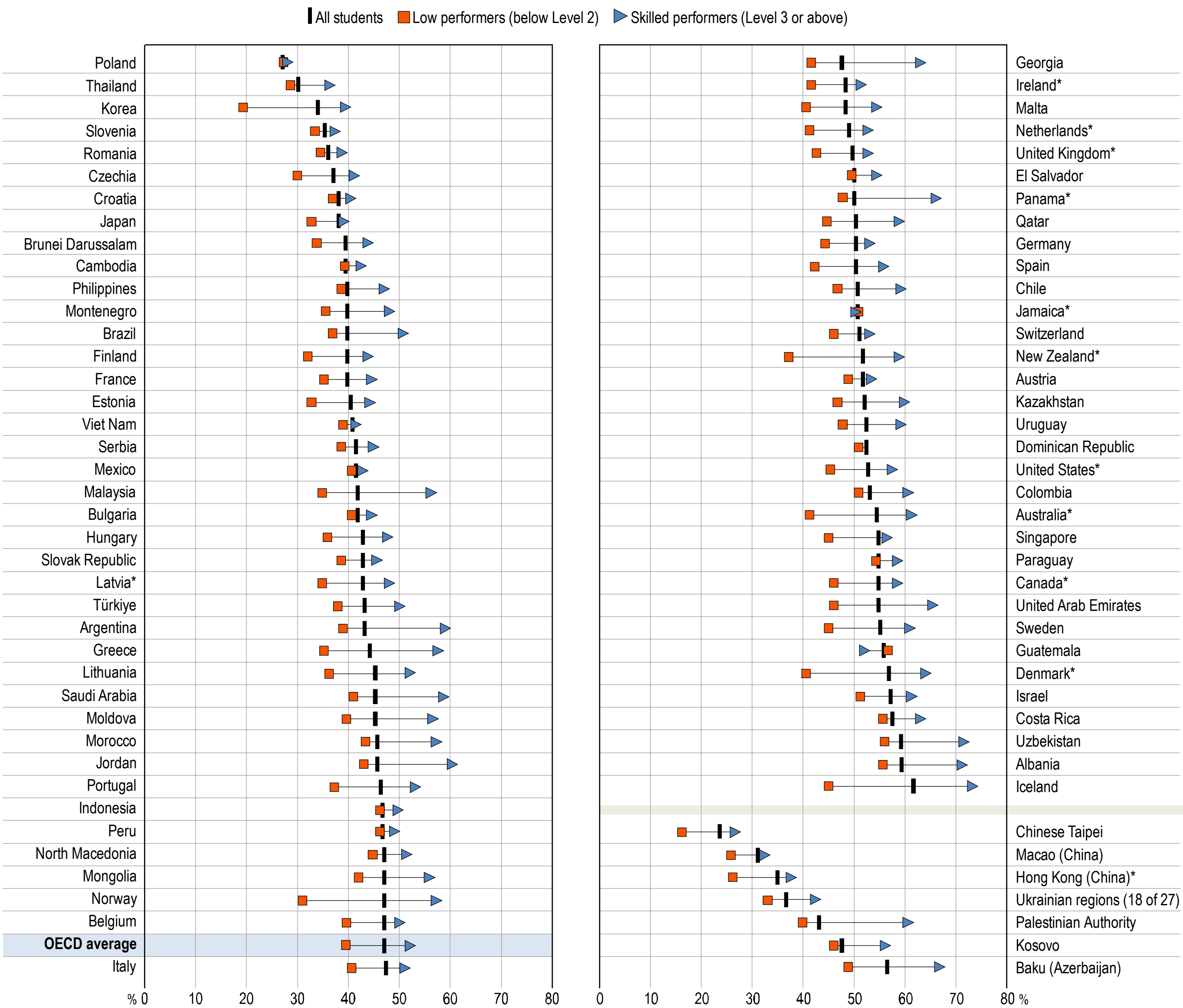
In what follows, two control or self-monitoring strategies will be analysed: actively asking questions in class when in doubt and being meticulous about not making mistakes[2].

Most students do not ask questions when they do not understand what is being taught

PISA data show that less than half of students frequently ask questions when they do not understand something being taught in mathematics (i.e. over half of the time they have doubts). On average, only 47% of students frequently seek clarification (Figure V.2.1). This is important as it reflects students' engagement in the learning process and their readjustment of learning when needed.

Figure V.2.1. Control one's own work and learning: I ask questions when I do not understand the mathematics material being taught, by students' level of performance in mathematics

Percentage of students responding that they ask questions when they do not understand the mathematics material being taught, at least more than half of the time



Countries and economies are ranked in ascending order of the percentage of all students.

Source: OECD, PISA 2022 Database, Table V.B1.2.7. See Table V.2.1 for StatLink at the end of this chapter.

Low performers tend not to ask questions frequently to clarify something being taught and only half of skilled performers will do so

Students who reported asking questions frequently outperform those who do not in almost all countries/economies, even after accounting for the socio-economic profile of students and schools. However, not all skilled performers (at Level 3 or above in mathematics) reported using this strategy. An average of 52% of skilled performers in OECD countries reported frequently asking questions (Table V.B1.2.8). However, in Macao (China), Poland and Chinese Taipei, 32% or less of skilled performers reported doing so frequently. In contrast, in Albania, Iceland and Uzbekistan over 70% of skilled performers ask questions (Figure V.2.1 and Table V.B1.2.7).

Among low performers (below Level 2 in mathematics), less than 40% reported frequently asking questions when they do not understand what is being taught, on average. This suggests that those who are likely to need more support are more reluctant to openly ask questions when they are unsure of something they are being taught. This is especially so in Czechia, Hong Kong (China)*, Korea, Macao (China), Poland, Chinese Taipei and Thailand, where less than 30% of low performers reported frequently asking questions. This is particularly important as these students are likely to face a double challenge: they lack essential mathematics skills and knowledge, and the key strategies needed for continuous learning and adaptation (see Box V.2.3). Only in Albania, Colombia, Costa Rica, the Dominican Republic, Guatemala, Israel, Jamaica*, Paraguay and Uzbekistan do at least half of low performers frequently ask questions when unsure of the material (Figure V.2.1 and Table V.B1.2.7).

Box V.2.1. Skilled performers

In analysing students' preparedness for lifelong learning, it is important to recognise that establishing a direct relationship between learning strategies and metrics like mathematics performance yields insights but should not be the sole focus. Rather, the aim is to identify learning strategies that can be universally applied to improve educational outcomes at different stages of their lives, regardless of their level of performance.

A more constructive approach is to identify ways in which learning strategies are used by students with different mathematics proficiency levels. This can help to design interventions tailored to students' needs. This chapter focuses on the following two groups of students:

- Low performers below proficiency Level 2 in mathematics: In today's rapidly changing world, a strong foundation in mathematics is essential. PISA proficiency Level 2 represents the essential baseline of mathematical competence. Students who do not attain baseline Level 2, or "low performers", are likely to struggle when faced with challenging future educational and career endeavours (OECD, 2023[3]). In the context of lifelong learning, students who do not develop appropriate learning strategies may be doubly burdened: they will have limited knowledge and skills in mathematics and lack effective learning strategies to cope with new challenges.
- Skilled students at or above proficiency Level 3 in mathematics: Level 3 encompasses skills that are essential for lifelong learning, including the use of computational thinking to develop strategies, the ability to solve problems involving different calculations that are not clearly defined, and the ability to interpret and use representations based on different sources of information and reason directly from them (OECD, 2023[3]). These students already possess a solid foundation and strong mathematical skills. The question now is how well they are prepared to navigate their own learning, what strategies they have mastered, and where they could benefit from further support.

This comprehensive group captures the nuances of performers from Level 3 to Level 6 and allows this report to examine strategies used by well-rounded students who are prepared for the challenges of the 21st century.

Inquisitive classroom environments can contribute to better learning attitudes

Asking questions when one does not understand the mathematical material being taught indicates that the student believes it is possible to improve one's understanding, knowledge and skills even if it is a struggle. Creating learning environments in which all students feel confident and supported in their efforts can significantly foster positive learning mindsets. Encouraging students to ask questions in class is a crucial part of this process. It helps them embrace challenges, seek help when needed, and view mistakes as opportunities for growth. Findings in Chapter 3 suggest that some education systems may be more attuned to develop such mindsets than others.

Developing such environments can empower students, giving them greater control over their learning and mindsets to meet future learning challenges. Moreover, attitudes towards learning can also be incorporated into curricula together with subject knowledge and skills to cultivate the use of learning strategies (see Box V.2.2).

Box V.2.2. Canada: The Council of Ministers of Education, Canada's (CMEC) pan-Canadian global competencies

Education goals can be designed in line with student profiles. These goals can include key attitudes, skills, competencies and knowledge that students are expected to have acquired upon completion of different education levels and are defined in curricula and subject-specific education goals. These skills include learning strategies such as critical thinking and problem-solving, and are commonly integrated into curricula.

In Canada, the Ministers of Education, through the Council of Ministers of Education, Canada (CMEC), articulated six broad global competencies in 2016. CMEC's global competencies are a set of attitudes, skills, knowledge and values that are interdependent, interdisciplinary and can be leveraged in a variety of situations both locally and globally. Building on strong foundations of literacy and numeracy, these competencies are: Critical Thinking and Problem-Solving; Innovation, Creativity, and Entrepreneurship; Learning to Learn/Self-Awareness and Self-Direction; Collaboration; Communication; and Global Citizenship and Sustainability. They provide learners with the abilities to meet the shifting and ongoing demands of life, work and learning; to be active and responsive in their communities; to understand diverse perspectives; and to act on issues of global significance.

This framework is closely aligned with the competencies that provinces and territories have prioritised in new curricula, programmes, and initiatives. It is anticipated that the CMEC global competencies will evolve based on provincial and territorial engagement with these competencies.

Source: (OECD, 2020[4]; Council of Ministers of Education, Canada, 2018[5]; Council of Ministers of Education, Canada, 2020[6])

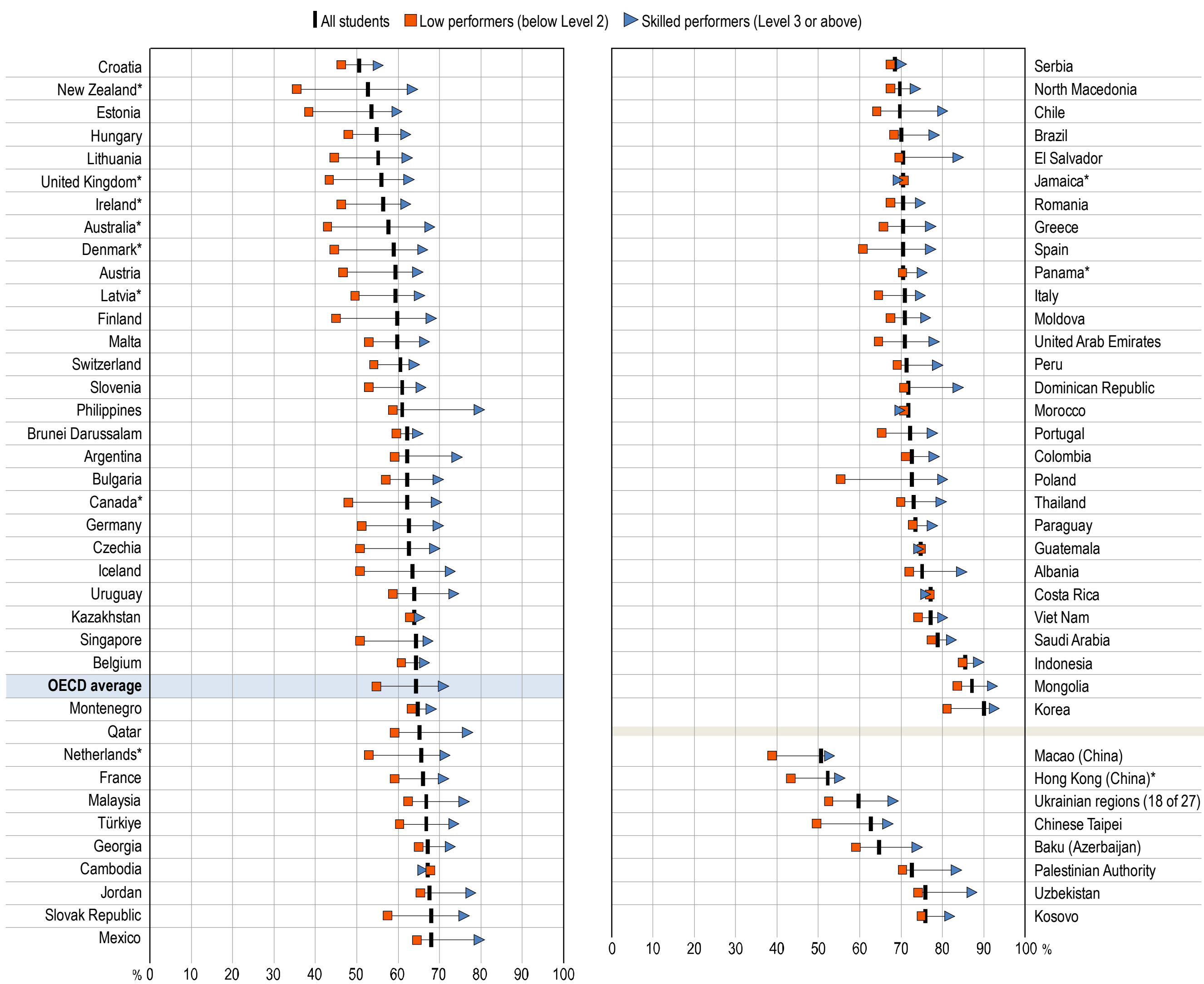
About two-thirds of students reported being meticulous and checking for mistakes

Data from PISA 2022 show that 64% of students, on average, agreed or strongly agreed with the statement "I like to make sure there are no mistakes"[3] (Table V.B1.2.1). Double-checking for mistakes is a typical control or self-monitoring strategy used to evaluate how one is doing compared to the learning objectives one has set for oneself.

Skilled performers have especially cultivated this habit of double-checking for errors as they more consistently agreed or strongly agreed that they do so (71% on average) in most surveyed countries and economies (Figure V.2.2 and Table V.B1.2.3). The share of PISA skilled performers who reported checking for errors is at least 60% in all countries and economies except for Croatia and top-performing[4] Estonia, Hong Kong (China)* and Macao (China). In contrast, about half of low performers reported double-checking for errors on average. Yet, there is wide variation across countries: slightly over one-third in Estonia and New Zealand* reported doing this compared to over 80% in Indonesia, Korea and Mongolia (Table V.B1.2.3).

Figure V.2.2. Control one's own work and learning: I like to make sure there are no mistakes, by students' level of performance in mathematics

Percentage of students agreeing or strongly agreeing they like to make sure there are no mistakes



Note: Only countries and economies with available data are shown.
Countries and economies are ranked in ascending order of the percentage of all students.
Source: OECD, PISA 2022 Database, Table V.B1.2.3. See Table V.2.1 for StatLink at the end of this chapter.

As with other learning strategies analysed in this volume, the interplay between double-checking for mistakes and learning outcomes likely depends on several student- and context- related aspects. Analyses of students' reports that they check for mistakes in their work and their mathematics performance show a positive relationship between the two in most countries and economies with varying positive performance gaps across different performance levels[5] (Table V.B1.2.8). This suggests that meticulous checking habits may be an effective aspect of students reaching their targeted learning objectives and an essential strategy in sustained lifelong learning.

The variability across countries/economies and among skilled and low performers invites further exploration into how targeted control strategies are used for learners' self-monitoring (see Box V.2.3).

Box V.2.3. Homework and being meticulous about schoolwork

Students employ various strategies to control and self-monitor their learning, especially by double-checking homework. Reports indicate significant variation across countries and economies in the habit of carefully checking homework before submission. On average, only 44% of students clearly reported doing so. In some countries like Cambodia, Indonesia, and Uzbekistan about three-quarters of students do this while in Finland, the Netherlands*, and Latvia*, the percentage drops below 30% (Table V.B1.2.5).

But who is more rigorous in homework-checking? Interestingly, 46% of skilled performers and 42% of low performers reported double-checking their homework, on average. However, in countries like Cambodia, Costa Rica, Guatemala, Indonesia, Uzbekistan and Viet Nam, over 75% of low performers are diligent in this practice. Only in Finland and the Netherlands* did about a quarter or less of students report homework-checking, irrespective of their level of performance (Table V.B1.2.5).

There are also interesting discrepancies between students who aim to generally make no mistakes and those who thoroughly check their homework. Notably, 44% of students who try not to make mistakes in general do not apply the same rigour to their homework. This discrepancy is as much as 64% in Finland and the Netherlands* (Figure V.2.3).

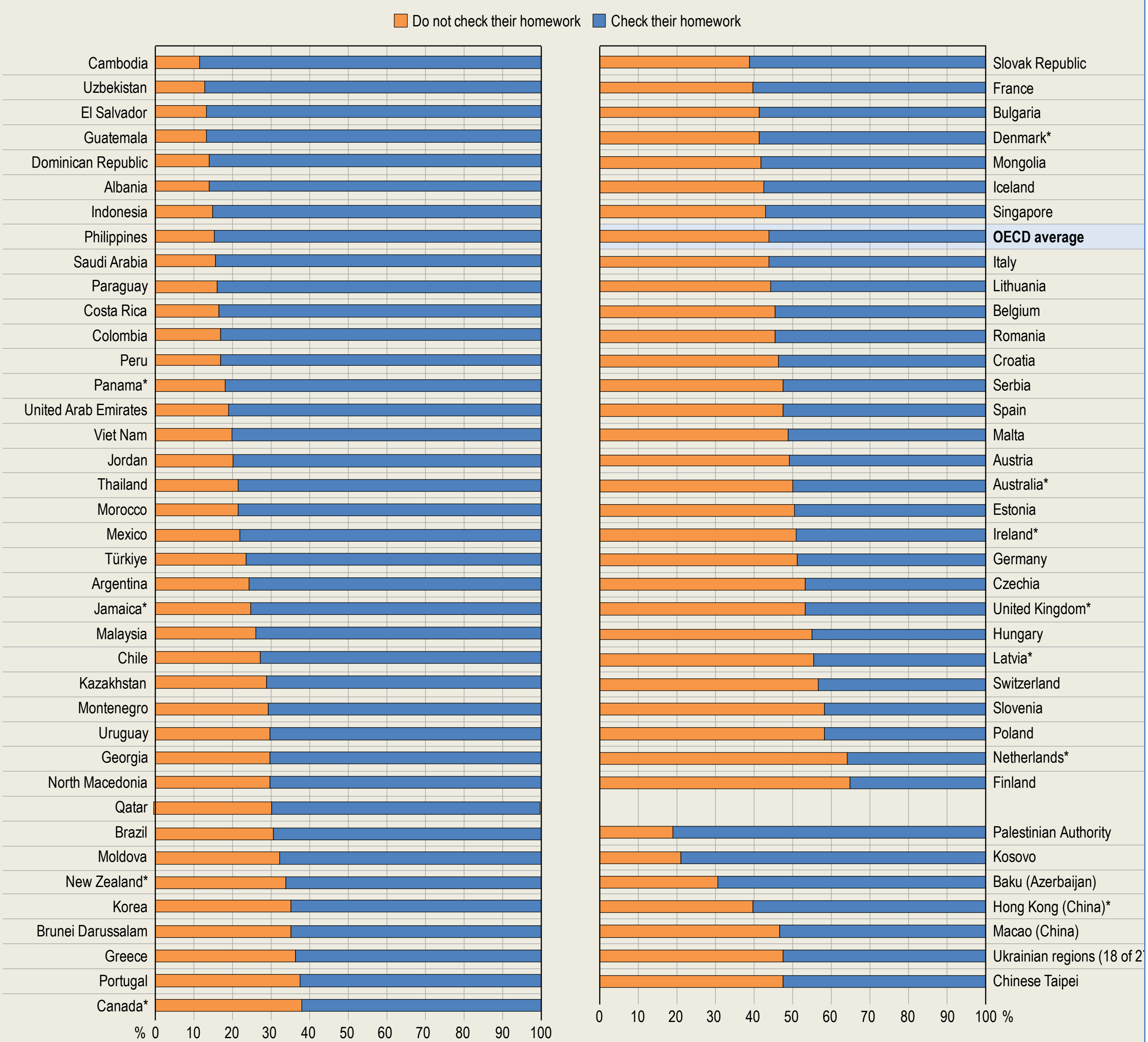
When analysing these results, it is important to consider that the emphasis on homework varies across education systems, likely influencing students' homework verification practices. In some systems, homework is a critical component of overall grading and learning. This could partly explain why checking homework before submission shows a stronger positive relationship with performance in some contexts, particularly for students who have more significant learning gaps. Conversely, in systems where homework is less critical, this meticulousness might not significantly impact academic performance.

On average, there is a moderate gap of four score points in mathematics between students who check their homework before turning it in and those who do not, after accounting for socio-economic factors. In many countries and economies, this association is not significant; however, when positive, the gap is typically significant for students on the lower end of the performance scale. While these analyses do not allow for establishing causality, they suggest that going carefully over homework is a way to reinforce learning for students who have the most difficulties learning in some countries/economies (Table V.B1.2.8).

To provide the greatest benefits, homework and the habit of double-checking homework should be tailored to students' actual needs rather than mechanically implemented without consideration of their effectiveness (Corno, 2000[7]; Hong, Milgram and Rowell, 2004[8]).

Figure V.2.3. Discrepancy: "I like to make sure there are no mistakes" over "I like to check my homework before turning it in"

Percentage of students responding whether they check (or not) their homework before submitting among those who agree/strongly agree they make sure there are no mistakes



Note: Only countries and economies with available data are shown.
Countries and economies are ranked in ascending order of the percentage of students not checking their homework.
Source: OECD, PISA 2022 Database, Table V.B1.2.27. See Table V.2.1 for StatLink at the end of this chapter.

Critical thinking

Critical thinking or perspective-taking is a pivotal skill for autonomous learning. It involves questioning initial beliefs, integrating new information, and justifying newly formed understandings. This is fundamental for developing and validating new ideas (Garrison, 1992[9]).

Lifelong learning in formal and informal settings relies on moving from an established knowledge base to a state of questioning. Critical thinking helps to identify new problems and knowledge needs, thereby enhancing the scope of learning and knowledge application (Southworth, 2022[10]). It is essential for renewing and relearning, and collaborative and active learning, making it a cardinal strategy for sustained lifelong learning.

Three aspects of students' ability to critically consider different viewpoints and perspectives are considered in the following analyses: students' agreement with the statements "I try to consider everybody's perspective before I take a position" and "I can view almost all things from different angles", and their disagreement with the statement "I think there is only one correct position in a disagreement".

Open-mindedness: A strong basis for lifelong learning

Students' reports in PISA reveal that slightly more than half of students are capable of perspective-taking, with 59% and 57% agreeing to the first two statements, on average, respectively. However, also slightly over half (54%) did not challenge the notion that there is only one correct position in a disagreement, highlighting open-mindedness and the recognition of multiple viewpoints as areas for education systems to focus on (Table V.B1.2.9).

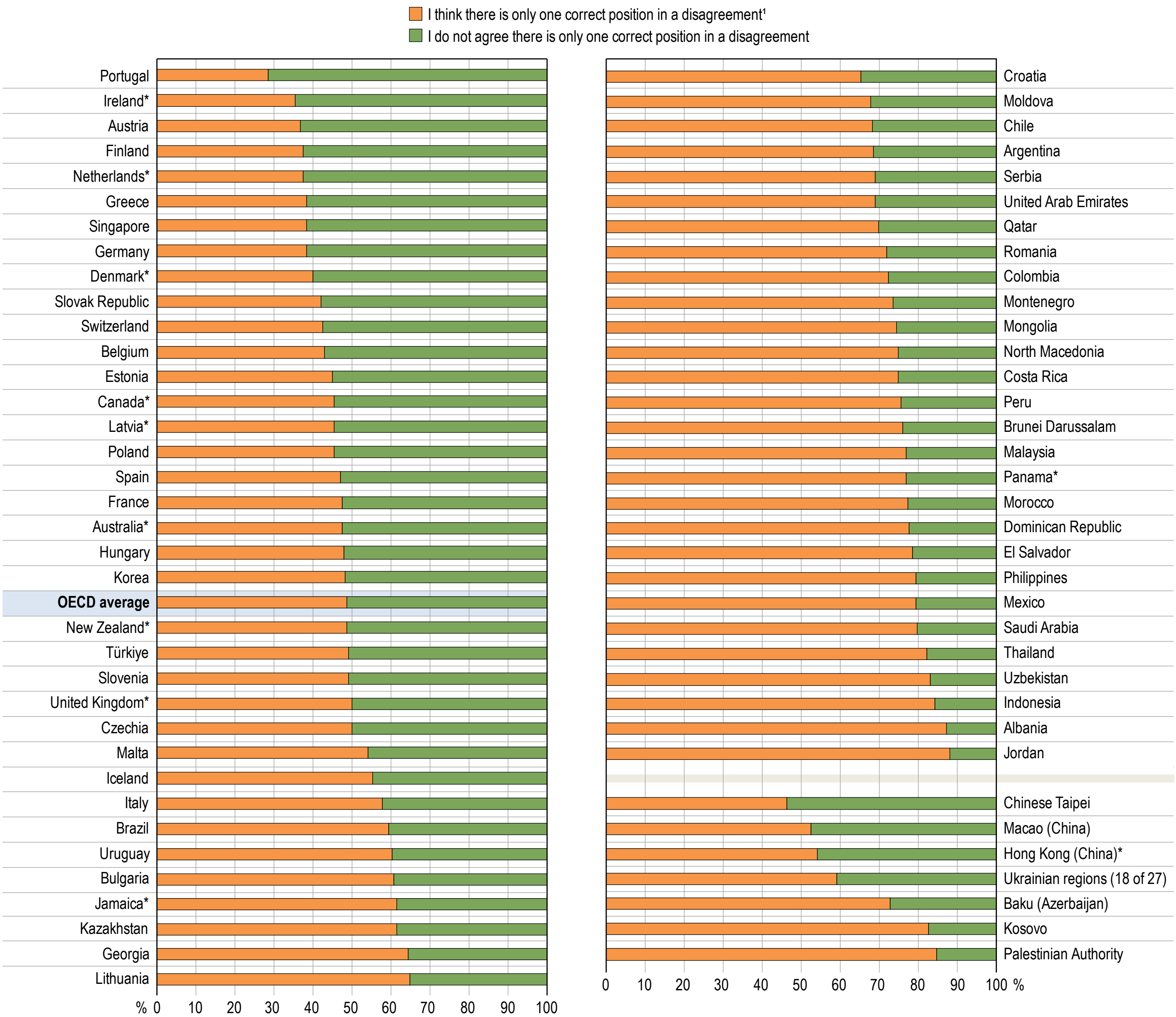
In the majority of countries and economies, both trying to consider everybody's perspective and viewing issues from different angles are clearly the two perspective-taking strategies that most students embrace, reported by over half of students. Only in Iceland, Jordan, Kosovo and the Palestinian Authority did less than half of students report both these strategies. However, the inverse is true of not agreeing that there is only one correct position in a disagreement: only in 12 countries did at least half of students challenge this notion (Table V.B1.2.9).

Skilled performers often consider multiple perspectives and view things from different angles (over 60% on average). While about half of low performers do the same, only 31% rejected the notion that there is only one correct position in a disagreement, on average. In stark contrast, about 57% of skilled performers rejected this notion (Tables V.B1.2.11, V.B1.2.13 and V.B1.2.15).

Interestingly, among students who try to consider everyone's perspective before taking a position, about half still believe there is only one correct position in a disagreement. As many as 67% of low performers show this contradiction but only 38% of skilled performers do, on average. When we zero in on top performers (students who attained proficiency Level 5 or Level 6 in mathematics) alone, only 27% consider everyone's perspective while still believing there is only one correct position in a disagreement. This suggests that it is top performers who explain the relatively small percentage of skilled performers who have these contradictory attitudes. Top performers demonstrate the flexible thinking and ability to integrate information from diverse sources that should be reinforced for all students (Figure V.2.4, Figures V.2.4b and V.2.4c (available online), and Table V.B1.2.28).

Figure V.2.4. Discrepancy: "I try to consider everybody's perspective before I take a position" over "I think there is only one correct position in a disagreement"

Percentage of skilled performing students reporting there is only one correct position in a disagreement among those who agree/strongly agree they try to consider everybody's perspective before taking a position



1. The label "I think there is only one correct position in a disagreement" includes students who agree or strongly agree with this statement as well as students who neither agree nor disagree.

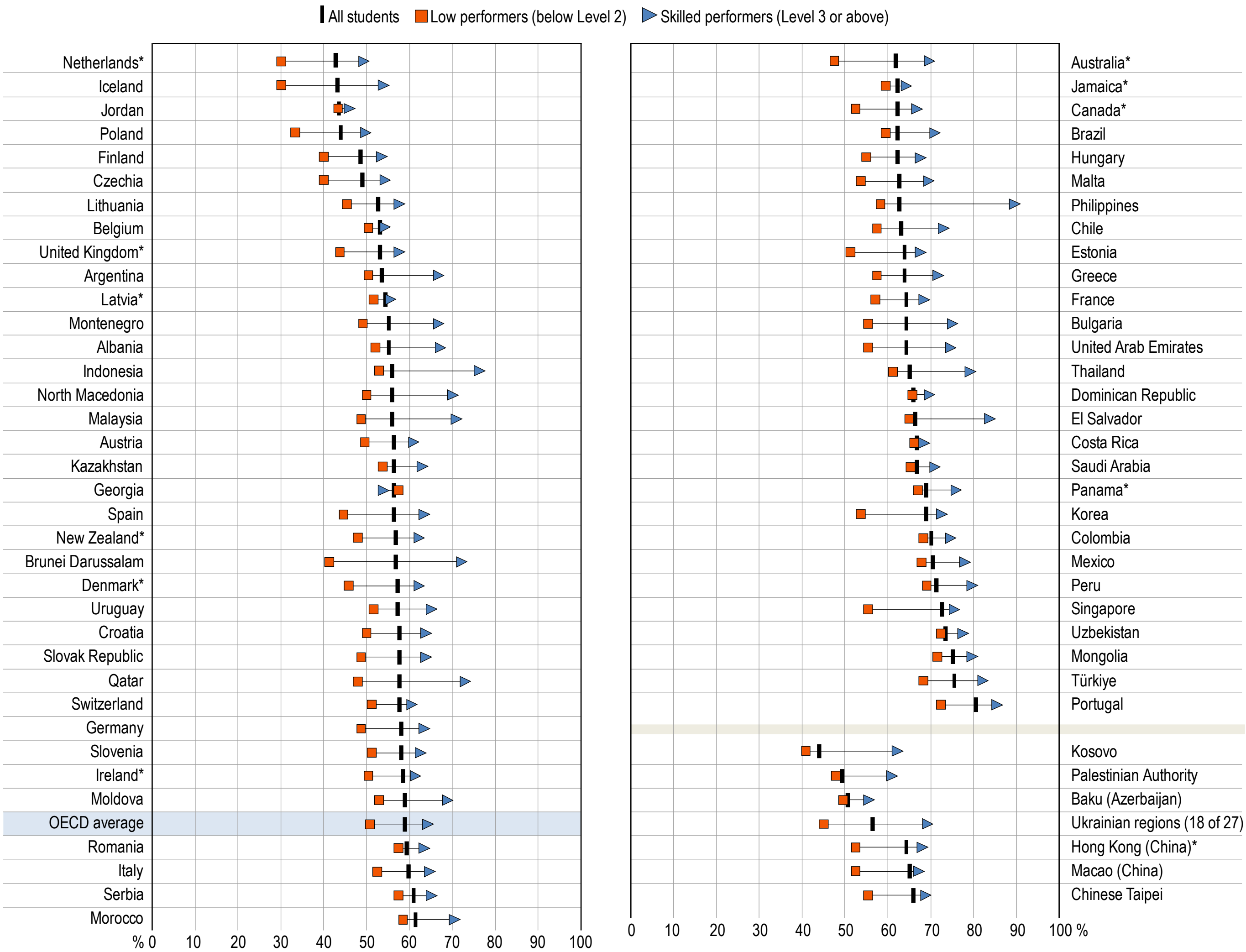
Note: Only countries and economies with available data are shown.

Countries and economies are ranked in ascending order of the percentage of students who think there is only one correct position in a disagreement.

Source: OECD, PISA 2022 Database, Table V.B1.2.28. See Table V.2.1 for StatLink at the end of this chapter.

Figure V.2.5. Critical thinking: I try to consider everybody's perspective before I take a position, by students' level of performance in mathematics

Percentage of students agreeing or strongly agreeing that they try to consider everybody's perspective before they take a position

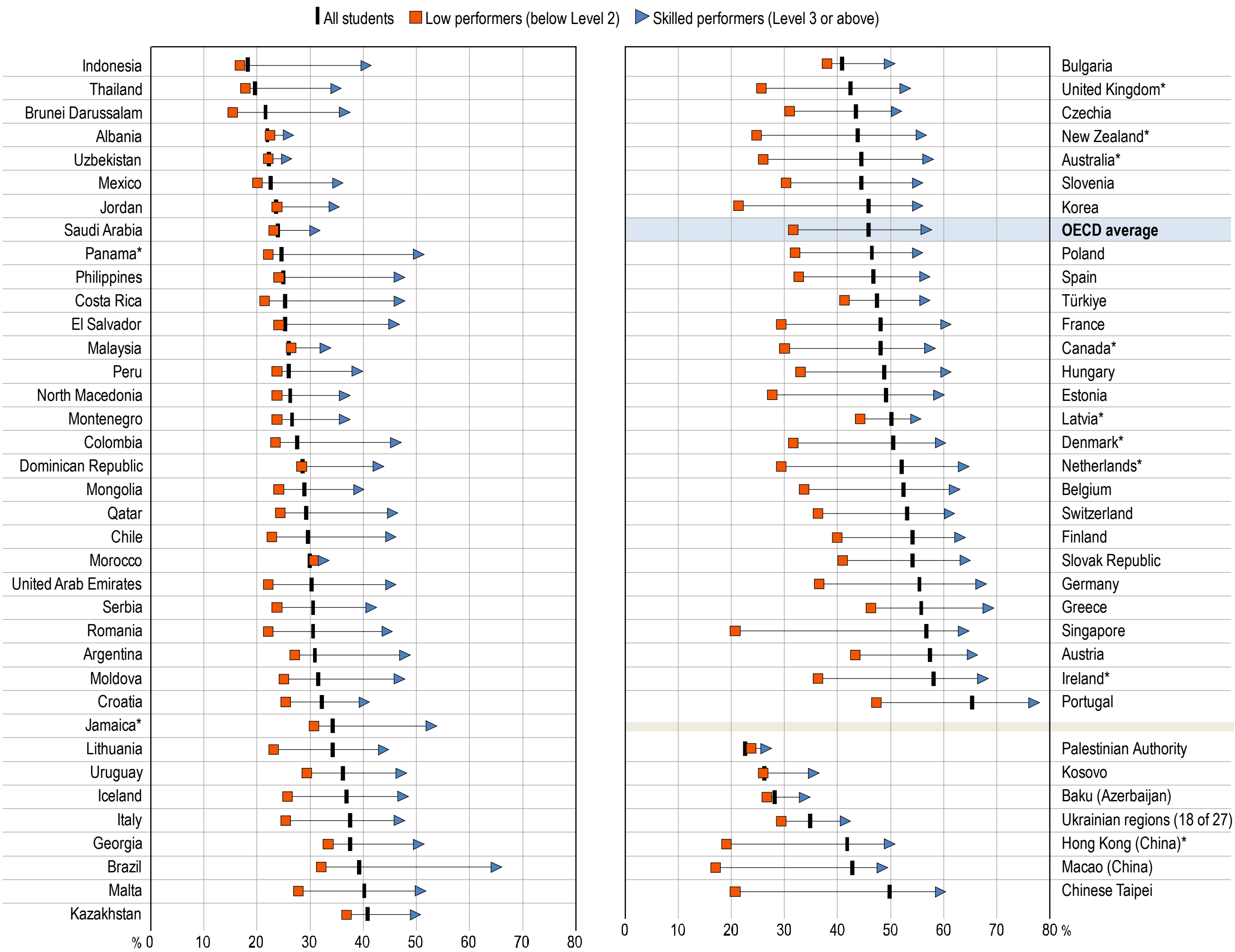


Note: Only countries and economies with available data are shown.
Countries and economies are ranked in ascending order of the percentage of all students.
Source: OECD, PISA 2022 Database, Table V.B1.2.11. See Table V.2.1 for StatLink at the end of this chapter.

If we look at countries and economies, Portugal stands out for its large share of students reporting that they consistently consider everyone's perspectives before taking a position (80%) among both low (72%) and skilled performers (85%). Portugal is the country with the biggest share of students challenging the notion that there is only one correct position in a disagreement (65%). Portugal also showed the smallest discrepancy (29%) in students considering everyone’s perspective while still believing there is only one correct position in a disagreement. At the opposite end of the spectrum, only in Czechia, Finland, Iceland, Jordan, Kosovo, the Netherlands*, the Palestinian Authority and Poland did less than 50% of all students report considering everybody’s perspective before taking a position. In Indonesia and Thailand, less than 20% of students disagreed with the idea that there is only one correct position in a disagreement (Figure V.2.56 and Tables V.B1.2.11, V.B1.2.15and V.B1.2.28).

Figure V.2.6. Critical thinking: I think there is only one correct position in a disagreement, by students' level of performance in mathematics

Percentage of students disagreeing or strongly disagreeing that there is only one correct position in a disagreement



Countries and economies are ranked in ascending order of the percentage of all students.
Source: OECD, PISA 2022 Database, Table V.B1.2.15. See Table V.2.1 for StatLink at the end of this chapter.

This discrepancy underscores a crucial aspect for lifelong learning. Maintaining a perspective on people's opinions and trying to see things from different angles reflects the capacity to analyse new information and alternative viewpoints. Yet, unlike binary reasoning, which views situations as either correct or incorrect, a person who thinks it is possible there can be more than one correct position in a disagreement is one who must constantly weigh different pieces of information in order to make nuanced, logically reasoned and well-informed decisions in complex scenarios. Finally, this kind of attitude requires us to question our own understanding and accept the possibility of being incorrect (Southworth, 2022[10]). It is this adaptability that will help us navigate a rapidly evolving global landscape and the lifelong learning it entails.

The implications for lifelong learning are important. Learning in general requires us to be able to take multiple perspectives into consideration. Measurable outcomes, like performance in mathematics, support this. All three critical perspective-taking strategies relate positively with academic performance even after accounting for students' and schools' socio-economic profile (15, 14 and 28 score-point gaps, on average), although relationships are not uniformly distributed across education systems (Table V.B1.2.16). Interestingly, the largest performance gaps are seen among students that challenge the notion that there can be only one correct position in a disagreement, especially in top-performing countries/economies Hong Kong (China)*, Korea, Singapore and Chinese Taipei (over 50-point score gap). Surprisingly, students who reported taking multiple perspectives into consideration often did not report being open to the possibility that there can be different valid positions in a disagreement. This can be problematic for decision-making in situations where there are many different (often unverifiable) opinions at play. Accepting that one can be wrong triggers learning and is a key area of interest for lifelong learning.

Critical thinking (perspective-taking) is the cornerstone of lifelong learning. As shown in previous PISA reports, this form of perspective-taking promotes both convergent and divergent thinking and open-mindedness. It brings out the benefits of diverse groups and heterogeneity of viewpoints in the development of new and original ideas (OECD, 2024[11]). Schools should hone these skills to equip students to navigate and contribute to an increasingly complex world. Activities in which students work on real-world problems or structured debates, which allow students to argue from different perspectives and develop a deeper understanding of complex issues, can encourage them to take multiple perspectives and think critically about the consequences of different solutions (Kokotsaki, Menzies and Wiggins, 2016[12]; Kennedy, 2007[13]). Similarly, schools can encourage group projects in which students work together. This fosters an environment in which they must understand and integrate different viewpoints to achieve common goals (Johnson and Johnson, 2009[14]). This last point is important, as Box V.3.4 in Chapter 3 shows: critical thinking is an area in which the socio-emotional skill of co-operativeness is crucial and co-operative students are the most likely to consider multiple perspectives before forming their own opinions, on average and across surveyed countries and economies. As learners move beyond formal education, the ability to apply critical thinking independently becomes essential for the validation of knowledge, both individually and collectively.

Proactive behaviour towards learning

The last aspect to consider is proactivity in learning, specifically in mathematics, as assessed by PISA 2022. Proactivity is understood not merely as an inherent trait but a set of deliberate behaviours and practices that students can develop and enhance over time (Crant, 2000[15]) (Seibert, Kraimer and Crant, 2001[16]).

Proactive behaviour is a strategy for sustained learning that can contribute to learning outcomes as it encourages students to approach learning tasks intentionally and at their own pace and manner.

There is room to improve in encouraging students to learn proactively

PISA measures students' proactive study behaviour by how frequently they engage in activities that demonstrate effort and persistence. This involves student reports on how often they do certain learning tasks that are key for lifelong learning. One essential proactive study task is to autonomously connect what is being learned to what one already knows. Less than half of students (46%) in OECD countries reported that they try to relate new material to what they have learned in previous mathematics lessons more than half of the time. The same share reported that they often start their work on mathematics assignments right away. In both cases, about half of skilled performers reported frequently connecting new and previous things learned, and starting mathematics assignments right away while less than 40% of low performers did (Tables V.B1.2.22 and V.B1.2.24).

Likewise, when looking at student reports on frequently engaging in group discussions during mathematics class when given the opportunity to do so, only about a third of students do so (33%). Skilled performers reported quite little participation in class group discussions on average (38%). In less than half of countries and economies with available data is the share above 50% and in no country do more than half of low performers engage frequently in this practice (26% on average) (Table V.B1.2.20). Group discussions in mathematics class embody proactive learning behaviour and promote other lifelong learning strategies like critical thinking.

Countries and economies that score the highest on the index of proactive mathematics study behaviour[6] are also those in which more students frequently participate in group discussions, start their assignments right away and, most importantly for lifelong learning, try to connect new material to what they had learned in previous mathematics lessons (Table V.B1.2.17).

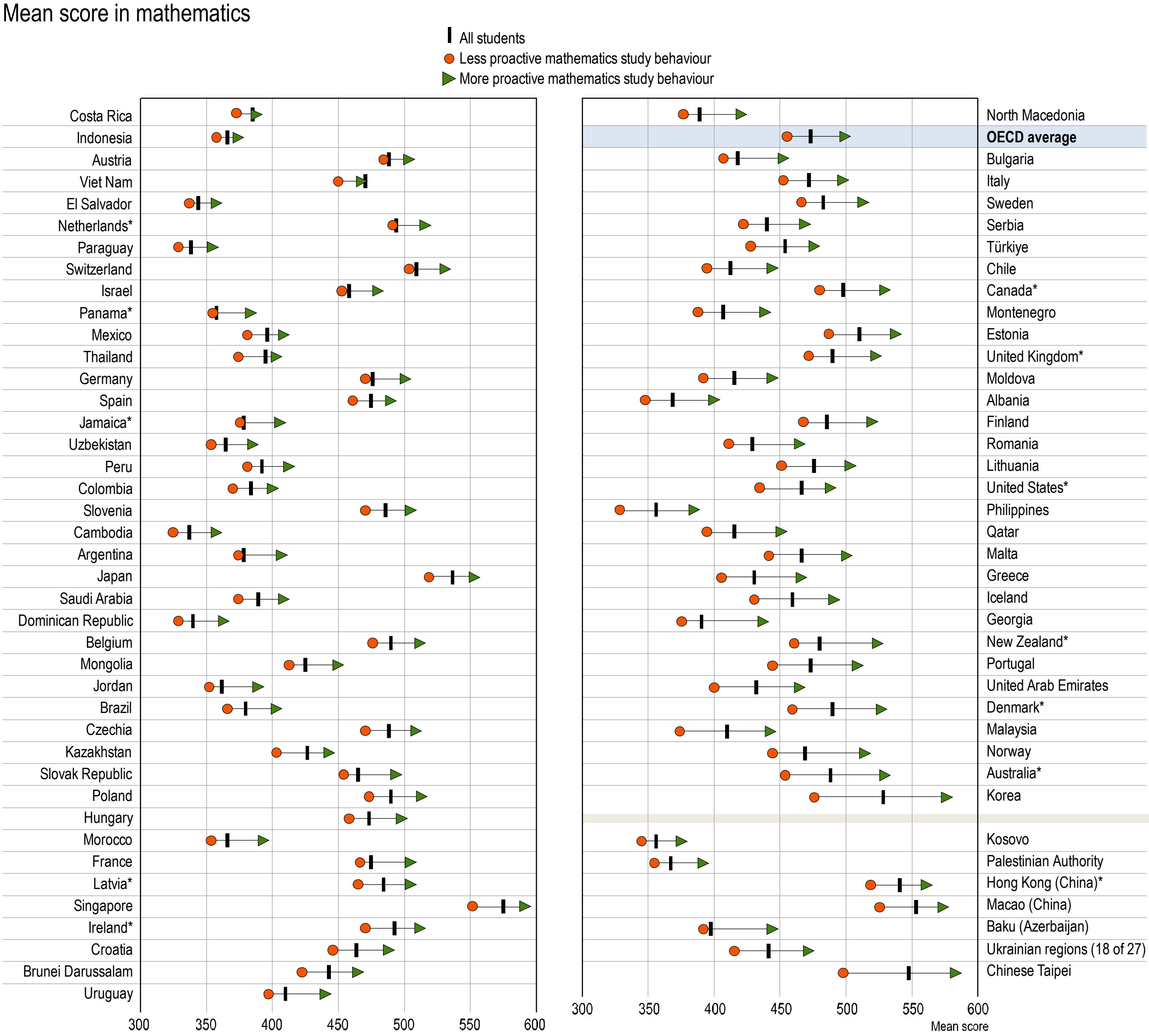
Figure V.2.7 shows the relationship of students' proactive behaviour with their performance in mathematics. In countries in the right panel of the figure, the relationship between proactive behaviour and student mathematics performance is the strongest.

Proactive learning strategies relate to key skills for lifelong learning

Students who reported frequent proactive behaviours tend to outperform those who reported less frequent use by 45 points, on average across OECD countries (Figure V.2.7 and Table V.B1.2.26).

Figure V.2.7. Proactive mathematics study behaviour and mathematics performance

Mean score in mathematics



Notes: Only countries and economies with available data are shown.
Students who have a less (more) proactive mathematics study behaviour are those in the bottom (top) quarter of the index on proactive mathematics study behaviour in their own country/economy.
Countries and economies are ranked in ascending order of the difference in score between those that are more proactive in mathematics study behaviour compared to those that are less.
Source: OECD, PISA 2022 Database, Table V.B1.2.26. See Table V.2.1 for StatLink at the end of this chapter.

A more detailed understanding of what these differences entail for lifelong learning requires looking at the tasks students can do at each end of the proactive mathematics study behaviour index. In Korea we find the biggest gap between students. Those within the top quarter of the proactive mathematics study behaviour index can typically handle mathematics tasks at Level 4, which is significantly above average difficulty. These students can make qualitative judgements when computations are not possible from the information at hand. At this level of mathematics proficiency, students can select and integrate different representations of information and link them directly to real-world situations. These are essential skills to build further knowledge on but also to navigate one's own learning sustainably throughout life. Less proactive students, however, struggle with Level 2 tasks, indicating a much more basic understanding of mathematics and a significantly more basic set of lifelong learning skills (Figure V.2.7 and Table V.B1.2.26).

In countries and economies with a smaller performance gap between students at opposite ends of the index of proactive mathematics study behaviour, it is, nonetheless, significant. In Costa Rica, for example, both groups are under Level 2. But even when the gap is small, differences remain in what students know and can do with what they know (Figure V.2.7).

These findings show the importance of fostering proactive learning behaviours for all students to ready them to take control of their own learning and enhance their learning outcomes. This builds the foundation for lifelong learning. Examples of classroom activities include enquiry-based learning, where students formulate questions, investigate to find answers, and build new understanding as they progress. Research suggests that enquiry-based learning stimulates independent research skills as well as curiosity and critical thinking (Pedaste et al., 2015[17]). By means of their self-directed progression, activities of this type can help students develop proactive learning behaviours.

Students' socio-economic differences and the use of learning strategies

Understanding socio-economic disparities in students' learning strategies is crucial for developing effective policies and interventions. Analyses using PISA data reveal significant gaps and nuanced differences between socio-economically advantaged and disadvantaged students in their approaches to learning across various countries and economies.

Socio-economically advantaged students consistently reported higher engagement in error-checking, homework review, question-asking, proactive study behaviours, and critical thinking than their socio-economically disadvantaged peers. However, the gaps are not uniform across all contexts, with some countries/economies showing minimal or even inverse differences.

PISA data show that in most countries and economies socio-economically advantaged students are more likely to engage in error-checking practices. On average, 69% of advantaged students reported that they like to ensure there are no mistakes in their schoolwork compared to 58% of disadvantaged students. This difference is most pronounced in New Zealand*, with a gap exceeding 20 percentage points, while it is smallest in Mexico and Viet Nam, where it is less than 5 percentage points. Interestingly, in Cambodia and Morocco, disadvantaged students reported this practice more than their advantaged peers, with a gap of 6 and 8 percentage points, respectively (Table V.B1.2.2). The general trend of these disparities suggests that in most systems, advantaged students may benefit more from structured, detail-oriented learning environments while disadvantaged students may need additional support in developing consistent error-checking habits.

Similarly, 46% of advantaged students and 41% of disadvantaged students reported carefully checking their homework before handing it in. This gap is largest in Iceland and Korea (over 15 percentage points) and smallest in Saudi Arabia and Spain (less than 5 percentage points). However, in a number of systems (12 countries), disadvantaged students reported checking homework more frequently, with gaps of more than 10 percentage points in Cambodia and Mongolia (Table V.B1.2.4). It is important to note that approaches to homework vary across contexts but it is not uncommon to find that aspects of students that may be positively associated with homework-checking, as a disadvantaged socio-economic background in these cases, do not correlate positively in predicting performance in mathematics. There may be several reasons for this; for example, in such contexts top performers may not need to spend much time on homework and may be less meticulous than low performers because they have good prior knowledge, the appropriate skills to complete the homework and feel more confident (Trautwein, 2007[18]). It may also be the case that in some systems homework is designed to give extra support or reinforcement to students with specific weaknesses (Epstein and Van Voorhis, 2001[19]). Due to the strong correlation between performance and socio-economic profile, in such contexts, disadvantaged students may be more inclined than advantaged students to engage in diligent homework practices because they may face more learning difficulties than their socio-economically advantaged peers.

Beyond carefulness, when it comes to seeking help in mathematics in the classroom or with teachers, 52% of advantaged students reported frequently asking questions when they do not understand the material on average across the OECD compared to 40% of disadvantaged students. This difference is particularly large in Denmark*, Iceland, Korea, Lithuania, Saudi Arabia and the United States* and (at least 20 percentage points) while it is around 7 percentage points in Kazakhstan (Table V.B1.2.6). Similarly, socio-economically advantaged students also exhibit higher proactive mathematics study behaviour in several areas. For example, across the OECD, about half of advantaged students reported trying to connect new material to what they had previously learned (52%) but only 39% of disadvantaged students did. This difference is most significant in Australia*, Greece, Korea, Malta, Poland, and the Ukrainian regions (18 of 27), (at least 20 percentage points), and smallest in Argentina and Mexico (slightly less than 6 percentage points) (Table V.B1.2.21).

Likewise, advantaged students are more likely to engage in critical-thinking practices. For instance, 64% of advantaged students reported trying to consider everyone's perspective before taking a position compared to 53% of disadvantaged students, on average. The largest differences are in Brunei Darussalam, Iceland, Malaysia and the Ukrainian regions (18 of 27) (at least 20 percentage points) while Kazakhstan and Mongolia show gaps of less than 5 percentage points (Table V.B1.2.10).

An average of around 63% of advantaged students agreed that they can view almost all things from different angles compared to 50% of disadvantaged students, resulting in a 13-percentage point gap. Hungary shows the largest gap (over 20 percentage points) whereas Thailand shows the smallest (less than 5 percentage points) (Table V.B1.2.12). Lastly, 55% of advantaged students disagreed with the statement that there is only one correct position in a disagreement compared to 39% of disadvantaged students, indicating a 16-percentage point gap. Australia*, Belgium, Estonia, France, Hungary, Macao (China), Singapore, Switzerland, and Chinese Taipei, show the largest gaps (at least 20 percentage points) while Croatia, Thailand, and Türkiye show gaps of around 5 percentage points (Table V.B1.2.14).

These findings suggest that students' socio-economic profiles need to be taken in consideration when analysing what shapes students' learning practices. To address disparities, targeted interventions that consider both socio-economic and contextual factors are essential. Improving access to resources, providing support for disadvantaged students, and fostering an inclusive learning environment can help bridge the gap, enhancing educational outcomes and promoting lifelong learning for all students.

Table V.2.1. Chapter 2 figures: Learning strategies - Student approaches to learning

Figure V.2.1	Control one's own work and learning: I ask questions when I do not understand the mathematics material being taught, by students' level of performance in mathematics
Figure V.2.2	Control one's own work and learning: I like to make sure there are no mistakes, by students' level of performance in mathematics
Figure V.2.3	Discrepancy: "I like to make sure there are no mistakes" over "I like to check my homework before turning it in"
Figure V.2.3b	Control one's own work and learning: I carefully check homework before turning it in, by students' level of performance in mathematics
Figure V.2.4	Discrepancy: "I try to consider everybody's perspective before I take a position" over "I think there is only one correct position in a disagreement"
Figure V.2.4b	Discrepancy: "I try to consider everybody's perspective before I take a position" over "I think there is only one correct position in a disagreement", among low-performing students
Figure V.2.4c	Discrepancy: "I try to consider everybody's perspective before I take a position" over "I think there is only one correct position in a disagreement", among skilled performers

Figure V.2.5	Critical thinking: I try to consider everybody's perspective before I take a position, by students' level of performance in mathematics
Figure V.2.5b	Critical thinking: I can view almost all things from different angles, by students' level of performance in mathematics
Figure V.2.6	Critical thinking: I think there is only one correct position in a disagreement, by students' level of performance in mathematics
Figure V.2.7	Proactive mathematics study behaviour and mathematics performance
Figure V.2.7b	Proactive learning: I try to connect new material to what I have learned in previous mathematics lessons, by students' level of performance in mathematics

StatLink https://stat.link/27cbdy

Notes

[1] There are six proficiency Levels in mathematics in PISA. For further information see (OECD, 2023[3])

[2] In the PISA 2022 student questionnaire, what is measured are students agreeing or strongly agreeing with the statement "I like to make sure there are no mistakes" and their reports on frequency ("more than half of the time" or "all or almost all the time") in "I asked questions when I did not understand the mathematics material that was being taught".

[3] Students endorsing this approach outperform students who did not by 22 score points in mathematics, after accounting for students' and schools' socio-economic profile (Table V.B1.2.8).

[4] In terms of top performance, Singapore, Macao (China), Chinese Taipei, Hong Kong (China)*, Japan, Korea. Estonia and Switzerland (in order of performance) outdid all other countries and economies in mathematics (with mean score in mathematics over 500), which was the focus subject of PISA 2022.

[5] Analyses of the relationship between strategies and mathematics performance include analyses focusing on the 25th and 75th percentiles of the performance scale to analyse how changes in students' reports on learning strategies and other variables relate to performance in mathematics at the lower and top quarters of the distribution. For example, the coefficients in a 75th percentile quantile regression show how a one-unit increase in each variable is associated with changes in mathematics performance at the 75th percentile. This percentile captures the performance dynamics among students who are performing better than the bottom three-quarters of the sample.

[6] The proactive mathematics study behaviour index used in PISA measures the frequency of students' engagement in such activities. It includes the three questions mentioned here, and a number of others, including "I put effort into my assignments for mathematics class", "I made time to learn the material for mathematics class" or "I put effort into my assignments for mathematics class".

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3 Empowering students to be motivated lifelong learners

This chapter analyses the relationship between motivation to learn and the use of learning strategies. It also explores a number of concepts that are key to further understanding the interplay between the use of learning strategies and students' attitudes towards learning and self-beliefs. These include students' growth mindsets, social and emotional skills such as persistence and co-operation, and teacher inputs to cognitive activation and creative problem-solving.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

Learning strategies, student motivation, and self-belief form a triangle of learning. Each part of this triangle contributes something unique to the learning process. Working together, they can help students learn better and for life.

While learning strategies, and control and self-monitoring strategies are what learners use to understand, learn, and retain information, motivation is the drive that compels students to learn in the first place. Motivation determines the amount of effort a student will invest in their learning. A supportive environment that fosters student motivation can lead to higher levels of engagement and enthusiasm for learning (Deci, 1985[1]).

Self-belief is a student's confidence in their ability to succeed in learning tasks. One example is the belief that abilities can be developed through dedication and hard work, empowering students to embrace challenges and see failure as an opportunity for growth rather than an insurmountable obstacle. This positive self-belief is crucial for resilience. Students with strong self-beliefs are more likely to use effective learning strategies and remain motivated even when facing setbacks (Dweck, Walton and Cohen, 2014[2]).

In close connection with motivations and self-beliefs, metacognitive learning strategies; that is, learning strategies that entail awareness, understanding and control of learning processes, are key in fostering independent and active learning (Schneider and Artelt, 2010[3]). In the critical-thinking and perspective-taking sphere, these strategies involve reflective thinking exercises and creative problem-solving tasks. These are often exercised through cognitive activation and promote the deeper learning processes necessary for self-directed lifelong learning. When students are motivated and have strong self-belief, they are more likely to adopt challenging, creative and effective learning strategies. This chapter looks closely at this triangular relationship between learning strategies, motivation, and self-belief (c.f. Tables V.1.2 and V.1.3 in Chapter 1).

Key findings

Analyses of the learning triangle of strategies, student motivation, and self-belief show that intrinsic motivations such as enjoying learning new things in school consistently predict the uptake of learning strategies though they are not always the strongest factor. In specific cases, enjoying challenging schoolwork shows the strongest relationship with asking questions when not understanding the material in some countries, including Estonia, Latvia*, Poland, Türkiye and the United Kingdom*. Still, the challenge remains: only half of students on average in OECD countries reported enjoying learning new things at school and less than half reported that they like challenging schoolwork.

Growth mindsets are strongly linked to positive learning strategies, attitudes, and outcomes as well. However, even when they have a growth mindset, many students still hold on to negative mathematics-learning stereotypes. Slightly over half of students with a general growth mindset reported a fixed mindset in mathematics. Argentina, Georgia, Peru, Singapore, and the United Arab Emirates show the smallest share of students with a contradictory combination of a general growth mindset and fixed mathematical mindset.

Low performers may need extra support connecting what they learn with what they had learned previously as they seldom use this learning strategy even when prompted by teachers.

Boys and girls may perceive and engage with learning strategies differently, highlighting the importance of tailored approaches to effectively reach all students.

Co-operation is the social and emotional skill most strongly related to critical-thinking attitudes, such as considering multiple perspectives before forming an opinion. This relationship is particularly strong in top-performing systems like Hong Kong (China)*, Korea, Singapore and Chinese Taipei. This suggests a strong cultural and educational emphasis on co-operative learning and considering multiple perspectives.

Students with higher levels of persistence, regardless of their socio-economic profile or mathematics achievement, are more adept at using a variety of learning strategies. Persistent students are more likely to be meticulous about their schoolwork, and they are also more proactive. These relationships are strong in several countries and economies, including Australia* for proactivity and Bulgaria and Hong Kong (China)* for meticulousness.

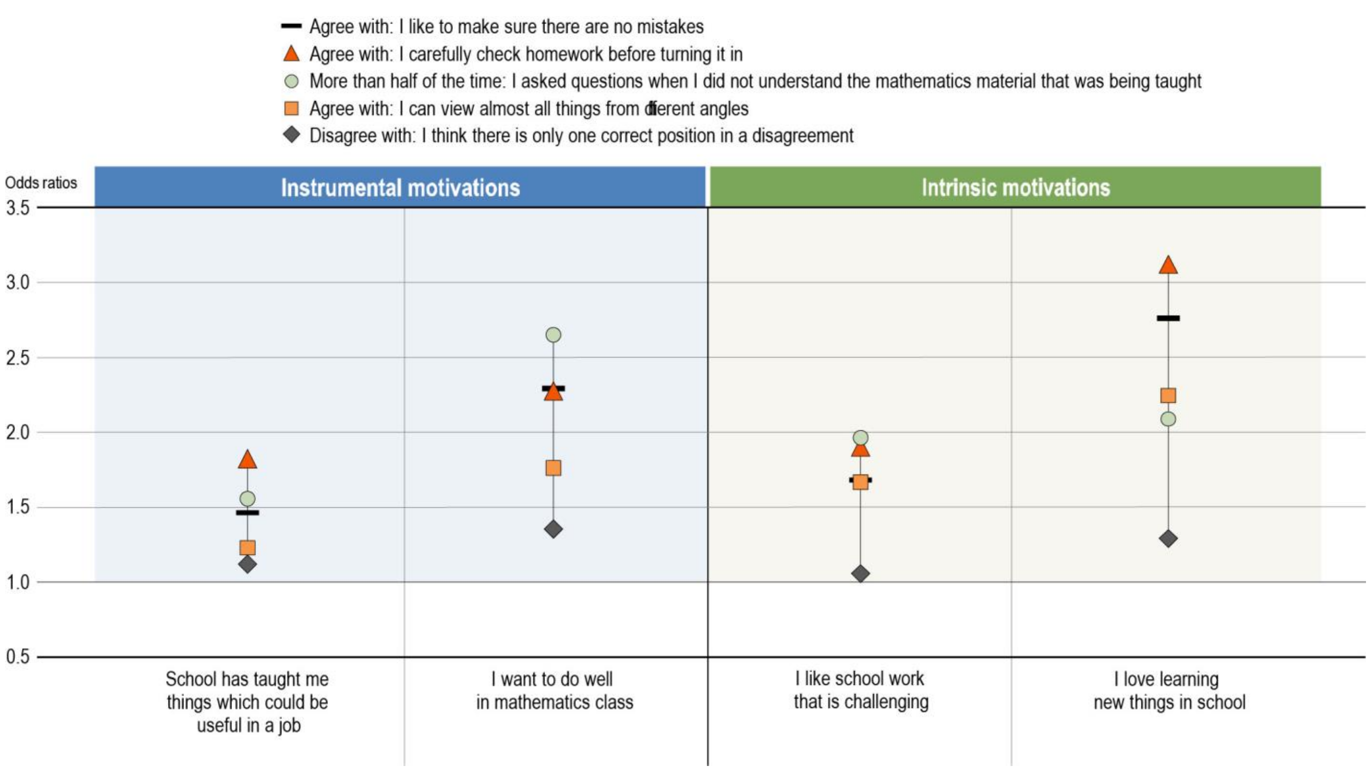
Students' motivation to learn

Students' adoption of learning strategies is intricately linked to their motivations. In self-determination theory (Deci, 1985[1]), research suggests that the way motivations influence specific outcomes can vary according to the type of motivation (Taylor et al., 2014[4]). Some are intrinsic while others are extrinsic and more instrumental[1]. Intrinsic motivations generally have the strongest relationship to student outputs.

To get a measure of students' intrinsic motivations, PISA analysed how much students enjoy learning new things in school and embrace challenging schoolwork. To measure their instrumental motivations, PISA looked at how much students want to do well in school and believe that school teaches things that can be useful in a job. These four motivations have a positive influence on students' uptake of strategies for sustained lifelong learning.

Figure V.3.1. Learning strategies and students' motivation to learn

Likelihood of reporting learning strategies when intrinsically or instrumentally motivated, after accounting for students' and schools' socio-economic profile; OECD average



Notes: All odds ratio coefficients are statistically significant (see Annex A3).
The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Source: OECD, PISA 2022 Database, Tables V.B1.3.51-V.B1.3.55.
See Table V.3.1 for StatLink at the end of this chapter.

Intrinsic motivations are a consistent predictor of learning strategies uptake but not always the strongest

To measure students' use of learning strategies, PISA focused on their responses about five of them (see Chapter 1, Table V.1.2). Indicative of control and self-monitoring strategies are students' propensity to try to not make mistakes in their work, double-check homework, and ask questions when they do not understand something that is being taught. Critical-thinking strategies are captured by students' ability to view issues from different angles and belief that there is more than one correct position in a disagreement.

Students who reported having intrinsic motivations are more likely to employ control and self-monitoring strategies as well as critical-thinking (perspective-taking) strategies, demonstrating a robust association between them (Figure V.3.1).

Of the four learning motivations analysed in Figure V.3.1, enjoying learning new things in school has, on average, the strongest relationship with the strategy of checking work for mistakes, especially homework. This intrinsic motivation shows some of the strongest average relationships with three of the five learning strategies whereas an instrumental motivation like thinking that school teaches things useful for a job shows some of the weakest (Figure V.3.1).

In terms of countries and economies, these relationships are largely positive, particularly for intrinsic motivations such as enjoying learning new things in school as well as the more instrumental wanting to do well in mathematics class – the latter strongly related to the study behaviour of asking questions when one does not understand something (Figures V.3.1b-V.3.1g [available online]). Interestingly, liking schoolwork that is challenging shows the strongest relationship with asking questions when not understanding the material in some OECD countries: Estonia, Latvia*, Poland, Türkiye and the United Kingdom* (Figure V.3.1d [available online]). It shows the strongest relationship to carefully checking homework before handing it in the United Kingdom* and seeing things from different angles in Ireland* and Mexico (Figure V.3.1e [available online]). Yet, the relationship between the four student motivations and the critical-thinking indicator of embracing different perspectives in disagreements differs greatly from country to country. And, interestingly, the relationship between instrumental motivations and this complex type of critical thinking (perspective-taking) is often stronger than for the intrinsic motivations considered in these analyses (Figure V.3.1f [available online]).

Further analyses show similar relationships between the four motivations and learning strategies that make up students' proactive mathematics study behaviours. These particular learning strategies include connecting new and prior knowledge, actively participating in group discussions, and doing mathematics assignments right away. Yet, the main driver for proactivity is wanting to do well in mathematics class even though liking schoolwork that is challenging is a stronger driver in two OECD countries, Mexico and the Slovak Republic (Table V.B1.3.50). Overall, these findings support the hypothesis that positive attitudes towards learning encourage students to employ effective learning strategies. They also show the value of fostering student interest in learning. Interestingly, the attitude of thinking there is more than one correct position in a disagreement shows the weakest relationship to students' motivation to learn, though it is still positive on average (see Box V.3.1).

Box V.3.1. The interplay between critical thinking (perspective-taking) and curiosity

One way to improve students' sustainable learning strategies is to work on how to best motivate them. PISA analyses show that in most of the cases analysed here there is a weaker, on average, relationship between motivation and critical thinking or perspective-taking learning strategies (Figure V.3.1).

However, the association of critical thinking or perspective-taking with more robust motivations can buttress the relationship, as measured by its indirect effect on student performance. The PISA index of curiosity encompasses different types of intrinsic motivations, including, for example, students' enjoyment of learning new things in school, asking questions, and developing hypotheses and checking them based on what they observe[2].

Across OECD countries, about 32% of the performance difference between students who try to consider everybody's perspective before taking a position and those who do not can be understood as the indirect effect of their differences in intrinsic motivations measured by the index of curiosit*y* (Table V.B1.3.6). Between students who reported they can view almost all things from different angles and those who cannot, the share of the performance difference indirectly resulting from intrinsic motivations can be as high as 40% on average. However, as mentioned earlier, the relationship between motivation and critical thinking or perspective-taking is the weakest between students who think there can be more than one correct position in a disagreement and those who do not. Only about 6% of the performance difference between these two groups of students can be interpreted as the indirect result of differences in intrinsic motivations as measured in the index of curiosity (Table V.B1.3.6)[3].

These findings show the complexity of the relationships between student motivation, engagement with learning strategies, and academic outcomes. They also suggest that, just like learning strategies, motivations do not act alone. Students probably have different incentives for engaging in their own learning. But boosting motivations can encourage students to use learning strategies in school and later on in life.

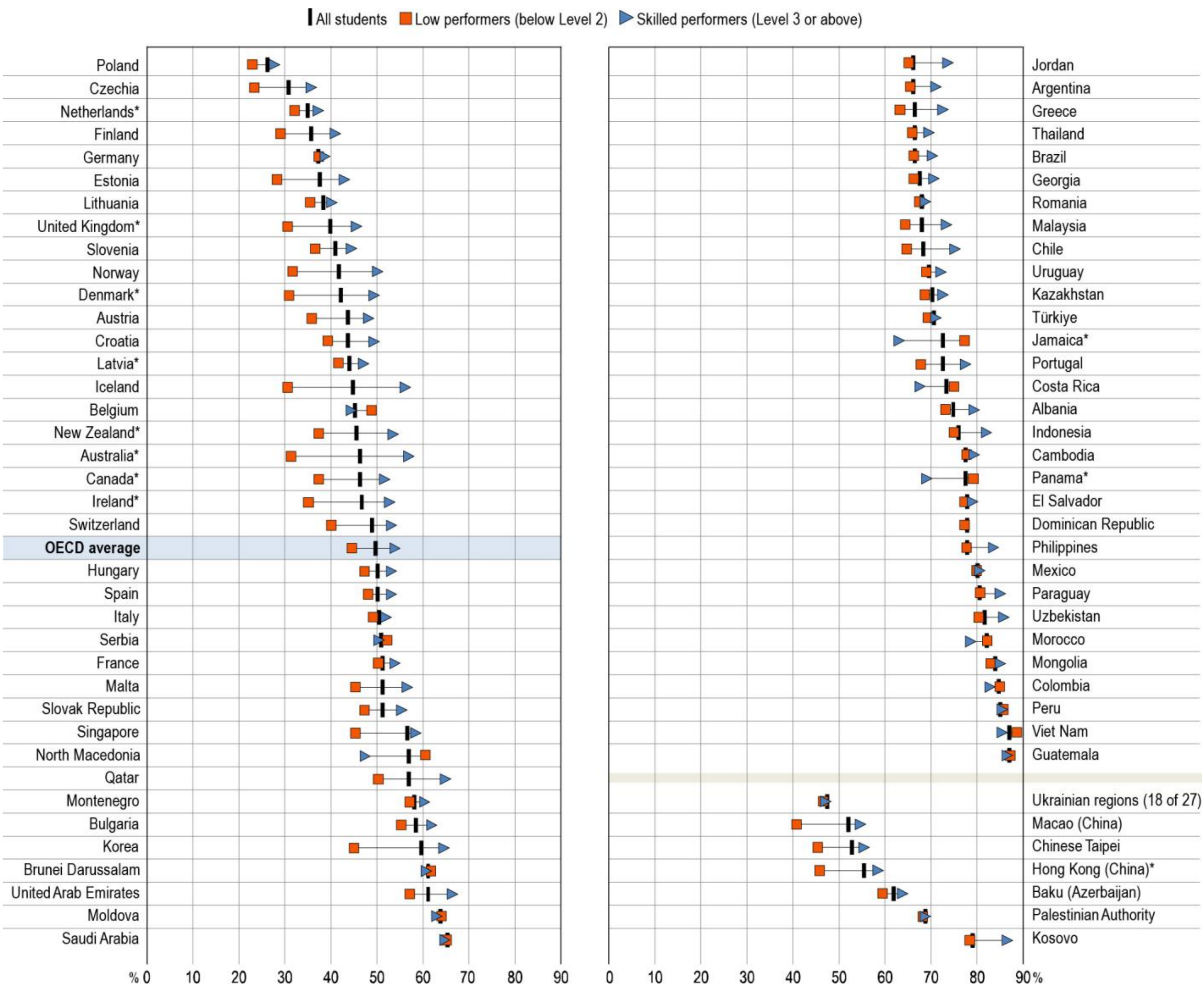
Boosting students' motivation to learn is key to lifelong learning

Not only do motivations have a positive link with students using learning strategies in most countries and economies but PISA data also show a positive relationship between these diverse types of motivation and mathematics performance. This indicates the broad influence of motivation on learning outcomes (Tables V.B1.3.5, V.B1.3.10, V.B1.3.15).

PISA 2022 data show that only half of students in OECD countries reported enjoying learning new things at school and 47% reported enjoying challenging schoolwork. While about the same percentage of skilled performers reported being intrinsically motivated, less than half of low performers said they were. There are, however, important differences depending on countries/economies; for example, at least 85% of students in Guatemala, Peru and Viet Nam reported enjoying learning new things in school. In these same countries, over 85% of low performers are also intrinsically motivated. Conversely, in countries like Czechia and Poland, around a third of students, or less, reported this motivation, with both skilled and low performers among the least intrinsically motivated (Tables V.B1.3.4 and V.B1.3.18).

Figure V.3.2. Intrinsic motivation: I love learning new things in school, by students' level of performance in mathematics

Percentage of students who agree or strongly agree that they love new things in school



Countries and economies are ranked in ascending order of the percentage of all students.
Source: OECD, PISA 2022 Database, Table V.B1.3.4.
See Table V.3.1 for StatLink at the end of this chapter.

Instrumental motivations are more prevalent, with a substantial majority of students (89%, on average across OECD countries) expressing a strong desire to do well in mathematics class. Additionally, 67% of students agreed or strongly agreed that school has taught them things useful for working. Only in Germany did less than half of students report this instrumental motivation. Both skilled and low performers are, generally, instrumentally motivated but less than half of skilled performers are in Germany and Poland, and less than 50% of low performers in Germany (Figures V.3.2b and V.3.2c [available online], Tables V.B1.3.9 and V.B1.3.14).

While wanting to do well in mathematics class clearly motivates students across countries and economies, PISA data suggest that education systems might pay more attention to all four motivations for lifelong learning, whether intrinsic or instrumental. Of the four, intrinsic motivations should be a priority for schools. They have a strong relationship with proactive learning behaviours and sustained learning strategies, especially for low performers.

Growth mindset

The third side of the learning triangle is self-belief, an important part of which is the conviction that abilities can be developed through dedication and effort. The concept of a growth mindset is the belief that abilities and intelligence can be developed over time. This contrasts with a fixed mindset or the belief that intelligence and abilities are static or fixed traits (Dweck, 2006[5]). Schools that foster a growth mindset can enhance student learning (Yeager and Walton, 2011[6]).

On average, across OECD countries, 58% of students reported having a growth mindset though this varies significantly by country/economy. For instance, over 70% of students in Austria, Estonia, Germany, Ireland*, Japan and Sweden reported a growth mindset compared to only a third or fewer in Albania and Kosovo (Table V.B1.3.39). Gender differences are non-significant in almost half of countries/economies and when they are, they are not more than 10 percentage points, with boys slightly more often reporting a growth mindset (Table V.B1.3.40).

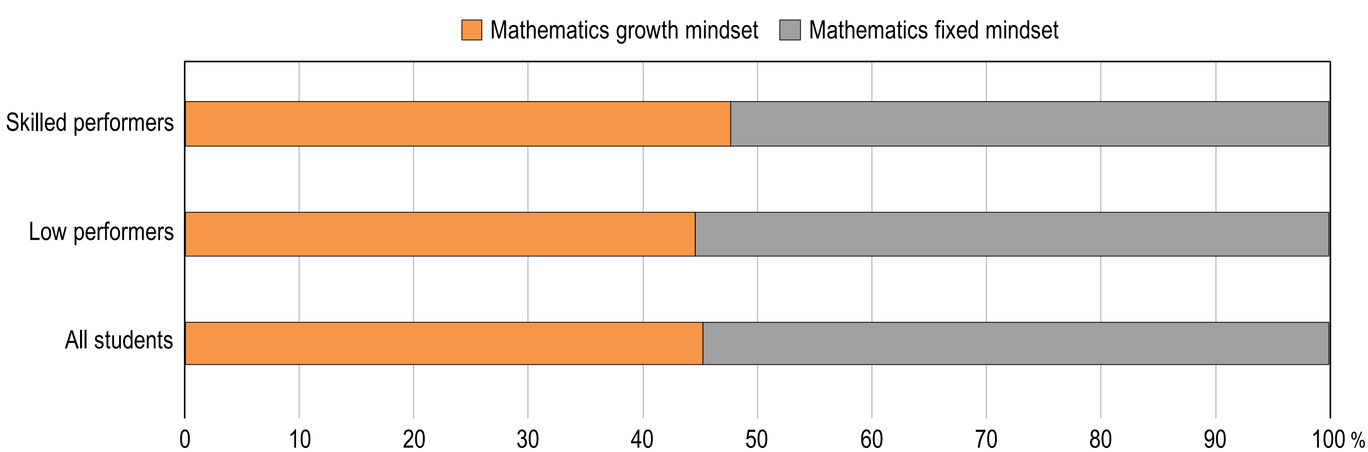
In mathematics, however, only 35% of students reported a growth mindset.[4] In countries like Georgia, New Zealand*, Peru, Singapore, and Sweden, at least half of their students reported a mathematics growth mindset while in Czechia, Japan, Poland and Slovenia, fewer than 20% did (Table V.B1.3.43). Unlike a general growth mindset, gender differences in mathematics growth mindset are more pronounced and significant across most countries and economies, with boys being more likely to report it by an average of 7 percentage points. This gap can be as sizeable as over 15 percentage points in countries/economies like Jordan and the Palestinian Authority (Table V.B1.3.42).

Math-learning stereotypes are obstinate even among students with a growth mindset

The discrepancy between general and mathematics-specific growth mindsets is notable. Slightly over half of students with a general growth mindset reported a fixed mindset in mathematics (55%, on average across OECD countries), with consistent gaps across low and skilled performers. Among top performers, the gap is slightly smaller but remains substantial at 48% (Figure V.3.3, and Table V.B1.3.44). Overall, the smallest gaps are in Argentina, Georgia, Peru, Singapore, and the United Arab Emirates.

Figure V.3.3. Discrepancy-mismatch: Mathematics growth mindset over general growth mindset

Percentage of students with general growth mindset who reported agreeing/strongly agreeing (fixed mindset) or disagreeing/strongly disagreeing (growth mindset) with the statement "Some people are just not good at mathematics, no matter how hard they study"; OECD average



Note: Only countries and economies with available data are shown.
Countries and economies are ranked in ascending order of the percentage of students with a mathematics growth mindset.
Source: OECD, PISA 2022 Database, Table V.B1.3.44. See Table V.3.1 for StatLink at the end of this chapter.

This discrepancy is particularly important because it suggests that many students view math ability as innate, reinforcing fixed mindsets and stereotypes, including damaging math-gender stereotypes (Correll, 2004[7]; Cvencek, Kapur and Meltzoff, 2015[8]; Cvencek et al., 2017[9]). Students with fixed mindsets about school or about themselves as learners are more likely to withdraw from essential learning behaviours and give up easily when encountering setbacks. They are also more likely to attribute failures to what they perceive as aspects beyond their control (Dweck, Walton and Cohen, 2014[2]).

Growth mindsets show a strong relationship with learning strategies, attitudes and outcomes

Why is this relevant? The self-belief concept of growth mindset explains some of the reasons and motivations behind students engaging with specific learning strategies and using their energy and resources to meet their learning goals. This is central to lifelong learning and to this report.

For example, students who reported asking questions when unsure of material are, on average and across OECD countries, more likely to report a growth mindset in mathematics (Figure V.3.3b [available online]). The relationship is particularly strong in Korea and Chinese Taipei. While causality cannot be attributed to these analyses, the relationship suggests that creating spaces where students feel confident enough to ask questions encourages students' conviction that they can master something even if it is difficult. Research suggests that students with a growth mindset are more willing to put in an effort even when they encounter challenges or fail (Dweck and Yeager, 2019[10]).

Findings in this section suggest that some education systems may be more attuned to growth mindset than others. However, low performers face the challenge of not only struggling to ask questions but also being at risk of not developing positive mindsets. If a student believes (or has been told) they are not good at mathematics, regardless of how hard they try, they are less likely to ask questions when in doubt. In the same vein, growth mindset relates positively to relevant critical-thinking behaviours such as considering there can be multiple valid perspectives in disagreements. This relationship is particularly strong in some OECD countries like Colombia, Mexico and New Zealand* (Table V.B1.3.47).

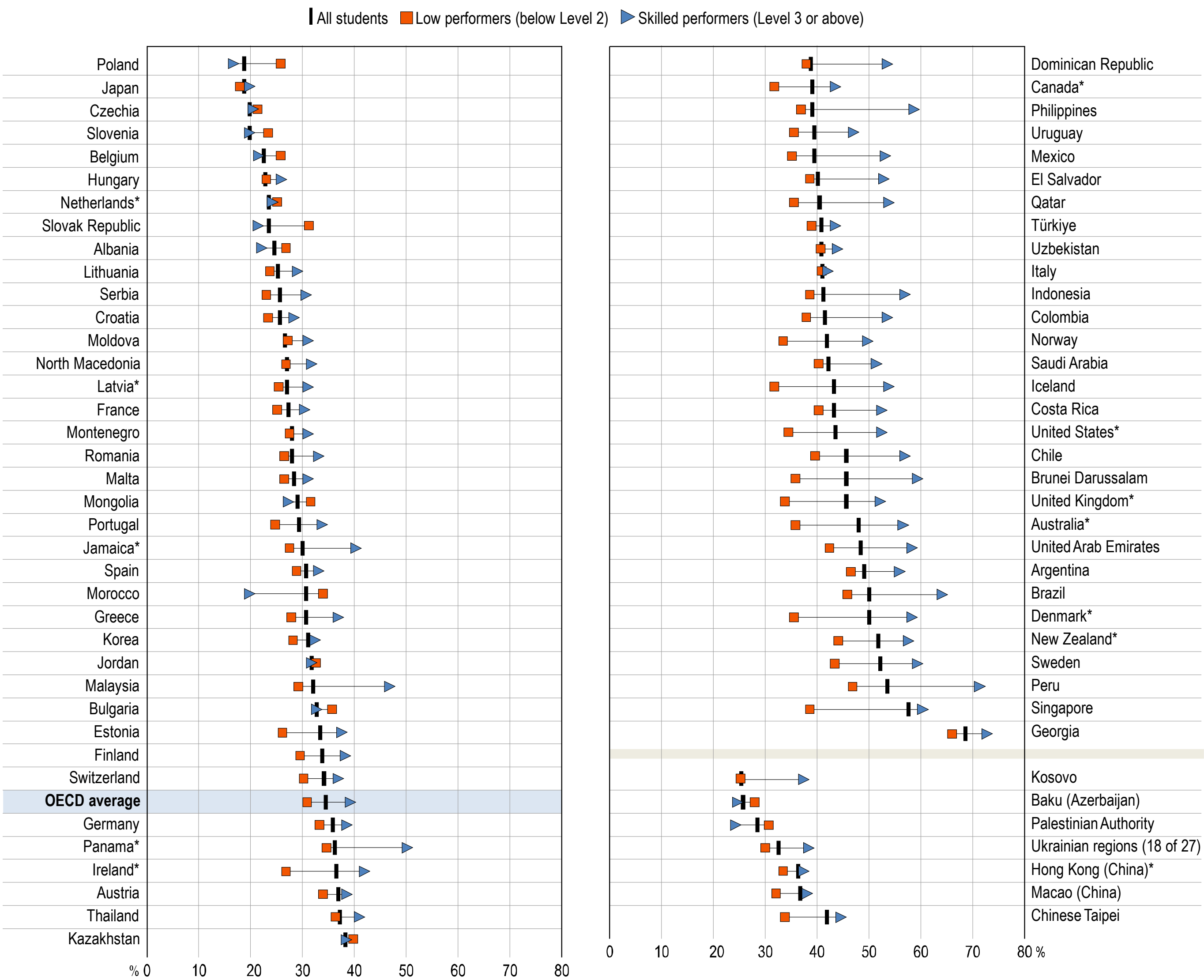
In close relation to this, intrinsic motivations such as enjoying challenging schoolwork and liking learning new things are also significantly related to growth mindset. These relationships are strong across most countries and economies, emphasising that students embracing the belief they can enhance their intelligence, skills and knowledge are often those that enjoy learning as well. Interestingly, students in Australia* and Denmark* are about twice as likely to report these two intrinsic motivations when they have a mathematics growth mindset (Table V.B1.3.47).

Research suggests that students with a growth mindset are more likely to persevere with their schoolwork, leading to better academic behaviours and improved performance, including in mathematics (Claro, Paunesku and Dweck, 2016[11]; Farrington et al., 2012[12]). PISA 2022 data support these claims as growth mindset in mathematics is strongly associated with higher perseverance, greater confidence (self-efficacy) in mathematics, and proactive study behaviour in mathematics. These relationships are robust across countries/economies, although they are influenced by mathematics performance in many countries/economies. The case of Colombia is particularly interesting as the relationship between all these aspects becomes non-significant when accounting for performance in mathematics. This suggests that success in mathematics for Colombian students is a crucial factor in sustaining their growth mindset and related behaviours (Table V.B1.3.46). As with a general growth mindset, a growth mindset in mathematics has a strong, positive relationship with learning outputs like performance in mathematics (Tables V.B1.3.45 and I.B1.2.17 [from Volume I, PISA 2022 Results]).

These results suggest that while the prevalence of a growth mindset varies across countries and economies, its positive relationship with learning attitudes and outcomes is consistent. Intervention research shows that academic mindsets are malleable and can be intentionally shaped through contextual and instructional variables (Yeager and Walton, 2011[6]). Developing positive mindsets in schools can support the development of students' positive attitudes towards learning. It can encourage them to use effective learning strategies, enhance their motivation, and through this, foster lifelong learning. Building growth mindsets in different areas, particularly in mathematics, and tailoring teaching strategies to diverse learner needs can help all students achieve their full potential. Opportunities for students to develop growth mindsets have been incorporated into national plans. For example, the Youth Sector Development Plan (2021-2023) in Estonia helps create environments and opportunities for each student to cultivate attitudes and motivations through growth mindset activities (see Box V.3.2).

Figure V.3.4. Mathematics growth mindset, by students' level of performance

Percentage of students who disagree/strongly disagree (growth mindset) with the statement "Some people are just not good at mathematics, no matter how hard they study"



Note: Only countries and economies with available data are shown.
Countries and economies are ranked in ascending order of the percentage of all students.
Source: OECD, PISA 2022 Database, Table V.B1.3.43.
See Table V.3.1 for StatLink at the end of this chapter.

Box V.3.2. Estonia: Youth Sector Development Plan (2021-2035)

Estonia's Youth Sector Development Plan for 2021-2035 outlines strategies such as instilling entrepreneurship, and skills and competencies to support the growth and development of young people who are key to Estonia's lifelong learning tradition and policy. An integrated youth policy has been implemented since 2006. It requires all ministries to consider the principles of this youth policy in formulating measures and making decisions that impact young people.

The plan highlights that it is necessary for youth to build self-confidence and self-reliance as these qualities enable individuals to experience and deal with mistakes, and succeed and learn from the outcomes of their decisions. It emphasises encouraging young people to pursue their talents and interests, and providing opportunities for youth development.

Activities are held in youth centres and participation in these activities is voluntary for young people. The centres provide young people with growth-oriented and meaningful activities that focus on one's development rather than outcome. In 2024, there were 288 youth centres, with most in rural areas. Youth initiatives that allow young people to develop and execute their ideas, safely experiment, make mistakes and learn from one's experience are also supported. Implementing one's own ideas allows individuals to acquire and value new skills and experiences, and develop a proactive frame of mind. Youth initiatives are supported locally through project calls and internationally through activities such as the Erasmus+ programme.

Source: (Ministry of Education and Research, 2021[13])

Cognitive activation

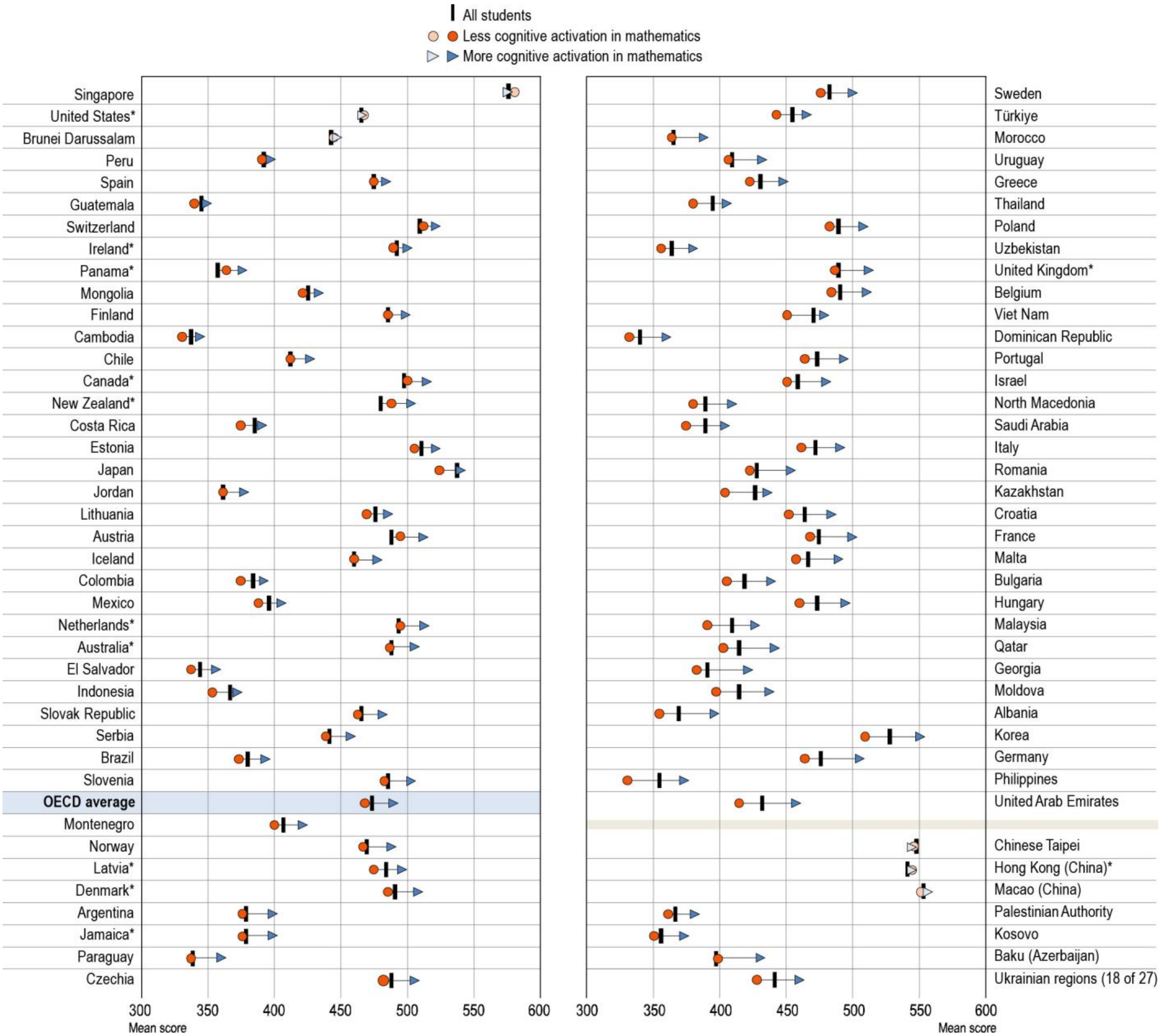
Cognitive activation encompasses instructional activities that often require student engagement in the evaluation, integration, and application of knowledge in problem-solving contexts, typically linked with (but not exclusive to) sharing and explaining their thoughts, concepts and solutions to given problems or tasks (Lipowsky et al., 2009[14]). These strategies are essential for fostering higher-order thinking skills such as critical analysis, problem-solving, and decision making.

Despite the established benefits of these practices, as highlighted in previous OECD studies (Echazarra et al., 2016[15]; Le Donné, Fraser and Bousquet, 2016[16]), student reports in PISA 2022 suggest they are not widespread on average: more "traditional" strategies like memorisation and perseverance are the most prevalent (52% of students reported memorising and persevering very frequently, on average across OECD countries) (Table V.B1.3.20).

Less than half of students frequently engage in self-reflective practices such as explaining how to solve a mathematics problem and explaining the reasoning involved in solving it, on average across OECD countries. Interestingly, students who face difficulties in the classroom perceive these strategies differently than more skilled students. On average, about 40% of low performers reported that their teachers use cognitive activation practices that require them to think about how problems are solved and their reasoning. Conversely, over half of skilled performers reported that their teachers do the same (Table V.B1.3.23). These results highlight important aspects of classroom teaching and learning. Low-performing students reporting less exposure to cognitive activation suggests that some systems adapt teaching practices for different performance levels. In a similar vein, low and skilled performers may be segregated in some systems and the exposure to these practices may, indeed, be different. This could also indicate, however, that low-performing students are less likely to recognise cognitive activation components in teaching even when they are as exposed to them as their skilled peers. Interestingly, students in Peru reported this self-reflective practice the most (60%), with very similar shares of low and skilled performers (59% and 63%, respectively) (Figure V.3.5b [available online] and Table V.B1.3.23).

Figure V.3.5. Cognitive activation in mathematics (foster reasoning) and mathematics performance

Mean score in mathematics



Notes: Score-point difference between students with more cognitive activation in mathematics and those with less that are statistically significant are shown in a darker tone (Annex A3). Students who reported less (more) frequent cognitive activation in mathematics are those in the bottom (top) quarter of the index of cognitive activation in mathematics in their own country/economy.

Countries and economies are ranked in ascending order of the difference in score between students with more frequent cognitive activation in mathematics compared to those with less.

Source: OECD, PISA 2022 Database, Table V.B1.3.31. See Table V.3.1 for StatLink at the end of this chapter.

Explicitly connecting new learning to existing knowledge may require reinforcement, especially for low performers

Some examples of cognitive activation practices that are relevant for self-directed learning are teachers frequently asking students to think about how new and old mathematics topics are related (31%, on average across OECD countries). Another is teachers frequently asking students to think about how to solve mathematics in different ways than demonstrated in class (37%) (Table V.B1.3.20). What is interesting about frequently asking students to think about how new and old mathematics topics are related is that roughly the same percentage of both low and skilled performers, on average across OECD countries, reported that their teachers do this: slightly more than 30%. This is particularly important as few low performers said they proactively do this, suggesting that low performers may struggle to internalise this strategy (see Chapter 2). Finally, on average, slightly above 36% of both skilled and low-performing students reported their teachers frequently ask them to think about how to solve mathematics problems in different ways than demonstrated in class (Tables V.B1.3.27 and V.B1.3.29). Peru, again, stands out as a country where students not only reported frequent teacher prompting but by similar proportions of low and skilled performers, suggesting these practices are more homogeneously integrated and implemented than in other education systems.

These findings have potential implications for sustained learning. Figure V.3.5 shows how students in most countries and economies who reported that their teachers frequently use cognitive activation practices[5] outperformed those who reported that their teachers use it less frequently (by 21 score points on average, across OECD countries).

Students with a strong grounding in cognitive activation are better prepared to keep learning past their school years

As with proactive study behaviours, a way to understand how cognitive activation relates to lifelong learning is to observe the types of tasks students are able to handle at each end of the cognitive activation index. About half of countries on the right panel of the figure show differences of at least one proficiency level between students who reported more and less exposure to cognitive activation practices. For instance, in the United Arab Emirates, students reporting the most frequent exposure to cognitive activation practices from their teachers could typically handle Level 2 tasks, which is considered the baseline for mathematics proficiency. Students reporting the least exposure often scored below this level. At the opposite end, in Peru, both groups scored below Level 2: the difference remains significant although the gap between the two ends appears small (Figure V.3.5).

These analyses suggest that the relationship between cognitive activation and academic proficiency is positive and statistically significant on average across OECD countries and among most countries and economies for all students regardless of their proficiency level (Table V.B1.3.30).

Students who reported more exposure to cognitive activation practices may be better prepared for sustained learning as they have a double benefit: an increase in their capacity to use metacognitive strategies (e.g. to do better planning, monitoring, and evaluating of one's own understanding as well as to transfer practices to enhance learning effectiveness) and, simply, better mathematics skills.

Skilled achievers may make better use of cognitive activation practices, but they can be beneficial for all students if adapted to their needs. Exposure to cognitive activation practices can enable students to be active agents in their own learning. This creates the foundation for methodical and transferable reasoning, a hallmark of sustained lifelong learning.

Box V.3.3. Gender differences in the use of learning strategies: Insights from PISA 2022

PISA data on gender differences in the use of specific learning strategies reveal interesting findings. Boys often reported more exposure to cognitive activation practices than girls (Table V.B1.3.21). This suggests that boys and girls may perceive learning strategies differently.

Gender differences can also be seen in how girls and boys reported strategies for sustained learning analysed in Chapter 2. Girls consistently exhibit higher control and self-monitoring strategies, particularly in checking for mistakes and reviewing homework before submission. Among skilled performers, girls outstrip boys by 8 percentage points in checking for mistakes and 14 percentage points in checking homework, on average across

OECD countries. Among low performers, these differences are 7 and 10 percentage points, respectively (Table V.B1.3.48).

However, there is no significant gender difference on the matter of students asking questions when they do not understand the mathematics being taught in most countries and economies. Among skilled performers, the gender gap is not significant in most countries and economies either. For low performers, the gap is slightly significant in favour of girls in 19 out of 22 countries (from 4 to 12 percentage points) (Table V.B1.3.48).

In terms of critical thinking (perspective-taking), girls generally reported stronger abilities in assimilating multiple viewpoints before taking a position. Among skilled performers, girls outstripped boys by 8 percentage points in terms of considering everyone's perspective and 5 percentage points in being able to see things from different angles, on average across OECD countries. For low performers, these gaps increase to 11 and 9 percentage points, respectively. Additionally, girls were more likely to disagree with the notion that there is only one correct position in a disagreement, with gaps favouring girls by an average of 14 percentage points among skilled performers and 7 percentage points among low performers (Table V.B1.3.49).

Overall, these findings emphasise the need for tailored educational strategies that address the specific strengths and weaknesses of both genders, fostering an equitable learning environment that supports the development of strategies for sustained learning for all students (OECD, 2015[17]).

Creative school and class environment

Imagination and creativity significantly shape students' educational experiences and future career trajectories (Gotlieb et al., 2019[18]). A creative person generates novel ideas and formulates original solutions, and the process of implementing and refining these ideas in learning is dynamic (Beghetto and Schuh, 2020[19]). The focus should not merely be imparting knowledge but cultivating students' ability to think innovatively.

The enduring link between creativity and problem-solving has been a subject of scholarly interest for many decades (Weisberg, 2006[20]). While a detailed discussion of creativity is presented in a separate volume (OECD, 2024[21]), the focus here is on creativity's role in enhancing students' preparedness for lifelong learning, especially in problem-solving. On average, across OECD countries, over 60% of students reported that teachers give them enough time to come up with creative solutions on assignments; activities students do in class help them think about new ways to solve problems; and that mathematics assignments require students to come up with different solutions for a problem (Table V.B1.3.32). When looking at responses to the latter two questions, which focus explicitly on finding new ways to solve problems, skilled and low performers reported over 60% on average (Tables V.B1.3.35 and V.B1.3.37). This suggests a broad emphasis on creative problem-solving overall.

Notably, PISA 2022 data show that students who reported more creative problem-solving activities do not always show positive relationships with learning outcomes like mathematics performance. In a number of countries/economies, the relationship is non-significant or even, negative (Table V.B1.3.38).

These findings suggest that different educational systems have different standards and practices in creative problem-solving activities. In some educational systems, they might be heavily integrated into the curriculum and teaching methods; in others, it may be less emphasised or implemented in a more fragmented way (Wyse and Ferrari, 2014[22]). Educational policies also support creative environments to very different extents. Further PISA analyses are needed to better understand how creative environments positively influence other learning outcomes, such as performance in mathematics. (c.f. Volume 3, PISA 2022 Results).

Box V.3.4. How do social and emotional skills relate to learning strategies?

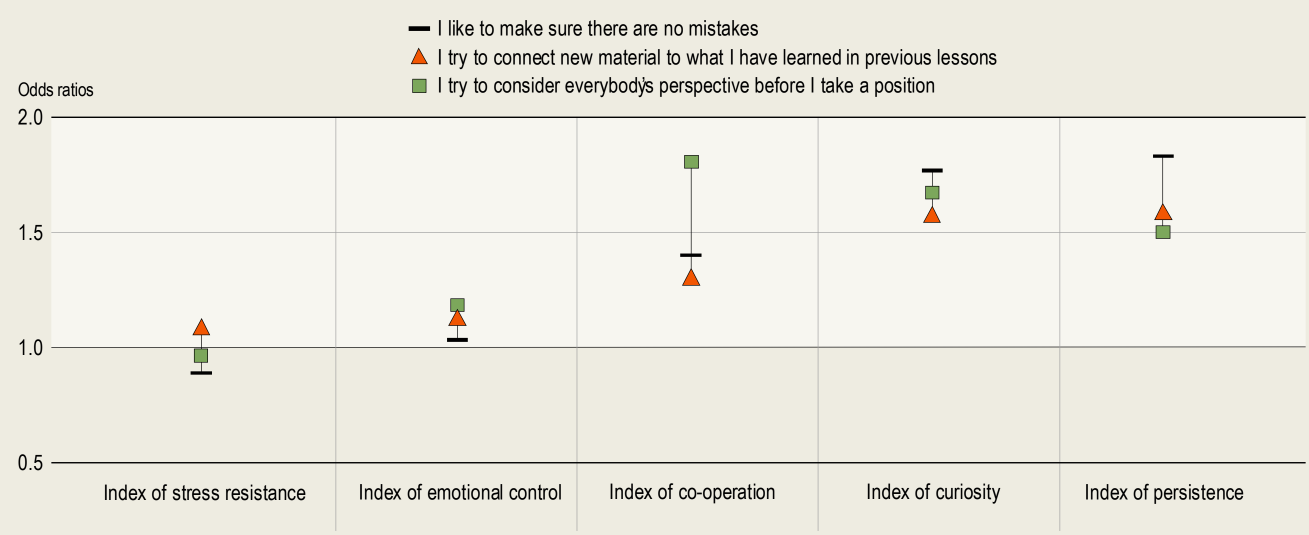
As shown in previous PISA reports (OECD, 2023[23]), social and emotional skills (SES) such as persistence, curiosity, co-operation, stress resistance and emotional control play a central role in shaping students' learning processes. PISA 2022 results confirm existing research showing that SES not only contribute to academic performance but support the development of lifelong learning habits by fostering resilience and adaptability (Poulou, 2007[24]) (Durlak et al., 2011[25]).

PISA 2022 data highlight the relationship between SES and learning strategies for sustained lifelong learning. Key findings show that persistence is the strongest driver among the SES analysed in this report. Students with higher levels of persistence are more adept at using a variety of learning strategies, regardless of their socio-economic profile or mathematics performance. For example, with a one-unit increase in the persistence index, students are twice as likely to carefully check their homework before handing it in and almost as likely to be meticulous with their schoolwork. This relationship is particularly strong in Bulgaria and Hong Kong (China)*. Persistent students are also more proactive, particularly in engaging with new material by relating it to previous lessons, especially so in Australia*, where persistent students are almost twice as likely to engage in such practices. This proactive approach is a hallmark of effective and sustained learning (Table V.B1.3.56).

Curiosity and co-operation also play important roles. Curious and co-operative students show a high propensity for thoroughness in their learning across different countries/economies. These students, along with those who manage their emotions well, are more likely to proactively engage with new material, relate it to prior knowledge and thereby deepen their understanding (Table V.B1.3.60).

Figure V.3.6. Learning strategies and students' social and emotional skills

Likelihood of reporting using learning strategies for each the following social and emotional skills, after accounting for students' and schools' socio-economic profile, and students' performance in mathematics; OECD average



Notes: All odds ratio coefficients are statistically significant (see Annex A3).
The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Source: OECD, PISA 2022 Database, Tables V.B1.3.56-V.B1.3.60. See Table V.3.1 for StatLink at the end of this chapter.

Critical thinking is another area where SES are crucial. Co-operative students, across the countries and economies surveyed, are the most likely to consider multiple perspectives before forming their own opinions. Interestingly, this relationship is particularly strong in high-performing systems such as Hong Kong (China)*, Korea, Singapore and Chinese Taipei, suggesting a strong cultural and educational emphasis on co-operative learning and considering multiple perspectives. This approach to education may help students to develop a more nuanced and comprehensive understanding of complex issues. Curious and persistent students also tend to embrace this integrative approach, highlighting the interplay between these skills and critical thinking (Table V.B1.3.57).

Conversely, while students with higher stress resistance are, on average across OECD countries, less likely to check their homework carefully, the relationship is not significant in many countries/economies. This interesting finding suggests that stress-resilient students rely more on their innate abilities and confidence in their understanding of the material, reducing the perceived need for meticulous checking of homework. In contrast, students with lower stress resistance may be more anxious about their performance and check their homework more carefully. In addition, in about half of the countries/economies surveyed, stress resistance is not related to proactive learning behaviour or to the ability to consider multiple perspectives (Table V.B1.3.59).

Finally, emotional control, while relating positively to meticulousness and perspective-taking, on average across OECD countries, shows a non-significant relationship in several countries/economies and even a negative relationship in some cases. Interestingly, emotional control is positively related to the belief that there can be more than one correct position in a disagreement, on average and across countries and economies. While the relationship is likely to be non-linear, the question remains whether maintaining emotional control might allow individuals to be more flexible and open to conflicting perspectives (Table V.B1.3.58).

As shown throughout this report, SES are highly relevant to students' autonomous learning and confidence in their learning. Persistence, in particular, shows interesting relationships with almost all sustained learning behaviours. Yet, as the OECD's Survey on Social and Emotional skills has shown, there can be important differences in SES across gender, age and socioeconomic groups (OECD, 2024[26]). Understanding the nuanced relationship between these skills and students' approaches to learning is essential for developing targeted education policies that can close learning gaps. As such, analysis of the PISA 2022 data on the relationship between SES and learning strategies provides valuable insights into how these skills can be nurtured to support all students in reaching their full potential.

Table V.3.1. Chapter 3 figures: Empowering students to be motivated lifelong learners

Figure V.3.1	Learning strategies and students' motivation to learn
Figure V.3.1b	Learning strategy: Control (checking) I like to make sure there are no mistakes
Figure V.3.1c	Learning strategy: Control (checking) I carefully check homework before turning it in
Figure V.3.1d	Learning strategy: Control (checking) I ask questions when I do not understand the mathematics material being taught
Figure V.3.1e	Learning strategy: Critical thinking (perspective-taking) I can view almost all things from different angles
Figure V.3.1f	Learning strategy: Critical thinking (perspective-taking) I think there is only one correct position in a disagreement
Figure V.3.2	Intrinsic motivation: I love learning new things in school, by students' level of performance in mathematics
Figure V.3.2b	Instrumental motivation: School has taught me things which could be useful in a job, by students' level of performance in mathematics
Figure V.3.2c	Instrumental motivation: I want to do well in my mathematics class, by students' level of performance in mathematics
Figure V.3.3	Discrepancy-mismatch: Mathematics growth mindset over general growth mindset
Figure V.3.3b	Control one's own work and learning: I ask questions when I do not understand the mathematics material being taught and likelihood of reporting a growth mindset in mathematics
Figure V.3.4	Mathematics growth mindset, by students' level of performance
Figure V.3.4b	Mathematics growth mindset
Figure V.3.4c	General growth mindset
Figure V.3.5	Cognitive activation in mathematics (foster reasoning) and mathematics performance
Figure V.3.5b	Cognitive activation: the teacher asked us to explain how we solved a mathematics problem, by students' level of performance in mathematics
Figure V.3.6	Learning strategies and students' social and emotional skills

StatLink https://stat.link/9reh46

Notes

[1] Intrinsic motivation refers to doing an activity for its inherent satisfaction or enjoyment, rather than for some identifiable outcome. Extrinsic or instrumental motivation, on the other hand, involves doing a task to obtain an external reward or even to avoid punishment. This type of motivation is driven by external factors such as grades, money, opportunities or recognition.

[2] The PISA index of curiosity is based on students' ratings of their agreement with statements about a range of behaviours, including "I like to know how things work", "I like to ask questions", "I love learning NEW things in school" and "I like to develop hypotheses and check them based on what I observe". Each of the items included four response options ("strongly disagree", "disagree", "agree", or "strongly agree").

[3] The indirect effects described here are based on the coefficients resulting from two linear regressions: (1) the total effect of the critical-thinking strategy, which represents the change in score points in mathematics performance associated with agreeing/strongly agreeing (or disagreeing/strongly disagreeing) with the corresponding perspective-taking statement, controlling for students' socio-economic profile (measured by the PISA index of economic, social and cultural status [ESCS]), and (2) the effect of the critical-thinking strategy, controlling for the indirect effect of the index of curiosity. These coefficients are reported in the Table V.B1.3.6.

[4] PISA 2022 asked students whether they agreed ("strongly disagree", "disagree", "agree", or "strongly agree") with the following statement: "Your intelligence is something about you that you can't change very much". Disagreeing with the statement is considered a precursor of a growth mindset as it is more likely that someone who thinks intelligence can change will challenge him/herself to improve it. To measure a growth mindset towards mathematics specifically, PISA 2022 asked students whether they agreed with the statement "Some people are just not good at mathematics, no matter how hard they study". As with the first statement, disagreeing with the statement is considered a precursor of a growth mindset in mathematics. However, analyses based on this second question should be interpreted with caution. The fact that the question is not centred on the respondent but asks their judgement about 'some people' changes the interpretation of a growth mindset to some extent. It is possible that some students may experience difficulties with mathematics regardless of their study practices (for example, students with certain types of learning needs or challenges). In such cases, the question and statement could be interpreted as true and still not be inconsistent with a growth mindset. Yet, the object of analysis in this chapter is the preconceived notion that some students may have about learning mathematics in general and their belief that it is possible to be better at mathematics by studying hard.

[5] The relationship is based on the index of cognitive activation in mathematics to foster reasoning. Countries and economies with the highest index are those in which more students reported that teachers frequently ask them to think about how new and old mathematics topics are related; to engage in self-reflective practices explaining how a mathematics problem was solved and their reasoning; and to think on how to solve a mathematics problem in different ways, among other activities.

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4 Students' predispositions to learning

This chapter explores students' self-beliefs, such as mathematics self-efficacy and mathematics anxiety, and how these relate to students' attitudes and dispositions to learning. In addition, it examines the interaction between liking mathematics and feeling confident in it, and the role of teachers' support. It also analyses the interplay between students' uncertainty about the future and anxiety towards learning, and the impact of teachers' attitudes towards students on students' anxiety.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

Students' self-beliefs about how well they can perform on specific tasks or subjects are formed when they are young and follow them over the course of their lives (Bandura, 1997[1]). While these beliefs are partly formed based on students' past performance, once they are formed, it is difficult to modify them. These self-beliefs will affect students' attitudes towards learning, the development of their skills and their decisions about educational pathways and careers. Students who feel confident and do not associate anxiety with certain subjects are more likely to continue to study them and pursue a career related to them (Bong and Skaalvik, 2003[2]; Wang, Eccles and Kenny, 2013[3]).

Under the umbrella concept of self-belief is self-efficacy: this is the extent to which students believe in their ability to engage in certain activities and perform specific tasks even when facing difficulties (Bandura, 1977[4]). Students who believe they can carry out certain tasks feel less anxious and stressed about them and vice versa. Self-efficacy and anxiety are often, even if not always, concepts that represent two sides of the same coin, with one negatively affecting the other. Since mathematics often provokes students' stress and lack of confidence, this chapter focuses on mathematics self-efficacy; that is, confidence in solving mathematical tasks or its opposite, mathematics anxiety, as measured by PISA 2022.

This chapter examines students' mathematics self-beliefs, how these concepts vary across and within different countries and economies, and how they are associated with different strategies for sustained lifelong learning and students' motivations.

Key findings

While 15-year-olds who participated in PISA 2022 reported feeling particularly confident solving mathematical problems in the classroom, they feel less confident about those related to real-life events. This is the case especially in Viet Nam and Thailand. PISA 2022 also finds that 15-year-olds in most countries and economies (except for Korea, Singapore and Thailand) show higher levels of mathematics anxiety than they did in 2012 and that they feel anxious not only about their grades and failing in mathematics but dealing with mathematical tasks in general. Most education systems that show the lowest levels of self-efficacy, such as Argentina, Brazil, Brunei Darussalam, Cambodia, Chile, Costa Rica, the Dominican Republic, Guatemala, Malaysia, Mexico and the Philippines, also show the highest levels of mathematics anxiety.

Students who are more confident and students who are less anxious ask more questions when they do not understand something being taught. They are more proactive in their learning than students who are less confident and those who are more anxious, respectively. They are also more motivated and they especially love learning new things.

All learning strategies for sustained lifelong learning and motivations are related to students feeling more confident solving mathematical tasks and less anxious about mathematics, regardless of their performance. This is particularly true for strategies related to proactive behaviour and motivations to learn. Albania and Uzbekistan show the largest associations between self-efficacy or anxiety and most learning strategies or motivations.

Teachers can alleviate students' anxiety about mathematics by building positive relationships with their students. This is especially true in El Salvador, Georgia, Kazakhstan and the Ukrainian regions (18 of 27), where the association between student-teacher relationships and students' anxiety levels is particularly strong. Teachers who are extra supportive can also help students like mathematics more. While in top-performing countries, large shares of students do not necessarily consider mathematics as one of their favourite subjects, overall, there is a positive relationship between performance and having mathematics as one's favourite subject.

What PISA shows about 15-year-olds' mathematics self-efficacy

Self-efficacy plays an important role in motivating students and helping them succeed. When students do not believe in their abilities to do specific tasks, they will likely not put the effort into completing them successfully. A lack of confidence in doing mathematics may impede students' lifelong learning as they will face mathematics-related problems throughout their lives. Such a lack of confidence may also influence the choices they make as they will be less likely to choose studies or careers that require mathematical skills or are related to mathematics in any way.

Students who are more confident are more likely to set challenging goals for themselves, make more of an effort and persevere longer. On the contrary, students who experience low levels of self-efficacy need to have much higher levels of self-control to succeed as they are less likely to be motivated to learn (Klassen and Usher, 2010[5]; Schunk and Pajares, 2009[6]). Mathematics self-efficacy is positively associated with all socio-emotional skills measured in PISA 2022, even when accounting for students' and schools' socio-economic profile and mathematics performance (see Table V.B1.4.11). In line with the literature, a large association was especially found with persistence[1], meaning that persistence could also potentially help students' confidence in their abilities.

A lack of confidence in applying mathematical skills to real-life contexts might hinder students' opportunities for lifelong learning

Across OECD countries, students reported feeling particularly confident solving mathematical tasks that are usually seen in the classroom.[2] For example, 70% or more agreed or strongly agreed that they feel confident solving different types of equations. On the contrary, students reported feeling less confident solving mathematical problems related to real-life events; for example, less than 50% agreed or strongly agreed that they can confidently calculate the power consumption of an electronic appliance per week or find the actual distance between two places on a map (see Table V.B1.4.1). In Albania, France, Singapore and Uzbekistan, more than 60% of students reported that they can confidently solve these problems but in Thailand and Viet Nam, less than 40% did. This result is concerning for students' lifelong learning opportunities as it suggests that students who are less confident applying their mathematical skills to real-life contexts may struggle. In other words, they will feel less confident with all the various forms of mathematics they may need as adults in daily life.

Students who reported more mathematics self-efficacy tend to have higher mathematics scores

In line with previous PISA cycles, there is a positive association in PISA 2022 between mathematics self-efficacy and mathematics performance even after accounting for students' and schools' socio-economic profile. Specifically, a one-unit increase in the index of mathematics self-efficacy is associated with an increase of 28 points in mathematics on average across OECD countries. This means that students who feel more confident solving mathematics tasks perform better in mathematics (see Table V.B1.4.3). This association is larger in Australia*, Korea, Macao (China), New Zealand*, Singapore and the United Kingdom*, with an increase of more than 35 score points in mathematics. On the contrary, this association is smaller in Cambodia, the Dominican Republic, Guatemala and the Philippines, with an increase lower than 10 score points.

Low-achieving students feel less confident in some top-performing countries and economies

Among countries and economies that show the widest gaps in self-efficacy between low and skilled performers are some top-performing systems. These include Australia*, Austria, Canada*, Japan, Korea, Macao (China), New Zealand*, Singapore, Sweden and Chinese Taipei (see Table V.B1.4.4) – systems that tend to show the highest levels of mathematics self-efficacy overall. Low achievers in top-performing systems might feel particularly insecure about their mathematics skills. This could also be related to the low shares of students who like mathematics in top-performing countries and economies (Box V.4.1). Given the strong association between self-efficacy and performance, it is important to help low achievers feel confident about solving mathematics tasks. This could help improve their performance.

Box V.4.1. The role of liking mathematics for lifelong learning

Liking mathematics might improve students' readiness for lifelong learning

High shares of students liking mathematics reflects positive learning experiences. This motivates students to put more effort into and feel optimistic about overcoming challenges and can have a positive impact on students' lifelong learning attitudes towards mathematics. Across OECD countries on average, 39% of students agreed or strongly agreed that mathematics is one of their favourite subjects. Singapore and Uzbekistan have the highest shares, with, respectively, 65% and 69% of students reporting mathematics as one of their favourite subjects (see Table V.B1.4.30).

In all PISA-participating countries and economies, liking mathematics is positively associated with mathematics self-efficacy even when accounting for students' and schools' socio-economic profile and mathematics performance (see Table V.B1.4.39). This means that when students like mathematics they might feel more confident about their mathematics abilities. This can be important, especially for students who feel less confident and underperform in mathematics. Not surprisingly, fewer girls than boys and fewer disadvantaged than advantaged students reported that mathematics was one of their favourite subjects in almost all countries and economies. The differences are, respectively, an average of 11 and 13 percentage points across OECD countries (see Table V.B1.4.30).

Students in top-performing countries did not report mathematics to be one of their favourite subjects but skilled-performing students reported it more than their low-performing peers

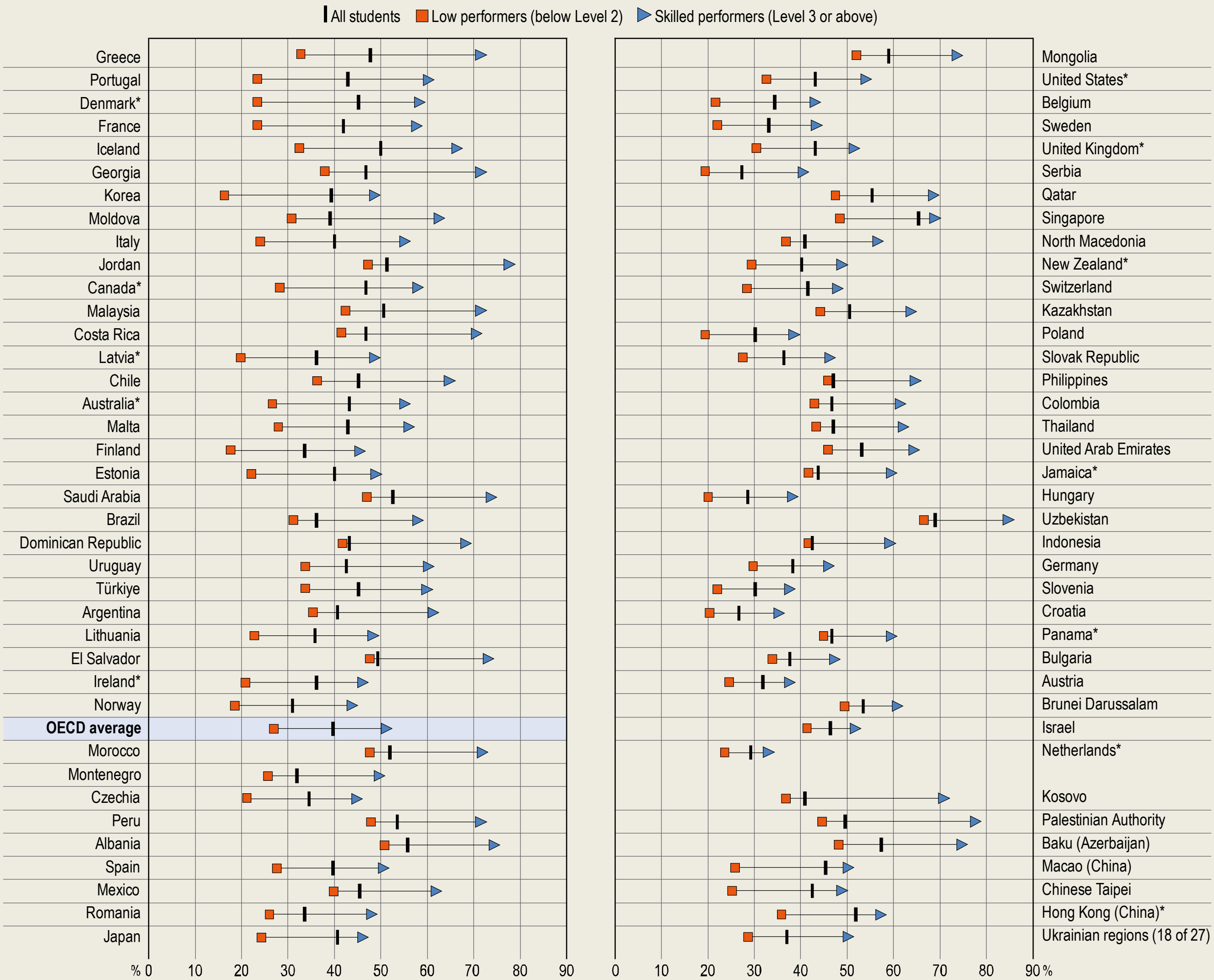
While the expectation would be that top-performing countries and economies in mathematics have a larger share of students who consider mathematics to be one of their favourite subjects, there is no clear country-level association between liking mathematics and performance. In most top-performing countries and economies in mathematics, the overall share of students who consider mathematics to be one of their favourite subjects is only around the OECD average. The exceptions are the Netherlands*, which has one of the lowest shares (29%), Hong Kong (China)* and Singapore, which both have much higher shares (more than 50%). Surprisingly, other education systems with large shares of students who consider mathematics to be one of their favourite subjects do not necessarily perform well in mathematics (see Table I.B1.2.1 [Volume I – PISA 2022 Results] and Figure V.4.1).

However, PISA 2022 also shows there is a strong relationship within countries/economies between performance and liking mathematics. Specifically, students in OECD countries agreeing or strongly agreeing that mathematics is a favourite subject is associated with an increase in performance of 42 points on average, after accounting for students' and schools' socio-economic profile. Korea presents by far the strongest association, with an increase of 63 points in mathematics. The lowest associations (below 20 points) were found in the Dominican Republic, El Salvador, Jamaica*, the Philippines and Thailand (Table V.B1.3.15).

This result is confirmed when looking at the shares of students within countries who like mathematics and their performance. In all countries and economies, more skilled than low performers agreed or strongly agreed that mathematics is one of their favourite subjects. On average across OECD countries, 51% of skilled performers and 27% of low performers reported so (see Figure V.4.1). Some countries that are top performers in mathematics but show, overall, low shares of students liking mathematics are also characterised by larger differences between skilled and low performers reporting to like mathematics. This is the case, for example, in Denmark* and Korea. It is important, especially in these countries, to support low performers and provide them with more support in mathematics class as they might feel more pressure to perform well and discouraged in their learning.

Figure V.4.1. Mathematics as favourite subject and performance in mathematics

Percentage of students agreeing or strongly agreeing that mathematics is one of their favourite subject, by level of performance in mathematics



Note: Only countries and economies with available data are shown.

Countries and economies are ranked in descending order of the percentage-point difference relative to mathematics performance (skilled performers minus low performers).

Source: OECD, PISA 2022 Database, Table V.B1.4.30. See Table V.4.1 for StatLink at the end of this chapter.

Teacher support can help increase students' chances of liking mathematics

Liking mathematics is also influenced by other factors, notably curricula and pedagogy. Singapore, for example, emphasises mathematical reasoning and problem-solving in mathematics curricula and allows students to choose among different options and levels: this may be why more students say that mathematics is one of their favourite subjects (Box V.4.2). Additionally, teacher support can play a key role in helping students enjoy learning.

PISA 2022 Volume II shows how students with supportive teachers suffer less from anxiety and perform better. PISA 2022 results also show that students with supportive teachers are more likely to agree or strongly agree that mathematics is one of their favourite subjects (see Table V.B1.4.41) in almost all countries and economies. This is particularly salient as there is discussion that teacher support has deteriorated since 2012 in many countries and economies. Countries with low teacher support, such as Austria, Croatia, Czechia, Hungary, the Netherlands*, Poland and Slovenia, also show low shares of students liking mathematics. On the contrary, countries with highly supportive teachers such as Albania, Kazakhstan and Saudi Arabia have high shares of students liking mathematics (see Tables V.B1.4.30 and V.B1.4.37).

Source: OECD (2023[7]), PISA 2022 Results (Volume II): Learning During – and From – Disruption, https://doi.org/10.1787/a97db61c-en; OECD (Forthcoming[8]), Mathematics for Life and Work, A Comparative Perspective on Mathematics to Inform Upper Secondary Reform in England.

How is students' mathematics self-efficacy related to learning strategies that strengthen sustained lifelong learning?

Students who are more confident ask more questions and apply more proactive study behaviours than those who are less confident

Students who are more confident in mathematics reported applying different types of learning strategies more frequently (see Table V.B1.4.7). They especially reported using more strategies related to controlling their own learning, such as asking questions when not understanding the mathematics material being taught. This not only requires confidence but is essential to improving one's understanding and learning outcomes. In Albania, Baku (Azerbaijan), Iceland, Korea, Mongolia and Norway, the difference between the shares of confident and less confident students reporting that they asked questions is more than 40 percentage points compared to an OECD average of 29 percentage points. In Costa Rica and Guatemala this difference is below 20 percentage points.

Students who are more confident also demonstrate more use of proactive study behaviours, which includes things like connecting new material with previous lessons. This is another key association for lifelong learning: confident students tend to trust their knowledge more and might find it easier to build on it with new information. While this difference is an average of 33 percentage points across OECD countries, it is a difference of more than 50 percentage points in Albania and Korea. In Austria, Belgium and Japan, it is less than 20 percentage points.

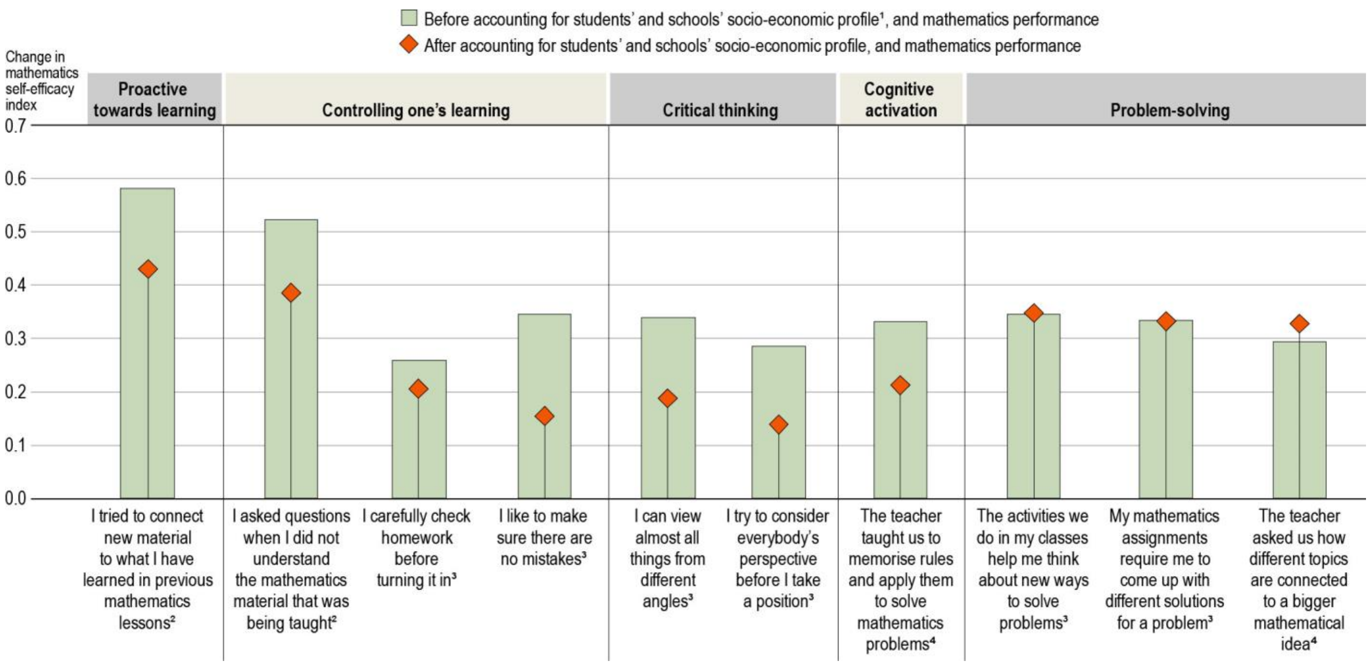
Learning strategies, especially those related to proactive behaviours and problem-solving, relate positively to mathematics self-efficacy

Figure V.4.2 shows that mathematics self-efficacy is positively associated with all learning strategies even when accounting for students' and schools' socio-economic profile and students' mathematics performance. While we cannot attribute causality from these analyses, one way to interpret these results is that when students use specific learning strategies and teachers encourage them to use them, they might become more confident solving mathematics tasks for the same level of performance. Learning strategies that show the largest associations are those that require proactive learning behaviours such as connecting new and prior knowledge and those related to problem-solving such as finding new ways to solve problems. Students asking questions when they do not understand something has a strong association with mathematics self-efficacy. This suggests that not only are these students more likely to ask questions, but they are more confident. Asking questions helps students become more confident in mathematics tasks.

Interestingly, some education systems show larger associations between mathematics self-efficacy and all or most learning strategies. This is the case, for example, in Albania, Baku (Azerbaijan), the Dominican Republic, Israel, Jordan, North Macedonia, Saudi Arabia and Uzbekistan. These associations are smaller in Belgium, Brunei Darussalam, Italy, Singapore, Spain, Switzerland and Viet Nam (see Table V.B1.4.9).

Figure V.4.2. Mathematics self-efficacy and learning strategies

Change in mathematics self-efficacy when students reported the following learning strategies; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
2. Students doing the corresponding statement more than half of the time.
3. Students agree or strongly agree with the corresponding statement.
4. Students doing the corresponding statement more than half of the lessons.
Note: All differences are statistically significant (see Annex A3).
Items are ranked by kind of learning strategies and then in descending order of the change in mathematics self-efficacy index, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.4.9. See Table V.4.1 for StatLink at the end of this chapter.

How the relationship between students' mathematics self-efficacy and motivations encourages sustained lifelong learning

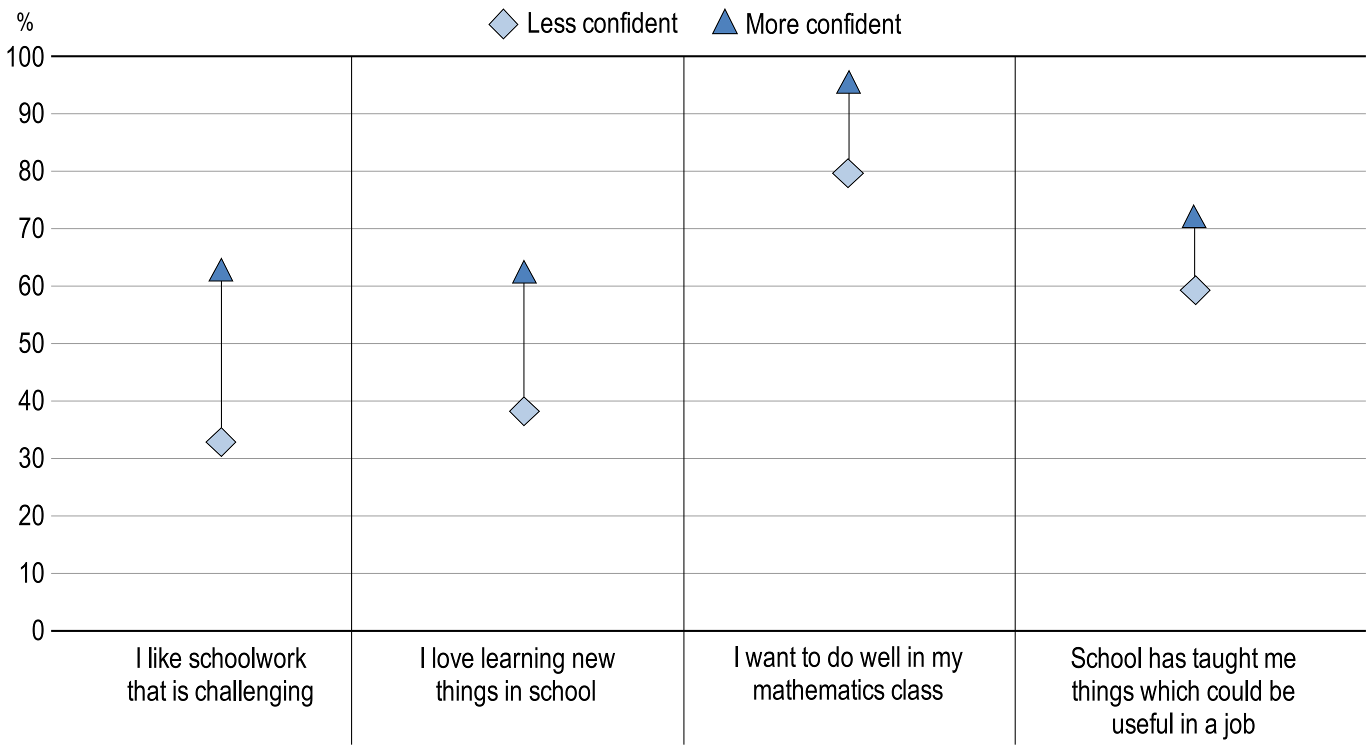
Students who are more confident feel more motivated and enjoy learning more than those who are less confident

Students who are more confident in their capacity to solve mathematics problems also reported feeling more motivated (see Figure V.4.3). Responses to "I like schoolwork that is challenging" and "I love learning new things in school" revealed the biggest difference between confident and less confident students. This suggests that students who are more confident enjoy learning and challenging themselves more than those less so.

Australia*, Canada*, Denmark*, Finland, Hong Kong (China)*, Ireland*, Macao (China), New Zealand*, Norway and the United Kingdom* show wider differences between the shares of confident and less confident students liking challenging schoolwork. These differences range between 40 and 48 percentage points compared to 30 percentage points on average across OECD countries. On the contrary, Albania, Brunei Darussalam, Colombia, Georgia, Serbia, the Slovak Republic, Slovenia and Uruguay show smaller differences between confident and less confident students, ranging between 16 and 20 percentage points (see Figure V.4.3b [available online] and Table V.B1.4.8).

Figure V.4.3. Difference between more and less confident students in reporting motivations

Percentage of students agreeing or strongly agreeing with the following motivations, by the bottom and top quarters of the index of mathematics self-efficacy; OECD average



Notes: Students who are less confident (more confident) are those in the bottom (top) quarter of the index of mathematics self-efficacy in their own country/economy.
Differences between students in top and those in bottom quarters of the index of mathematics self-efficacy are all statistically significant (see Annex A3).
Items are ranked in descending order of the percentage-point difference related to confidence in mathematics (more confident minus less confident students).
Source: OECD, PISA 2022 Database, Table V.B1.4.8. See Table V.4.1 for StatLink at the end of this chapter.

Intrinsic motivations have an especially positive relationship with confidence

Mathematics self-efficacy is positively associated with all types of motivation even after accounting for students' and schools' socio-economic profile, and mathematics performance (see Table V.B1.4.10). But the largest association is between mathematics self-efficacy and liking schoolwork that is challenging. When students are motivated to learn and challenge themselves, they are more likely to have confidence in their abilities to succeed. Hong Kong (China)* and Uzbekistan show the largest associations between self-efficacy and liking schoolwork that is challenging. Students who like challenging schoolwork in these countries and economies are particularly likely to feel confident about their capacity to solve mathematics tasks.

While students who are less confident in their mathematic abilities need more support and encouragement to take on new and challenging learning, most students with low levels of confidence still want to do well in school. This is a strong driver of using learning strategies (see Chapter 2). Students with low levels of confidence also show high levels of instrumental or extrinsic motivation as they think school teaches them things that might be useful for a job (see Table V.B1.4.10). These results suggest that even if students find learning less enjoyable, they still see its value for instrumental purposes and feel motivated to do well at school. This finding has important implications for lifelong learning: supporting students to become more confident could help them enjoy learning as a process in itself rather than just as a means to an end. Learning for the sake of learning is the kind of motivation that is more related to learning strategies for lifelong learning than learning to be able to get a job (see Chapter 3). While instrumental motivation is a good driver for learning in school, it is less likely to motivate them as adults if they do not enjoy learning. As discussed in Box V.4.1 and Box V.4.2, one way to improve students' enjoyment of learning mathematics is through curricula and pedagogy. These include providing different options and levels to learn mathematics and ensuring teachers' support.

Box V.4.2. Singapore: Providing guidance and options to learn mathematics

Schools having different options and levels in mathematics caters to different student needs and aspirations, and keeps them studying mathematics in upper secondary education

Mathematics is still a compulsory subject in most education systems. This ensures that all students develop the numeracy skills they will need as adults. But as students get older and develop their interests and preferences, it becomes more challenging to keep them motivated and in school. Schools in most countries, especially at the upper secondary level, have found a solution by allowing students to choose among a variety of different course levels and options in mathematics. This caters to students' wider set of needs and aspirations, and helps them stay motivated and finish their studies.

Singapore provides different mathematics levels as early as Grades 5 and 6. Primary education students who require more time and support can take the Foundation Mathematics syllabus instead of the Standard Mathematics syllabus. The Foundation Mathematics syllabus provides greater focus on basic concepts and skills, and allows students to learn a lower content load with more curriculum time.

At the secondary level, Singapore offers either the G1, G2 or G3 (G stands for General) Mathematics syllabus from Grade 7 to Grade 10, based on their Mathematics performance in primary school. Students have the flexibility to adjust their subject levels, based on their strengths, interests and learning needs. For example, G1 Mathematics caters to students who studied Foundation Mathematics in primary school. From Grade 9, students who are interested and are performing well at their current level may opt to study at a higher level; that is, either G2 Additional Mathematics or G3 Additional Mathematics.

Together, these 5 syllabi cater to students' different needs, interests and abilities, with the following goals:

- ensure that all students will achieve a level of mastery of mathematics that enables them to function effectively in everyday life
- for those who have the interest and ability, to learn more mathematics so that they can pursue mathematics or mathematics-related courses of study in the next stage of education.

High-quality education and career guidance ensure that all students understand their options and are supported in making choices that will be decisive for their future

A high degree of choice, however, comes with some risks. Young people are often not aware of the high-stakes nature of deciding what they take in upper secondary education. They do not think about how it shapes their future education and work pathways. Students and their parents often make decisions based on perceptions or parents' own experiences rather than objective information about the labour market outcomes associated with different options. Giving greater choice to students should go hand-in-hand with high-quality student guidance that informs students about future opportunities and labour market needs.

To help students better navigate these different options and decide which education and career pathways they want to pursue, Singapore provides Education and Career Guidance (ECG) to students across different levels of education:

- Secondary schools and post-secondary education institutions are resourced with ECG counsellors who help students identify their strengths and interests through education and career counselling, workshops and student development experiences (e.g. ECG talks/fairs, talks by industry professionals and learning journeys to industries). ECG counsellors ensure that all students, regardless of their background and performance, receive tailored advice and support to make informed decisions about their education and career plans. For students with greater ECG needs (e.g. those from disadvantaged socio-economic status), targeted support is provided by ECG counsellors in consultation with school personnel overseeing student development. They also work with the school team to help teachers and other school personnel be able to provide basic advice on ECG for their students.

- The "MySkillsFuture" is an online portal with information and tools to explore various education and career pathways for all students from primary to tertiary education.
- The ECG Centre at the Ministry of Education provides education and career counselling services for students during the period when national examination results are released. Students can book an ECG counselling appointment, which can be conducted online or via phone.
- ECG resources are made available online for students, teachers and their parents to better understand possible education and career pathways. Examples include a publication on the World of Work and the skills in demand, and a guide for parents to support their children in making choices at key moments in education. Stories of individuals and how they discovered their personal interests, and educational and career pathways are also part of these resources.

Source: Ministry of Education of Singapore (2024[9]), 2020 G1,G2 & G3 Mathematics Syllabuses and 2020 G2 & G3 Additional Mathematics Syllabus, https://www.moe.gov.sg/secondary/schools-offering-full-sbb/syllabus; Ministry of Education of Singapore (2024[10]), Overview of Education and Career Guidance, https://www.moe.gov.sg/education-in-sg/our-programmes/education-and-career-guidance/overview; OECD (Forthcoming[8]), Mathematics for Life and Work, A Comparative Perspective on Mathematics to Inform Upper Secondary Reform in England; Stronati (2024[11]), "Managing choice, coherence, and specialisation in upper secondary education", https://doi.org/10.1787/4a278519-en.

What PISA shows about 15-year-olds' mathematics anxiety

Mathematics can make many students feel worried, stressed and, even, helpless (OECD, 2015[12]). Mathematics anxiety is a major challenge for students' well-being but also for their lifelong learning. PISA 2022 results show that students with high levels of self-efficacy are more likely to use learning strategies and feel motivated. Results show the opposite effect for those who reported lower levels of mathematics self-efficacy and experience higher levels of mathematics anxiety. The same result is found at the country/economy level. Most education systems that show the lowest levels of self-efficacy, such as some Latin American countries (Argentina, Brazil, Chile, Costa Rica, the Dominican Republic, Guatemala and Mexico) and some Southeast Asian countries (Cambodia, Malaysia, and the Philippines), also show the highest levels of mathematics anxiety (see Tables V.B1.4.1 and V.B1.4.12).

Mathematics anxiety is negatively associated with all socio-emotional skills measured in PISA 2022, especially with stress resistance[3] and emotional control[4], even when accounting for students' and schools' socio-economic profile and mathematics performance (see Table V.B1.4.22). This means that students who have more control over their emotions and who can manage stress better experience less mathematics anxiety. Students who are particularly anxious about mathematics find it difficult to work through mathematical tasks because they focus on managing the stress associated with the process rather than solving problems (Ashcraft, Kirk and Hopko, 1998[13]). These students also tend to avoid challenging themselves because they are worried about failing. These negative associations with mathematics are detrimental for lifelong learning. They discourage students from taking on problems that involve mathematics, which they are sure to encounter in contexts outside school. Overall, anxious students will avoid challenging situations, which are, nonetheless, important opportunities for evolving and developing new skills.

A sharp rise in students' mathematics anxiety can hinder students' opportunities for lifelong learning

Students in OECD countries feel particularly anxious about their results and performance in mathematics[5]. On average, 65% of students worry about getting poor marks in mathematics and 55% feel anxious about failing in mathematics. Furthermore, around 40% of students reported feeling nervous, helpless or anxious while solving mathematics problems or doing homework, meaning that students are anxious simply dealing with the subject and not just because they are worrying about failing (see Table V.B1.4.12). These shares are even higher in Brazil, Brunei Darussalam, El Salvador, Indonesia, Malaysia, the Philippines and Thailand. Lastly, PISA shows there has been a sharp rise in mathematics anxiety from 2012 to 2022 in most PISA-participating countries and economies (Box V.4.3).

The association between anxiety and mathematics can be detrimental to lifelong learning. Students who develop negative feelings towards mathematics at schools may be less likely to opt for further education that includes mathematics. They may avoid reskilling opportunities that involve mathematics as well. Reducing students' mathematics anxiety has become a key policy challenge for improving students' well-being, performance and their readiness to keep learning throughout their lives.

Additionally, low performers (those who perform below Level 2 in mathematics) show higher levels of mathematics anxiety than skilled students (those who perform at Level 3 or above in mathematics) (see Table V.B1.4.15) (see Box V.2.1 Chapter 2). This suggests that while anxiety is an obstacle to lifelong learning for all learners, it is even more so for those who also struggle with basic skills. Skilled students who have a solid foundation and strong mathematical skills will be able to build on those and be less likely to experience high levels of anxiety about mathematics. Those who lack a strong foundation in mathematics, however, will struggle to engage with lifelong learning and be more likely to experience anxiety and develop an adverse attitude towards mathematics.

Box V.4.3. Increasing uncertainty and anxiety are a challenge for students' well-being and learning

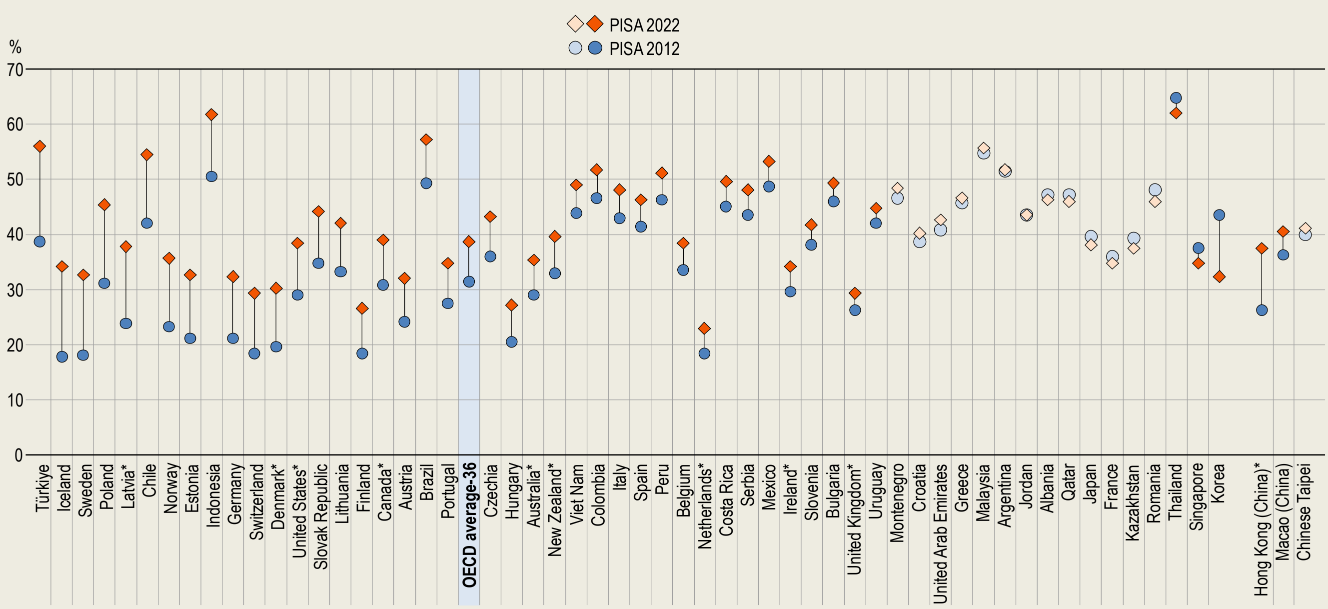
Students feel more anxious doing mathematics now than 10 years ago

Compared to 2012, students in 2022 reported higher levels of mathematics anxiety in most PISA-participating countries and economies. While anxiety levels have risen sharply, especially in most European countries and most Latin American countries, it fell significantly from 2012 levels in Korea. More students also reported feeling helpless or tense doing mathematics problems or homework on average across OECD countries than in 2012. On the contrary, there was only a slight increase in students worrying about their marks and no change in the share of students worrying that it would be difficult for them in mathematics classes (see Table V.B1.4.23). This result is worrying. Students are developing increasingly negative attitudes about learning mathematics. This may impact not only their performance but their readiness for lifelong learning. This finding also suggests that young people's well-being has deteriorated, and policies are needed to support students' mental health.

Iceland and Türkiye had the largest increases in the shares of students reporting that they felt nervous doing mathematics problems between 2012 and 2022. Korea, Singapore and Thailand are the only countries that show a significant drop between 2012 and 2022, with Korea showing an impressive drop of 11 percentage points (see Figure V.4.4).

Figure V.4.4. Change in mathematics anxiety between PISA 2012 and PISA 2022

Change between 2012 and 2022 in the percentage of students agreeing or strongly agreeing that they get very nervous when doing mathematics problems



Notes: Only countries and economies with available data are shown.
Statistically significant differences are shown in a darker tone (see Annex A3).
OECD average-36 refers to the average across OECD countries, excluding Israel and Luxembourg.
Countries and economies are ranked in descending order of the percentage-point difference of students agreeing or strongly agreeing that they get very nervous when doing mathematics problems between 2012 and 2022.
Source: OECD, PISA 2022 Database, Table V.B1.4.23. See Table V.4.1 for StatLink at the end of this chapter.

Students worry about the future and feel anxious about their learning

Since 2003, PISA has recorded an increase in students' levels of anxiety. This trend could be related to students increasingly feeling more uncertain and afraid of the future. PISA 2022 asked students a series of questions about their feelings about the future and how prepared they are for it. Almost 50% of students worry they are not prepared for life after they finish compulsory education, on average across OECD countries. This share is higher in Argentina, Brunei Darussalam, Singapore and Chinese Taipei, exceeding 70%. In Hungary, Morocco and Palestinian Authority, it is lower than 30% (see Table V.B1.4.31).

An average of almost 45% of students worry they won't have enough money to do what they would like to do after the final year of compulsory education. This share is higher for in Brazil, Brunei Darussalam, Chile, Colombia, Costa Rica and Peru, exceeding 65% (see Table V.B1.4.33). While less than 35% of students reported feeling pressure from family to follow a specific path after finishing compulsory education, in Brunei Darussalam, the Philippines and Uzbekistan, almost 60% reported this (see Table V.B1.4.32).

All these different anxieties about the future have a large positive association with mathematics anxiety, meaning that students who worry about the future can also suffer from greater mathematics anxiety. And, while all these different anxieties about the future relate negatively to mathematics performance, those who worry about not being prepared for life after school show the largest association with mathematics anxiety (see Table V.B1.3.10). In terms of performance, feeling pressure from parents has the largest impact, with a decrease of 14 points in mathematics performance after accounting for students' and schools' socio-economic profile (see Table V.B1.4.31). Because students' performance and mental health are so related to their fears about the future, it is important that students have access to career guidance and counselling as well as psychological and emotional support.

Source: (OECD, 2004[14]); (OECD, 2015[12]); (OECD, 2019[15]).

Reducing mathematics anxiety among girls and disadvantaged students can help improve their performance and readiness for lifelong learning

Since 2003, PISA has shown a negative association between mathematics anxiety and mathematics performance in every education system that has participated in PISA (OECD, 2004[14]). Specifically, PISA 2022 finds that a one-point increase in the index of mathematics anxiety is associated with a decrease in mathematics achievement of 18 score points after accounting for students' and schools' socio-economic profile on average across OECD countries (see Table V.B1.4.14) (OECD, 2023[16]). In some countries and economies this association is larger, especially in Denmark* where a one-point increase in the index of mathematics anxiety is associated with a decrease of 27 points. In Brunei Darussalam, the Dominican Republic and El Salvador, however, the decrease is of only 6 points.

In most countries and economies, 15-year-old girls reported significantly higher levels of mathematics anxiety than boys. While these differences partly reflect differences in mathematics performance related to gender, the gender gap in anxiety persists even among top-performing students, suggesting that girls feel more anxious than boys even when they perform at similarly high levels (see Table V.B1.4.16). Similar results are found when comparing advantaged and disadvantaged students (see Table V.B1.4.13). This suggests that focusing solely on performance is not the solution for reducing students' anxiety. Neither is it an effective way to tackle gender and socio-economic gaps. Rather, schools might work to make sure that girls and disadvantaged students do not perceive learning outcomes, like performance in mathematics, as inherently difficult or beyond their capabilities. This is important not just for lifelong learning but learning in general.

How can the relationship between students' mathematics anxiety and learning strategies be used to strengthen lifelong learning?

Students who are more anxious tend to ask less questions and demonstrate a less proactive study behaviour than those who are not

Students who are more anxious reported using learning strategies less often than those who are less anxious (see Table V.B1.4.18). In particular, anxious students are less likely to ask questions when they do not understand material covered in class than their less anxious peers. And, more anxious students use fewer proactive behaviour study techniques, such as connecting new material to previous mathematics lessons. These differences are, respectively, of 20 and 16 percentage points, on average across OECD countries. The gap is larger in non-OECD countries and economies, especially in Baku (Azerbaijan), Bulgaria, Morocco, Saudi Arabia and Uzbekistan, where the differences between the shares of anxious and less anxious students reporting these learning strategies exceed 30 percentage points.

Learning strategies, especially those related to proactive behaviour, relate negatively to mathematics anxiety

The negative association between mathematics anxiety and performance is partly related to the negative effect of anxiety on cognitive resource activation. This means that when students are anxious about mathematics, they cannot focus on solving mathematics problems because they are distracted by worrying about these tasks and their ability to solve them. One way to help students improve their performance is to help them develop learning strategies that can reduce anxiety.

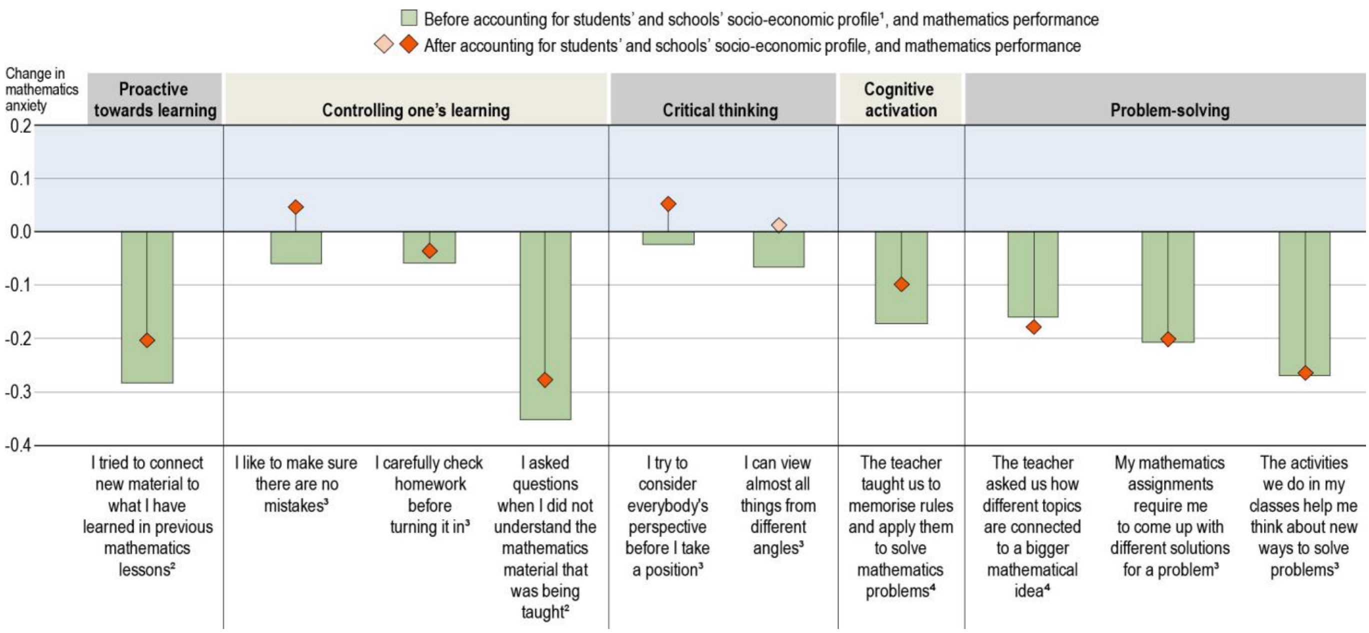
PISA data suggest that specific proactive mathematics study behaviours, which include connecting new and prior knowledge, have large negative associations with mathematics anxiety (see Figure V.4.5). This means that students who use certain proactive learning techniques do not suffer as much from mathematics anxiety. Similarly, learning strategies introduced by teachers to encourage cognitive activation, problem-solving and creativity are linked with lower levels of anxiety. This is true even after accounting for students' and schools' socio-economic profile, and students' mathematics performance. Fostering and supporting the use of learning strategies in the classroom, like new ways to solve problems, and connecting new and prior knowledge can help students cope with mathematics anxiety, and, in turn, improve their lifelong learning opportunities.

In contrast, learning strategies related to controlling one's learning, such as checking homework or making sure there are no mistakes, and those related to critical thinking have very small or almost no association with anxiety. While causality cannot be attributed from these analyses, one way to interpret these results is that independent learning behaviours such as checking for correct or incorrect answers might not always provide students with the external validation they need to reduce their anxiety.

It is important to mention that while most of the associations between anxiety and learning strategies are quite small for OECD countries, they become larger in some non-OECD education systems, especially in Albania, Baku (Azerbaijan), Jordan, Saudi Arabia and Uzbekistan (see Figure V.4.5b [available online] and Table V.B1.4.20).

Figure V.4.5. Mathematics anxiety and learning strategies

Change in mathematics anxiety when students reported the following learning strategies; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
2. Students doing the corresponding statement more than half of the time.
3. Students agree or strongly agree with the corresponding statement.
4. Students doing the corresponding statement more than half of the lessons.
Notes: Differences that are statistically significant are shown in a darker tone (see Annex A3).
Differences before accounting for students' and schools' socio-economic profile, and mathematics performance are all statistically significant (see Annex A3).
Items are ranked by kind of learning strategies and then in descending order of the change in mathematics anxiety index, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.4.20. See Table V.4.1 for StatLink at the end of this chapter.

How can the relationship between students' motivation and mathematics anxiety support sustained lifelong learning?

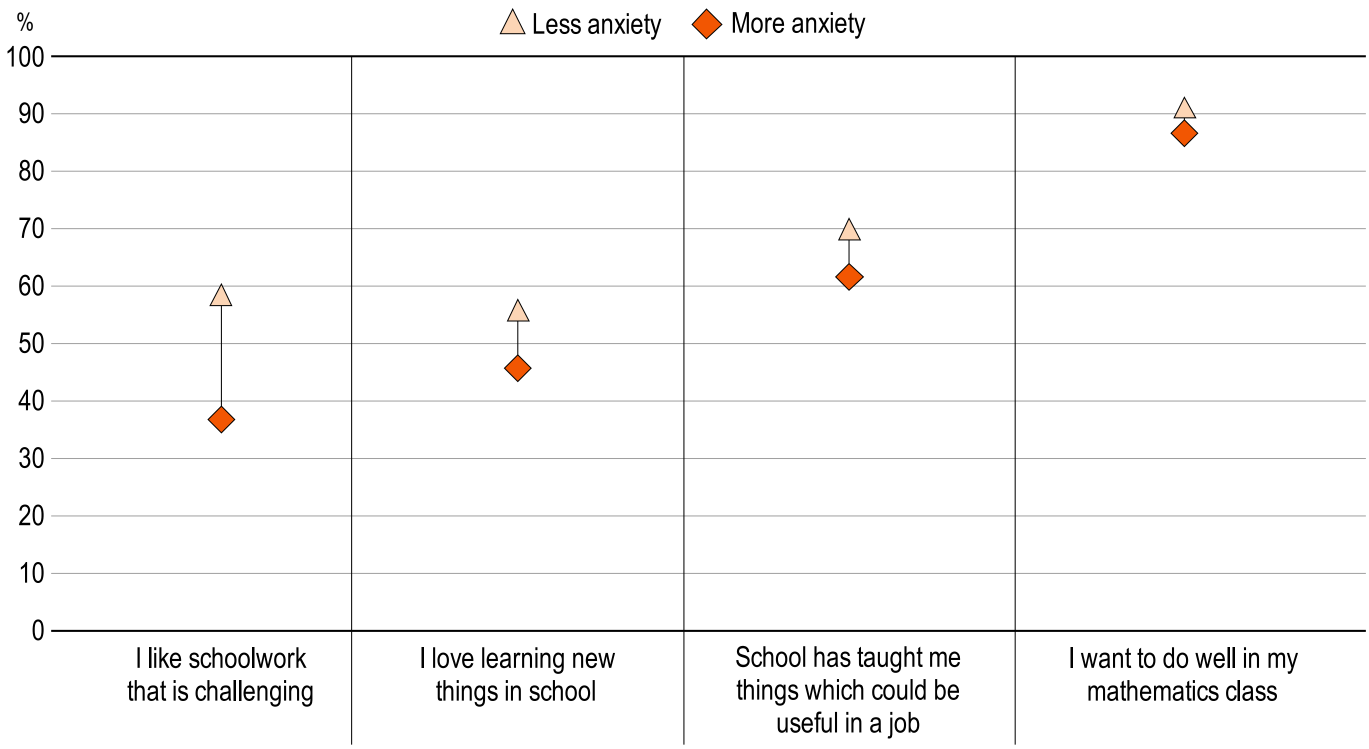
Students who are more anxious find less enjoyment in learning than those who are not

Responses to "I love schoolwork that is challenging" and "I love learning new things in school" uncovered the greatest gap in motivation (22 and 10 percentage points on average across OECD countries, respectively) between more and less anxious students (see Figure V.4.6). Students who are more anxious about mathematics are less likely to enjoy learning new and challenging things as they worry about their grades and failing. On the contrary, students feel motivated to do well in school despite their anxiety. This could be because the desire to do well in school can sometimes trigger worries about failing.

Compared to the OECD average, Italy shows smaller differences between anxious and less anxious students enjoying learning new things and challenging schoolwork. On the contrary, Denmark*, Finland, Macao (China) and Norway show much larger differences (see Table V.B1.4.19).

Figure V.4.6. Difference between more and less anxious students in reporting motivations

Percentage of students agreeing or strongly agreeing with the following motivations, by the bottom and top quarters of the index of mathematics anxiety; OECD average



Notes: Students who are less anxious (more anxious) are those in the bottom (top) quarter of the index of mathematics anxiety in their own country/economy. Differences between students in top and those in bottom quarters of the index of mathematics anxiety are all statistically significant (see Annex A3).
Items are ranked in descending order of the percentage-point difference related to mathematics anxiety (less anxious minus more anxious students).
Source: OECD, PISA 2022 Database, Table V.B1.4.19. See Table V.4.1 for StatLink at the end of this chapter.

Mathematics anxiety relates negatively to student motivation

Mathematics anxiety is negatively associated with all types of motivation, even when accounting for students' and schools' socio-economic profile (see Table V.B1.4.21). This means that motivation might help students feel less anxious. On average across OECD countries, this association is large with intrinsic motivations such as "I like schoolwork that is challenging". This suggests that being motivated to learn could help reduce anxiety. On the contrary, while there is a negative association between anxiety and wanting to do well in mathematics class, this is not significant when accounting for mathematics performance. This means that wanting to do well in mathematics class is not a sufficient enough motivation for reducing mathematics anxiety. Interestingly, in 11 education systems the association remains significant and positive, suggesting that wanting to do well in school could contribute to students' anxiety in these systems. This is especially true in Italy and Korea, where this positive association is larger than in other systems.

Finally, anxiety is also negatively associated with the instrumental motivation of making an effort at school because the knowledge may be useful in a job. While it is not possible to attribute causality from these analyses, one way to interpret this result is that understanding the value of school for finding a job in the future might help students feel less anxious. This finding is important as schools and teachers can help students build their instrumental motivation with school guidance and career exploration (see Chapter 6). This result also holds when accounting for mathematics performance.

Teachers' attitudes towards students can help reduce their anxiety towards mathematics and increase their use of learning strategies

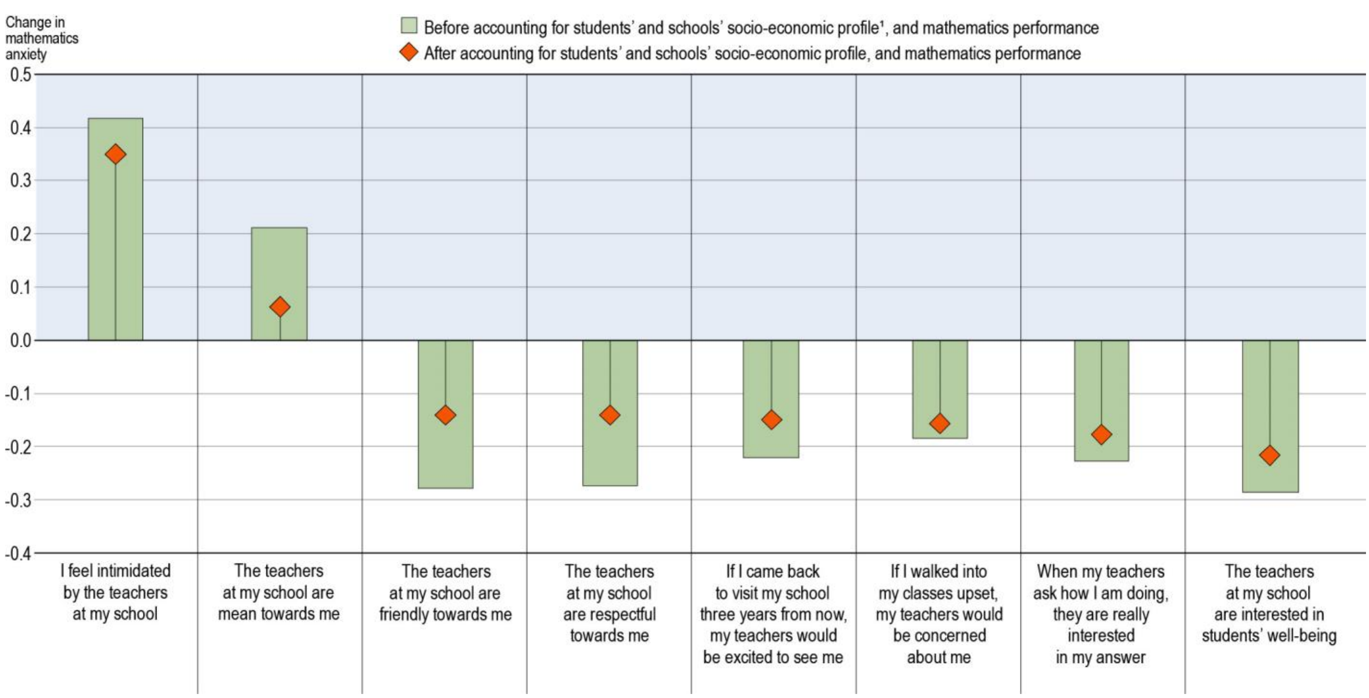
Reducing mathematics anxiety and tackling students' negative associations with mathematics while they are still in school can help learners embrace lifelong learning, especially lifelong learning that involves mathematics. Teachers can significantly enhance or diminish their students' self-beliefs, and this extends to anxiety. Teachers can go a long way towards alleviating their students' mathematics anxiety by using specific teaching techniques and support strategies, and, as found in PISA 2022 Volume II (OECD, 2023[7]), building positive relationships with students.[6]

The index of quality of student-teacher relationships is negatively associated with mathematics anxiety in almost all countries and economies (see Table V.B1.4.29). Feeling intimidated by teachers at school has the largest positive association with students' anxiety towards mathematics (see Figure V.4.7). Put another way: the better students get on with their teachers the less mathematics anxiety they suffer from. A one-point increase in the index of quality of student-teacher relationship is associated with a 0.13 decrease in the index of mathematics anxiety after accounting for students' performance in mathematics on average across OECD countries. Every PISA 2022 test item on the quality of teacher-student relationship has a strong association with mathematics anxiety across OECD countries.

Students who have more positive relationships with their teachers also reported using all learning strategies more than those who had less positive relationships and they are also more motivated (see Tables V.B1.4.25 and V.B1.4.26). In countries and economies where the quality of student-teacher relationships particularly impacts students' anxiety levels, such as in El Salvador, Georgia, Kazakhstan and the Ukrainian regions (18 of 27) healthy relationships between teachers and their students are crucial. It can directly galvanise students to use learning strategies and indirectly decrease students' anxiety (see Figure V.4.7b [available online] and Table V.B1.4.29).

Figure V.4.7. Quality of teacher-student relationship and mathematics anxiety

Change in mathematics anxiety when students agree or strongly agree with the following statements; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Note: All differences are statistically significant (see Annex A3).
Items are ranked in descending order of the change in mathematics anxiety, after accounting for students' and schools' socio-economic profile, and mathematics performance.
Source: OECD, PISA 2022 Database, Table V.B1.4.29. See Table V.4.1 for StatLink at the end of this chapter.

Table V.4.1. Chapter 4 figures: Students' predispositions to learning

Figure V.4.1	Mathematics as favourite subject and performance in mathematics
Figure V.4.2	Mathematics self-efficacy and learning strategies
Figure V.4.3	Difference between more and less confident students in reporting motivations
Figure V.4.3b	Difference between more and less confident students in reporting motivations, by countries and economies
Figure V.4.4	Change in mathematics anxiety between PISA 2012 and PISA 2022
Figure V.4.5	Mathematics anxiety and learning strategies
Figure V.4.5b	Mathematics anxiety and learning strategies, by countries and economies
Figure V.4.6	Difference between more and less anxious students in reporting motivations
Figure V.4.7	Quality of teacher-student relationship and mathematics anxiety
Figure V.4.7b	Quality of teacher-student relationship and mathematics anxiety, by countries and economies

StatLink https://stat.link/bmn4a3

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Notes

1 Students’ ratings of their agreement with statements about a range of behaviours indicative of persistence, such as “I keep working on a task until it is finished” or “I give up after making mistakes”, were scaled into the index of persistence. Each of the 10 items included in this scale have five response options: “Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree” and “Strongly agree”.

2 As in previous cycles of PISA, in 2022 students were asked to rate how confident they felt about having to do a range of formal and applied mathematics tasks. The tasks include: working out from a train timetable how long it would take to get from one place to another; calculating how much more expensive a computer would be after adding tax; calculating how many square metres of tiles are needed to cover a floor; understanding scientific tables presented in an article; solving an equation like $6x^2 + 5 = 29$; finding the actual distance between two places on a map with a 1:10,000 scale; solving an equation like $2(x+3) = (x + 3) (x - 3)$; calculating the power consumption of an electronic appliance per week; solving an equation like $3x+5=17$. Responses from these items were used to create the index of mathematics self-efficacy. The index of mathematics self-efficacy used in this chapter is for formal and applied mathematics. PISA also provides the index of mathematics self-efficacy for mathematical reasoning and 21st-century mathematics, which is constructed by asking students how they feel about having to do a range of mathematical reasoning and 21st-century mathematics tasks. This index is not used in this chapter but is covered in Chapter 8.

3 Students’ ratings of their agreement with statements about a range of behaviours indicative of stress resistance, such as “I remain calm under stress” or “I get nervous easily”, were scaled into the index of stress resistance. Note that this scale used a within-construct matrix sampling design. Each of the 10 items included in this scale have five response options: “Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree”, “Strongly agree”.

4 Students’ ratings of their agreement with statements about a range of behaviours indicative of emotional control, such as “I keep my emotions under control” or “I get mad easily”, were scaled into the index of emotional control. Each of the 10 items included in this scale have five response options: “Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree”, “Strongly agree”.

5 PISA 2022 asked students to report whether they agreed or strongly agreed with a series of statements about experiencing anxiety about mathematics. These responses were then combined to construct the index of mathematics anxiety.

6 Students who participated in PISA 2022 were asked to rate their agreement with a series of statements about the quality of their student-teacher relationships. The items were scaled into the index of “Quality of student-teacher relationships”.

5 How are students' relationships with families and teachers associated with their use of sustained learning strategies?

This chapter examines students' interactions with their parents at home and teachers in school, and how these relate to their use of sustained learning strategies. It also explores how certain types of interactions can particularly encourage low-performing students to use these learning strategies.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

Lifelong learning is a dynamic, multifaceted and continuous process whereby a person acquires skills and knowledge throughout their life (UNESCO, 2021[1]; OECD, 2021[2]). It extends beyond the traditional educational stages and settings, and cannot be confined to a single, specific phase of life or context. (OECD, 2019[3]; UNESCO, 2006[4]). Supportive environments in and out of the classroom can shape students' attitudes towards learning, and their motivations and willingness to try new ways to learn better.

Alongside teachers, parents play a key role in furthering (or, not) children's cognitive abilities, and their disposition towards learning (Fan and Chen, 2001[5]; Bornstein, 2019[6]; Skinner, Johnson and Snyder, 2005[7]; OECD, 2012[8]; OECD, 2023[9]; Borgonovi and Montt, 2012[10]).

This section looks at how student-parent interactions at home and student-teacher interactions in school relate to students' use of strategies for sustained lifelong learning and students' motivations (see Chapter 1). It also emphasises how certain interactions particularly help low-performing students (students who perform below Level 2 in mathematics; see Box V.2.1 in Chapter 2 for definitions).

Key findings

Fifteen-year-olds who interact with their parents on an ordinary, everyday basis and in conversations about learning and school, employ more sustained learning strategies. They are more proactive in mathematics learning, more meticulous about their schoolwork and stronger in critical thinking. Interacting more frequently with parents is also associated with students' motivation to learn.

Students whose teachers are often supportive are more proactive in learning mathematics. They use critical-thinking skills more and take control of their learning. They also reported more exposure to problem-solving and cognitive activation practices. Students who receive teacher support more often also show motivation to learn.

Low performers benefit the most from parental interactions and teacher support. Low-performing students who experience *any* form of parental interaction more frequently use learning strategies more than those who have less parental interaction in most countries and economies. Additionally, low performers who receive teacher support often are more proactive in learning mathematics and use critical-thinking skills more than their peers who receive less.

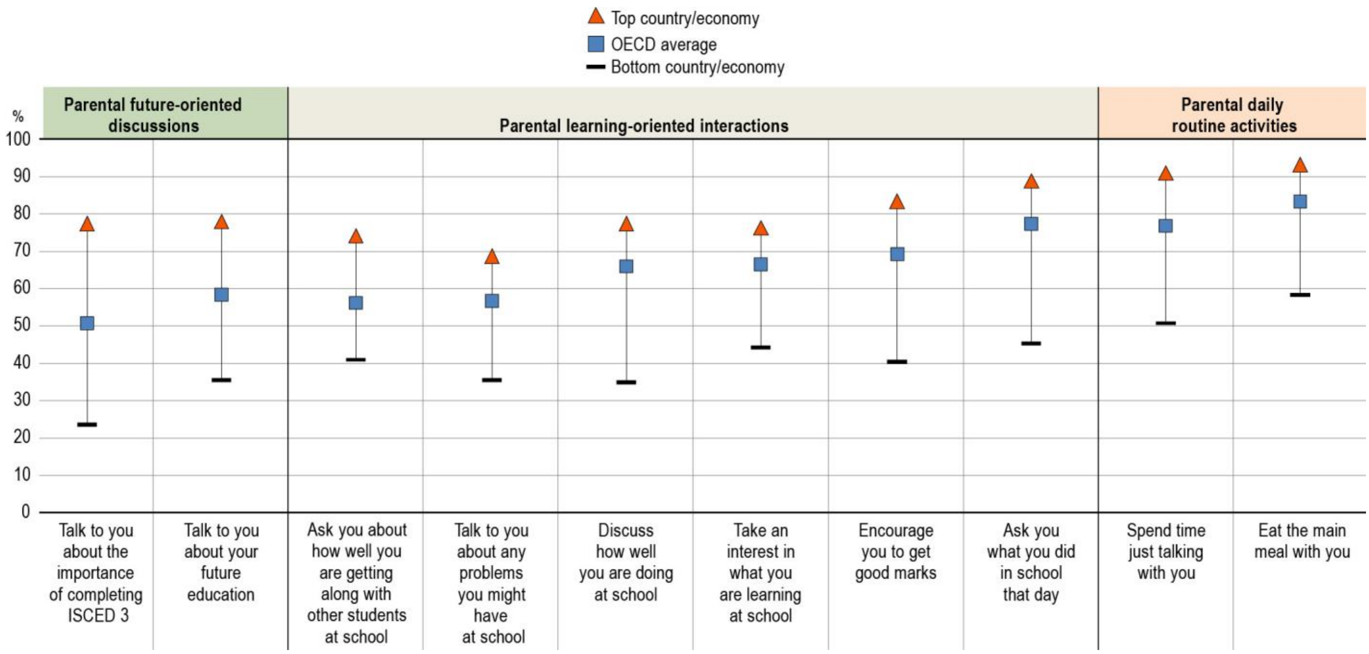
How are parental interactions related to students' use of sustained learning strategies?

PISA 2022 asked 15-year-old students how often their parents (or other family members) do different activities with them. These activities break down into three forms of parental interactions:

- Daily routine activities such as eating meals together and spending time talking.
- Learning-oriented conversations around how well students are doing at school, encouragement to get good marks, interest in what students are learning, etc.
- Future-oriented conversations about education or the importance of completing secondary schooling (see Figure V.5.1).

Figure V.5.1. Types of parental interactions

Percentage of students reporting their parents or someone in their family do the following with them, at least once a week; OECD average



For each category, items are ranked in ascending order of the percentage of students at the OECD average.
Source: OECD, PISA 2022 Database, Table V.B1.5.1. See Table V.5.1 for StatLink at the end of this chapter.

Students who interact often with their parents employ more sustained learning strategies

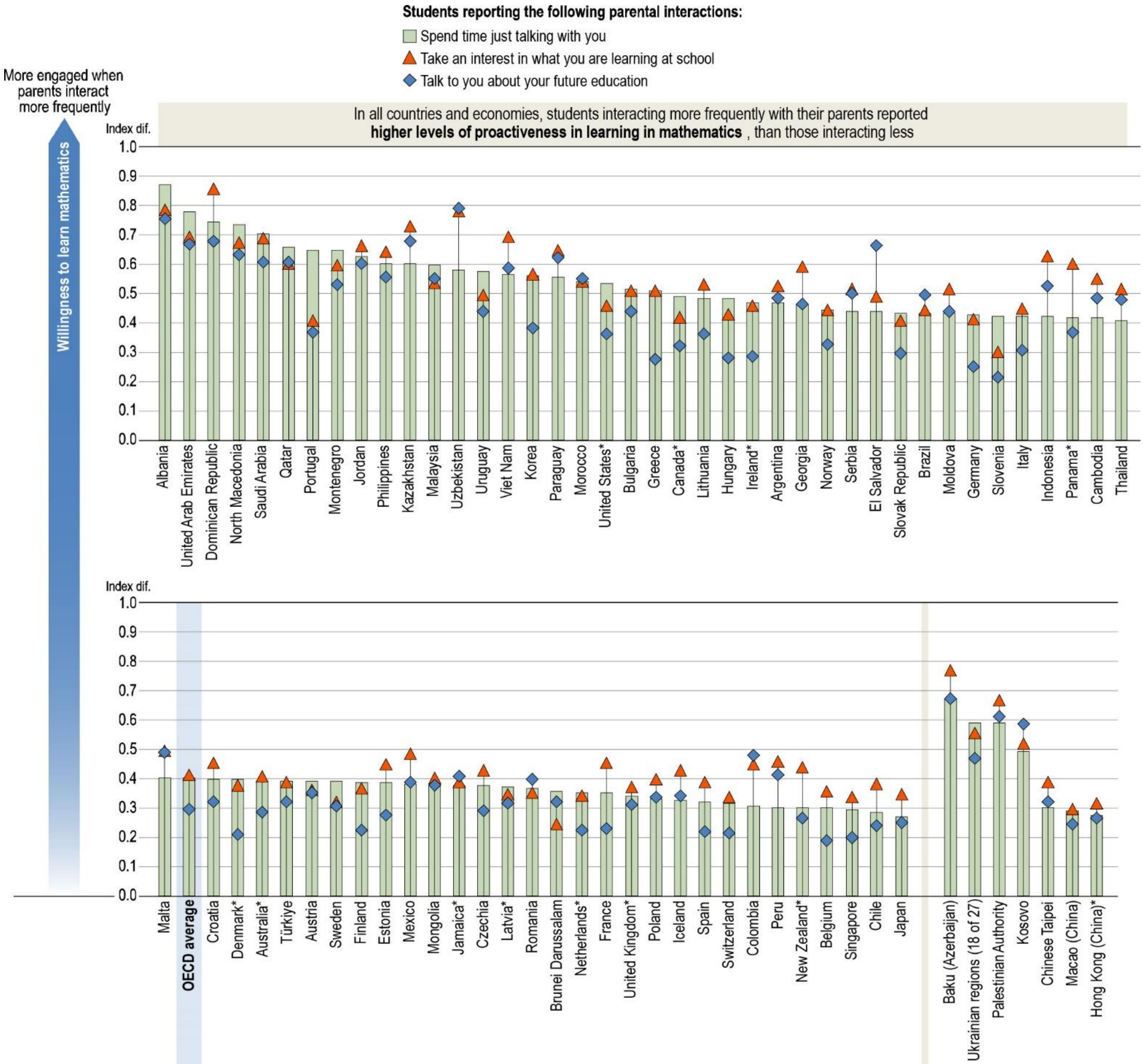
They are more proactive in mathematics learning

PISA 2022 data show that students whose parents generally interact more frequently with them have higher levels of proactive learning attitudes towards mathematics[1] than those whose parents interact less (see Figure V.5.2b [available online]). This is true even after accounting for students' and schools' socio-economic profile. Learning-focused conversations (e.g. what students are learning, what problems they may be facing, their relationships with other students) show the strongest associations with students' proactive mathematics behaviours and is positive across all countries and economies – Albania, Cambodia, Paraguay, the Philippines and the United Arab Emirates show the strongest relationships (Table V.B1.5.3).

Parental future-oriented discussions are more weakly associated with students' proactive mathematics learning but the relationships are still positive. Students whose parents talk to them about their educational future have weaker proactive learning attitudes towards mathematics than those whose parents just spend time talking with them or take an interest in what their children are learning. This holds across most countries and economies (see Figure V.5.2). These results suggest that students whose parents simply show interest in their learning are more actively engaged in their own learning. Moreover, students who have ordinary everyday interactions with their parents (e.g. eating meals together) are more likely to be proactive in learning mathematics than those who do not. These relationships hold true even after accounting for students' and schools' socio-economic profile (Tables V.B1.5.2 and V.B1.5.3).

Figure V.5.2. Proactiveness in learning in mathematics and parental interactions, across countries and economies

Difference in the mean index of proactive mathematics study behaviour between students interacting more frequently with their parents (once a week to almost everyday) and those interacting less frequently (never to once a month)



Notes: All differences are statistically significant (see Annex A3).

Only countries and economies with available data are shown.

Countries and economies are ranked in descending order of the difference in mean index of proactive mathematics study behaviour for students whose parents spend time just talking to them.

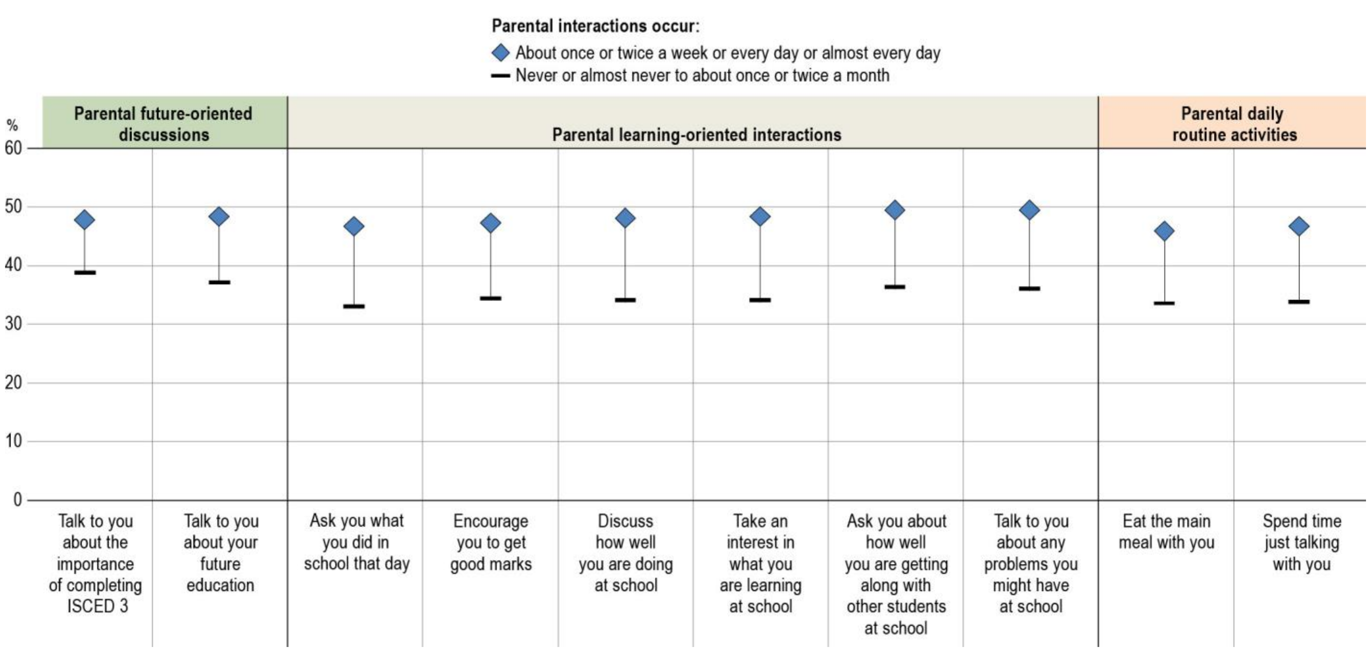
Source: OECD, PISA 2022 Database, Table V.B1.5.2. See Table V.5.1 for StatLink at the end of this chapter.

They are more meticulous about their schoolwork

Students whose parents frequently interact with them are more meticulous about their learning (e.g. more careful about their schoolwork and careful not to make mistakes). An average of at least 45% of students in OECD countries who reported more frequent parental interaction carefully check their homework before turning it in. This is 9 to 14 percentage points higher than students with fewer parental interactions (see Figure V.5.3). This variation was observed in nearly all countries and economies, and to some extent, depending on the type of interactions. Students whose parents spend more time in daily routine activities or learning-focused conversations with them are more meticulous, even after accounting for students' and schools' socio-economic profile. For example, in Albania and Ireland*, the percentage of students carefully checking their homework before turning it in is more than 15 percentage points higher among students whose parents interact with them in these ways (see Figure V.5.3b [available online]). However, in about half of countries and economies with available data, students are equally meticulous in their schoolwork (e.g. careful not to make mistakes) when their interactions with their parents take the form of conversations about future-oriented learning, even after accounting for students' and schools' socio-economic profile (Figure V.5.3b [available online], Tables V.B1.5.7, V.B1.5.9, V.B1.5.10 and V.B1.5.12).

Figure V.5.3. Controlling one's learning and parental interactions

Percentage of students agreeing or strongly agreeing that they carefully check homework before turning it in; OECD average



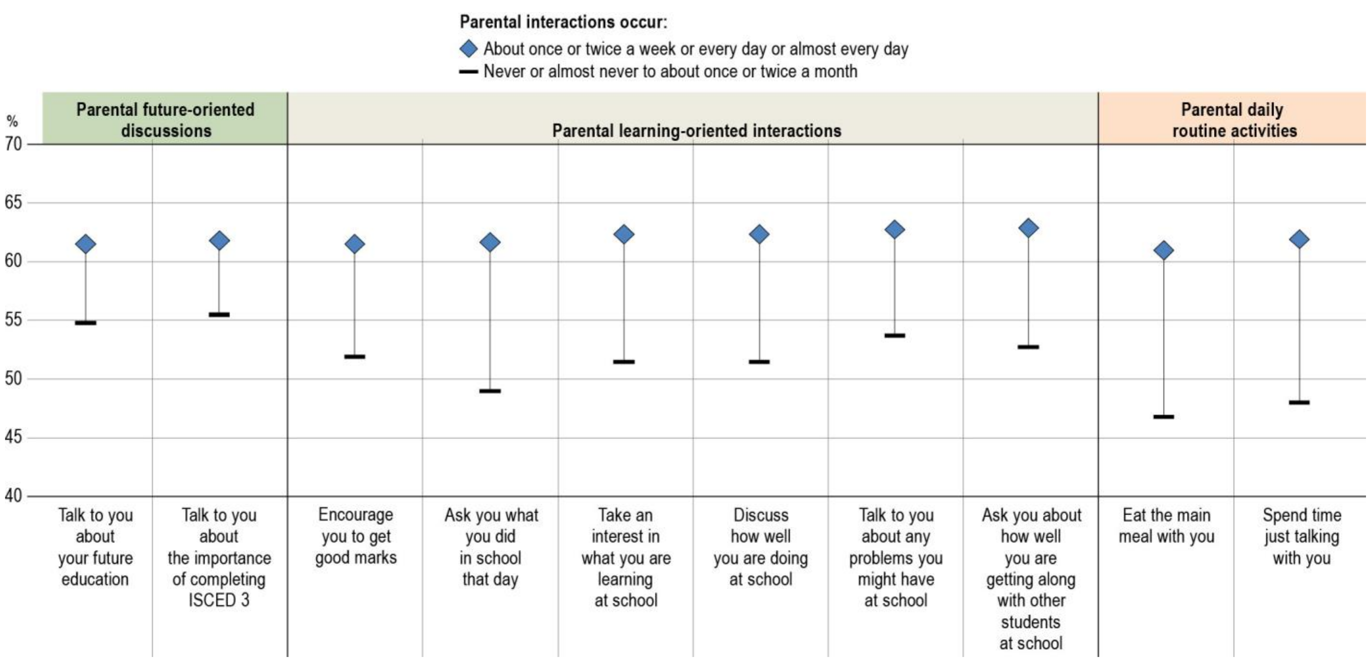
Note: All differences between students interacting at least once a week with their parents and those interacting at the most twice a month are statistically significant (see Annex A3).
For each category, items are ranked in ascending order of the percentage of students for students interacting at least once a week with their parents.
Source: OECD, PISA 2022 Database, Table V.B1.5.10. See Table V.5.1 for StatLink at the end of this chapter.

They are stronger in critical thinking

Parental interactions are also positively associated with students' critical thinking (perspective-taking). Approximately 60% of students whose parents generally interact with them often try to consider everybody's perspective before taking a position and can view almost all things from different angles. Around 50% of students with less frequent parental interactions show these critical-thinking skills, on average across OECD countries (see Figure V.5.4). Students who have more frequent daily routine interactions with their parents employ critical-thinking skills more in most countries and economies, even after accounting for students' and schools' socio-economic profile. Those who have more frequent learning-oriented and future-oriented conversations with their parents show this variation too but to a lesser extent compared to daily routine interactions. This suggests that daily routine interactions with parents help cultivate students' critical-thinking skills (Tables V.B1.5.22, V.B1.5.24, V.B1.5.25 and V.B1.5.27). PISA 2022 also explores other forms of parental interactions, such as discussions about political or social issues. These are associated with the use of critical-thinking skills and other learning strategies, and motivation to learn (see Box V.5.1).

Figure V.5.4. Critical thinking (perspective-taking) and parental interactions

Percentage of students agreeing or strongly agreeing they try to consider everybody's perspective before taking a position; OECD average



Note: All differences between students interacting at least once a week with their parents and those interacting at the most twice a month are statistically significant (see Annex A3).

For each category, items are ranked in ascending order of the percentage of students interacting about once or twice a week with their parents when considering everybody's perspective before taking a position.

Source: OECD, PISA 2022 Database, Table V.B1.5.22. See Table V.5.1 for StatLink at the end of this chapter.

Box V.5.1. Children whose parents show interest in them develop sustained learning strategies and are more motivated about mathematics

PISA 2022 examines additional forms of parental interaction such as engaging in discussions on political or social issues and nurturing a social connection between children and parents.[2]

Students whose parents talk about political or social issues with them are more engaged in critical thinking (perspective-taking)[3] than students whose parents do this less. This was observed in a majority of countries and economies with available data, particularly in Belgium, Brazil, Ireland* and Portugal, even after accounting for students' and schools' socio-economic profile (Table V.B1.5.119).

Students show higher levels of proactiveness in mathematics study behaviours when they feel more connected to their parents (e.g. students feel their parents encourage them to make their own decisions; feel their parents show that they care; etc.). For example, in the United Arab Emirates, more than 80% of students who reported feeling this way about their parents pay more attention when their mathematics teacher is speaking compared to around 60% of their less-supported peers. In New Zealand*, around 80% of students whose parents help them as much as they need reported putting effort into their assignments more frequently. This is 20 percentage points more than students whose parents help them less often (Tables V.B1.5.114, V.B1.5.115 and V.B1.5.116).

These two forms of parental interaction are also associated with students' motivation to learn. Students whose parents reported discussing political and social issues more frequently like to ask questions, love learning new things in school and like developing hypotheses and checking them based on what they observe more than their counterparts, even after accounting for students' and schools' socio-economic profile. In Belgium, Croatia, Ireland* and Latvia*, 50% of students whose parents talk about political or social issues love learning new things in school. This is around 8 percentage points more than for their counterparts whose parents discuss issues less frequently with them. On the other hand, in Colombia, the Dominican Republic and Panama*, around 80% of students love learning new things regardless of whether their parents discuss political or social issues with them (Table V.B1.5.118).

Students who reported feeling more connected to their parents want to do well in mathematics class more than their counterparts. In Slovenia and the United Arab Emirates, the share of students motivated in this way is around 10 percentage points more for students who feel more connected, even after accounting for students' and schools' socio-economic profile (Tables V.B1.5.119 and V.B1.5.117).

While causality cannot be attributed to these PISA results, they highlight various ways in which parents can potentially support their children's use of sustainable learning strategies and motivation towards learning.

Note: Data from the well-being questionnaire are available for 13 countries and economies, and 16 countries and economies for the parental questionnaire.
Source: OECD, PISA 2022 Database, Tables V.B1.5.113 - V.B1.5.119.

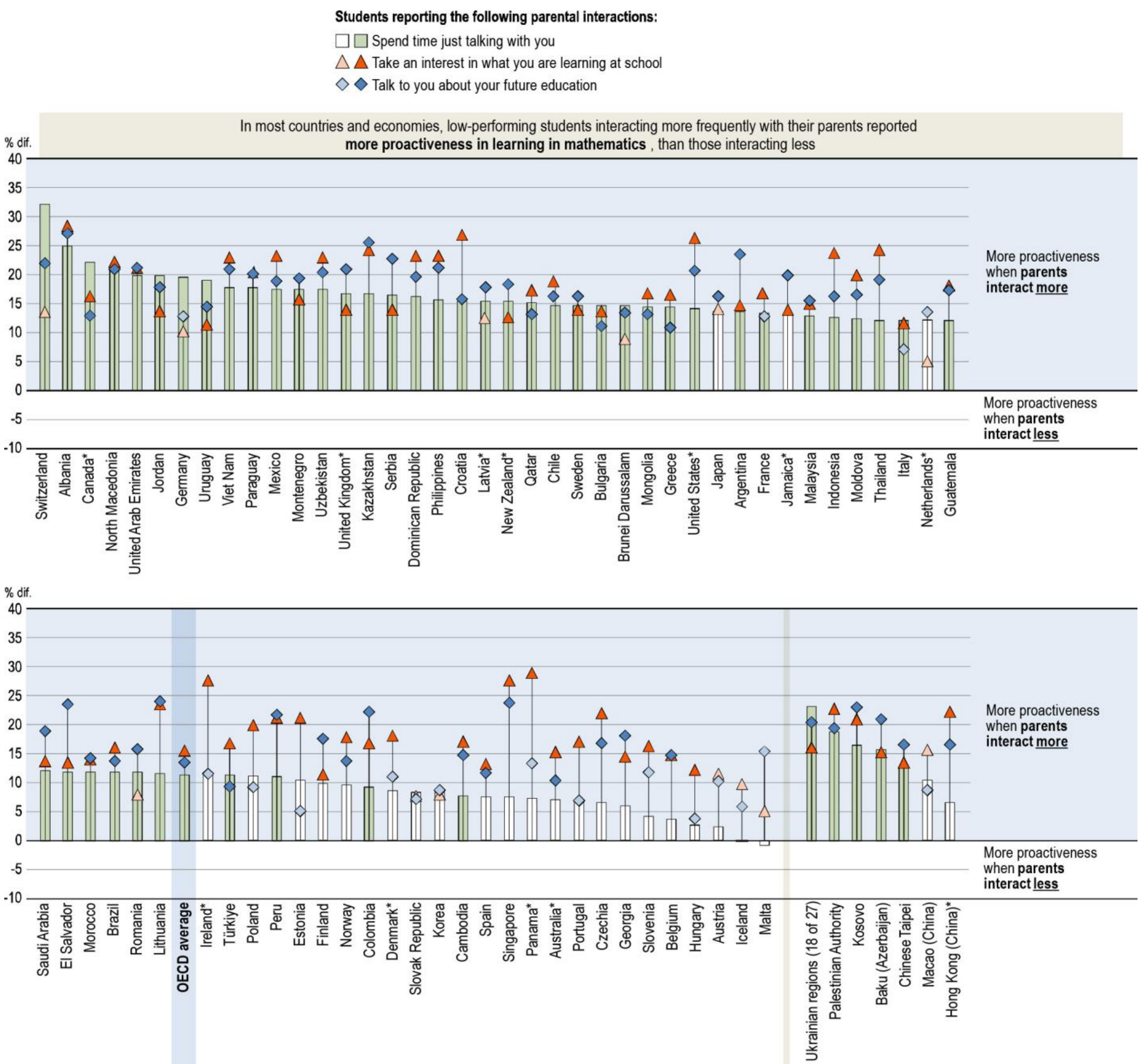
Parental interactions are especially supportive of low performers using learning strategies

Among low performers, there is a large and significant gap in the use of learning strategies between students who interact more often with their parents and those who do less in most countries and economies. For all forms of parental interaction (daily routine activities; learning-oriented conversations around how well students are doing at school; and future-oriented conversations about education), low performers show a greater use of learning strategies when they interact more often with their parents than their peers who do less. However, this gap is mostly non-significant among skilled performers (students who perform at Level 3 or above in mathematics) across most countries and economies. This suggests that students who have the potential to be skilled performers take up learning strategies regardless of parental interactions (see Chapter 2).

The gaps in the aforementioned learning strategies are particularly telling. The share of low-performing students who reported more proactiveness in learning mathematics (e.g. allocating more time to learn materials for mathematics class; asking questions when they do not understand; and connecting new content to previously learned mathematics lessons) is larger among students who interact more with their parents (regardless of the form of interaction) than those who do so less frequently in almost all countries and economies. For example, in Albania, the difference in the percentage of low-performing students is greater than 20 percentage points between students whose parents interact more and those whose parents interact less (Figure V.5.5, Tables V.B1.5.14, V.B1.5.17 and V.B1.5.20).

Figure V.5.5. Proactiveness in learning in mathematics and parental interactions, among low-performing students

Percentage-point difference among low-performing students responding to whether they try to connect new material to what they have learned in previous mathematics lessons, between those interacting more frequently with their parents (once a week to almost everyday) and those interacting less frequently (never to once a month)



Notes: Percentage-point differences among low performers that are statistically significant are shown in a darker tone (see Annex A3).
Only countries and economies with available data are shown.
Countries and economies are ranked in descending order of the change in the percentage of low-performing students when reporting their parents spend time just talking to them.
Source: OECD, PISA 2022 Database, Table V.B1.5.20. See Table V.5.1 for StatLink at the end of this chapter.

Another instance is that low performers are more meticulous when they interact more with their parents, regardless of the form of interaction, in more than half of countries and economies (Tables V.B1.5.8 and V.B1.5.11). Parents' involvement in their child's learning plays an important role in students' learning outcomes (previous PISA analyses highlighted the positive relationship between parental support and mathematics performance (OECD, 2023[9]) and their attitudes towards mathematics. This is especially so for those who have difficulties in mathematics. While causality cannot be attributed to these PISA results, these findings suggest that more frequent interactions with parents encourage low-performing students to take an active role in their learning process. It potentially helps them improve their learning outcomes as well.

Students with supportive families are more motivated to learn

Parental interactions are also related to students' motivations to learn. PISA 2022 data indicate a positive relationship between greater parental support and increased motivation to learn (both intrinsic and instrumental motivations) in almost all countries and economies, even after accounting for students' and schools' socio-economic profile. This is in line with previous research showing that students whose parents are involved in their learning development tend to have a stronger intrinsic motivation to learn (Bong, Hwang and Song, 2010[11]; Ginsburg and Bronstein, 1993[12]).

Students' intrinsic motivations are stronger when their parents talk with them often about how they are doing at school (around 50% in terms of loving learning new things and around 70% for enjoying new ways to solve problems). Compare this to students whose parents have fewer conversations of this nature with them (around 40% in terms of loving learning new things and around 60% for enjoying new ways to solve problems). These findings are observed in almost all countries and economies, even after accounting for differences in students' and schools' socio-economic profile. Another example of students' intrinsic motivation is their readiness to ask questions. Around 52% of students whose parents spend more time talking to them like to ask questions compared to 41% of students whose parents do so less, on average across OECD countries. This difference is more than 20 percentage points in Albania, Baku (Azerbaijan), Denmark*, the Dominican Republic, Ireland* and Qatar (Tables V.B1.5.34, V.B1.5.36, V.B1.5.37, V.B1.5.39, V.B1.5.43, and V.B1.5.45).

Daily routine activities with parents (e.g. eating meals together; spending time talking) also have a positive relationship with students' motivations to learn (52% on average across OECD countries) compared to students who reported less of these interactions with their parents (around 40% on average across OECD countries). Future-oriented conversations also show a positive relationship with students' motivations to learn but with less intensity (Tables V.B1.5.37 and V.B1.5.43).

Students with more frequent parental interactions are more instrumentally motivated, even after accounting for students' and schools' socio-economic profile. Around 70% of students agreed that school teaches them things that could be useful in a job compared to around 60% of students who did so less, on average across OECD countries. The difference between students who have more and less parental interaction is greater for daily routine interactions and learning-oriented conversations (between 10 to 14 percentage-point difference, on average across OECD countries) compared to future-oriented conversations (between 6 to 7 percentage-point difference, on average across OECD countries) (Tables V.B1.5.49 and V.B1.5.51).

Besides parental interaction, students' motivation to learn and use learning strategies can be further supported by other learning resources at home (see Box V.5.2).

Parental interaction helps students enhance their cognitive activation skills and develop problem-solving abilities in school

Talking with parents can stimulate students' intellectual curiosity and learning practices. PISA 2022 data suggest that parents who discuss school activities or progress with their children, and encourage them to learn can reinforce students' metacognitive skills at school.

Students with more parental interaction[4] reported being more exposed to cognitive activation practices[5] across all countries and economies, both before and after accounting for students' and schools' socio-economic profile (Table V.B1.5.59). Interestingly, low performers with more frequent parental interaction (of all kinds) reported more exposure to cognitive activation practices than skilled performers in most countries and economies (Table V.B1.5.5).

In addition, students with more frequent parental interaction are more engaged in classroom activities and assignments that involve problem-solving than students who interact less, even after accounting for students' and schools' socio-economic profile. Learning-oriented interactions with parents encourage students' engagement in classroom activities that involve problem-solving the most. On average across OECD countries, more than 65% of students whose parents more frequently take an interest in what students are learning at school agreed that activities in class help them think of new ways to solve problems compared to around 55% of their counterparts (Tables V.B1.5.30 and V.B1.5.31).

Box V.5.2. Accessing learning technological tools at home is positively related to students' motivation and proactiveness in learning

Digital devices can be a distraction for students, as reported in previous findings of PISA 2022 (OECD, 2023[9]). But, when these are oriented exclusively to learning, they can help students develop positive study behaviours in mathematics.

PISA 2022 data show that students who benefit from technological tools for specific learning purposes, such as having a computer for schoolwork or educational software or applications (see note), are more likely to develop proactiveness and motivation towards learning in mathematics. On average across OECD countries, students are at least 49% more likely to be meticulous with their homework or want to do well in their mathematics class, even after accounting for students' and schools' socio-economic profile (Tables V.B1.5.109 and V.B1.5.110).

Students who reported having a computer that can be used for schoolwork show higher levels of proactiveness in mathematics study behaviours in 66 out of 79 countries and economies with available data. These students take time to learn the material for mathematics class, carefully check homework before turning it in and try to connect new material to what they have previously learned. However, after accounting for differences in students' and schools' socio-economic profile, this was observed in *fewer* countries and economies (49 out of 79). This indicates that having a computer at home is related to socio-economic profile (Table B1.5.111).

Nonetheless, educational software and applications help students strengthen positive study behaviours, regardless of socio-economic profile. Students using these resources show higher levels of proactiveness in mathematics in almost all countries and economies. On average across OECD countries, these students are 33% more likely to connect what they are learning to what they know on their own and 56% more likely to check their homework (Tables V.B1.5.110 and V.B1.5.111).

Students are more likely to feel motivated to learn when they use a computer at home for schoolwork or educational software or applications in most countries and economies. On average across OECD countries, those who reported having education software or applications are almost 50% more likely to want to do well in their mathematics class while those who reported having a computer for schoolwork are 73% more likely to do so (Tables V.B1.5.109 and V.B1.5.110).

Although these PISA results do not establish causality, they suggest that a supportive home environment is positively related to favourable learning.

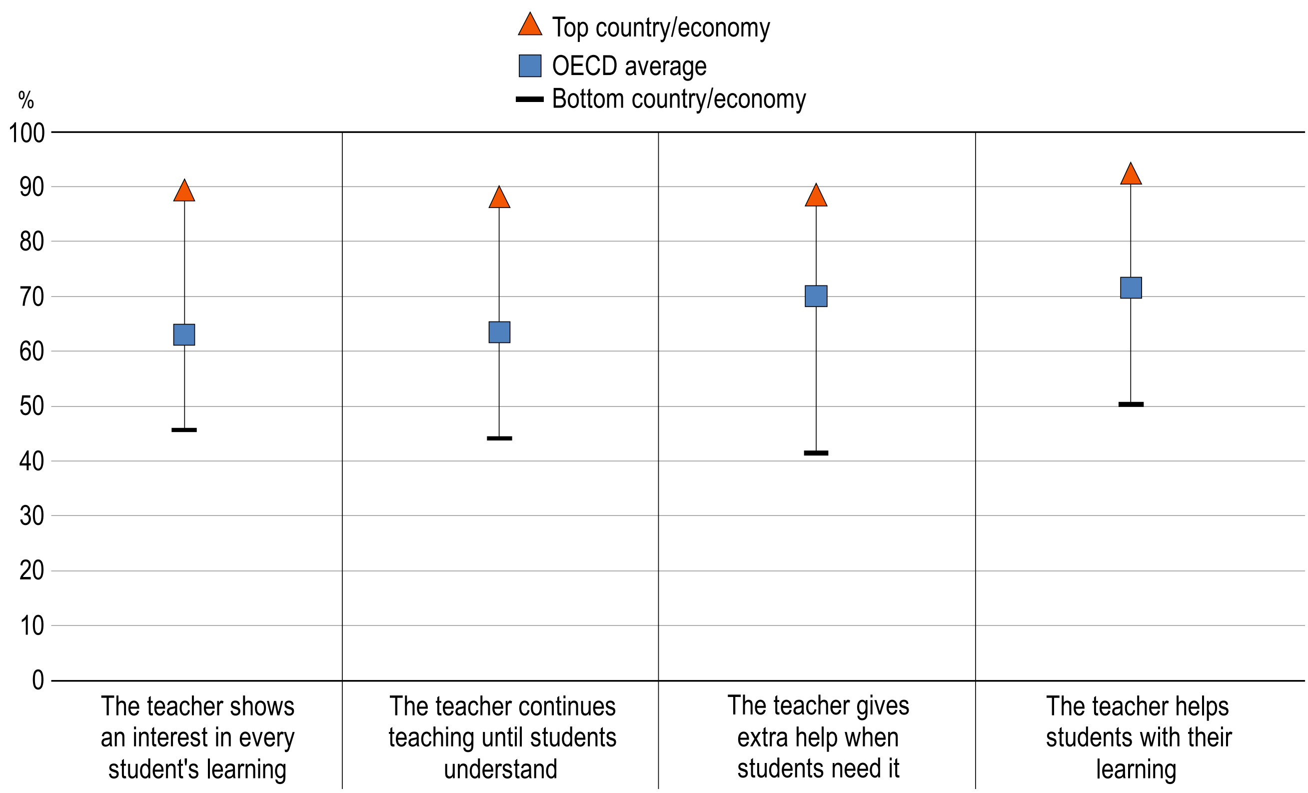
Note: On average, across OECD countries, 92% have a computer (laptop, desktop, or tablet) for schoolwork at home while 75% have education software or application at home.
Source: OECD, PISA 2022 Database, Tables V.B1.5.108 - V.B1.5.112.

How does teacher support relate to students’ use of strategies for lifelong learning?

In PISA 2022, 15-year-old students were asked how often their teachers support them in their mathematics lessons. Support can take the form of showing an interest in students’ learning, providing help, and teaching until students understand what is being taught (see Figure V.5.6).

Figure V.5.6. Types of teacher support

Percentage of students reporting the following things happen in their mathematics lessons, most lessons or every lesson; OECD average



Items are ranked in ascending order of the percentage of students at the OECD average.
Source: OECD, PISA 2022 Database, Table V.B1.5.60. See Table V.5.1 for StatLink at the end of this chapter.

Teacher support is key to lifelong learning skills

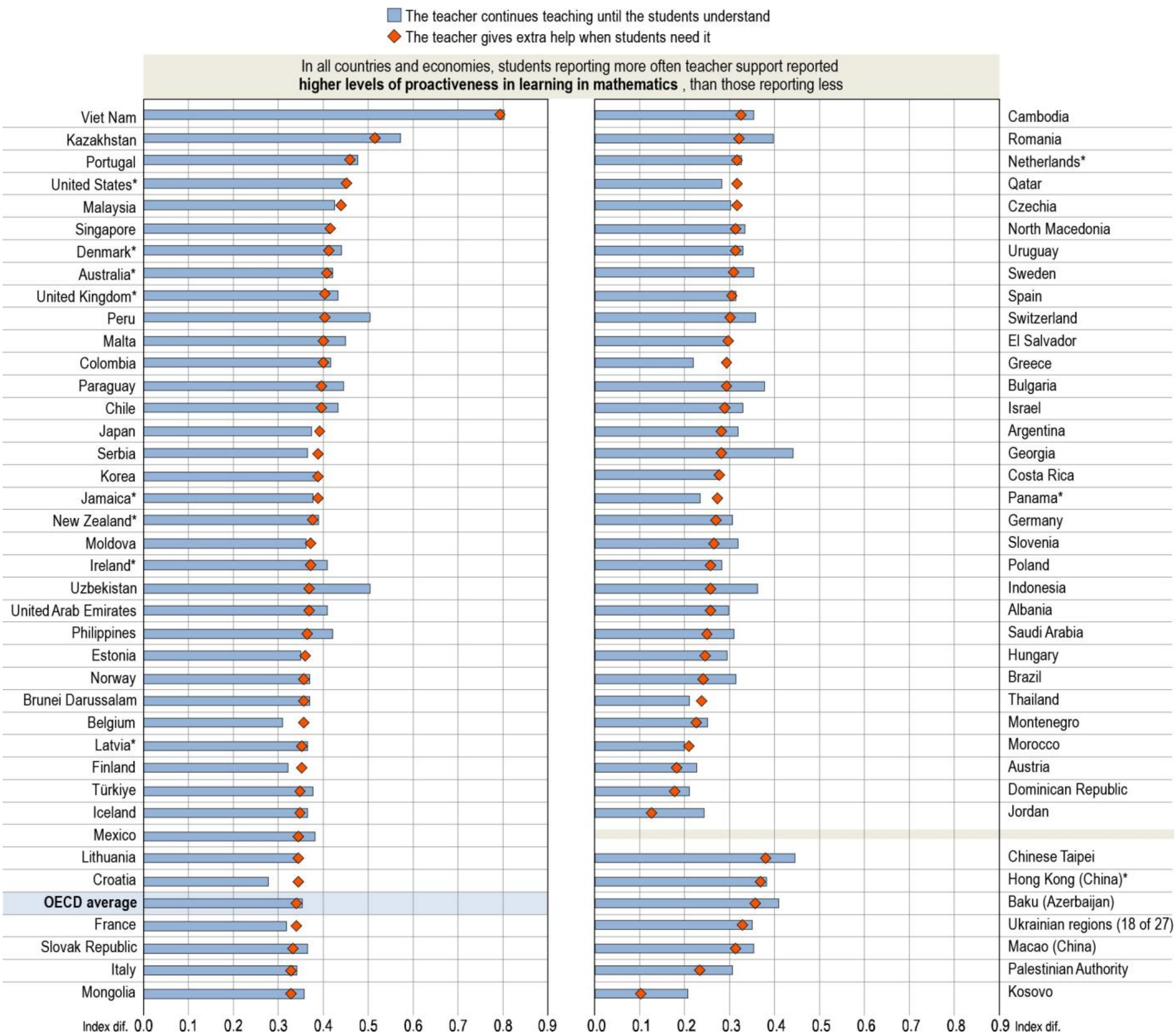
Students are more proactive in learning mathematics

PISA 2022 data find a strong and positive relationship between student performance and supportive teachers in most countries and economies (OECD, 2023[9]). A similar relationship is observed for every form of support from teachers (whether they show an interest in students’ learning, provide help, or persevere in teaching until students understand what they are teaching) and 15-year-old students’ proactiveness in learning mathematics. This finding is evident across all countries and economies (see Figure V.5.7, Figure V.5.7b [available online] and Figure V.5.8).

Motivating students to become active and autonomous learners is one major concern of educators and teachers. Effective teachers are not just adept at increasing students’ knowledge but provide a supportive learning environment for promoting skills such as critical thinking (Blazar and Kraft, 2017[13]). Helping teachers cultivate lifelong learning skills in students should be a priority for education systems (see Box V.5.3). PISA 2022 results show that students who benefit from more teacher support pay more attention and put more effort into their assignments for mathematics class (around 78% and 67%, respectively; among students who receive teacher support less often, this was around 63% and 53%, respectively, on average across OECD countries). In contrast, students who receive less teacher support give up when they do not understand the learning material and lose interest during mathematics lessons to a greater extent (around 26% and 40%, respectively; among students who receive teacher support more often, this was 18% and 25%, respectively, on average) (Tables V.B1.5.67, V.B1.5.69, V.B1.5.71 and V.B1.5.79)

Figure V.5.7. Proactiveness in learning in mathematics and teacher support across countries and economies

In all countries and economies, students reporting that they received teacher support more often reported higher levels of proactiveness in learning in mathematics than those reporting less



Notes: All differences are statistically significant (see Annex A3).

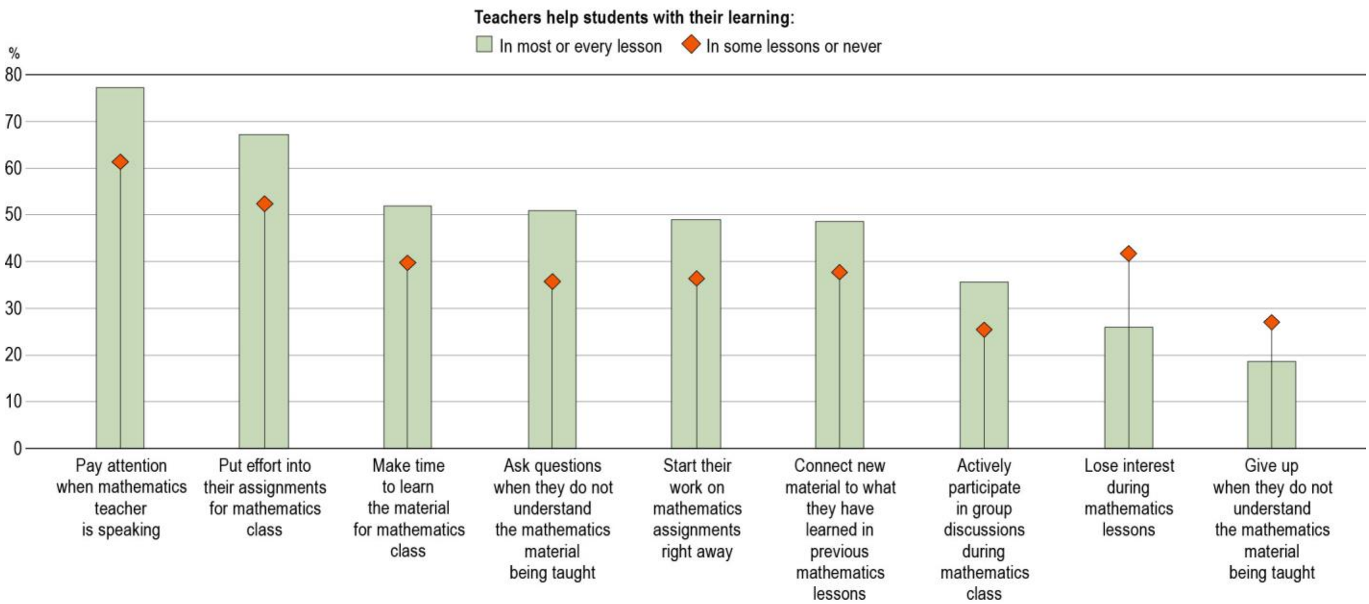
Only countries and economies with available data are shown.

Countries and economies are ranked in descending order of the difference in the mean index of proactive mathematics study behaviour for students whose teachers give extra help when they need it.

Source: OECD, PISA 2022 Database, Table V.B1.5.61. See Table V.5.1 for StatLink at the end of this chapter.

Figure V.5.8. Proactiveness in learning in mathematics and teacher support (helping students with their learning)

Percentage of students reporting they do the following at least more than half of the time during their school year when their teachers help them with their learning; OECD average



Note: All differences between students receiving teacher support more frequently and those less frequently are statistically significant (see Annex A3).
Items are ranked in descending order of the percentage of students whose teachers help them with their learning in most or every lesson.
Source: OECD, PISA 2022 Database, Table V.B1.5.73. See Table V.5.1 for StatLink at the end of this chapter.

Teacher-supported students use critical-thinking skills and take control of their learning

Teacher support also relates positively to critical thinking and control of one's own learning, even after accounting for students' and schools' socio-economic profile. Approximately 60% of students who have more support of any kind from their teachers try to consider everybody's perspective before taking a position and can view almost all things from different angles, on average across OECD countries. Students who try to consider everybody's perspective reported, on average, more teacher support than students who agreed or strongly agreed that they can view almost all things from different angles. Around 47% of students who reported more teacher support carefully check their homework before turning it in compared to less than 40% of students with less teacher support, on average across OECD countries (Tables V.B1.5.64, V.B1.5.66, V.B1.5.84, V.B1.5.86, V.B1.5.87 and V.B1.5.89).

Teacher support is also related to students' love of learning and motivations

Students who receive teacher support more often are more motivated. More specifically, teacher support is associated with students' love of learning at school. Across all types of teacher support, around 55% of students with more support like to learn new things in school compared to 43% of students with less support, on average across OECD countries (Table V.B1.5.96).

Additionally, students who receive teacher support more frequently want to do well in mathematics class more than students with less frequent teacher support, even after accounting for students' and schools' socio-economic profile. This is true across most countries and economies. The difference in the percentage of students who want to do well in mathematics class is more than 10 percentage points across all forms of teacher support in Finland, Hong Kong (China)* and Kazakhstan. On average across OECD countries, more than 90% of students with more frequent teacher support want to do well in mathematics class (Figure V.5.9 [available online], Tables V.B1.5.101 and V.B1.5.103).

Box V.5.3. Singapore: 21st-century teachers

Teachers in Singapore attend pre-service training at the National Institute of Education (NIE) where they learn about the purpose, values, knowledge and skills related to teaching. The Enhanced TE21: Empowering Teachers for the Future Model, launched in 2023, is based on:

Three value paradigms that motivate teachers to increase knowledge and develop skills and competencies to become lifelong learners. Teachers must be guided by values in their use of pedagogy. The three values include commitment to the learner, the teaching profession, and the community. Commitment to the learner is believing that all children can learn, nurturing each learner holistically, and valuing diversity. Commitment to the profession includes engagement in lifelong learning not only for one's personal and professional growth but as a role model to students. Commitment to the community highlights that teachers should be cognisant of their role in the ecosystem and contribute to society by impacting the next generation of learners.

Skills to prepare teachers of 21st-century learners**.** Examples of these skills include those promoting reflection and metacognition, self-regulation, adaptive thinking, digital and data literacy, cross-cultural literacy, and civic literacy.

Knowledge of the self as a teacher and knowledge of the learners, the subject content, and pedagogy. This includes expanding teachers' knowledge base in topics such as sustainability, global and environmental issues, and health and mental health so that teachers can better understand their students and their role in the broader context.

Competencies are the dynamic interactions of skills and knowledge mediated by positive values. The three competency dimensions of Professional Practice, Personal Growth and Development, and Leadership and Agency develop teachers to perform the five roles, namely, shapers of character, creators of knowledge, facilitators of learning, architects of learning environments and agents of educational change. These central components of Singapore's Enhanced TE21 model form the basis of the design and delivery of teacher education programmes. They prepare beginning teachers to develop 21st-century competencies (21CC) in their students.

The Ministry of Education (MOE) provides in-service teacher professional learning to further support teachers. The **Teacher Growth Model**, a comprehensive professional learning roadmap, equips teachers with the requisite skills and knowledge. It explicates the roles of the future-ready teacher and recommends learning experiences that cover areas such as curriculum, pedagogies, and digital literacies. Teachers are encouraged to pursue professional learning through platforms like work attachments to industries and organisations beyond education, which expose them to how 21CC is required as competencies to navigate and thrive in a dynamic work environment. Additionally, teachers can refer to the **Singapore Teaching Practice** (STP), which makes explicit effective teaching and learning to develop students' 21CC in Singapore schools. They are also supported by a digital learning portal where they can plan their learning, sign up for workshops, and share and reflect on their learning.

Source: (Academy of Singapore Teachers, 2024[14]; Academy of Singapore Teachers, 2024[15]; National Institute of Education, 2023[16])

Low performers benefit the most from teacher support in their uptake of learning strategies

Similar to parental interactions, the gap between students with more teacher support and those with less is significant in terms of their uptake of certain learning strategies in most countries and economies. This gap is mostly non-significant for skilled performers, suggesting that these students use learning strategies anyway regardless of the level of teacher support.

Teacher-supported low performers use critical-thinking skills more

Teachers who give students extra help when they need it; help students with their learning; and keep on teaching until students understand what they are teaching are most effective in getting low-performing students to use critical thinking. There is a statistically significant gap between teacher-supported low performers and less-supported low performers in their considering everybody's perspective. The gap is significant in more countries and economies than among skilled performers. This suggests that dynamic teacher-student interactions foster the use of critical-thinking skills in students, especially low-performing students, and that teachers' active support is more effective than passive forms such as simply showing interest in students' learning (Table V.B1.5.85).

Teacher-supported low performers are more proactive in learning mathematics

Low performers (and to some extent, skilled performers) who have more teacher support benefit more than top performers (students who perform at Level 5 or 6 in mathematics) in proactive mathematics learning. This is particularly true in their setting aside time to learn material for mathematics class and trying to connect new material to what they have learned in previous mathematics lessons (Tables V.B1.5.74 and V.B1.5.82).

Teacher-supported students are more motivated to learn

Low performers benefit from teacher support more than skilled performers in their motivations to learn. They love to learn new things in school and want to do well in their mathematics class when their teachers help them with their learning and continue teaching until they understand. In Japan, more than 80% of low performers who receive teacher support more frequently want to do well in mathematics class compared to around 60% of their counterparts who receive less teacher support (a difference of more than 20 percentage points). In contrast, in Mexico, the difference between teacher-supported low performers and those with less teacher support who want to do well in mathematics class is only around 5 percentage points. Among skilled performers this gap is mostly non-significant across most countries and economies. These findings suggest that students who have the potential to be skilled performers are intrinsically motivated, regardless of the support they receive from teachers. However, teacher support can help students with mathematics difficulties develop positive attitudes and motivation towards learning (Tables V.B1.5.97 and V.B1.5.102).

Other aspects of a student's life in school, such as satisfaction, can also be beneficial to students' motivation to learn and their use of sustainable learning strategies (see Box V.5.4).

Box V.5.4. Students who are satisfied with various aspects of school engage in more learning strategies and are more motivated to learn

PISA 2022 shows that students' satisfaction with various aspects of school, including what they learn at school, their relationship with their teachers and their life at school, is associated with the use of learning strategies and motivation to learn.

Students who reported being satisfied in these areas exhibit more proactive behaviours in learning mathematics, including taking time to learn the material, asking questions when they do not understand, and trying to connect new learning material to what they have learned in previous lessons. Across the 13 countries and economies with available data, the percentage of students who take time to learn the material for class who are satisfied with what they learn in school ranges from around 25% in Macao (China) to 60% in the United Arab Emirates. This is 7 to 23 percentage points more than for students who are not satisfied. These students also employ more problem-solving skills and are more meticulous about their learning. For example, in Hong Kong (China)* and the United Arab Emirates, around 8 in 10 students who are satisfied in these areas agree that activities in class help them think of new ways to solve problems compared to around 5 in 10 students who are not satisfied (Tables V.B1.5.123, V.B1.5.124, V.B1.5.125, V.B1.5.120, V.B1.5.121 and V.B1.5.122).

Student satisfaction at school is also associated with students being more motivated to learn. For example, in Hong Kong (China)*, Hungary, Ireland* and the Netherlands*, more than 70% of students who are satisfied with what they learn in school agree that school teaches them things that could be useful in a job compared to around 40% of students who are not satisfied (Table V.B1.5.123).

These findings suggest that students being satisfied with what they learn at school, their relationship with teachers and their lives at school are more likely to adopt learning strategies and be motivated to learn.

Note: Data from the well-being questionnaire are available for 13 countries and economies.
Source: OECD, PISA 2022 Database, Tables V.B1.5.123 - V.B1.5.125.

Parental and teacher support are essential in promoting sustainable learning strategies for 15-year-old students

PISA 2022 findings show that parental interaction and teacher support play a crucial role in 15-year-old students' use of sustained learning strategies. Students without these – especially low performers – are likely to be disadvantaged compared to their peers who have both kinds of support.

What can parents and teachers do?

Parental interactions, especially routine activities and conversations about learning, are connected to students' sustained learning strategies and motivation to learn. Having discussions about political and social issues are related to students' critical thinking. In addition to these interactions, feelings of connectedness to parents can encourage students to use learning strategies and be motivated. This can be fostered by parents showing that they care or encouraging students to make their own decisions and can take place on an everyday basis.

Teacher support similarly stimulates student motivation and learning strategies such as critical-thinking abilities and problem-solving skills. Students who are satisfied with their school life also use more learning strategies and are more motivated to learn. To further support students, teachers can make sure they have good relationships with their students.

While schools cannot replace parental interaction and support, education systems can help make up the difference with supportive classrooms for students who have little possible family support. Encouraging school environments can help these students develop their learning skills as much as possible.

Table V.5.1. Chapter 5 figures: How are students' relationships with families and teachers associated with their use of sustained learning strategies?

Figure V.5.1	Types of parental interactions
Figure V.5.2	Proactiveness in learning in mathematics and parental interactions, across countries and economies
Figure V.5.2b	Proactiveness in learning in mathematics and parental interactions
Figure V.5.3	Controlling one's own learning and parental interactions
Figure V.5.3b	Controlling one's own learning and parental interactions, by country/economy
Figure V.5.4	Critical thinking (perspective-taking) and parental interactions
Figure V.5.5	Proactiveness in learning in mathematics and parental interactions among low-performing students
Figure V.5.6	Types of teacher support
Figure V.5.7	Proactiveness in learning in mathematics and teacher support across countries and economies
Figure V.5.7b	Proactiveness in learning in mathematics and teacher support
Figure V.5.8	Proactiveness in learning in mathematics and teacher support (helping students with their learning)
Figure V.5.9	Personal motivation and teacher support

StatLink https://stat.link/kvg2oq

Notes

[1] The index of proactive mathematics study behaviour (MATHPERS) is based on question ST293, which asked students how often they engaged in behaviours indicative of effort and persistence in mathematics (e.g. "I actively participated in group discussions during mathematics class", "I put effort into my assignments for mathematics class"). For further information please refer to the PISA 2022 Technical Report, Chapter 19.

2 The index of social connection to parents (SOCONPA) is based on students' ratings of how often their parents or guardians engaged in a range of behaviours (e.g. "Help me as much as I need", "Let me do the things I like doing") in question WB163. For further information please refer to the PISA 2022 Technical Report, Chapter 19.

3 Students who report to agree/strongly agree they consider everybody's perspective before taking a position, or students who report to agree/strongly agree they can view almost all things from different angles.

4 The index of family support (FAMSUP) is based on students' ratings of how often their parents or someone else in their family engaged in a range of behaviours indicative of family support (e.g. "Discuss how well you are doing at school", "Spend time just talking with you") in question ST300. For further information please refer to the PISA 2022 Technical Report, Chapter 19.

5 The index of cognitive activation in mathematics: foster reasoning (COGACRCO) is based on students' ratings of their mathematics teacher showing a range of behaviours indicative of fostering mathematics reasoning during the ongoing school year (e.g. "The teacher asked us to explain our reasoning when solving a mathematics problem", "The teacher asked us to defend our answer to a mathematics problem") in question ST285. For further information please refer to the PISA 2022 Technical Report, Chapter 19.

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6 Students' attitudes about the future

This chapter examines students' attitudes about the future, such as the ability to seek information for future opportunities and career expectations, and how these relate to students' attitudes and dispositions towards learning. It also explores how these attitudes change between students in general and vocational education, how career expectations differ across different groups of students and, finally, whether students' educational expectations reflect their career plans and expectations.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

PISA tells us how students use specific strategies for sustained lifelong learning. It also gives us information about their confidence in being able to plan and reach goals on their own. Both are key for lifelong learning. Throughout their lives, young people will need to anticipate the need to upskill, retrain or complete further education. They will need to be able to do this to respond to a world that is increasingly uncertain. It is important that while they are still in school, they develop skills and attitudes like searching for information and developing a plan that will empower them to act autonomously.

This chapter looks at how students' approaches to learning relate to their motivation to be actors in their own future. It analyses the relationship between attitudes and dispositions towards learning, and career expectations and the ability to seek information.

Key findings

More than half of 15-year-old students in OECD countries have never done an internship, visited a job fair, spoken to a career advisor, or researched information on student financing. One-fifth have never searched the Internet for information about careers. Compared to the average, more students in Denmark*, Finland, Jordan, Norway, the Palestinian Authority, Thailand and Uzbekistan seek information about the future. Students who more frequently do research on future jobs and education reported using learning strategies for sustained lifelong learning more than those who do so less frequently. They are especially more likely to adopt self-monitoring strategies and to be proactive, meticulous and motivated in their learning.

More students enrolled in vocational education and training (VET) than students enrolled in general education seek information about future opportunities. In Croatia, France, Germany, Greece, Hungary, Mongolia, Montenegro, Romania, Serbia, Slovak Republic, and Slovenia, these differences are more pronounced than in other countries/economies. More vocational students agree that school has taught them things that could be useful in a job, but fewer agree that they want to do well in mathematics compared to their peers enrolled in general education.

An average of 80% of 15-year-old students in OECD countries know what job they want to do by the time they are 30. This share is higher in Albania, Jordan, Kosovo and Uzbekistan and lower in Finland, Georgia and the Netherlands*. Students who have clear career expectations use more learning strategies than those who do not. They are more likely to adopt strategies related to problem-solving and critical thinking. They are also more likely to be motivated, especially in their learning.

PISA 2022 shows what kinds of jobs students would like to have in the future. Some 36% would like to become professionals (such as doctors, engineers, lawyers and teachers) and less than 3% would like to become managers. Students were also asked the highest level of education they expect to complete. Almost 70% reported expecting to complete tertiary education. Results also suggest that even students who have clear and ambitious plans for their future are sometimes not realistic about how to reach their goal. For example, they might expect to become a manager or professional without completing tertiary education.

In addition to the strategies for lifelong learning analysed in this volume, seeking information about future careers and education appears to be an essential skill in itself since it is related to students' preparedness for lifelong learning. Students with defined career expectations seek more information about future opportunities than those who do not. However, interestingly, seeking information about the future is negatively related to mathematics performance in over half of PISA-participating countries and economies. This suggests that students' academic performance is not always a good indicator of how prepared students are for lifelong learning.

Do students do research about future education and work, and how does it connect to performance and lifelong learning?

Having a clear idea of what job they expect to do by age 30 can give direction to students' study pathways and keep them motivated. However, the life paths of many young people will likely change between age 15 and 30, and the jobs of today will probably be different from those 15 years into the future. It is important that students develop and practise the skills they need to seek out new information so that they can refine their future plans as needed.

PISA 2022 asked students to report whether they had undertaken a range of activities to find out about future study or types of work.[1] An average of 65% of students in OECD countries have never done an internship or visited a job fair; more than 50% have never spoken to a career advisor or researched information on student financing; and 20% have never searched the Internet for information about careers or about education programmes. Students in Denmark*, Finland, Jordan, Norway, the Palestinian Authority, Thailand and Uzbekistan do more of this kind of research. Students in Belgium, Israel, Italy, Japan, Korea, Macao (China) and Chinese Taipei do less (see Table V.B1.6.1).

Students who more frequently seek information about the future tend to do more poorly in mathematics than those who do so less frequently

Searching for information about future jobs and study is an important life skill for young people. That said, students in OECD countries who do it more frequently scored 3 points below those who do it less frequently in mathematics. In 48 countries and economies that participated in PISA, seeking information about the future is negatively related to mathematics performance even when accounting for students' and schools' socio-economic profile. In Greece, Israel, the Philippines, and Switzerland, students who more frequently research future opportunities performed more poorly than those who do it less frequently by a score-point difference of between 9 and 13 points. Only in Denmark*, Korea and Chinese Taipei is the relationship positive, though small (see Table V.B1.6.3). This suggests that students' academic performance is not always a good indicator of how prepared they are for lifelong learning.

To flesh this out further, PISA 2022 data show that students in vocational education and training (VET) who typically underperform in PISA reported seeking more information about careers than their peers in general education (see Box V.6.1).

Box V.6.1. Vocational students' readiness for lifelong learning

Vocational students are more oriented towards the future than general students

While vocational students tend to perform more poorly in PISA than their peers in general education (OECD, 2023[1]), they may be better prepared for lifelong learning: vocational students are more oriented towards entering the labour market and planning for the future. More vocational students know what job they want to do in the future compared to general students on average across OECD countries. This is especially true in Belgium, Chile, Croatia, Serbia, Slovenia and the Ukrainian regions (18 of 27) while more general than vocational students know what job they want to have in the future in Czechia, Guatemala, Hungary, Kazakhstan, Mongolia, Romania and Thailand (see Table V.B1.6.17).

More vocational students than students enrolled in general education reported seeking information about the future on average across OECD countries. They especially reported doing activities related to finding a job or learning about different professions. The latter includes doing an internship, attending a work visit, visiting a job fair, or speaking to a career advisor at school or outside of school. However, they also reported visiting schools more than general students. In Croatia, France, Germany, Greece, Hungary, Mongolia, Montenegro, Romania, Serbia, the Slovak Republic, and Slovenia, these differences are more pronounced than in other countries/economies, with much higher shares of vocational students reporting to seek information. On the other hand, general students reported more often that they had completed a questionnaire to find out about their interests and abilities; searched the Internet for information about careers; and searched the Internet for information about education programmes (see Table V.B1.6.16).

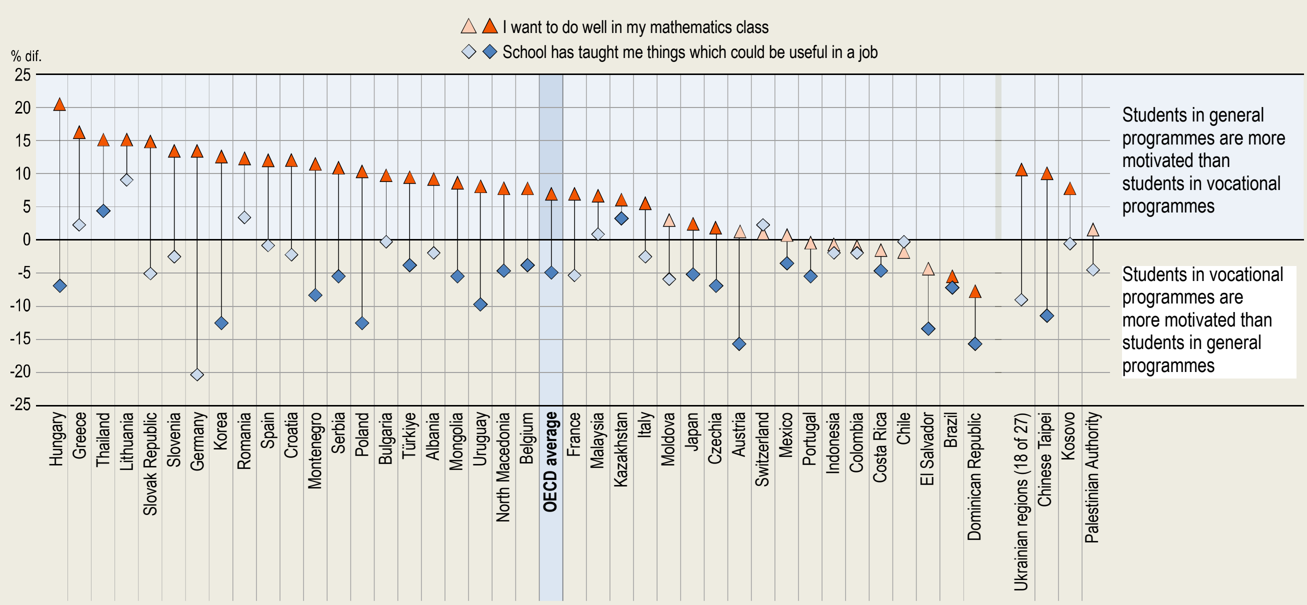
Vocational students are exposed to more opportunities and have instrumental motivation

More vocational students than general students agreed that school has taught them things that could be useful in a job. This is especially true in Austria, the Dominican Republic, El Salvador, Korea, Poland and Chinese Taipei, where the difference between vocational and general students who think that school has taught them things that could be useful in a job is more than 10 percentage points (see Figure V.6.1). Vocational programmes are usually more oriented to preparing students for the labour market and training for a specific occupation. However, this result also suggests that students enrolled in vocational education are exposed to more opportunities and are motivated and see the value of their education in relation to their future jobs. This can be fundamental later in life, both for finding a job that they enjoy and re-entering education or training for upskilling purposes.

On the other hand, a larger share of general students than vocational students are motivated to do well in mathematics class. This difference is more pronounced in Greece, Hungary, Lithuania and Thailand, where it is more than 15 percentage points (see Figure V.6.1). Students enrolled in general education might be more motivated in mathematics than vocational students, but their focus may be more on grades rather than learning as they are generally more oriented towards entering tertiary education with the requisite grades for acceptance.

Figure V.6.1. Students in general and vocational programmes, and motivations

Percentage-point difference of students agreeing or strongly agreeing with the following motivations, by programme orientation



Notes: Only countries and economies with available data are shown.
Statistically significant differences are shown in a darker tone (see Annex A3).
Countries and economies are ranked in descending order of the percentage difference (students in general - vocational programmes) related to doing well in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.6.18. See Table V.6.1 for StatLink at the end of this chapter.

What is the relationship between motivations, researching future opportunities, and strategies for sustained lifelong learning?

Students who more frequently seek information about future opportunities use more critical-thinking strategies and are more proactive and meticulous in their learning than those who do so less frequently

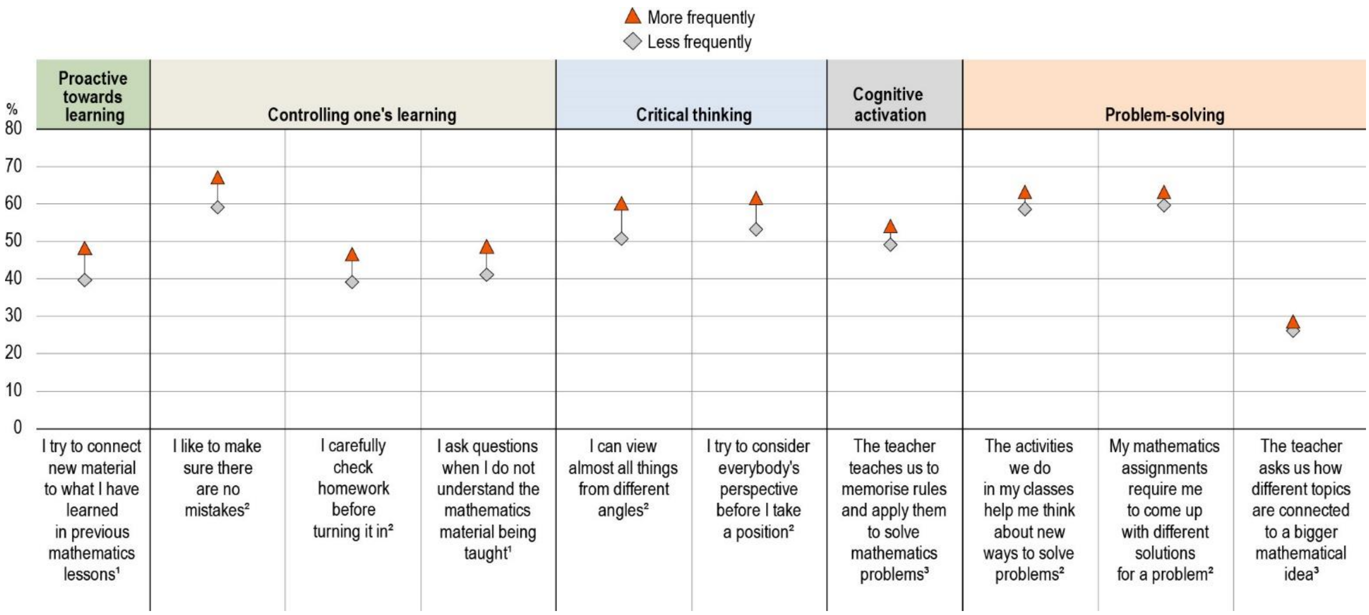
PISA 2022 shows that students who more frequently do more research about future opportunities use more learning strategies than those who do so less frequently (see Figure V.6.2). Students who seek information more frequently reported especially using strategies related to critical thinking. Approaching situations with a more flexible and open mindset might help students see how school relates to the adult world and the future. And, this may encourage them to start considering options for the future. On average across OECD countries, the difference between students who seek information more frequently and those who do so less frequently reporting that they try to consider everybody's perspective before taking a position is of almost 9 percentage points. This difference is of 15 percentage points or more in Hong Kong (China)*, Malaysia and Thailand (see Table V.B1.6.4).

Students who more frequently seek information about future study and work are also more proactive about learning and adopt more self-monitoring strategies. They are more liable to carefully check homework before turning it in, make sure there are no mistakes, and ask questions when they do not understand mathematics material being taught. Students who are more meticulous and proactive in their learning may feel more motivated to plan their lives and careers after school. The difference between students in OECD countries who seek information more frequently and those who do it less frequently on whether or not they try to connect new material to what they have learnt in previous lessons is around 8 percentage points. In Chile, Costa Rica and Jamaica* this difference is around 15 percentage points, and in 24 countries and economies this difference is not significant (see Table V.B1.6.4).

Additionally, all learning strategies are positively related to seeking future-oriented information even after accounting for students' and schools' socio-economic profile, and students' mathematics performance on average across OECD countries. Even if the magnitude of these associations is modest, this result suggests that students who make use of sustained lifelong learning strategies are more likely to seek information about future education and work than those who do not (see Table V.B1.6.6).

Figure V.6.2. Students who are seeking information about future career and learning strategies

Percentage of students reporting the following learning strategies, by the bottom and top quarters of the index of information-seeking regarding future career; OECD average



1. Students doing the corresponding statement more than half of the time.
2. Students agree or strongly agree with the corresponding statement.
3. Students doing the corresponding statement more than half of the lessons.
Notes: Students reporting less frequently (more frequently) the use of learning strategies are those in the bottom (top) quarter of the index of information-seeking regarding future career in their own country/economy.
Differences between students in top and those in bottom quarters of the index of information-seeking regarding future career are all statistically significant (see Annex A3).
Items are ranked by kind of learning strategies and then in descending order of the percentage-point difference related to involvement in information-seeking regarding future career (more frequently minus less frequently students).
Source: OECD, PISA 2022 Database, Table V.B1.6.4. See Table V.6.1 for StatLink at the end of this chapter.

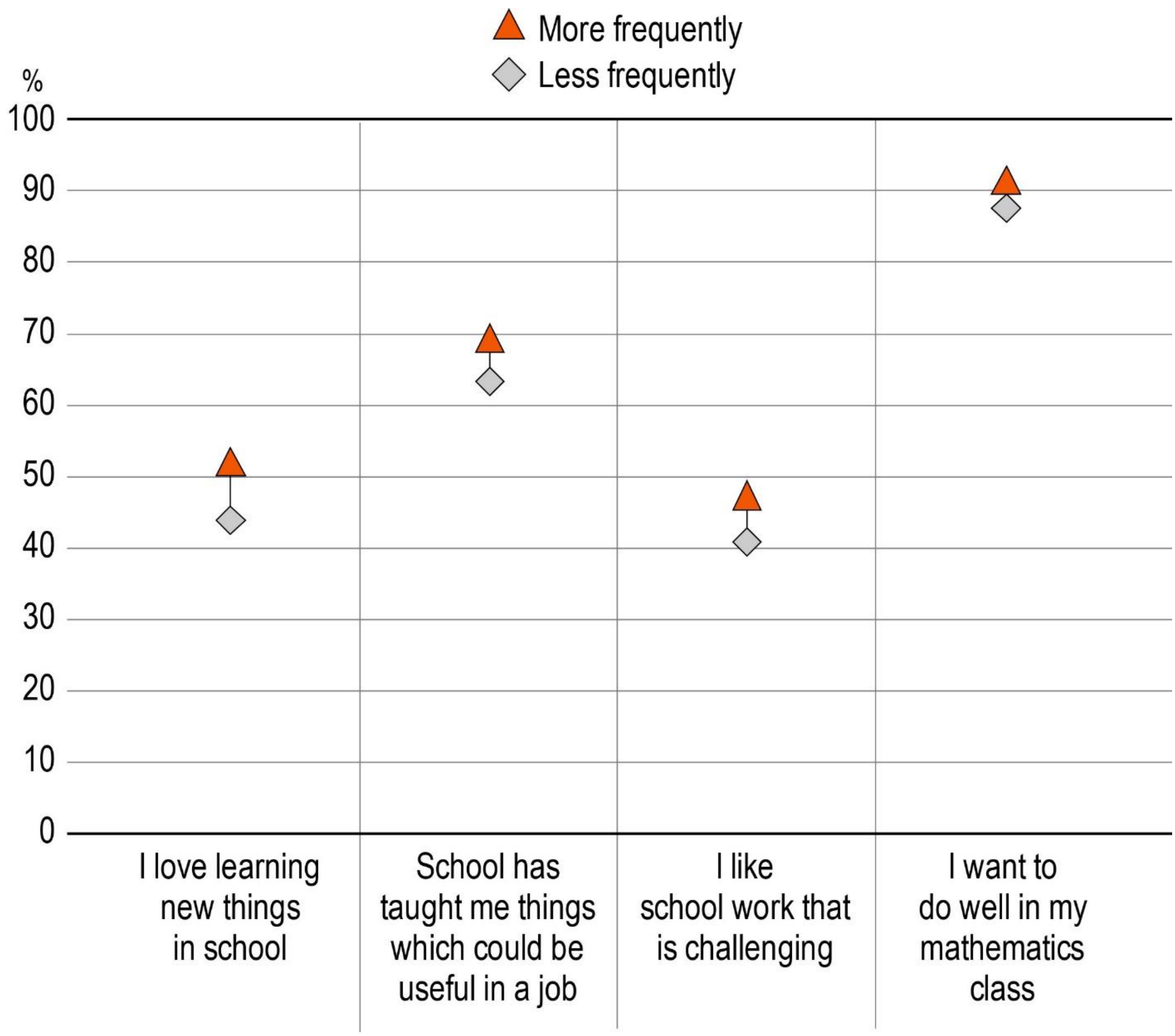
Students who do more research about future opportunities more frequently are more motivated than those who do so less frequently (see Figure V.6.3). They are especially more motivated to learn new things in school (with a difference of 8 percentage points on average across OECD countries). This difference is equal to or bigger than 10 percentage points in 15 countries, while it is not significant in 19 countries and economies. Seeking information is a skill that requires students to know how and where to find what they need. Enjoying learning can help students feel more motivated to seek information (around 15 percentage points), and in 24 countries and economies this difference is not significant (see Figure V.6.3b [available online] and Table V.B1.6.5).

Additionally, students who do more research about future opportunities more frequently are also more likely to think that school has taught them things that can be useful in a job (with a difference of 6 percentage points on average across OECD countries). In Croatia, Iceland, and the Netherlands*, this difference is larger than in other countries and economies, reaching more than 12 percentage points. This suggests that these students are not only more likely to enjoy school but more likely to understand the relationship between school, work, and future opportunities. This awareness can be important for young people as it helps them understand the importance of studying and attending school, and it can influence their choices (see Figure V.6.3b [available online] and Table V.B1.6.5).

On average across OECD countries, all motivations are positively related to seeking information even after accounting for students' and schools' socio-economic profile, and students' mathematics performance, with the exception of wanting to do well in mathematics class. While these results do not imply any causal relationship and the magnitude of these associations is modest, they suggest that students who are more motivated to learn and who see the instrumental value of school also feel more motivated to seek information about future opportunities (see Table V.B1.6.7). On the contrary, students who want to do well in class might be very focused on school and are not necessarily thinking about the future.

Figure V.6.3. Students who are seeking information about future career and motivations

Percentage of students agreeing or strongly agreeing with the following motivations, by the bottom and top quarters of the index of information-seeking regarding future career; OECD average



Notes: Students reporting less frequently (more frequently) the use of learning strategies are those in the bottom (top) quarter of the index of information-seeking regarding future career in their own country/economy.
Differences between students in top and those in bottom quarters of the index of information-seeking regarding future career are all statistically significant (see Annex A3).
Items are ranked in descending order of the percentage-point difference related to involvement in information-seeking regarding future career (more frequently minus less frequently students).
Source: OECD, PISA 2022 Database, Table V.B1.6.5. See Table V.6.1 for StatLink at the end of this chapter.

Students' expectations: How do they project into the future?

Thinking and planning for the future is a fundamental skill for lifelong learning. It helps young people adjust to the changing labour market and develop new skills. This is crucial for transitioning from school to work and reskilling, upskilling and switching jobs in the future.

PISA asked students about the job they expect to do when they are about 30 years old. Some 80% of students in OECD countries responded with a job that they would expect to have[2]. In Albania, Jordan, Kosovo and Uzbekistan, more than 95% of students were able to identify what job they expect to have. In Finland, Georgia and the Netherlands*, less than 70% were able to respond (see Table V.B1.6.8).

There is no clear relationship between defined job expectations and mathematics performance

The relationship between having a defined job expectation and mathematics performance is unclear, especially when accounting for students' and schools' socio-economic profile. While in 7 countries, students who know what job they want to do when they are 30 performed worse, in 18 countries and economies they performed better. In some of the countries with the largest negative associations, such as Belgium and Slovenia, having defined job expectations is associated with a decrease of 16 and 10 score points, respectively, in mathematics performance. In education systems where this association is positive, such as in Cambodia, Korea, Macao (China), Malaysia, the Philippines, Uzbekistan, and Viet Nam, students with defined career expectations scored between 16 and 24 points more in mathematics than those without (see Table V.B1.6.10).

What is the relationship between students' motivations, career expectations, and strategies for sustained lifelong learning?

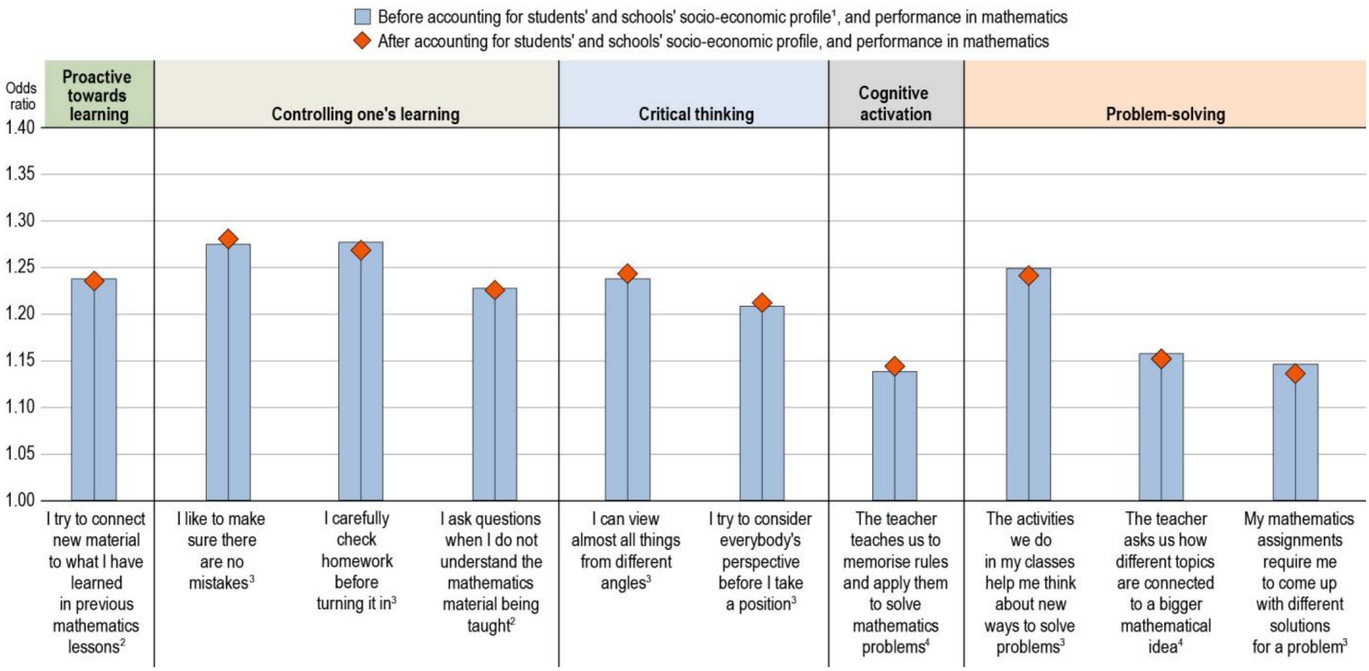
Students who know what job they want to do are more likely to adopt self-monitoring strategies and to be encouraged to use problem-solving strategies

Students who know what job they want to do in the future are more likely to adopt learning strategies even after accounting for students' and schools' socio-economic profile, and students' mathematics performance (see Figure V.6.4). Students with clear career expectations are more likely to adopt self-monitoring strategies such as making sure there are no mistakes in their work and carefully checking homework. In Mexico, Moldova, North Macedonia and the Philippines, the likelihood of students having a clear idea about a future job when adopting these self-monitoring strategies is higher compared to other countries and economies while in 25 countries this likelihood is not observed. Having a more flexible and open way of thinking and enjoying problem-solving can encourage students to think about how school relates to the outside world and their future plans (see Table V.B1.6.13).

Students with clear career expectations are also more likely to be encouraged by teachers to use strategies related to problem-solving, such as thinking about new ways to solve problems. In some countries and economies, the likelihood of students having a clear idea about a future job when the activities in class help them think about new ways to solve problems is higher, especially in Malaysia and the Philippines, while in 33 countries/economies this result is not found (see Table V.B1.6.13).

Figure V.6.4. Knowing what job one wants to do and learning strategies

Likelihood of knowing what job one wants to do in the future when students reported the following learning strategies; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
2. Students doing the corresponding statement more than half of the time.
3. Students agree or strongly agree with the corresponding statement.
4. Students doing the corresponding statement more than half of the lessons.
Note: All coefficients are statistically significant (see Annex A3).
Items are ranked by kind of learning strategies and then in descending order of the odds ratio, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.6.13. See Table V.6.1 for StatLink at the end of this chapter.

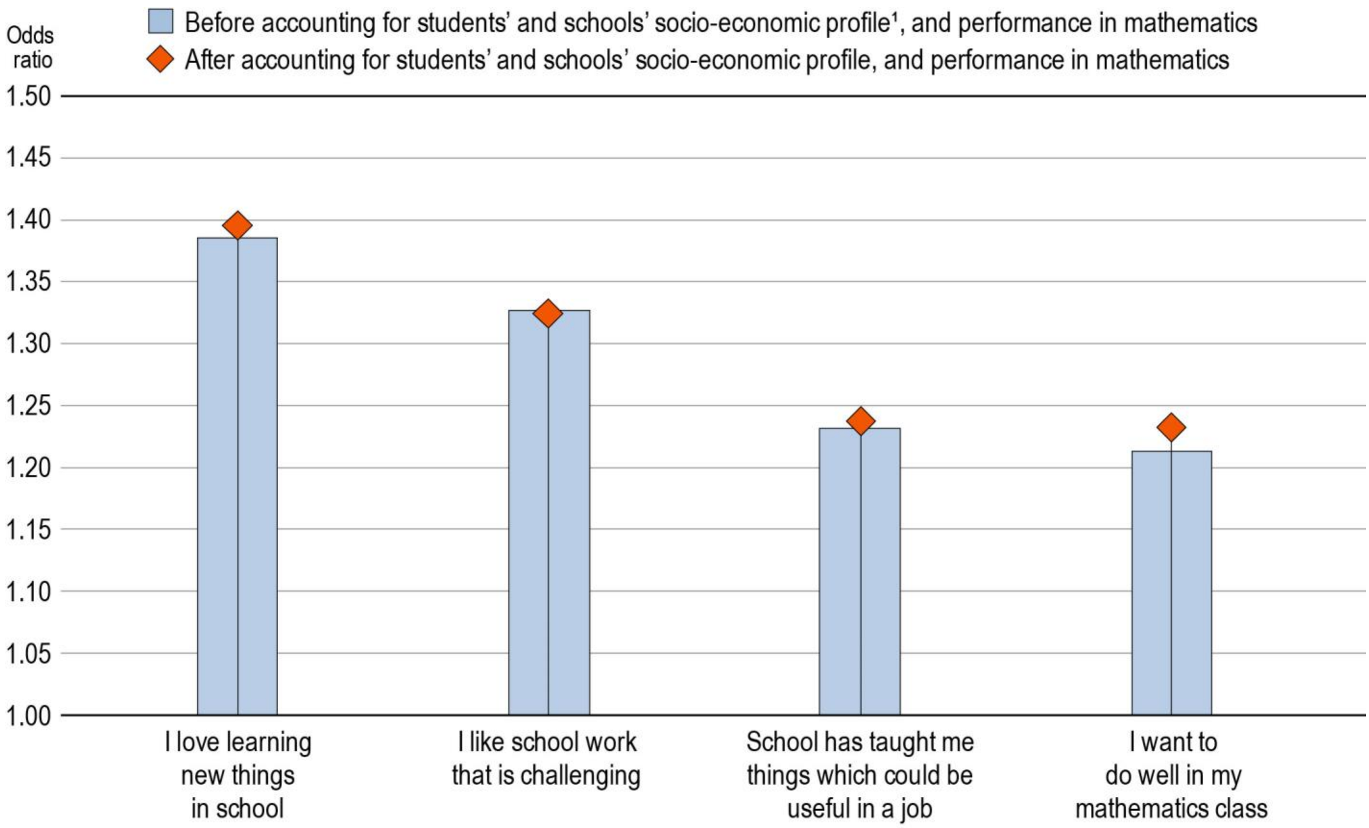
Students who know what job they want to do are more likely to feel motivated than those who do not

Students who know what job they would like to have in the future are more likely to be intrinsically and instrumentally motivated (see Figure V.6.5). They are especially more likely to enjoy schoolwork that is challenging and to learn new things. These motivations can encourage students to think about the future and how they will be able to apply what they have learnt to new challenging situations. In Malaysia, Malta, North Macedonia and the Philippines, the likelihood of students having a clear idea about future jobs when reporting loving learning new things is higher than in other countries. In 31 countries and economies, this likelihood is not observed (see Table V.B1.6.14).

Students who know what job they want are also more likely to want to do well in class and think that school has taught them things that could be useful for a job. These associations are found even when accounting for students' and schools' socio-economic profile, and students' mathematics performance. Students who see the link between school and the world of work, and between their grades and consequences for their future can probably better project themselves into the future and are more likely to ask themselves what job they would like to do when they are adults. In the Dominican Republic, Malaysia and the Ukrainian regions (18 of 27), the likelihood of students having a clear idea about future jobs when reporting that school has taught them things that could be useful for a job is higher than in other countries and economies (see Table V.B1.6.14).

Figure V.6.5. Knowing what job one wants to do and motivations

Likelihood of knowing what job one wants to do in the future when students agree or strongly agree with the following motivations; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Note: All coefficients are statistically significant (see Annex A3).
Items are ranked in descending order of the odds ratio, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.6.14. See Table V.6.1 for StatLink at the end of this chapter.

Box V.6.2. Students' job expectations and their background characteristics

PISA 2022 data tell us what kind of job 15-year-old students would like to have when they are 30 years old. Less than 3% of students reported that they would like to become a manager on average across OECD countries. Some 36% reported they would like to become professionals (such as doctors, engineers, lawyers and teachers). In Indonesia, Kazakhstan and Viet Nam, 10% or more of students would like to become a manager while in Baku (Azerbaijan), Czechia, the Dominican Republic and Peru less than 1% reported so (see Table V.B1.6.23). In Costa Rica, Ireland*, Macao (China), Singapore and Türkiye, more than 50% of students would like to become a professional while in Baku (Azerbaijan), Belgium, Czechia, the Dominican Republic, Finland, Germany, Georgia and Panama* less than 25% reported so (see Table V.B1.6.24). Being ambitious and setting high goals can help students feel more motivated in their studies. At the same time, their expectations may be influenced by many factors.

More skilled performers than low performers expect to do highly-paid jobs

There is no clear association between mathematics performance and knowing what job students want to do in the future (see Table V.B1.6.10). However, a difference emerges in terms of the type of job students want to do based on their performance. More skilled performers than low performers want to become managers or professionals. On average across OECD countries, 48% of skilled performers and 25% of low performers want to become a manager or professional. The Philippines presents the widest gap, with 79% of skilled performers and 32% of low performers wanting to become managers or professionals. Costa Rica presents the smallest gap, with 63% of skilled performers and 55% of low performers reporting so (see Table V.B1.6.28).

Having ambitious plans can be motivating for students but it is also important that they are realistic. Failure to reach set goals can be detrimental for self-esteem, work motivation and adult learning. Managerial and professional occupations generally require a solid foundation and skills. They also require young people to successfully complete tertiary education. In Costa Rica, Kazakhstan and Mexico, more than 50% of students who are low performers reported wanting to be a manager or professional (see Table V.B1.6.28). This result suggests that students in these countries need additional support and information about the steps and skills required to reach their goals.

Students' characteristics could influence their aspirations and ambitions for the future

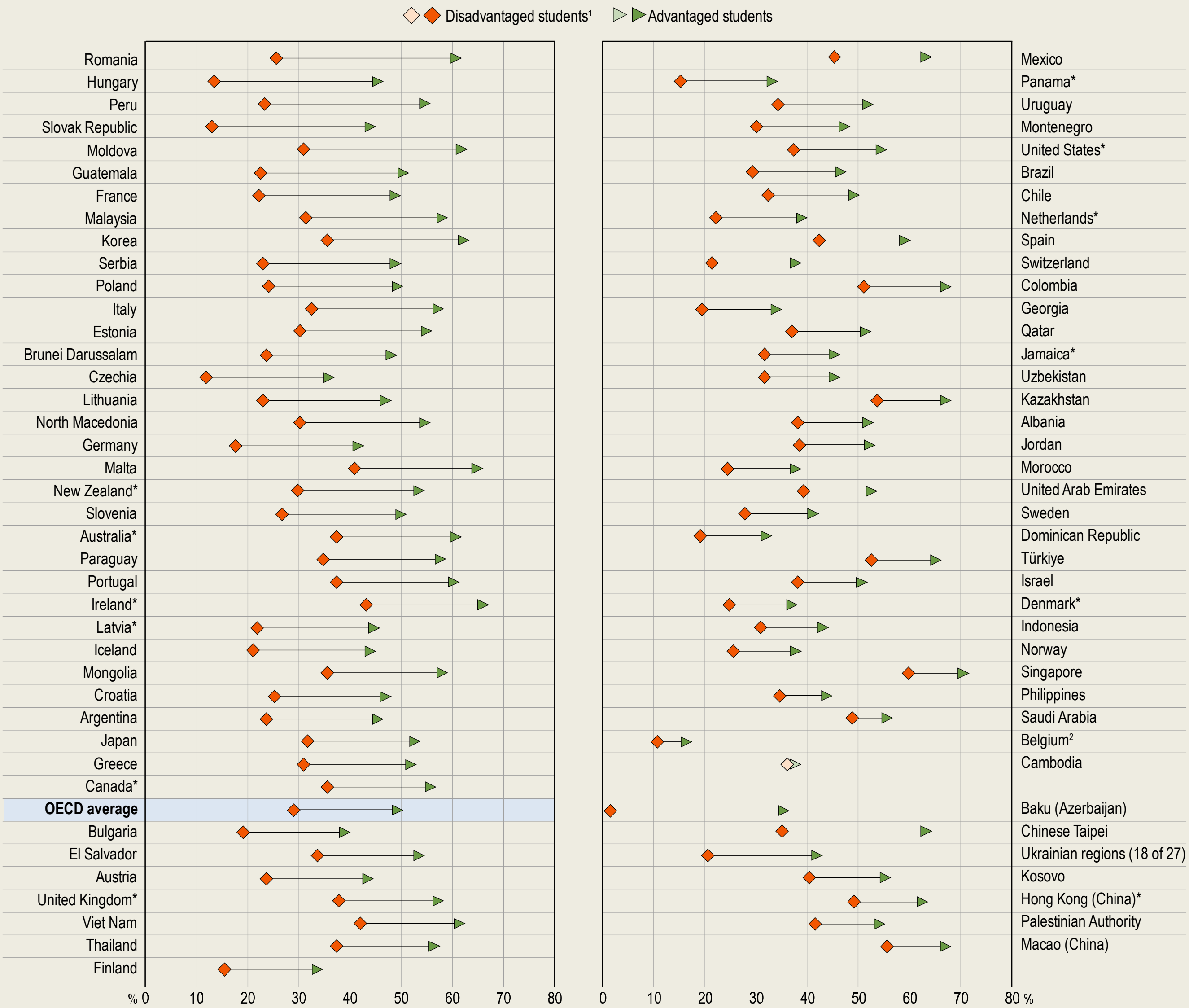
While, on average, slightly more girls than boys are able to report what job they want to do in the future, slightly more boys than girls reported that they expect to become managers (see Tables V.B1.6.9 and V.B1.6.23). This could be due to gender stereotypes that discourage girls from considering more leadership positions and a lack of women in leadership positions as role models. Across OECD countries this difference is very modest (around 1 percentage point) but it is slightly more prominent (around 5 percentage points) in Kazakhstan, Kosovo, Romania and Uzbekistan. In Mongolia and the Philippines, the gap is reversed, with slightly more girls than boys expecting to become managers (with a difference of around 1 to 2 percentage points) (see Table V.B1.6.23).

On the other hand, more girls than boys want to become professionals in all countries and economies. This difference is 14 percentage points on average across OECD countries but more pronounced – with a more than 25 percentage-point difference – in Albania, Jordan, Kosovo, Montenegro, the Palestinian Authority, Saudi Arabia and Türkiye. In Belgium and Peru, this difference is less than 5 percentage points (see Table V.B1.6.24).

Managers and professionals tend to be highly paid and 38% of students overall across OECD countries would like to become either (see Table V.B1.6.25). In terms of socio-economic status differences, though similar shares of advantaged and disadvantaged students were able to report what job they want to do in the future (see Table V.B1.6.9), more advantaged than disadvantaged students want to become managers or professionals. In some countries, this gap is less pronounced, especially in Baku (Azerbaijan), Belgium, Cambodia, the Philippines and Saudi Arabia, where the gap is less than 10 percentage points. In Hungary, Moldova, Peru, the Slovak Republic and Romania, the gap exceeds 30 percentage points (see Figure V.6.6). To ensure equality, it is important that all students can plan according to their preferences, skills and ambitions regardless of their socio-economic status.

Figure V.6.6. Students who expect to work as manager or professional, by socio-economic status

Percentage of students expecting to work as manager or professional, by students' socio-economic status



1. A socio-economically disadvantaged (advantaged) student is a student in the bottom (top) quarter of the PISA index of economic, social and cultural status (ESCS) in his or her own country/economy.
2. Data of Belgium represent only the French-speaking and German-speaking Communities.
Notes: Only countries and economies with available data are shown.
Statistically significant differences are shown in a darker tone (see Annex A3).
Countries and economies are ranked in descending order of the percentage-point difference related to students' socio-economic status (advantaged - disadvantaged students).
Source: OECD, PISA 2022 Database, Table V.B1.6.25. See Table V.6.1 for StatLink at the end of this chapter.

Are students with clear career expectations more apt to look for information about future opportunities?

In many countries and economies, career exploration is considered a transversal skill that young people should develop in school. In some countries, it is included in the curriculum as a compulsory activity (OECD, 2023[2]). In addition to the strategies for lifelong learning that are analysed in this volume, seeking information about future careers and education is an essential skill in itself as it empowers students for lifelong learning.

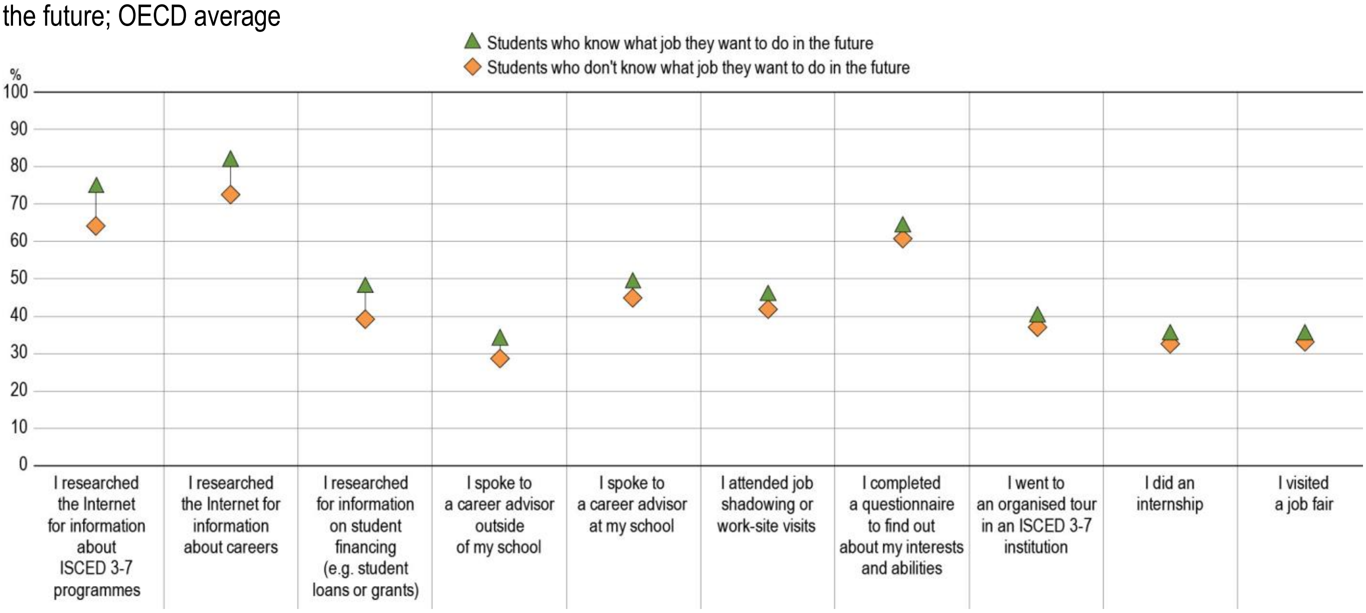
Students with defined career expectations seek more information about future opportunities than those without

Students in OECD countries who have clear career expectations participate more often in activities about future study or career options than those who do not (see Figure V.6.7). They especially research the Internet for information about educational programmes and careers. Research helps define future plans and having plans encourages research, creating a virtuous circle. In some countries and economies, these differences are more pronounced. For example, in Belgium and Ireland*, the difference between students who have clear career expectations and those who do not in looking for information about educational programmes on the Internet is more than 20 percentage points. This is around twice the average across OECD countries (see Figure V.6.7b [available online] and Table V.B1.6.15).

Students who know what job they would like to have in the future also seek more information on student financing such as loans and grants. Searching for financial opportunities is key for students, especially those from disadvantaged backgrounds, as it allows them to achieve their goals. It is important that students learn to make realistic plans and understand the steps required to get where they want (see Box V.6.3). New Zealand* presents the widest gap between students who have clear career expectations and those who do not in terms of looking for information on student financing. The 18 percentage-point gap is double the OECD average (see Figure V.6.7b [available online] and Table V.B1.6.15).

Figure V.6.7. Activities to seek information among students who know what job they want to do in the future

Percentage of students reporting the following statements across students who know or don't know what job they want to do in the future; OECD average



Note: Differences between students who know what job they want to do in the future and those who don't know are all statistically significant (see Annex A3). Items are ranked in descending order of the percentage-point difference between students who know what job they want to do in the future and those who don't know.
Source: OECD, PISA 2022 Database, Table V.B1.6.15. See Table V.6.1 for StatLink at the end of this chapter.

Box V.6.3. What are students' educational expectations and what factors influence them?

PISA 2022 asked students about the level of education they expect to complete in the future. Almost 70% expect to complete at least ISCED 5 (see Table V.B1.6.20) on average across OECD countries. Being motivated to pursue further education can influence students' academic achievements and behaviour in school as they have a clear project and goal. To take control of their future learning, students need to be aware of their learning options and pathways to be able to make informed decisions about how to reach their goals.

In countries that have historically low levels of attainment in tertiary education, such as Chile, Colombia, Costa Rica, Mexico, Peru and Türkiye – more than 85% of students reported expecting to complete tertiary education. On the contrary, in Brunei Darussalam, Denmark*, Finland, Germany, New Zealand*, the Philippines and Poland, 60% or less expect to complete tertiary education (see Table V.B1.6.20).

Students' socio-economic status is related to their expectations about going on to tertiary education

Some 83% of advantaged students expect to complete tertiary education compared to 53% of disadvantaged students on average across OECD countries. Students with disadvantaged socio-economic status may feel less encouraged or supported by teachers or their parents to enrol in tertiary education, and less confident and optimistic about the future. Perhaps the cost of tertiary education is too much of a burden or they need to enter the workforce and start earning sooner. In some countries/economies, the difference between advantaged and disadvantaged students expecting to complete tertiary education is more pronounced, such as in Czechia, Hungary, Korea, Lithuania, Moldova and Poland, where it exceeds 40 percentage points. On the contrary, in Chile, the Dominican Republic, Singapore and Uzbekistan, this difference is less than 10 percentage points (see Table V.B1.6.20).

There is a positive association between performance in mathematics and expecting to complete tertiary education, on average across OECD countries. This suggests that students who perform well in mathematics are more motivated to attend tertiary education as they are more confident they will succeed. It also suggests that students who want to attend tertiary education feel more motivated in school and perform better in mathematics. This association drastically changes when considering students' socio-economic status. Before accounting for socio-economic profile, the change in performance associated with expecting to complete tertiary education is of 44 score points but after accounting for socio-economic status the change is of 21 (see Table V.B1.6.21). This confirms that disadvantaged students are less likely to expect to go on to tertiary education despite their performance (see Table V.B1.6.22).

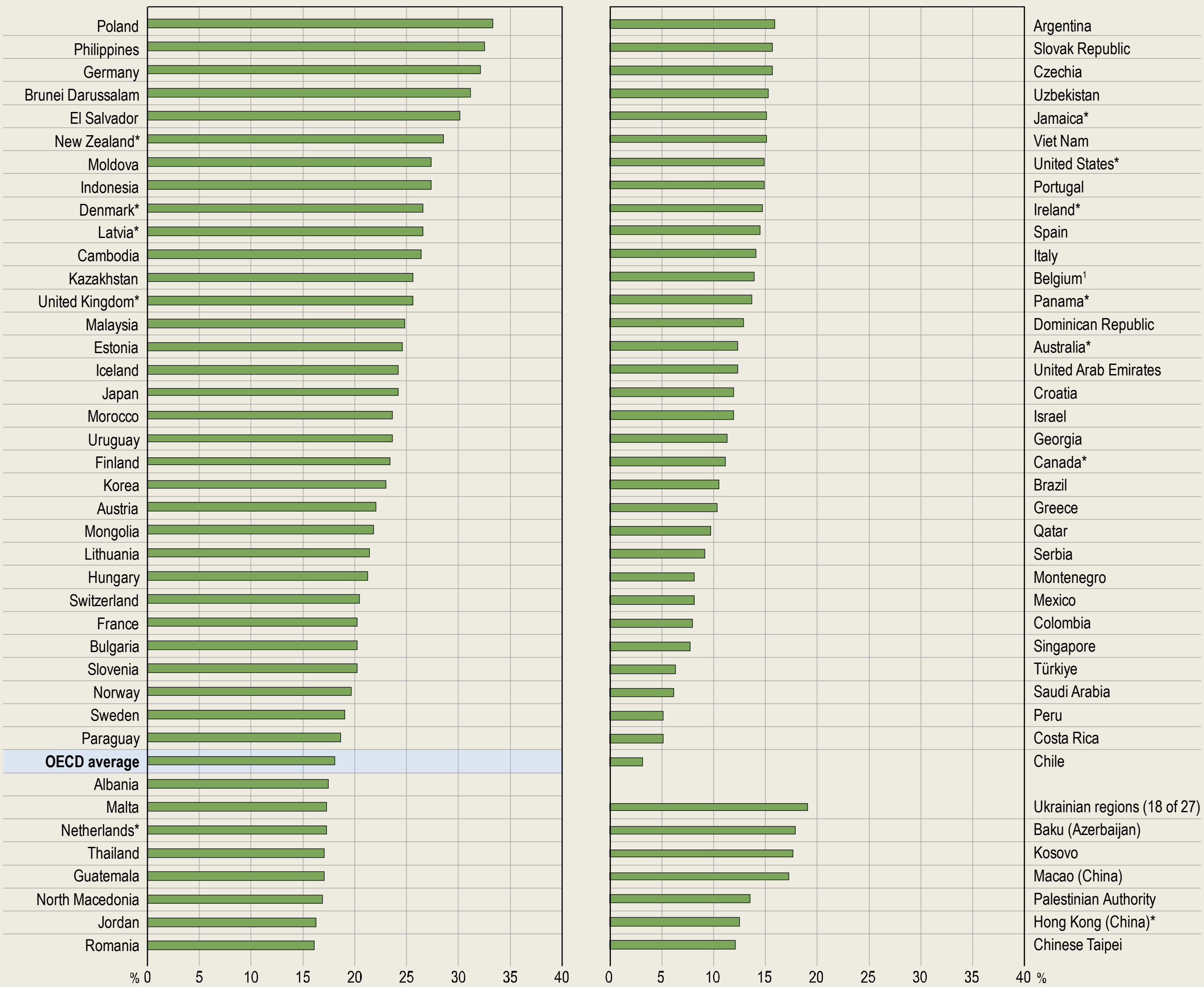
Students' educational expectations are not always aligned with their career expectations

While having clear career expectations can be motivating for students and signal their willingness to plan for the future, it is important that these expectations are aligned with their plans to pursue education and that their goals are realistic.

Figure V.6.8 shows that, on average across OECD countries, 18% of students do not expect to complete at least ISCED 5 but would like to become a manager or professional. This suggests that even if students have clear and ambitious plans for their future, some do not have a realistic idea of the steps required to reach their goal. In some countries, such as Brunei Darussalam, El Salvador, Germany, the Philippines and Poland, this result is even more worrying, with more than 30% of students who would like to become a manager or professional reporting that they do not expect to complete tertiary education. In Chile, Costa Rica and Peru, this share is lower, at below 6%. It is important to provide all students with career guidance and accurate information on possible pathways and requirements to access and complete them (see Box V.6.4).

Figure V.6.8. Students who do not expect to complete higher education among those who plan to work as managers or professionals

Percentage of students reporting they don't expect to complete higher education when they plan to work as manager or professional



1. Data of Belgium represent only the French-speaking and German-speaking Communities.
Note: Only countries and economies with available data are shown.
Countries and economies are ranked in descending order of the percentage of students who don't expect to complete higher education amongst those who plan to work as manager or professional.
Source: OECD, PISA 2022 Database, Table V.B1.6.20. See Table V.6.1 for StatLink at the end of this chapter.

Box V.6.4. Germany: Mentoring programmes for disadvantaged students

Germany offers different mentoring programmes to connect university students with school students in the last two years of lower secondary education. The goal is to help young people successfully transition into adult and professional life, focussing especially on disadvantaged students. These programmes provide career guidance, and foster self-esteem and trust in the mentees' skills and abilities.

Mentoring programmes usually follow these steps:

- Volunteer university students visit participating schools in their city to introduce the programme. Interested secondary students receive information material and consent forms to be signed by parents with which they apply to the programme.
- During kick-off training, participating students meet the mentors in a round of introductions. Mentees are matched to mentors based on mutual preferences immediately after introductions.
- After the match, pairs are expected to meet every two weeks for one to two years. While mentoring activities include going to the cinema or the zoo, mentors are also expected to support students in dealing with stressful situations at school and at home; provide occupational orientation; and assist in job-application processes.

"Arbeiterkind" ("Blue-collar-child") is a mentoring programme for students from blue-collar families. Founded in 2008 it supports students who are the first in their families to attend tertiary education. Some 6 000 volunteers in 80 local groups provide easy-access help for prospective and current university students (e.g. by providing information about scholarships). The goal is to equip students who are the first of their families to go to university with the implicit knowledge that students from more advantaged households already have. In 2022 alone, the programme involved 23 000 students.

Another example of a mentoring programme is "Rock Your Life!", which was founded by a group of university students in Germany in 2008. It is offered in 42 cities across Germany and has established more than 7 000 mentoring relationships since its launch.

A study conducted with 308 students from 10 German cities that participated in the "Rock Your Life!" mentoring programme between 2015 and 2018 found that mentored students benefited substantially from their mentoring relationship. It improved mentees' attainment in mathematics and non-cognitive social skills, and helped them develop clearer occupational plans. Students were much more likely to transition successfully into apprenticeships, leading to well-paying skilled employment. Through engagement with university students, mentees gained access to new sources of trusted information that encouraged them to think more pragmatically about their options for post-secondary education and training, and future employment.

Source: Arbeiterkind, (2024[3]) , redakteur | ArbeiterKind.de; Federal Ministry of Education and Research of Germany (2022[4]), Arbeiter Kind, arbeiterkind.de_jahresbericht_2022.pdf ; OECD (Forthcoming[5]), OECD Youth Policy Toolkit; Resnjanskij, S., Ruhose, J., Wiederhold, S., Woessmann, L., & Wedel, K. (2024[6]), Can mentoring alleviate family disadvantage in adolescence? A field experiment to improve labor market prospects. *Journal of Political Economy, 132*(3), 1013-1062. https://doi.org/10.1086/726905.

Table V.6.1. Chapter 6 figures: Students' attitudes about the future

Figure V.6.1	Students in general and vocational programmes, and motivations
Figure V.6.2	Students who are seeking information about future career and learning strategies
Figure V.6.3	Students who are seeking information about future career and motivations
Figure V.6.3b	Students who are seeking information about future career and motivations, by countries and economies
Figure V.6.4	Knowing what job one wants to do and learning strategies
Figure V.6.5	Knowing what job one wants to do and motivations
Figure V.6.6	Students who expect to work as manager or professional, by students' socio-economic status
Figure V.6.7	Activities to seek information among students who know what job they want to do in the future
Figure V.6.7b	Activities to seek information among students who know what job they want to do in the future, by countries and economies
Figure V.6.8	Students who do not expect to complete higher education among those who plan to work as managers or professionals

StatLink https://stat.link/vrb4ky

Notes

[1] These questions were scaled to construct the index of information-seeking regarding future career.

[2] Students who had a clear idea about their future job index was based on the human-coded open-ended expected occupation index. Students who had no clear idea about their future jobs were considered those who indicated "I do not know" or gave a vague answer such as "a good job", "a quiet job", "a well-paid job", "an office job".

References

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Resnjanskij, S. et al. (2024), "Can Mentoring Alleviate Family Disadvantage in Adolescence? A Field Experiment to Improve Labor Market Prospects", *Journal of Political Economy*, Vol. 132/3, pp. 1013-1062, https://doi.org/10.1086/726905. [6]

7 Effects of economic deprivation on sustainable learning strategies and motivation to learn

This chapter examines the relationship between experiences of economic deprivation such as food insecurity and missing school for economic reasons, and the use of sustainable learning strategies and attitudes towards learning. The chapter also looks at how working for pay before or after school relates to socio-economic background and the use of learning strategies.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

Economic deprivation – the inability of households to meet their basic material and financial needs – limits students' capacity to learn and develop learning strategies (Schenck-Fontaine and Ryan, 2022[1]). While the effects of economic deprivation on learning outcomes have been the subject of many studies, little is known about its effect on the development of strategies for sustained learning. This chapter examines how economic deprivation, and, particularly, food insecurity, relates to students' use of sustainable learning strategies. The chapter also looks at indirect proxies for deprivation such as working part-time to earn money and the inability to attend school for financial reasons: the latter is described in Box V.7.2.

Key findings

PISA finds that, unsurprisingly, 15-year-olds who experience food insecurity or work part-time during the school week tend to come from disadvantaged socio-economic status. In many PISA-participating countries and economies, they are more likely to be boys or come from an immigrant background.

PISA 2022 findings show that economic deprivation relates negatively to students' ability to develop and use sustainable learning strategies. In particular, students are less likely to exhibit proactive learning strategies and to show control over their own learning.

There is a somewhat negative relationship between deprivation and young people being able to understand different points of view and ways of looking at the world. These are all hurdles to young people's lifelong learning, keeping in mind, as well, that this is a student population at high risk of dropping out from formal education. Interestingly, students suffering from food insecurity or working for pay show similar levels of cognitive agility as other students when accounting for socio-economic status and mathematics performance.

On a bright note, students suffering from economic deprivation show as much as or even more interest in learning and curiosity about the world around them than their advantaged peers. This is true especially of students who hold part-time jobs[1]. They show marked creativity and persistence, and are positive about learning, particularly mathematics. These positive attitudes are a springboard to lifelong learning strategies that education systems can build on.

What do we know about 15-year-olds facing food insecurity?

A key dimension of material deprivation, food insecurity is defined as the inability to meet the nutritional needs of an individual (Aurino, Fledderjohann and Vellakkal, 2019[2]). Students participating in PISA were asked to report how many times a week they are not able to eat due to lack of money[2]. While not encompassing all dimensions of food security such as the nutrition level of meals, access to food is a good proxy for examining food insecurity among 15-years-olds (Aurino, Fledderjohann and Vellakkal, 2019[2]).

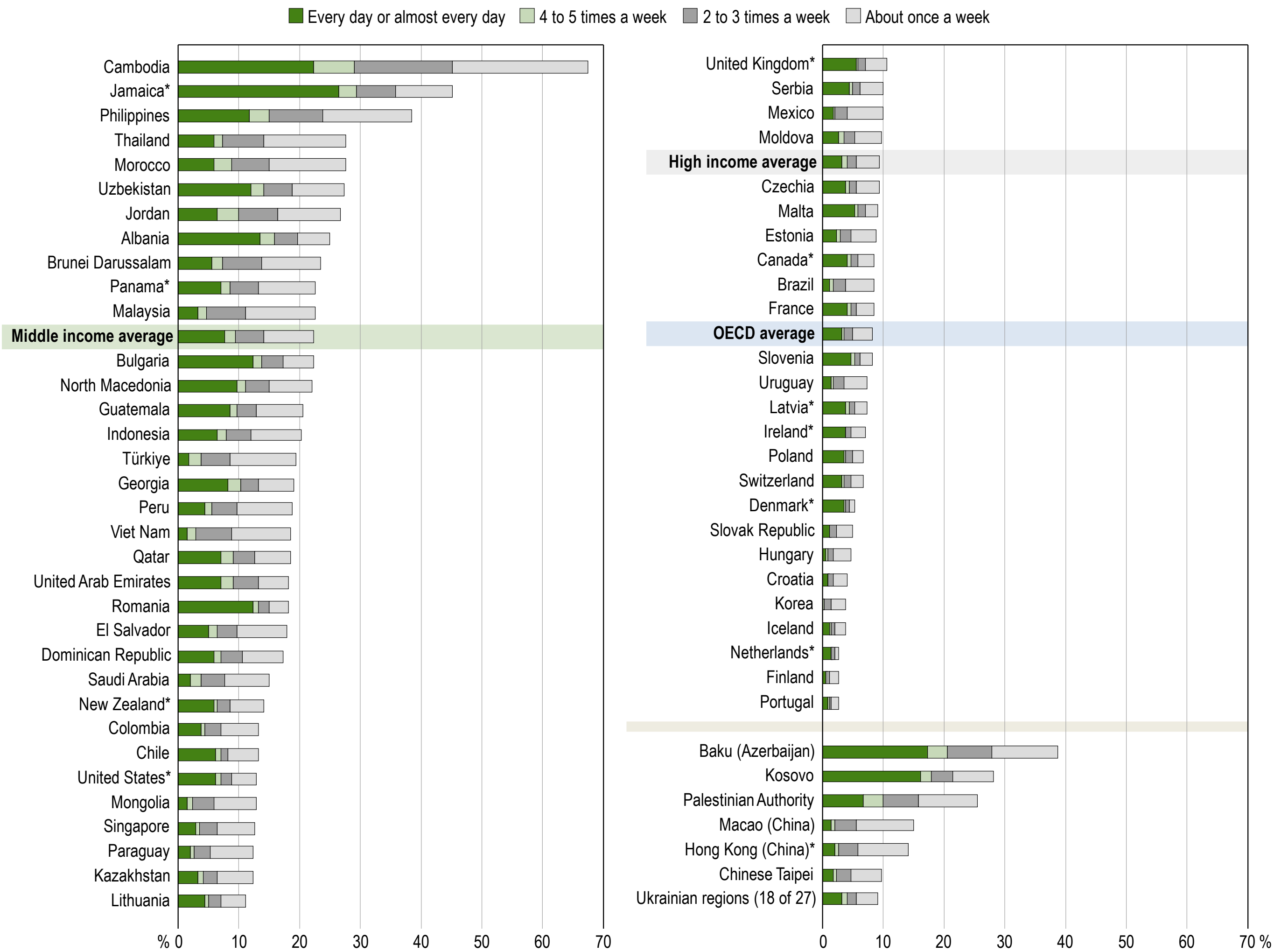
Food insecurity is widespread in all PISA-participating countries/economies

Food insecurity is observed in all PISA-participating countries and economies with available data. An average of 8% of students in OECD countries reported that there was at least one day a week in the previous 30 days they had not eaten because there was not enough money to buy food. Some 3% of students reported that this happens every day or almost every day (see Figure V.7.1).

In middle-income countries and economies, about one student in five, on average, reported that they did not have enough money to buy food at least once a week in the 30 days prior to the PISA test and 8% reported that they skip meals daily or almost daily due to lack of means. In high-income countries, 10% of students reported not eating at least once a week, on average (see Figure V.7.1).[3]

Figure V.7.1. Food insecurity: How often did students not eat because there was not enough money to buy food, in the past 30 days

Percentage of students who reported not eating once a week or more because there was not enough money to buy food in the past 30 days



Note: Only countries and economies with available data are shown.

Countries and economies are ranked in descending order of the percentage of students who, at least once a week in the past 30 days, did not eat because there was not enough money to buy food.

Source: OECD, PISA 2022 Database, Table V.B1.7.2. See Table V.7.1 for StatLink at the end of this chapter.

See Table V.7.1 for StatLink at the end of this chapter.

Food insecurity is most widespread among immigrant students and boys

Immigrant students suffer more from food insecurity than non-immigrant students in many PISA-participating countries and economies (4.9 percentage-point difference, OECD average). This may be explained by immigrant students' more precarious socio-economic status and overall exposure to economic deprivation in many PISA-participating countries/economies. In addition, boys reported slightly higher levels of food insecurity than girls (one percentage-point difference that is statistically significant) on average across OECD countries. While a gender difference in food insecurity is small among OECD countries (within two percentage-point difference), food insecurity is, nonetheless, more widespread among boys than girls in most PISA-participating countries, and exceeds 10 percentage points in difference in Jordan, Qatar, the Palestinian Authority and the Philippines (see Table V.B1.7.3).

Recurring food insecurity is related to lower learning outcomes

Students suffering from food insecurity tend to have lower learning outcomes in all countries and economies with available data. Students who reported not eating at least one day a week in the 30 days leading up to the test because of lack of money scored, on average, lower in mathematics (42 points difference after accounting for socio-economic profile across OECD countries) than their peers who never experience food insecurity (see Table V.B1.7.4). Hunger and poor nutrition lead to fatigue, limited attention-span and slower working memory. Students who suffer from food insecurity are more likely to work within or outside the household to help the family respond to food insecurity. Additionally, families facing food insecurity likely invest less time and financial resources in school education as the priority is to secure food (Aurino, Fledderjohann and Vellakkal, 2019[2]; Gallegos et al., 2021[3]).

Given the strong relationship between food insecurity and learning, many PISA-participating countries and economies are addressing students' nutritional needs through school-level policy interventions such as free meals, food stamps or food vouchers to socio-economically disadvantaged students. For example, New Zealand's school lunch programme, "Ka Ora; Ka Ako" has shown promising results in addressing food insecurity (see Box V.7.1).

Box V.7.1. New Zealand: Ka Ora, Ka Ako – Healthy school lunches

Food insecurity is a challenge for many young people in New Zealand. Around 1 in 5 children live in households that face difficulties accessing good quality food.

New Zealand's school-based healthy lunch programme, Ka Ora, Ka Ako, was first introduced in 2019 and aims to reduce food insecurity by providing lunches to students everyday. A study in 2022 showed that the programme had a positive impact on food security and student well-being, particularly among the most disadvantaged students who experience the greatest levels of food insecurity. The programme also improved school attendance among these students but not the overall population.

Ka Ora, Ka Ako provides free lunches to all students everyday in schools and *kura* (schools where teaching is based on Māori culture and values) with the highest number of students experiencing socio-economic barriers. Instead of targeting students on the basis of individual need, this reduces the stigma associated with receiving free meals and ensures that students receive the lunches they need. In May 2024, the programme served over 236 000 students in 1 013 schools and *kura*.

Schools and *kura* are selected based on the Ministry of Education's Equity Index (EQI), which measures the extent to which students at school may face socio-economic barriers that could impact their academic achievements. Currently, participating schools can choose to make their own lunches internally or provide lunches through an approved external supplier. There is currently no set lunch menu for the programme, and schools and suppliers can decide what to include in their lunches. The cost of lunches depends on the model of school lunch delivery and age of the learners.

Source: (Ministry of Education, 2024[4]; Ministry of Education, 2024[5]; Ministry of Education, 2024[6]; Vermillion Peirce et al., 2022[7])

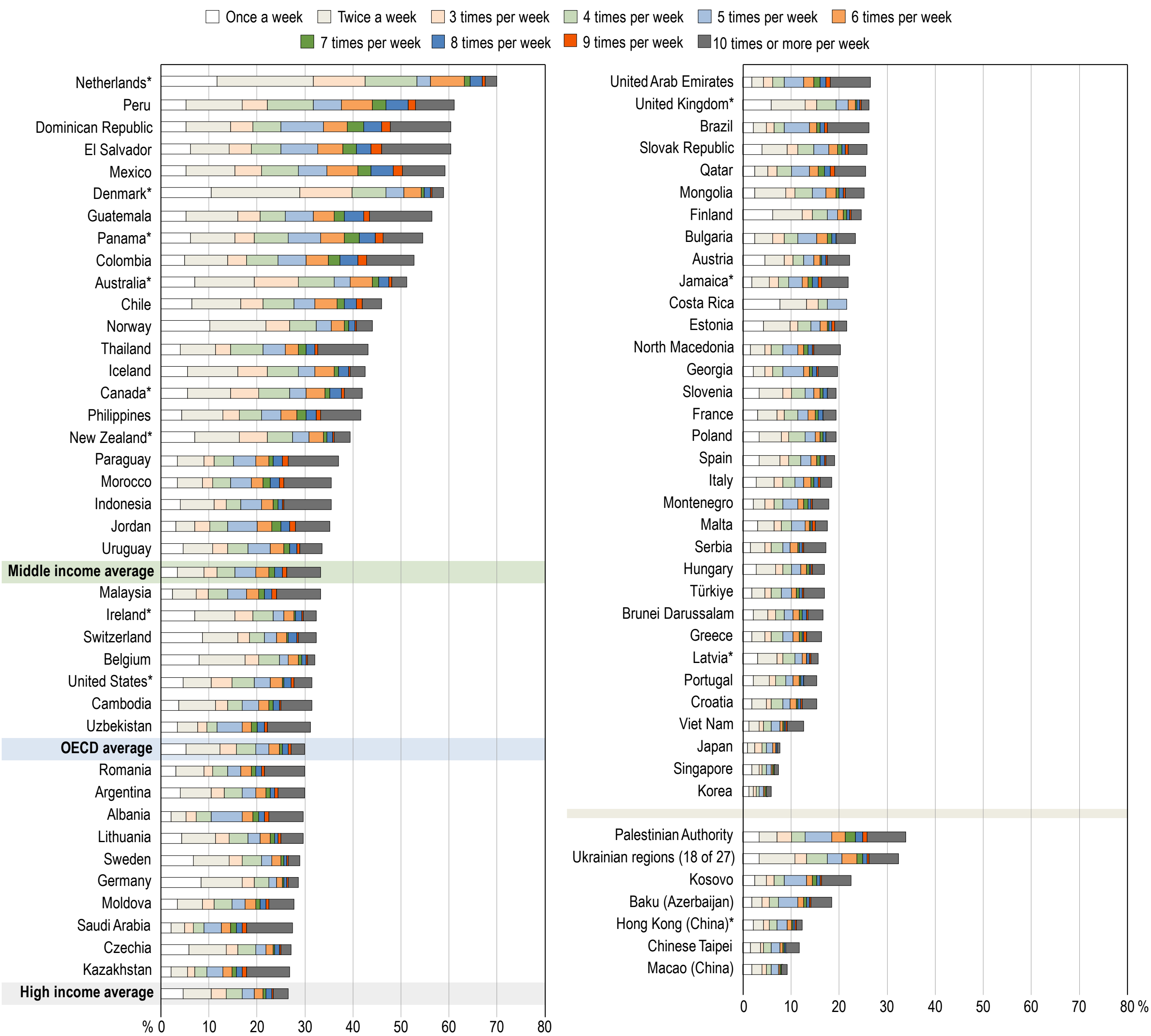
What do we know about 15-year-olds with part-time employment?

Part-time employment is the experience of holding a job and receiving pay for work outside of schooling hours (Holford, 2020[8]). Students participating in PISA were asked to report how many days per week in a typical school week they had worked before or after school[4]. Part-time employment is not unusual among adolescents in many countries/economies in PISA. Some 30% of 15-year-old students work at least once a week before or after school and 10% reported working at least 5 times per week before or after school, on average across OECD countries. In some countries, more than half of students hold part-time employment. This is the case, for example, in the

Netherlands* where 70% of 15-year-old students reported working part-time at least once a week. The share of students working for pay is higher among middle-income countries and economies participating in PISA (33%) than high-income countries (26%). Similarly, the share of intensive part-time employment (at least five times a week) is higher in middle-income countries and economies in PISA (18%) than high-income ones (10%) (see Figure V.7.2).

Figure V.7.2. Students working for pay before or after school

Percentage of students working for pay before or after school during a typical school week



Note: Only countries and economies with available data are shown.

Countries and economies are ranked in descending order of the percentage of students working for pay before or after school at least once a week.

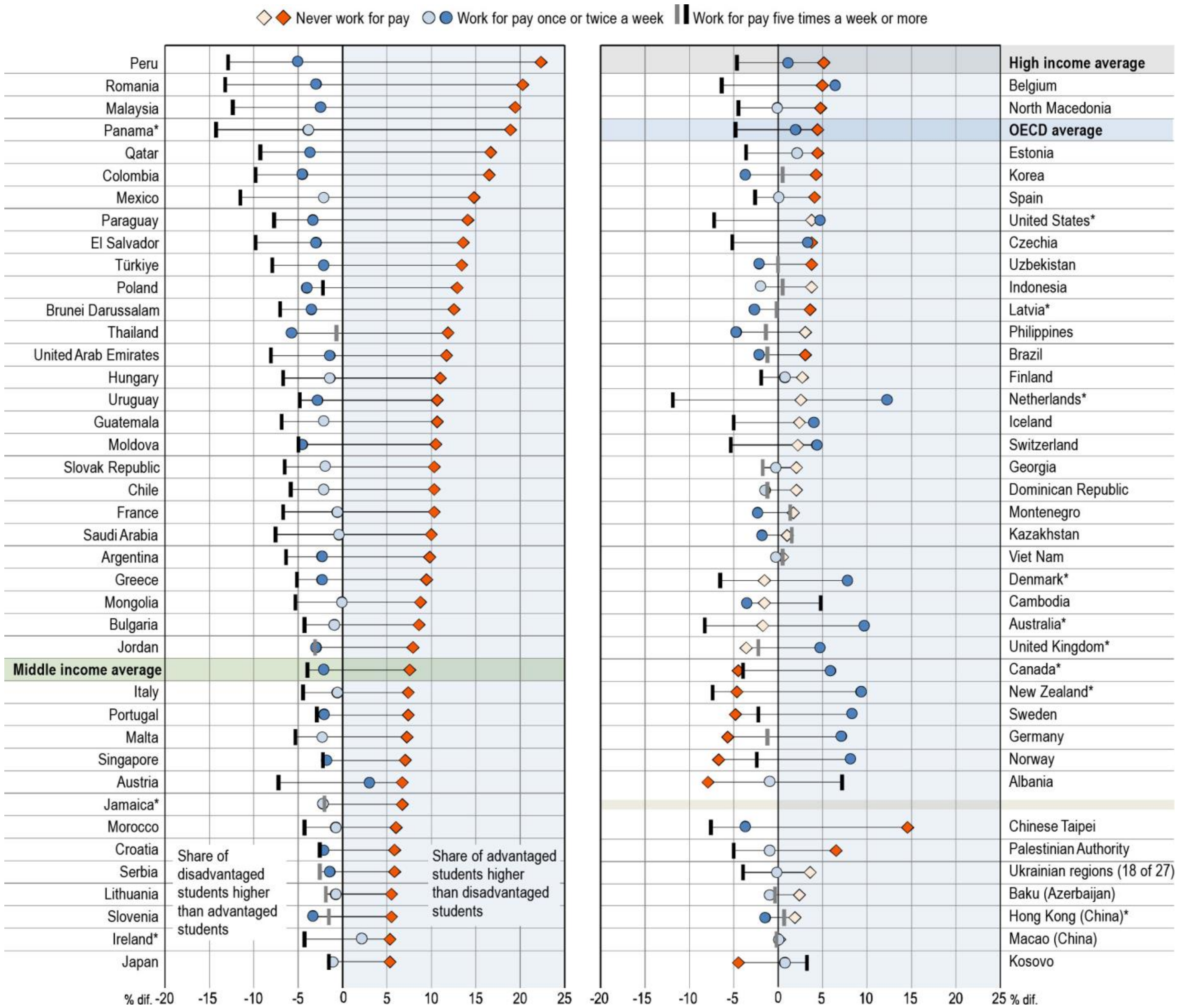
Source: OECD, PISA 2022 Database, Table V.B1.7.12. See Table V.7.1 for StatLink at the end of this chapter.

While not a measure of economic deprivation, part-time employment tends to be most prominent among students facing high levels of poverty or economic deprivation in most PISA-participating countries and economies. Socio-economically disadvantaged students generally hold part-time jobs more than advantaged students (4.5 percentage-point difference, on average across OECD countries). However, in 20 participating countries and economies, there is no difference in the share of disadvantaged and advantaged students working for pay at least once a week and in 8 countries and economies advantaged students report more instances of part-time employment than disadvantaged students: Albania, Canada*, Germany, Kosovo, New Zealand*, Norway, Sweden and the United Kingdom*. This is particularly the case in some OECD countries where a large share of the 15-year-old student population holds a part-time job, such as Australia*, Denmark*, the Dominican Republic and the Netherlands* (see Table V.B1.7.12 and Table V.B1.7.14).

Socio-economically disadvantaged students tend to also work more intensively during the school week (+0.42 points more on the work-for-pay index, on average across OECD countries) (see Table V.B1.7.15). While among OECD and high-income countries and economies, slightly more advantaged students than disadvantaged work once or twice a week (+1.1 percentage-point difference among high-income countries and economies, and +1.9 percentage-point difference among OECD countries), more disadvantaged students than advantaged work for pay five times a week or more (-4.6 percentage-point difference among high-income countries and -4.8 percentage points among OECD countries) (see Figure V.7.3).

Figure V.7.3. Work for pay, by students' socio-economic status

Percentage-point difference between advantaged and disavantaged students reporting to work for pay before or after school



Notes: Only countries and economies with available data are shown.

A socio-economically disadvantaged (advantaged) student is a student in the bottom (top) quarter of the PISA index of economic, social and cultural status (ESCS) in his or her own country/economy.

Statistically significant differences are shown in a darker tone (see Annex A3).

Countries and economies are ranked in descending order of the difference of students who never work for pay related to socio-economic status (advantaged minus disadvantaged students).

Source: OECD, PISA 2022 Database, Table V.B1.7.13. See Table V.7.1 for StatLink at the end of this chapter.

Part-time employment is most prominent among boys

Boys reported working for pay outside of school hours at least once a week more than girls in almost all PISA-participating countries and economies. Among OECD countries, 33% of boys on average reported working for pay against 27% of girls (see Table V.B1.7.14). This gender gap is particularly pronounced among middle-income countries and economies participating in PISA (19.4 percentage-point difference on average among middle-income countries/economies compared to 6.6 on average among OECD and high-income countries and economies). Additionally, boys have a higher intensity of work during the school week than girls (+0.5 point increase in the work-for-pay index on average across OECD countries) (see Table V.B1.7.15). This may be explained by the gendered socio-cultural division of labour in which girls are more likely to work in the household or take care of family members in many PISA-participating countries and economies (Hayford and Halliday Hardie, 2020[9]; UNICEF, 2022[10]).

Part-time employment is related to lower mathematics performance

Students who spend more time on part-time employment tend to perform worse in mathematics in PISA even after accounting for socio-economic profile (see Table V.B1.7.18). This finding corroborates national studies from the United States and the United Kingdom that find a negative relationship between part-time employment among adolescents and their learning outcomes, in particular, for intensive work (Staff et al., 2020[11]; Holford, 2020[8]). Intensive part-time employment also increases the risk of drop-out and fading out from education as students invest more time in work and are not able to keep up with schoolwork demands (Staff et al., 2020[11]). This also heightens the risks of students not developing needed learning strategies to engage with lifelong learning.

Economic deprivation relates to somewhat lower levels of development and use of strategies for sustained learning

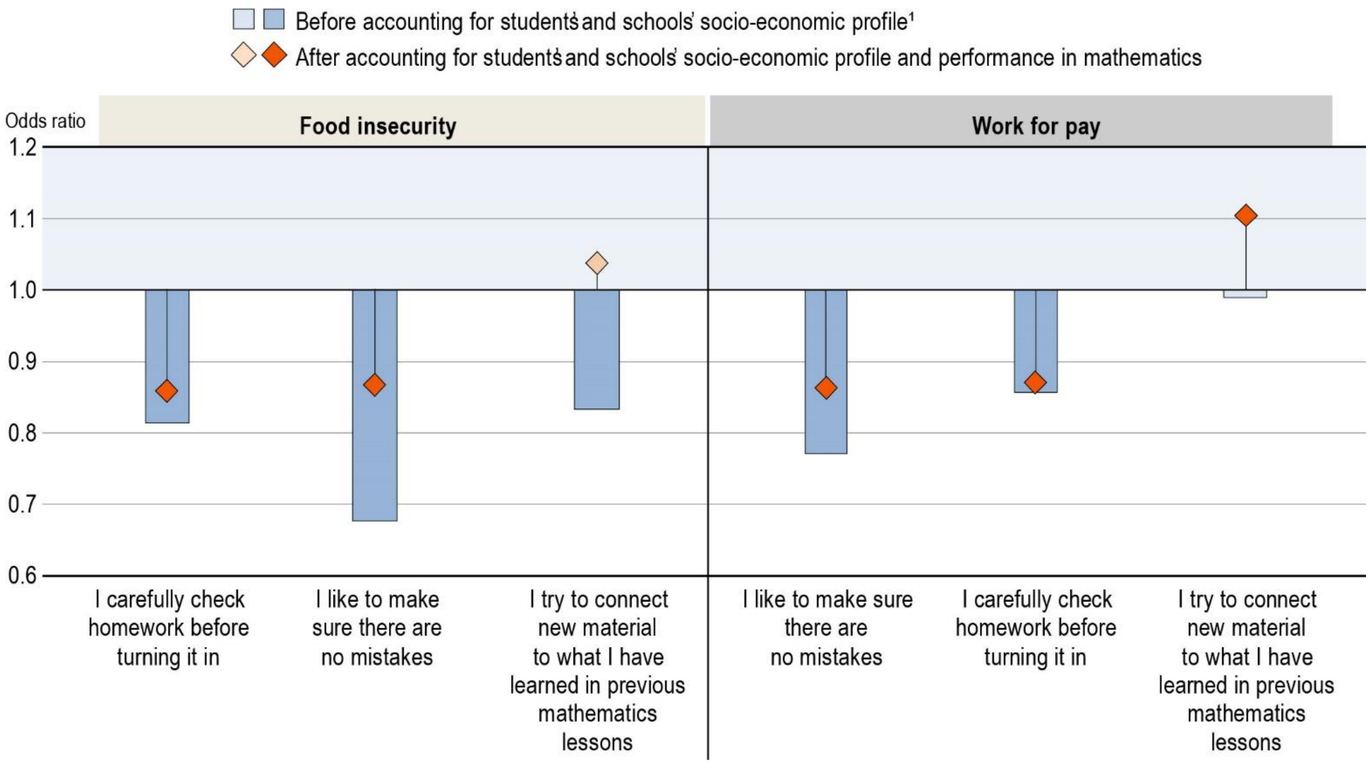
Experiences of food insecurity and working for pay before or after school are related to somewhat lower levels of development and use of strategies for sustained learning even when accounting for students' and schools' socio-economic profile, and students' mathematics performance. Students with these life experiences are less likely to be in control of their own learning or demonstrate critical-thinking skills in their decision making. Poorer learning strategies among an already vulnerable student population exacerbates the risk of drop-out from formal education and may limit lifelong learning in the future.

Students suffering from economic deprivation are somewhat less likely to be proactive and in control of their own learning

Students suffering from food insecurity or who hold part-time jobs are somewhat less likely to report using some self-regulated learning strategies such as carefully checking their homework, on average across OECD countries, even after considering students' and schools' socio-economic profile and students' mathematics performance. In general, these students also show lower levels of proactive study, on average across OECD countries. This includes making sure there are no mistakes or connecting new material to what was learnt previously – although they are as likely to connect new material to what they learned previously once students' and schools' socio-economic profile and students' mathematics performance were accounted for (see Figure V.7.4). Economic deprivation seems to distract students from schoolwork. They are less likely to have the time or energy for proactive and self-regulated learning, making them passive learners (Gallegos et al., 2021[3]).

Figure V.7.4. Food security and working for pay before or after school and being in control of one's own learning and using proactive learning strategies

Likelihood of reporting using learning strategies associated with control of one's own learning and proactive learning when students suffer from food insecurity or when they work for pay; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Note: Odds ratio coefficients that are statistically significant are shown in a darker tone (see Annex A3).
Items are ranked (for each graph) in ascending order of the odds ratio, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Tables V.B1.7.6 and V.B1.7.20. See Table V.7.1 for StatLink at the end of this chapter.

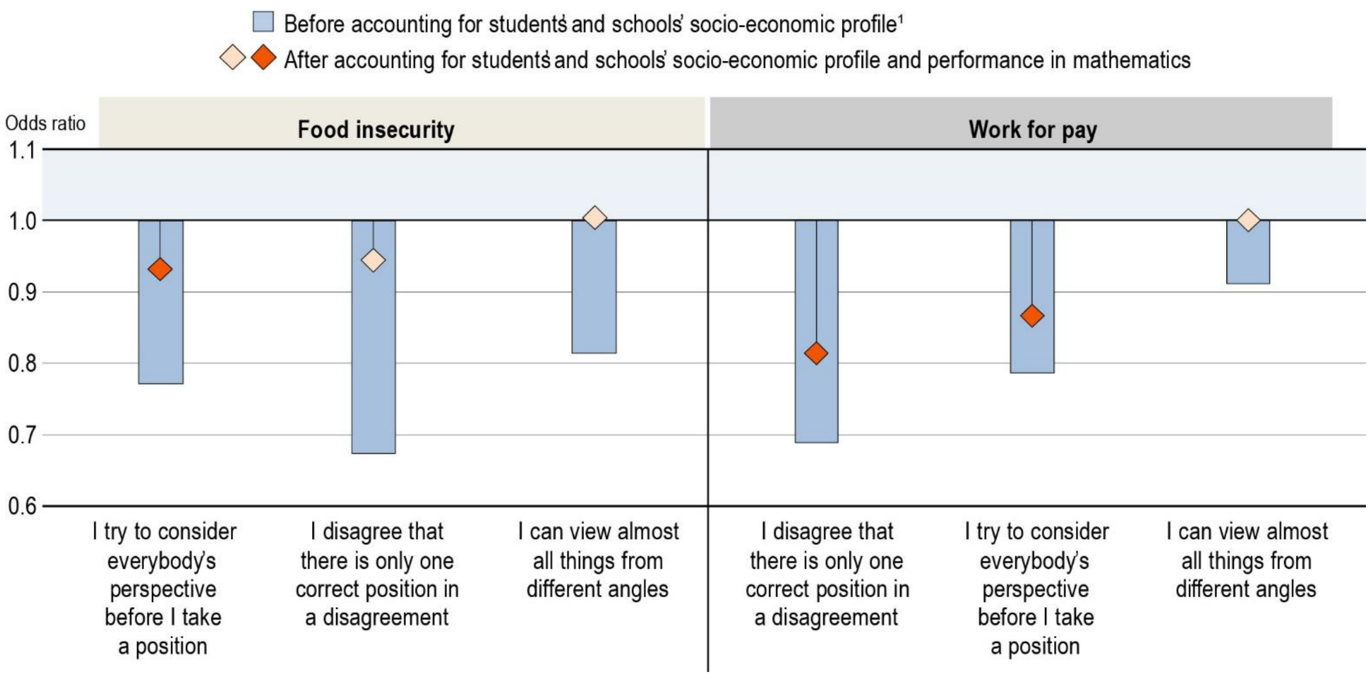
Economic deprivation relates somewhat negatively to critical thinking but not to cognitive agility

Economic deprivation relates to somewhat less development and use of critical-thinking strategies for sustained learning. Students suffering from food insecurity are 7% less likely to consider everybody's perspective before taking a position, after accounting for socio-economic profile and mathematics performance, on average across OECD countries. They also exhibit slightly less cognitive agility and are more likely to agree that there is only one correct position in a disagreement before accounting for students' and schools' socio-economic profile and mathematics performance. It is worth noting that no significant difference is observed in cognitive agility once socio-economic profile and mathematics performance are accounted for (see Figure V.7.5).

Students with part-time jobs also show less developed critical-thinking strategies. Students working for pay at least once a week are 20% less likely than those who do not to consider others' perspectives before making a decision. They are also more likely to think there is only one correct position in a disagreement (30% more likely, on average across OECD countries) (see Figure V.7.5).

Figure V.7.5. Food insecurity, working for pay before or after school and the use of critical-thinking learning strategies

Likelihood of reporting using learning strategies associated with critical thinking when students suffer from food insecurity or when they work for pay; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Note: Odds ratio coefficients that are statistically significant are shown in a darker tone (see Annex A3).
Items are ranked (for each graph) in ascending order of the odds ratio, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Tables V.B1.7.8 and V.B1.7.22. See Table V.7.1 for StatLink at the end of this chapter.

Students facing food insecurity and those who work for pay exhibit positive attitudes toward learning

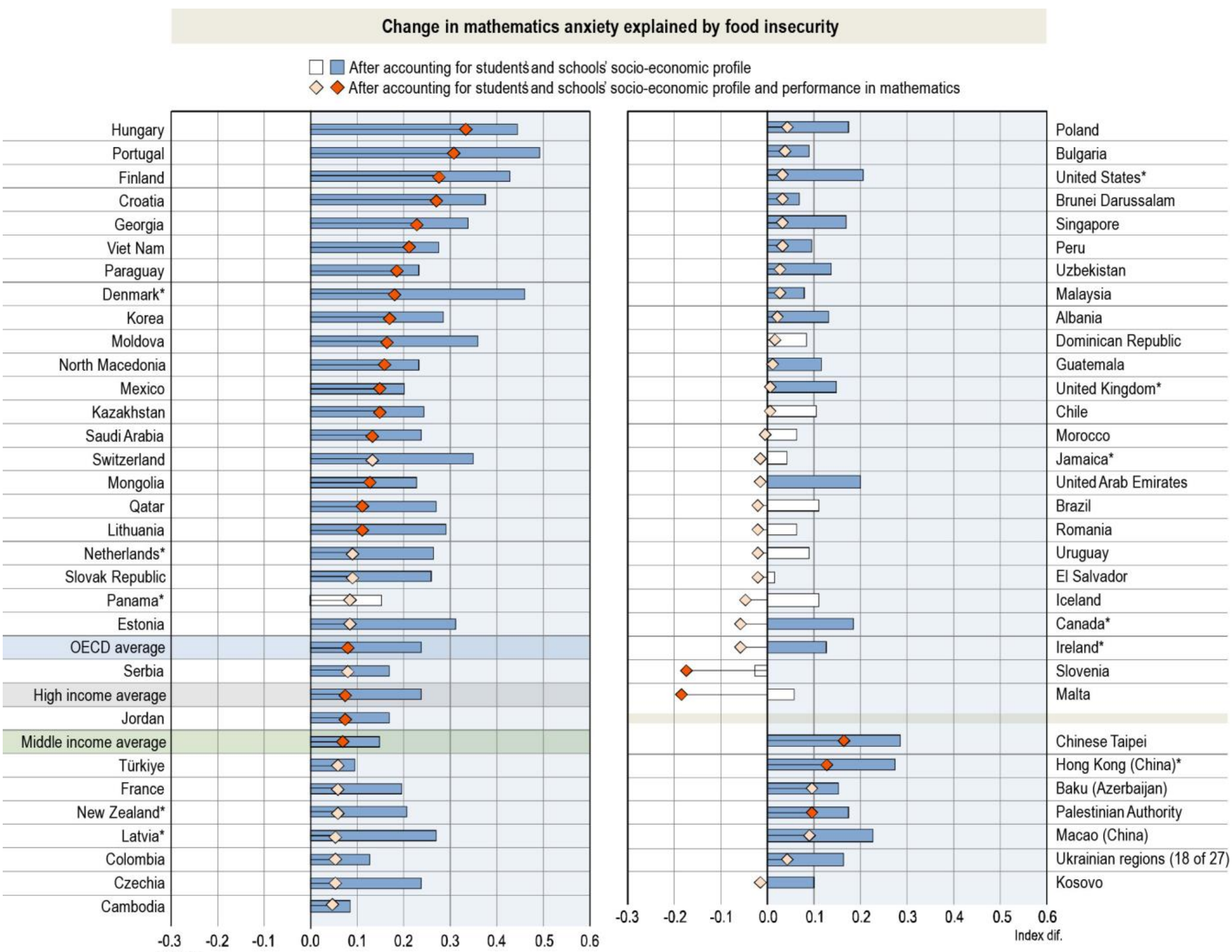
Students facing economic deprivation or holding part-time employment are motivated to learn and are curious about the world. While economic deprivation in the form of food insecurity is related to negative self-beliefs about learning, students holding part-time jobs, on the other hand, tend to feel more positive about learning – in particular, in mathematics. And economic deprivation does not impede students' motivation to learn or their interest in learning. Students with part-time jobs may feel even more motivated to learn. These findings provide policy makers with valuable insights. Flexible learning systems that give economically deprived students opportunities for combining their study with work or re-entry points into schooling can keep students facing economic deprivation from fading out from formal education.

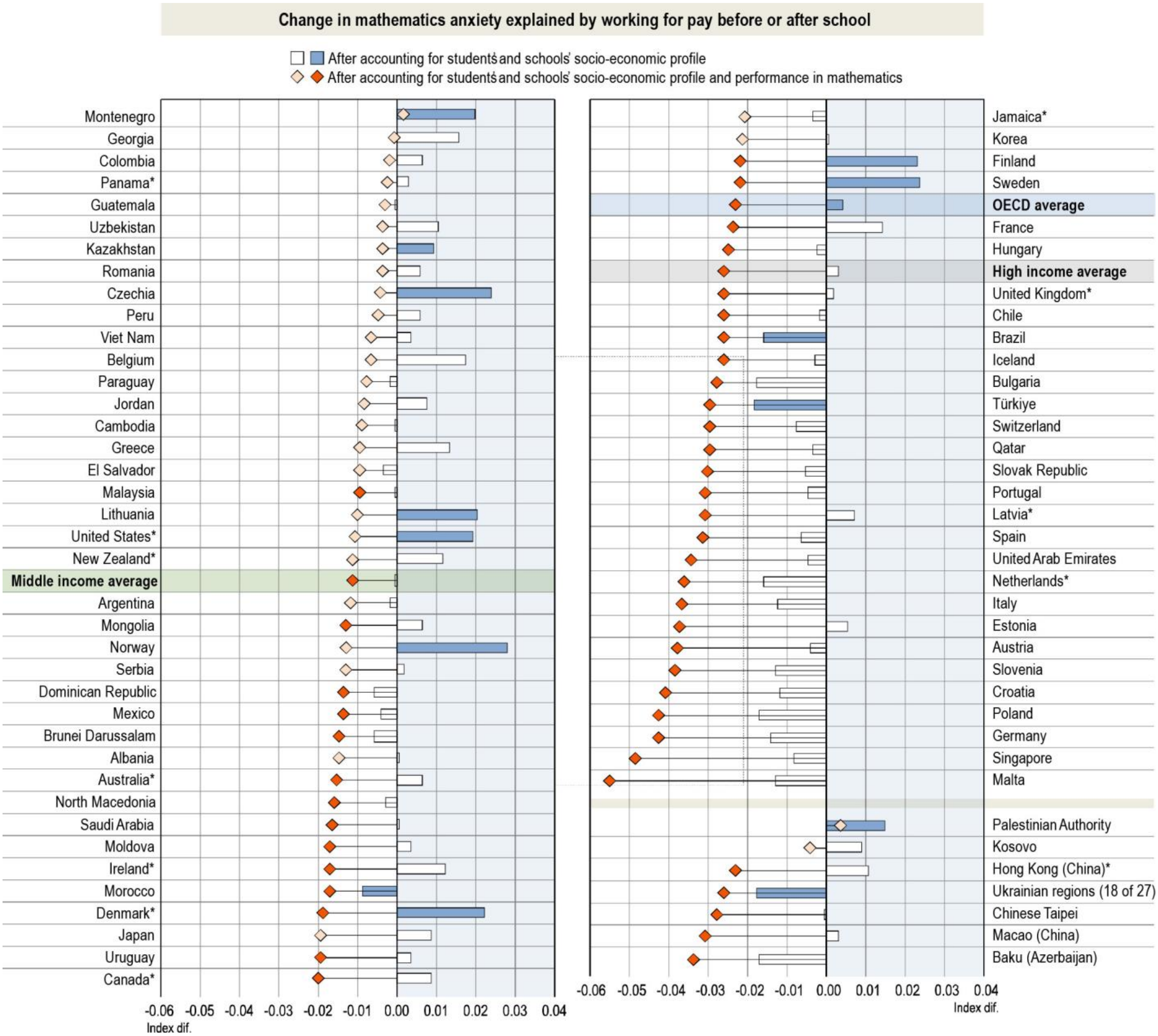
Economic deprivation is related to heightened mathematics anxiety but part-time student employment is associated with slightly lower mathematics anxiety

Students in OECD countries who experience food insecurity reported higher levels of mathematics anxiety than their peers, on average (0.24 points higher at the OECD average), even when accounting for socio-economic profile and mathematics performance (0.08 at the OECD average) (see Figure V.7.6). It is probable that this anxiety prevents these students from developing sustainable learning strategies (see Chapter 4). Students who work for pay have somewhat similar levels of mathematics anxiety than those who do not work before accounting for socio-economic profile and mathematics performance (see Figure V.7.6). The sense of a lack of self-efficacy and agency over one's own learning may also heighten mathematics anxiety among economically deprived students. However, once socio-economic profile and mathematics performance is accounted for, having a job and earning money correlates with a slight reduction in mathematics anxiety, on average across OECD countries (see Figure V.7.6 and Table V.7.25). This may point to a positive effect of using mathematical skills and knowledge in an applied setting (workplace) on mathematics anxiety. This finding opens up new possibilities for students at risk of dropping out to re-engage with mathematics and develop learning strategies. Education systems might look at applied learning opportunities and connecting learning more closely to students' lived experiences outside of the classroom.

Figure V.7.6. Change in the index of mathematics anxiety associated with food insecurity and working for pay

Change in mathematics anxiety when students reported suffering from food insecurity or working for pay





1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).

Notes: Only countries and economies with available data are shown.

Change in the index of mathematics anxiety that are statistically significant are shown in a darker tone (see Annex A3).

Countries and economies are ranked, within each chart, in descending order of the change of the index of mathematics anxiety, after accounting for students' and schools' socio-economic profile and mathematics performance.

Source: OECD, PISA 2022 Database, Tables V.B1.7.11 and V.B1.7.25. See Table V.7.1 for StatLink at the end of this chapter.

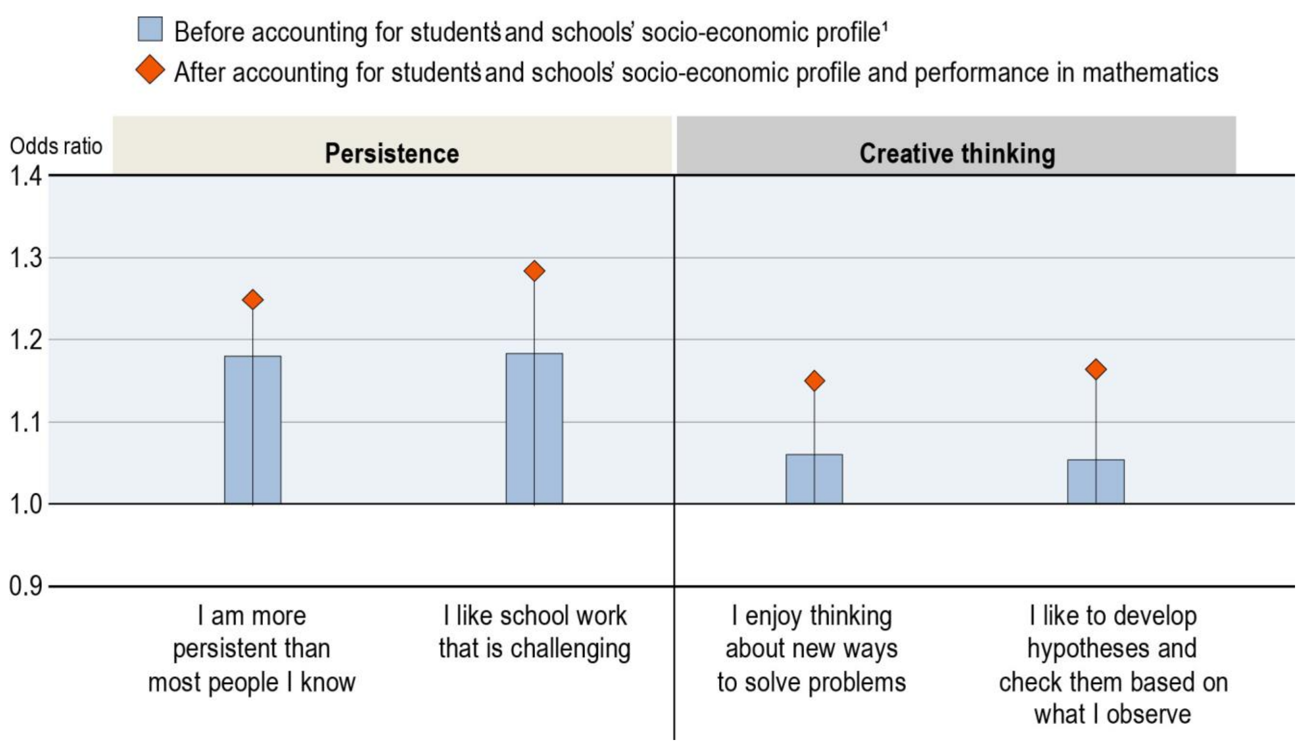
Students experiencing economic deprivation are motivated to learn and interested in learning

Although lacking sustainable learning strategies, students suffering from economic deprivation are as motivated to learn as their peers. In some cases, they are even more motivated. When accounting for both socio-economic profile and mathematical performance, students who experience food insecurity are just as curious and open-minded about the world as their peers who do not have food insecurity, on average across OECD countries (see Table V.B1.7.10 and Table V.B1.7.11).

Student employment tends to be associated with higher levels of curiosity, creativity and persistence in learning after accounting for socio-economic profile and mathematic performance. Students who work part-time are more likely to report being persistent and enjoying challenging schoolwork than those who do not, on average across OECD countries. They are also more likely to demonstrate creativity by thinking up new ways to solve problems (see Figure V.7.7). Finally, they also demonstrate slightly higher levels of curiosity about the world than others, on average across OECD countries (see Table V.B1.7.25). This positive disposition towards learning in both formal and informal settings may come from students' exposure to work situations and interaction requiring the application of skills and knowledge. It may also result from a self-selection process where students most motivated to learn are also more likely to work (Mortimer, 2010[12]).

Figure V.7.7. Working for pay, and creative thinking and persistence

Likelihood of reporting using strategies associated with persistence and creative thinking when students work for pay; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Note: All odds ratio coefficients are statistically significant (see Annex A3).
Items are ranked (for each graph) in ascending order of the odds ratio, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.7.24. See Table V.7.1 for StatLink at the end of this chapter.

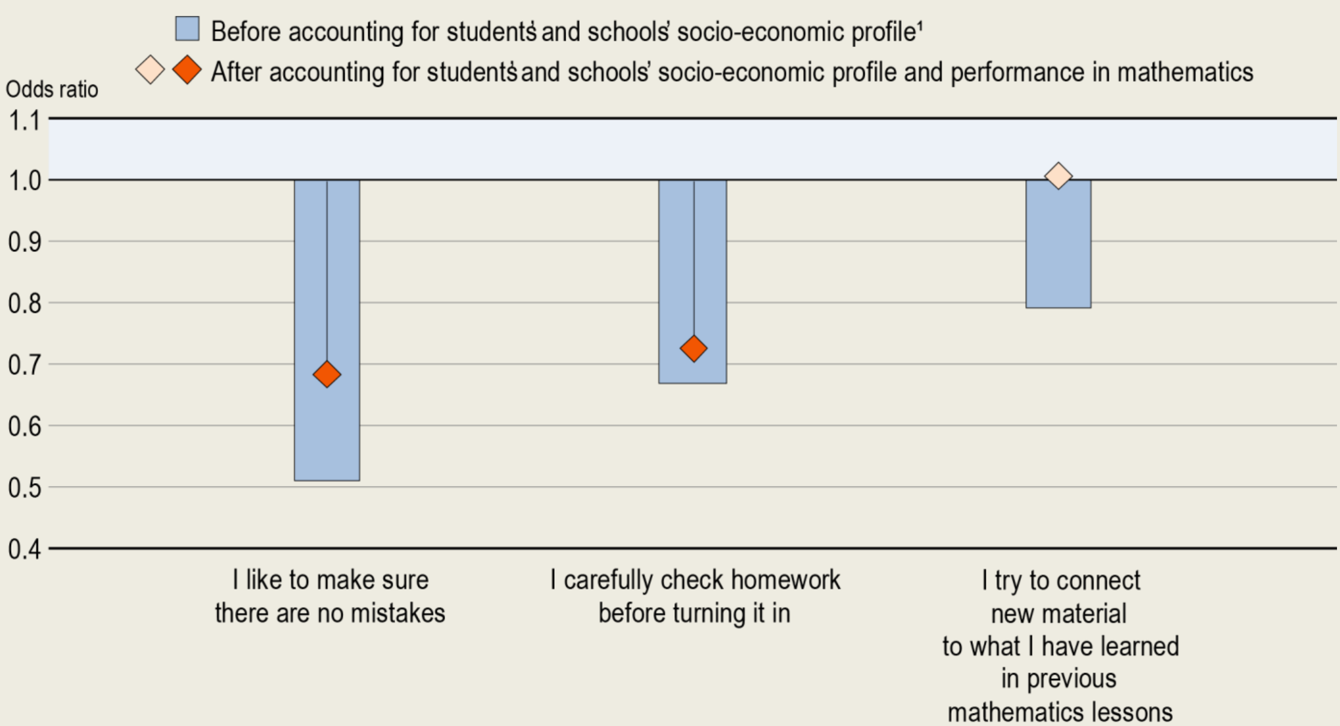
Box V.7.2. Long-term absenteeism for economic or care reasons and being in control of one own's learning

PISA asked students to report if they had missed school for three months or more in primary or secondary education and the reasons for this long-term absenteeism. Some of these reasons relate directly to economic deprivation such as taking care of a family member; helping with work at home, the family business or on the family land; getting work to bring money home; or not being able to pay for school fees. Only a small minority of students have experienced long-term absenteeism for these economic reasons (1.5% on average across OECD countries; 1.8% in high-income countries and economies and reaching 4.7% among middle-income countries and economies). While only a minority of students are concerned, the consequences for students' learning are dire. Long disruptions to schooling for economic reasons are related to lower learning outcomes (58 score points lower in mathematics after accounting for students' and schools' socio-economic profile among OECD countries, and 65 and 49 score points lower among high-income and middle-income countries, respectively) (see Table V.B1.7.27).

Missing school for an extensive amount of time is not only related to lower learning outcomes for 15-year-old students but lower use of sustained learning strategies and, in particular, the ability to control one's own learning. Missing school for an extended period for economic reasons is associated with less control of one's own learning strategies. For example, students who experience long-term absenteeism for economic reasons are less likely to report making sure there are no mistakes in their work or checking their homework before turning it in (31% and 27% less likely, respectively, among OECD countries after accounting for socio-economic profile and mathematics performance). The lack of control of their learning may further exacerbate and widen the gap between students who missed school for an extended period of time for economic reasons and those who did not (see Figure V.7.8)

Figure V.7.8. Missing school for more than three months in a row for economic reasons, and being in control of one's own learning and using proactive learning strategies

Likelihood of reporting using learning strategies associated with control of one's own learning and proactive learning when students missed school for more than three months in a row for economic reasons; OECD average



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Note: Odds ratio coefficients that are statistically significant are shown in a darker tone (see Annex A3).
Items are ranked in ascending order of the odds ratio, after accounting for students' and schools' socio-economic profile and performance in mathematics.
Source: OECD, PISA 2022 Database, Table V.B1.7.28. See Table V.7.1 for StatLink at the end of this chapter.

Table V.7.1. Chapter 7 figures: Effects of economic deprivation on sustainable learning strategies and motivation to learn

Figure V.7.1	Food insecurity: How often did students not eat because there was not enough money to buy food, in the past 30 days
Figure V.7.2	Students working for pay before or after school
Figure V.7.3	Work for pay, by student's socio-economic status
Figure V.7.4	Food security and working for pay before or after school and being in control of one's own learning and using proactive learning strategies
Figure V.7.4b	Working for pay before or after school and being in control of one's own learning and using proactive learning strategies, by countries and economies
Figure V.7.5	Food insecurity, working for pay before or after school and the use of critical-thinking learning strategies
Figure V.7.6	Change in the index of mathematics anxiety associated with food insecurity and working for pay
Figure V.7.7	Working for pay and creative thinking and persistence
Figure V.7.7b	Working for pay and creative thinking and persistence, by countries and economies
Figure V.7.8	Missing school for more than three months in a row for economic reasons and being in control of one's own learning and using proactive learning strategies

StatLink https://stat.link/six3r0

Notes

1 Experiences of economic deprivation are inter-related as students facing food insecurity are more likely to work for pay or take long leaves of absence from school to work or care for family members (Schenck-Fontaine and Ryan, 2022[1]). While accounting for socio-economic status helps isolate the effects of economic deprivation on students' development of learning strategies, the relationship between experiences of economic deprivation and the development of learning strategies is not always straightforward. For example, students' part-time employment is often taken on to mitigate their economic deprivation but it can also result in costly trade-offs that impede their learning as they have less time and energy for schoolwork.

2 Students participating in PISA 2022 were asked "In the past 30 days, how often did you not eat because there was not enough money to buy food?" with five response options ("Never or almost never", "Almost once a week", "2 to 3 times a week", "4 to 5 times a week" and "Every day or almost every day").

3 For the classification of countries by economic development levels, please refer to Table V.B1.7.1. High-income countries and economies are defined as countries or economies with GNI per capita superior to USD 13 845 in year 2022 (source: World Bank Analytical Classification, presented in the World Development Indicators, https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries). Middle-income countries refer to low and upper middle-income countries and economies defined as countries or economies with a GNI per capita between USD 1 136 and USD 13 205 in year 2022 (source: World Bank Analytical Classification, presented in the World Development Indicators, https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries).

4 The index of work for pay is a simple derived variable from questionnaire items in the PISA 2022 student questionnaire. Students' answers on how many days during a typical school week they worked for pay before going to school and/or after leaving school were scaled into the index of "Work for pay before or after school". Each item included six response options ("0 days", "1 day", "2 days", "3 days", "4 days", "5 or more days"). Values on this index range from 0 (no work for pay) to 10 (10 or more times of working for pay per week).

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8 Confident mathematics learners: Preparing for the future

This chapter examines students' confidence in 21st-century mathematics and their level of exposure to these specific tasks. It explores both the relationship between exposure and students' confidence, and between confidence and the use of specific learning strategies and motivation to learn. The chapter delves into the analysis of four specific key areas that together enhance students' ability to apply mathematical concepts in diverse and practical ways, preparing them for the complexity of modern challenges: representing a situation mathematically, extracting mathematical information, interpreting mathematical solutions in the context of a real-life challenge, and programming computers, which involves writing code to solve mathematical problems or simulate real-world phenomena.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

Previous PISA analyses revealed a significant decline in student performance over the past decade in science and reading, and a large drop between 2018 and 2022 in mathematics (OECD, 2023[1]). The decline suggests an erosion of skills that are essential for personal and professional development and which constitute the cornerstone of further learning. The downward trend has significant implications for basic education and lifelong learning, and calls for a reassessment of educational priorities and methodologies to meet the demands of the 21st century.

As mathematics was the main domain of assessment in PISA 2022, concepts and analyses in this report are directed towards understanding how students learn mathematics. This allows us to explore learning strategies, motivations, and self-beliefs related to mathematics education across education systems. This chapter focuses on how prepared students are to acquire the skills necessary for lifelong learning in the 21st century, providing a comprehensive view of how mathematical proficiency supports future learning and adaptation in a rapidly evolving world.

While mathematics is just one part of the larger picture, this report's findings can feed into policies that encompass broader lifelong learning contexts. It is imperative that policy makers and education systems prioritise the development of a robust foundation upon which future learning can be built. This adaptation involves not only revamping curricula but adopting innovative teaching methodologies that incorporate strategies for sustained learning in the 21st century (OECD, 2019[2]). In this way, education systems can better equip students to face new and unforeseen challenges, and ensure that they have the skills and knowledge necessary for lifelong learning (OECD, 2021[3]; OECD, 2019[4]).

Key findings

Students who engage in proactive behaviour such as relating new material to previously learned content, who diligently check that they have understood what is being taught, and who report being cognitively activated are most likely to be confident in their 21st-century mathematics skills.

However, frequency of exposure to 21st-century mathematics tasks is, overall, low. Less than a third of students frequently represent situations mathematically, for instance, and only one in five apply mathematical solutions to real-life situations. The mathematics task students are least exposed to is coding or programming computers. Education systems who want to prepare students for the technological demands of the modern workforce may want to look into these aspects.

Simply increasing the frequency of tasks is unlikely to be enough to build confidence. Other aspects are also important, including the motivation to learn, as in enjoying challenging schoolwork. This kind of motivation to learn could be a powerful component of confidence in 21st-century mathematics.

Student confidence in 21st-century mathematics varies across countries and economies, with around 70% or more of students being confident in extracting or representing mathematical information in Canada*, France and the United States* but no more than 40% in Japan and Thailand. Because of its positive relationship to learning strategies and outcomes, the integration of real-world applications and technological literacy into 21st-century mathematics education can help students develop a more robust and applicable skill set for the future.

Practices that promote cognitive activation, such as encouraging students to think about different ways of solving problems and explaining their reasoning, are strongly associated with overall confidence in 21st-century mathematics (including confidence in 10 different mathematics tasks). Confident students are more likely to be exposed to these practices. It is likely that teachers who use more cognitive activation techniques in the classroom build confidence while deepening students' understanding of mathematics.

Yet, when looking at individual practices, in particular, representing, extracting and interpreting mathematical information, including in real-life situations, it is more proactive behaviour, such as linking what students learn to prior knowledge, that shows the strongest relationship with confidence. Cognitive activation practices together with asking questions when uncertain are two other strategies for sustained learning that can buttress confidence in these essential 21st-century mathematics skills.

Social and emotional skills such as persistence, curiosity and stress resistance show strong and positive relationships with confidence in these four key areas of 21st-century mathematics. Denmark* and New Zealand* stand out as having students who are often likely to feel confident in mathematics when reporting higher social and emotional skills.

PISA data show disparities in reading fluency between socio-economically disadvantaged and advantaged students. To better equip students to be confident 21st-century learners, such disparities need to be addressed. Reading fluency is an important component of confidence in key 21st-century skills and learning outcomes such as performance in mathematics.

Are students confident about their 21st-century skills?

In addition to test questions on mathematics, reading and science students answered in PISA 2022, students were asked about their confidence in dealing with a range of 21st-century mathematics tasks. These include interpretation and analysis of mathematical data; real-world application; statistical reasoning; mathematical modelling; computational and technological literacy; and geometry and measurement. These tasks represent the diverse and essential skills needed for success in the data-driven, technologically advanced learning environments and workplaces of the 21st century. (OECD, 2023[5]). These responses have been integrated into the index of mathematics self-efficacy: mathematical reasoning and 21st-century mathematics[1].

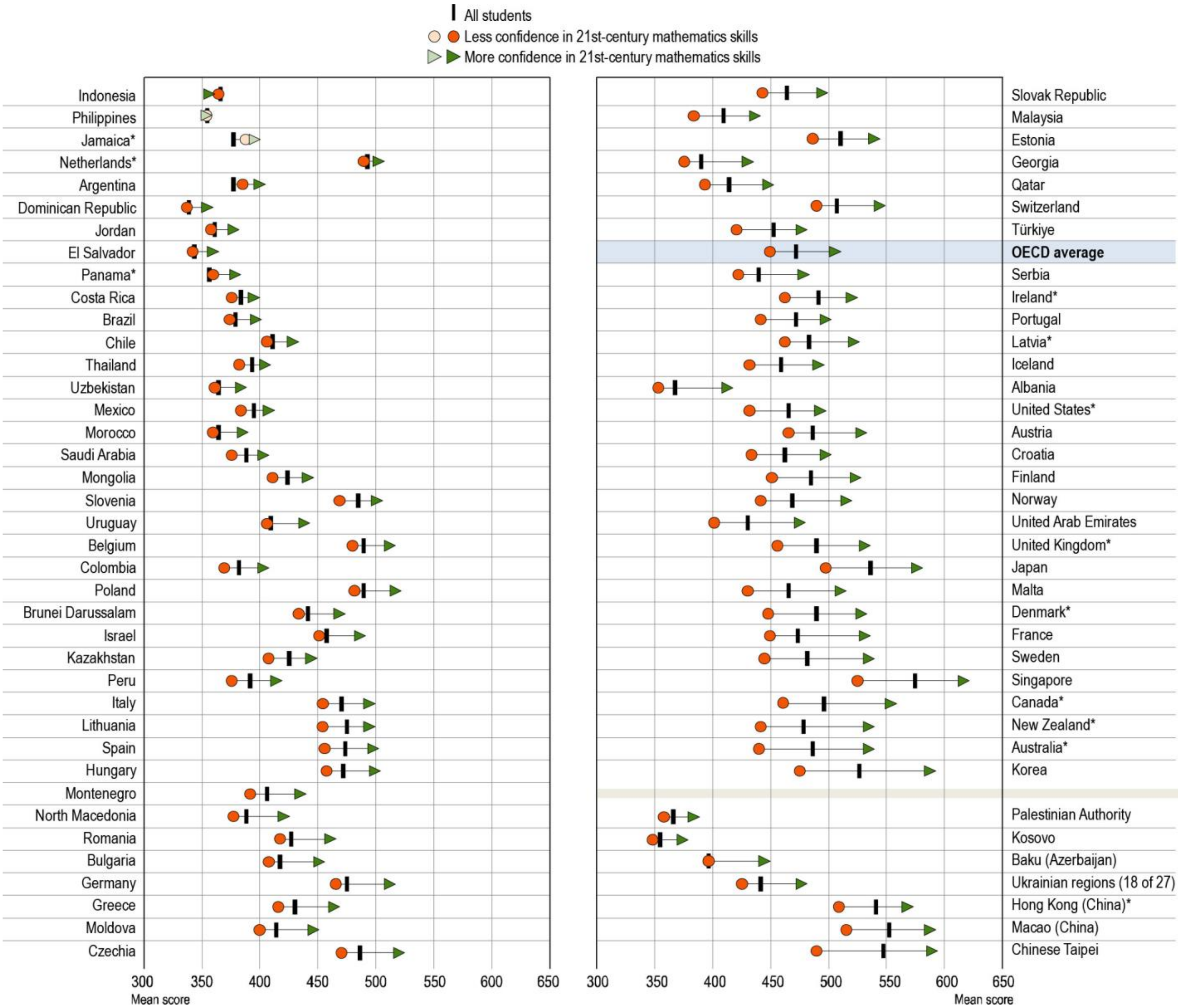
Confidence in 21st-century mathematics differs across various domains and countries/economies

Students in OECD countries feel most confident extracting mathematical information from diagrams, graphs or simulations (64%); representing a situation mathematically (using variables, symbols or diagrams) (56%); and interpreting mathematical solutions in the context of a real-life challenge (52%). In France, students are most confident extracting mathematical information and interpreting solutions to real-life challenges (79% and 69%, respectively). In Canada* and the United States*, around 70% or more of students feel most confident about representing situations mathematically. At the opposite end of the spectrum, only 36% of students in Thailand feel confident extracting information and in Brunei Darussalam and Japan, 30% or less of students feel confident interpreting mathematical solutions to real-life challenges. When it comes to representing situations mathematically, less than 40% of students in Japan and Thailand feel confident (Table V.B1.8.6).

Finally, on average across OECD countries, students feel the least confident about coding and programming computers (33%). In Uzbekistan and Albania, over 60% of students feel confident in this area while less than 25% feel confident in Brunei Darussalam, Japan, Singapore and Chinese Taipei (Table V.B1.8.6).

Figure V.8.1. Performance in mathematics, by confidence in 21st-century mathematics skills

Mean score in mathematics



Notes: Only countries and economies with available data are shown.

Students who are less confident (more confident) are those in the bottom (top) quarter of the index of confidence in 21st-century mathematics skills in their own country/economy.

Score-point difference between students in top and those in bottom quarters of the index of confidence in 21st-century mathematics skills that are statistically significant are shown in a darker tone (see Annex A3).

Countries and economies are ranked in ascending order of the difference in mathematics score related to confidence in 21st-century mathematics skills (more confident minus less confident students).

Source: OECD, PISA 2022 Database, Table V.B1.8.32. See Table V.8.1 for StatLink at the end of this chapter.

Understanding the reasons for these differences is important because confidence in these tasks has a positive relationship with learning outcomes. Confidence in performing 21st-century mathematics tasks is positively related to using strategies for sustained lifelong learning, as will be shown next. But it is also positively related to other learning outcomes. In most countries and economies, this kind of confidence is positively related to performance in mathematics – there is a positive change in average mathematics scores on the PISA test with a one-unit increase in the index of confidence in the 21st-century skill of mathematical reasoning in all but one country for which information is available (the higher the index, the more confidence students reported). Students who feel confident about their 21st-century mathematics skills (in the top quarter) outperformed their less confident peers (in the bottom quarter) by 56 score points, on average across OECD countries. This gap is greater than 20 score points, which is equivalent to about one year of schooling in most countries and economies (Avvisati, 2021[6]). In Korea, where the gap is the widest (over 100 score points), students in the top quarter of the index can typically complete Level 4 mathematics tasks. Conversely, less confident students struggle with Level 2 tasks, indicating a much more basic understanding of mathematics and a more limited set of lifelong learning skills (Figure V.8.1 and Table V.B1.8.8).

In conclusion, fostering confidence in 21st-century mathematics skills is essential as it is associated with better learning outcomes and stronger performance in mathematics. This highlights the importance of developing teaching and learning strategies that build student confidence in these critical areas.

Strategies for sustained learning and confidence in 21st-century skills

How much do strategies for sustained lifelong learning matter in preparing students for future challenges? Much of this depends on how they relate to students' confidence in their 21st-century mathematics skills. PISA 2022 finds that proactive learning behaviours, cognitive activation practices, and critical thinking are particularly related.

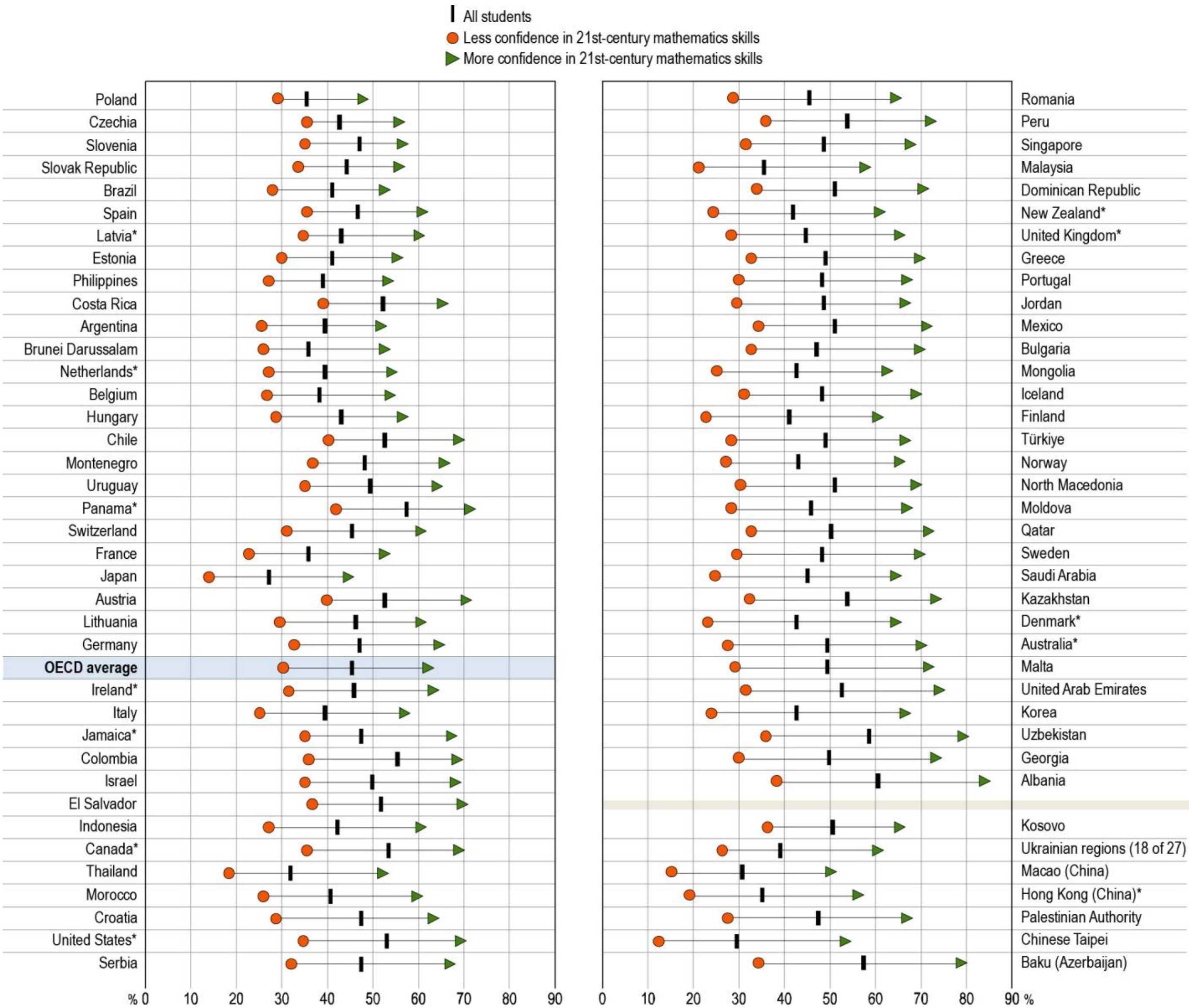
Proactive behaviours such as connecting new material to what has been learned in the past relate positively to student confidence

Confident 21st-century learners try to connect new material to what they have learned in previous mathematics lessons significantly more than their less confident peers. The gap between the two is 32 percentage points, ranging from 63% of confident learners to 31% of less confident learners, on average across OECD countries. The gap is large and positive across all countries and economies, ranging from 19 percentage points in Poland to at least 45 in Albania and Baku (Azerbaijan) (Figure V.8.2).

Such proactive behaviours show strong relationships with confidence, on average and across countries and economies, after accounting for students' and schools' socio-economic profile. Yet it is important to consider that the relationship is driven by performance in mathematics. While it is not possible to establish directionality, given the relevance of both, this suggests that proactivity and confidence are elements to be fostered together (Figure V.8.3).

Figure V.8.2. Frequently connecting new material to what is learned in previous mathematics lessons, by confidence in 21st-century mathematics skills

Percentage of students who frequently try to connect new material to what they have learned in previous mathematics lessons, by confidence in 21st-century mathematics skills



Notes: Only countries and economies with available data are shown.

Students who are less confident (more confident) are those in the bottom (top) quarter of the index of confidence in 21st-century mathematics skills in their own country/economy.

Percentage-point difference between students in top and those in bottom quarters of the index of confidence in 21st-century mathematics skills are all statistically significant (see Annex A3).

Countries and economies are ranked in ascending order of the percentage-point difference of students who frequently try to connect new material to what they have learned in previous mathematics lessons related to confidence in 21st-century mathematics skills (more confident minus less confident students).

Source: OECD, PISA 2022 Database, Tables V.B1.2.21 and V.B1.8.10. See Table V.8.1 for StatLink at the end of this chapter.

Confidence in one's mathematics skills does not exclude double-checking one's understanding

While confidence in one's abilities is an important factor in academic success, a meticulous approach to learning is also key. Confidence and carefulness complement each other in enhancing students' overall learning.

There is a positive relationship between students' confidence in their 21st-century mathematics skills and controlling one's own learning; in other words, confidence does not exclude double-checking. A characteristic of confident students seems to be to ask questions when they do not understand the material being taught (see Chapter 3 on the relationship of this practice with growth mindset). This strategy shows a strong relationship with confidence in one's modern mathematical competence (Figure V.8.3).

Across all participating countries and economies, the gap in the proportion of students who reported asking questions is significant. On average across OECD countries, 60% of confident students ask questions when in doubt while 35% of the least confident students do so. This average gap of 25 percentage points is the smallest in Belgium, Italy and Spain (with at least 17 percentage points) and largest in Baku (Azerbaijan) (44 percentage points) (Table V.B1.8.10).

Confident 21st-century learners reported more cognitive activation

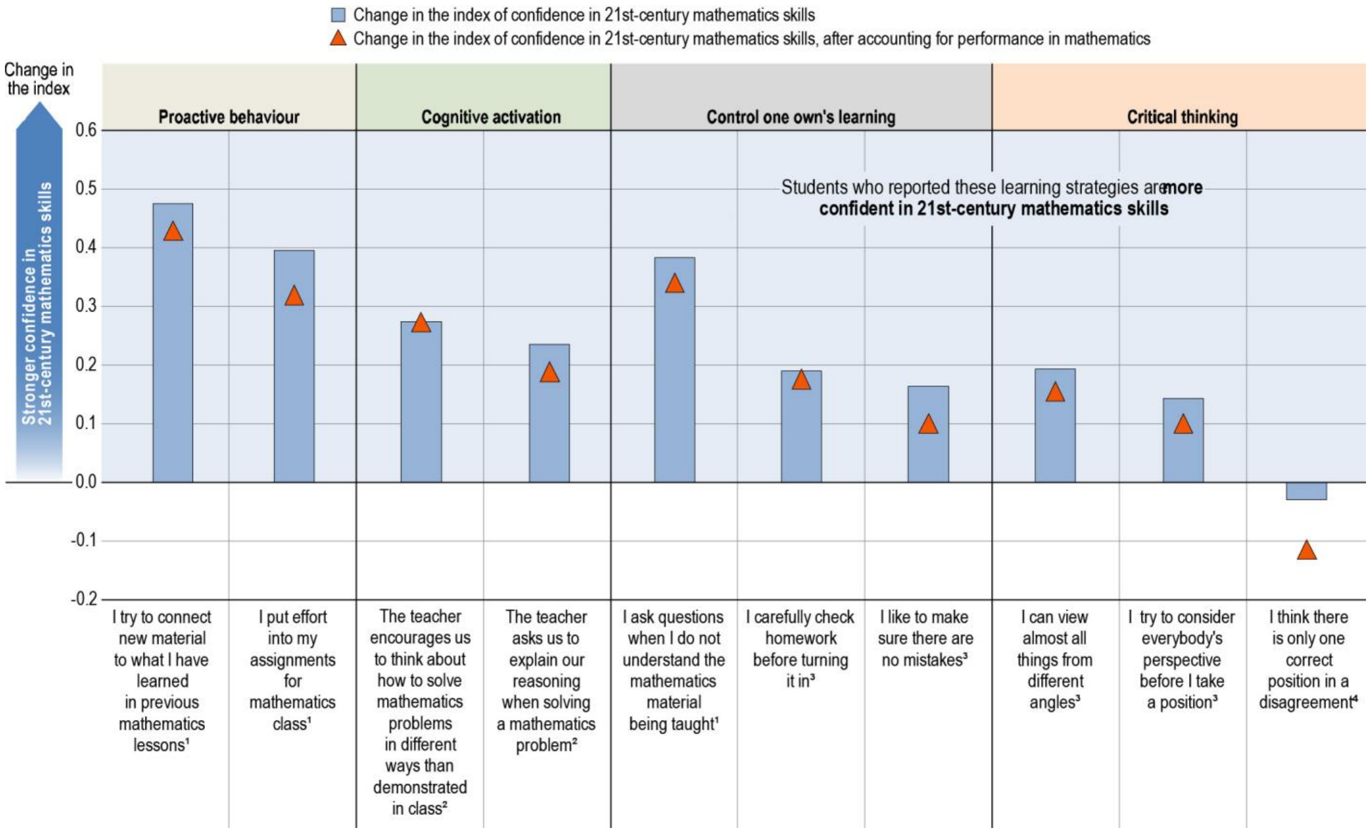
Interestingly, cognitive activation practices such as teachers encouraging students to think about how to solve mathematics problems in different ways and asking students to explain their reasoning when solving a mathematics problem are positively and strongly related to confidence in 21st-century mathematics skills (Figure V.8.3).

Explaining the chain of reasoning involved in solving a mathematics problem is driven by students' performance in mathematics in some countries but remains positive for all participants in PISA 2022. This is something that over half of confident learners reported being exposed to (54%) compared to only 38% of non-confident learners, across OECD countries. The gap between the two groups is the largest in Albania and the Dominican Republic, where it is at least 30 percentage points, and the smallest in Hungary, Japan, the Netherlands* and the Slovak Republic, where it is about 10 percentage points or less (Table V.B1.8.10).

Finally, critical-thinking (perspective-taking) strategies, including considering others' perspectives and seeing issues from different angles, are also positively related to confidence in 21st-century mathematics skills, even if they are more weakly related for the most part. Confident learners reported that they consider others' perspectives before taking a position to a greater extent than their less confident peers, with an average difference of 10 percentage points across OECD countries, rising to 23 in Albania, Saudi Arabia and the United Arab Emirates. Only in Chile and Latvia* is the difference between the two groups of students not significant. The same difference is significant in all countries/economies when looking at students' reports on viewing things from different angles. For this second perspective-taking, the range is also wide, from more than 25 percentage points in Albania, Singapore and the United Arab Emirates to 6 percentage points in Spain (OECD average difference of 15 percentage points). The only exception is thinking that there is only one correct position in a disagreement, whose relationship with confidence in 21st-century mathematics skills is not statistically significant in most countries and economies (Tables V.B1.8.10 and V.B1.8.33).

Figure V.8.3. Confidence in 21st-century mathematics skills, by learning strategies

Change in the index of confidence in 21st-century mathematics skills after accounting for students' and schools' socio-economic profile when students reported the following learning strategies; OECD average



1. Students doing the corresponding statement more than half of the time.
2. Students doing the corresponding statement more than half of the lessons.
3. Students agree or strongly agree with the corresponding statement.
4. Students disagree or strongly disagree with the corresponding statement.
Notes: Changes in the index of confidence in 21st-century mathematics skills are all statistically significant (see Annex A3).
The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Items are ranked by kind of learning strategies and then in descending order of the change in the index of confidence in 21st-century mathematics skills, after accounting for mathematics performance.
Source: OECD, PISA 2022 Database, Table V.B1.8.33. See Table V.8.1 for StatLink at the end of this chapter.

A closer look at confidence in specific 21st-century skills

Looking at the relationship between confidence and strategies for sustained learning more closely, four key areas are analysed in detail. Together, they enhance students' ability to apply mathematical concepts in diverse and practical ways, preparing them for the complexity of modern challenges:

- **Representing** a situation mathematically using variables, symbols, or diagrams, which involves translating real-world scenarios into mathematical language
- **Extracting** mathematical information from diagrams, graphs, or simulations, involving examining visual representations to identify and gather relevant data
- **Interpreting** mathematical solutions in the context of a real-life challenge, requiring students to apply their mathematical findings to practical situations, thereby making abstract concepts more concrete and relevant
- **Programming** computers, which entails writing code to solve mathematical problems or simulate real-world phenomena

Students who try to connect new material to what they already know feel more confident about their 21st-century skills

Students who frequently try to link what they learn to prior knowledge are, on average, more than twice as likely to feel confident representing, extracting and interpreting mathematical information in real-life situations than those who do not make those connections frequently, even after accounting for performance in mathematics. There is also a positive relationship with programming but it is weaker, on average. The relationship between this particular strategy and confidence in these four skills is the strongest, on average and in most countries and economies. While there are variations depending on the country or economy, programming shows the weakest relationship, with the sole exceptions of Baku (Azerbaijan), Belgium, Brunei Darussalam, the Dominican Republic, Jordan, Mongolia, Morocco, the Netherlands*, the Palestinian Authority and Poland (Table V.B1.8.11).

Similarly, asking questions when not understanding the material being taught is strongly related to confidence in these four specific skills. Students who do this are, on average, twice as likely to be confident representing situations as well as extracting information and interpreting solutions in real life. Even after accounting for performance in mathematics, the likelihood still remains at 1.9. Although this positive relationship is evident across all countries and economies, the strength of the association varies. Again, confidence in programming shows a weaker association, except in Brunei Darussalam, Hungary, Jordan, Morocco, Poland and Chinese Taipei (Table V.B1.8.12).

Interestingly, cognitive activation tasks that require students to think about how to solve problems differently from what is demonstrated in class show a positive relationship, on average, but the relationship seems weaker than with the previously analysed strategies and behaviours. While it is most strongly related to confidence in interpreting solutions in real life, it also shows positive relations, on average, with confidence in the other three tasks. Nevertheless, in Baku (Azerbaijan), the Dominican Republic, Denmark*, Morocco, Ukrainian regions (18 out of 27), Uzbekistan and Sweden, students are at least twice as likely to feel confident about interpreting solutions in real life if they reported that teachers encourage them to think about how to solve problems differently from what is demonstrated in class, after accounting for students' and schools' socio-economic profile (Table V.B1.8.13).

Finally, aspects of critical thinking like trying to consider everybody's perspective before taking a position and seeing things from different angles are mostly positively related to confidence in these 21st-century tasks but the relationships are weaker than for the previous strategies and attitudes. These perspective-taking attitudes are, on average, most strongly related to extracting information although the relationship varies across countries and economies. Interpreting solutions in real life also shows a positive relationship across countries but is not significant for the two perspective-taking strategies in Chile, France, Latvia*, Malta and the Slovak Republic. Likewise, representing a situation is mostly significant except in Baku (Azerbaijan), Czechia, Germany, Greece, Jordan and Latvia*. The relationship between these perspective-taking positions and confidence in programming is largely not significant across countries and economies, especially for considering everybody's perspective before taking a position (Tables V.B1.8.14 and V.B1.8.15).

In conclusion, fostering strategies that encourage students to connect new knowledge with prior learning, asking questions when uncertain, and engaging in cognitive activation tasks could support developing confidence in essential 21st-century skills. While there are variations across countries and economies, their overall positive relationship with confidence underscores their importance in sustained lifelong learning.

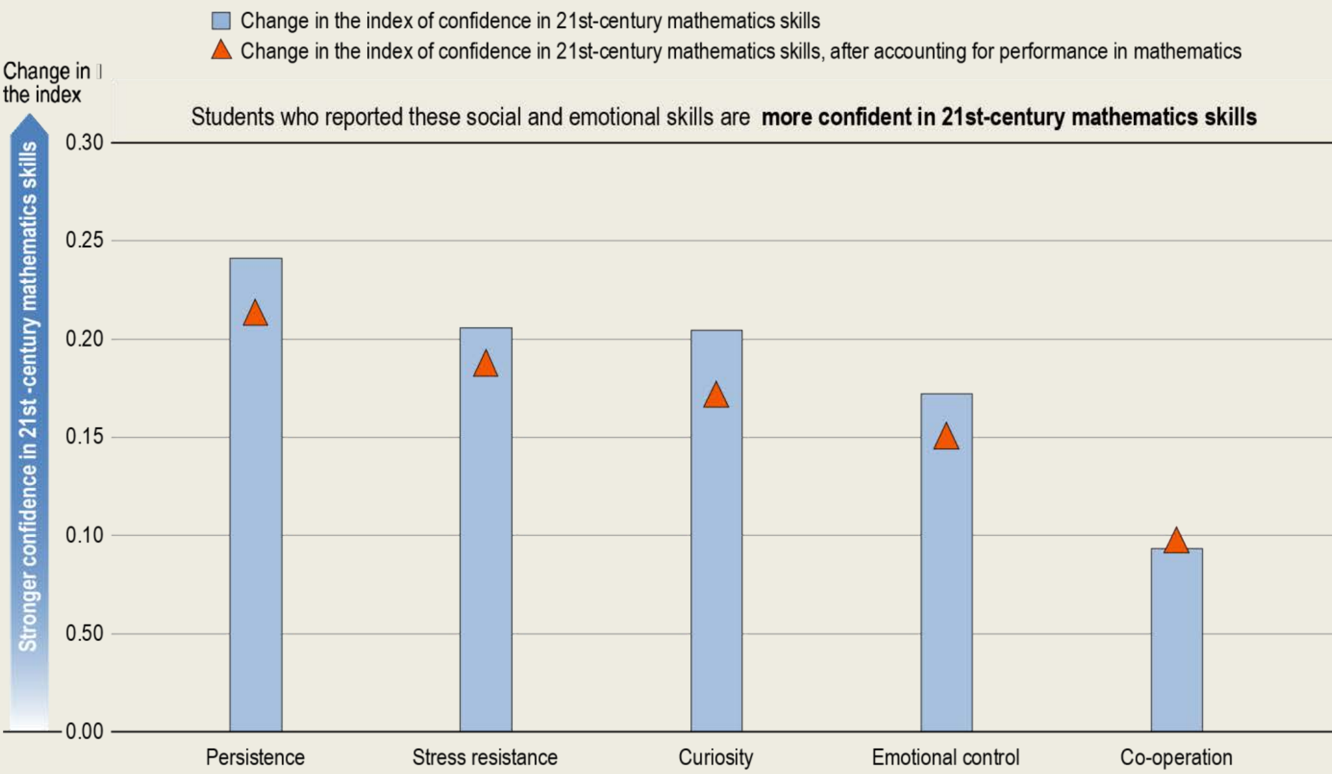
Box V.8.1. Social and emotional skills

The relationships between the five social and emotional skills (SES) considered in this report (stress resistance, co-operation, emotional control, curiosity and persistence) and confidence in 21st-century mathematics tasks is positive and significant in most countries and economies with available data, even after controlling for students' and schools' socio-economic profile and students' performance in mathematics.

Persistent, stress-resistant and curious students are, on average, the most confident in their 21st-century mathematics skills. In all three cases the relationship holds after accounting for performance in mathematics, which positively influences the relationship (Figure V.8.4).

Figure V.8.4. Confidence in 21st-century mathematics skills, by social and emotional skills

Change in the index of confidence in 21st-century mathematics skills after accounting for students' and schools' socio-economic profile with a one-unit increase in the following indices; OECD average

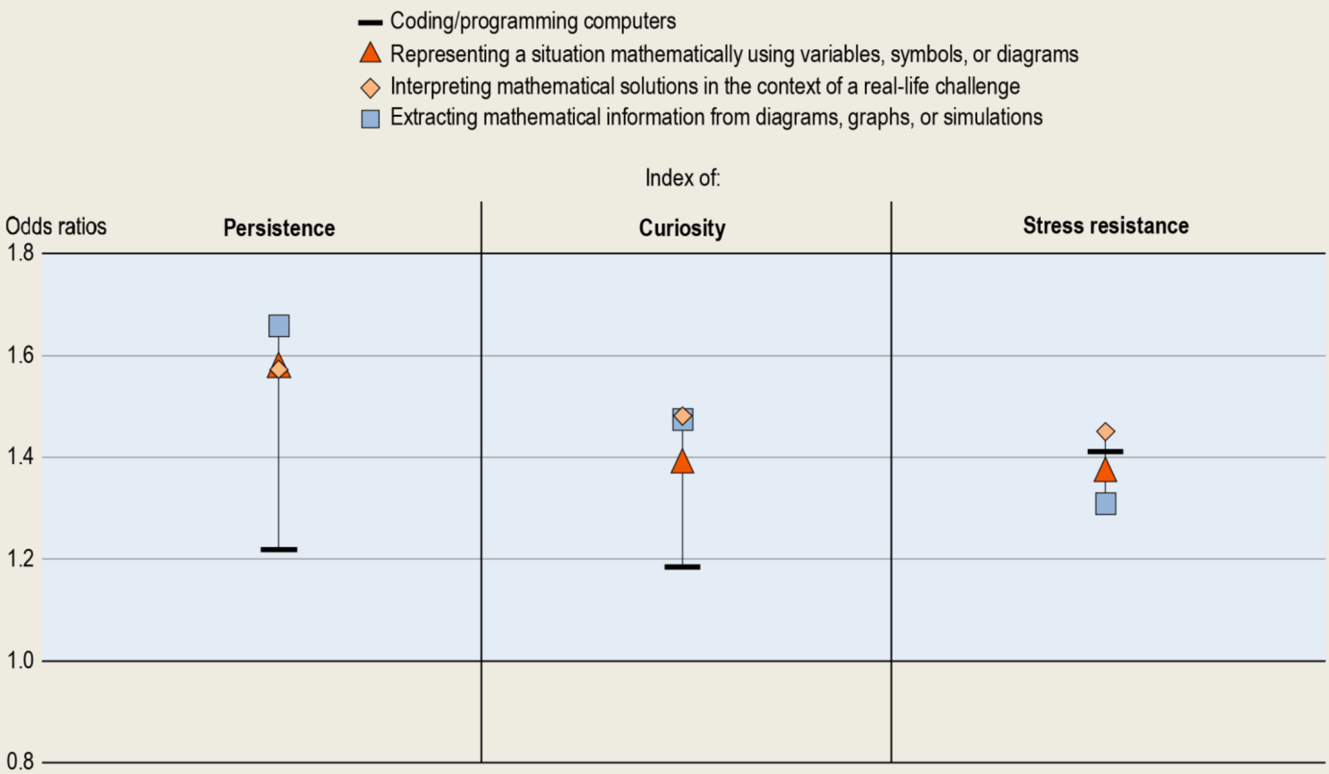


Notes: Changes in the index of confidence in 21st-century mathematics skills are all statistically significant (see Annex A3).
The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Items are ranked in descending order of the change in the index of confidence in 21st-century mathematics skills, after accounting for mathematics performance.
Source: OECD, PISA 2022 Database, Table V.B1.8.34. See Table V.8.1 for StatLink at the end of this chapter.

Moreover, persistent students are, above all, more likely to report feeling confident extracting information, on average. This is consistent across countries showing the strongest relationship in Australia*, Denmark* and New Zealand*. To a lesser extent, they are also more likely to be confident representing situations mathematically and interpreting solutions to real-life challenges, with Denmark* and New Zealand* again showing the strongest relationships in both cases. And although the relationship with confidence in programming is the weakest, persistent students are the most likely to report confidence in this area in OECD countries. The relationship is the strongest in Korea and Chinese Taipei, and is not significant only in Jamaica* (Figure V.8.4 and Table V.B1.8.17).

Figure V.8.5. 21st-century mathematics domains, and social and emotional skills

Likelihood to report confidence in the following 21st-century mathematics skills when persistent, curious or stress-resistant after accounting for students' and schools' socio-economic profile; OECD average



Note: All odds ratio coefficients are statistically significant (see Annex A3).
Source: OECD, PISA 2022 Database, Tables V.B1.8.17, V.B1.8.18 and V.B1.8.19. See Table V.8.1 for StatLink at the end of this chapter.

While curious students are likely to be confident extracting information, they are, on average across OECD countries, as confident about interpreting solutions to real-life challenges. In both cases, the relationship is the strongest in Denmark* and New Zealand*, together with Macao (China) and the Ukrainian regions (18 out of 27), respectively. They are also more likely than non-curious students to report confidence in representing situations mathematically and, to a lesser extent, programming. While in Denmark*, students are more likely to feel confident representing situations mathematically per one-unit increase in the index of curiosity, it is in Korea that students are the most likely to feel confident in programming. This pattern is observed across most countries and economies (Figure V.8.5 and Table V.B1.8.18).

Finally, students who report most stress-resistance are, on average, most likely to report confidence in interpreting mathematical solutions to real-life challenges, with Denmark* showing again the strongest relationship. Interestingly, these students are the most likely to report confidence in programming, on average, and across countries and economies. In Hong Kong (China)*, stress-resistant students are most likely to feel confident programming. The relationship between stress resistance and confidence in extracting information and representing situations mathematically is also positive and strong, on average and across countries, with the Netherlands*, and Finland and Iceland showing the strongest relationships, respectively (Figure V.8.5 and Table V.B1.8.19).

In all cases, the positive relationships described hold after accounting for students' and schools' socio-economic profile, and students' performance in mathematics.

Student opportunities to acquire 21st-century skills

To better understand students' opportunities to learn, acquire and develop essential skills for the future through mathematics instruction, PISA asked students about their exposure to 21st-century mathematics topics and tasks (see Box V.8.2). Analysing students' responses provides valuable insights into how effectively schools are preparing students for the future.

Exposure to 21st-century mathematics tasks is important for student confidence but there are other aspects at play too

PISA 2022 data suggest that student confidence and frequency of exposure to 21st-century mathematics tasks are positively related[2]. However, frequent exposure does not guarantee confidence, at least not in every education system. PISA data reveal a statistically significant but moderate correlation between the frequency of exposure to 21st-century mathematics tasks and students' confidence in completing such tasks. This suggests that exposure alone does not substantially boost confidence and that other aspects are at play.

Being motivated to learn likely plays a role in the relationship between exposure and confidence. For example, analyses show that intrinsic motivations such as enjoying learning new things at school and challenging schoolwork have an indirect effect on the relationship between frequency of exposure to tasks and students' confidence. On average, about 4% to 6% of the positive relationship between frequency of exposure and confidence can be indirectly attributed to differences in such intrinsic motivations (Table V.B1.8.9). However, results across systems vary. Detailed analyses in each system can shed further light on what the levers are for increasing student confidence.

Enjoying challenging schoolwork can be a strong component of confidence in 21st-century mathematics

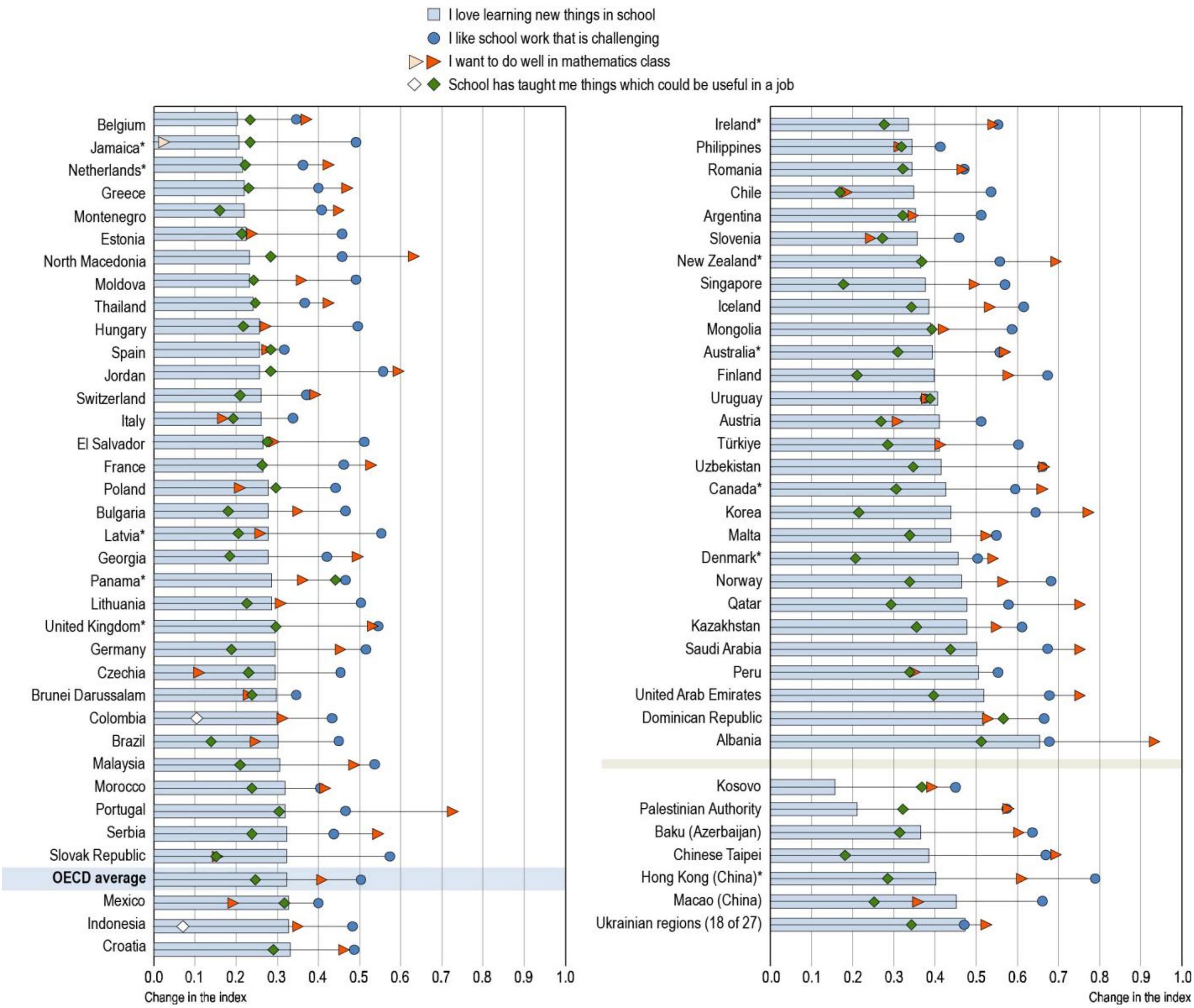
Previous sections have highlighted that intrinsic motivations such as enjoying learning new things in school show strong relationships with students' learning outcomes, including performance in mathematics. When examining the relationship with confidence in 21st-century tasks, enjoyment of challenging schoolwork stands out as the strongest related motivation. While more instrumental motivations such as wanting to do well in mathematics class also show a strong relationship, they are, unsurprisingly, strongly driven by performance in mathematics. Similarly, seeing school as a place that teaches useful skills for future jobs is positively related to confidence in 21st-century tasks, but to a lesser extent (Figure V.8.6).

At the country level, the patterns are consistent. Both enjoying challenging schoolwork and wanting to do well in mathematics class relate to confidence in 21st-century tasks. Challenging schoolwork is strongly related to confidence in Hong Kong (China)* while the relationship is the weakest, albeit positive, in Italy and Spain, after accounting for students' and schools' socio-economic profile and students' performance in mathematics. Viewing school as a place that teaches useful skills for future jobs, while positive and significant, is the least relevant of these four in most countries after accounting for students' and schools' socio-economic profile and students' performance in mathematics. While in the Dominican Republic we find the strongest relationship, it is not significant in Colombia and Indonesia. (Figure V.8.6).

The relationship between students' opportunities to learn through exposure to mathematics tasks and their confidence in 21st-century mathematics suggests that there are other aspects at play in how effectively students acquire and apply such skills. One of these is motivation to learn. Fostering intrinsic motivations such as the enjoyment of challenging schoolwork alongside more instrumental motivations such as wanting to excel in mathematics class can be important in increasing students' confidence in 21st-century mathematics. These motivations are associated not only with greater confidence but other learning outcomes such as mathematics performance. By emphasising these motivational components, educators can better prepare students for the complexity of modern mathematical challenges and ensure they are equipped with the confidence and skills needed for lifelong learning in the 21st century.

Figure V.8.6. Confidence in 21st-century mathematics skills, by student motivation

Change in the index of confidence in 21st-century mathematics skills after accounting for students' and schools' socio-economic profile when students agree or strongly agree with the following motivations



Notes: Only countries and economies with available data for the four motivations are shown.
Changes in the index of confidence in 21st-century mathematics skills that are statistically significant are shown in a darker tone (see Annex A3).
Changes in the index of confidence in 21st-century mathematics skills when students agree or strongly agree with the statements "I love learning new things in school" and "I like school work that is challenging" are all statistically significant (see Annex A3).
The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Countries and economies are ranked in ascending order of the average change in the index of confidence in 21st-century mathematics skills when students agree or strongly agree with the statement "I love learning new things in school".
Source: OECD, PISA 2022 Database, Table V.B1.8.22. See Table V.8.1 for StatLink at the end of this chapter.

Box V.8.2. Mathematics skills for the 21st century in PISA?

The PISA 2022 framework emphasises the need for students to be exposed to relevant mathematics content, focusing on content exposure. Content exposure considers the time allocated for and dedicated to instruction as well as the depth of teaching provided (OECD, 2023[5]).

This concept was developed within the framework of *opportunity to learn* (OTL), which refers to the extent to which students' learning is influenced by the time they spend engaged in it. Essentially, students cannot be expected to learn effectively unless they have sufficient time to engage in the learning process (Carroll, 1963[7]). The concept of OTL has expanded over time to encompass all contextual aspects that capture the cumulative learning opportunities a student encounters (Bertling, Marksteiner and Kyllonen, 2016[8]).

In PISA 2022, students were asked about their exposure to various 21st-century mathematics tasks in class and about their confidence in dealing with such tasks. Answers were integrated into two indices: the index of exposure to mathematical reasoning and 21st-century mathematics tasks[3], and the index of mathematics self-efficacy: mathematical reasoning and 21st-century mathematics[4].

In the 21st century, the role of mathematics extends beyond traditional calculations and theoretical problems to include practical applications and interdisciplinary integration (Boaler, 2022[9]). The areas covered by these two indices include extracting mathematical information from visual representations, applying mathematical solutions to real-world contexts, using statistical concepts for decision-making, identifying mathematical components in real-world problems, understanding the foundations of mathematical modelling, representing situations mathematically, evaluating data patterns, engaging in coding and computer programming, using mathematical software tools, and calculating the geometric properties of complex shapes. These tasks reflect a comprehensive approach to mathematics education that emphasises not only computational skills but also critical thinking, problem-solving, and the application of mathematics in different contexts.

Moreover, the emphasis on coding, computer programming, and the use of mathematical software tools reflects the integration of technology into mathematics education. These skills are not only relevant for careers in technology (STEM) but also for understanding and solving complex problems in various disciplines through mathematical modelling and simulations (Weintrop et al., 2015[10]).

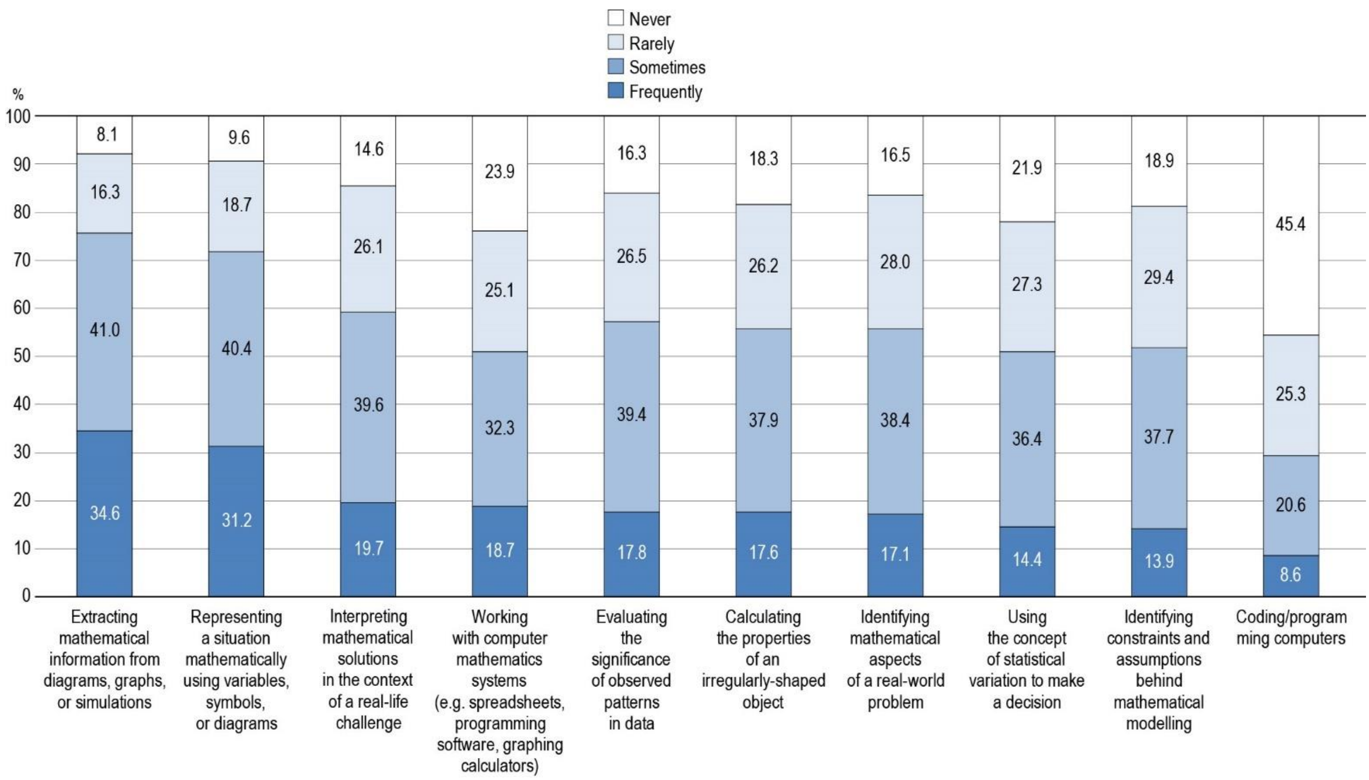
In conclusion, the domains of mathematics addressed in PISA 2022 are integral to developing a well-rounded mathematical education that prepares students for the complexities of the 21st century.

How much are 15-year-olds exposed to 21st-century mathematics?

Across countries and economies, students reported the highest exposure to tasks that involve extracting mathematical information, with just over a third of students across the OECD (35%). In some education systems such as in Canada*, Denmark*, Kazakhstan, the Netherlands*, the United Kingdom* and Singapore, about half of students reported frequent exposure to this task. Conversely, in Czechia and Slovenia, fewer than one in five students did (Figure V.8.7 and Table V.B1.8.1).

Figure V.8.7. Exposure to mathematical reasoning and 21st-century mathematics tasks

Frequency of exposure to 21st-century mathematics tasks; OECD average



Source: OECD, PISA 2022 Database, Table V.B1.8.1. See Table V.8.1 for StatLink at the end of this chapter.

Fewer than one-third of students are frequently engaged in representing situations mathematically

Representing situations mathematically, reported by just under a third of students (31%), is crucial for translating real-world problems into a mathematical framework, enabling the effective analysis, solution, and communication of complex situations. In Canada*, the United States* and Singapore, about half of students reported exposure. In Estonia, Finland, Iceland and Poland, however, less than one in five students reported exposure (Figure V.8.7 and Table V.B1.8.1).

Furthermore, an essential aspect of 21st-century mathematics is the ability to use mathematics to solve problems in real-world contexts. These contexts represent different aspects of an individual's environment in which problems arise. The choice of appropriate mathematical strategies and representations often depends on the context of the problem (OECD, 2023[5]).

One in five students frequently interpret mathematical solutions in real-life contexts in class

On average, only about 20% of students reported being frequently asked to interpret mathematical solutions in the context of a real-life challenge. This percentage is notably low in Czechia, Hong Kong (China)*, Korea, Macao (China) and Poland, where only about 11% of students reported being exposed to such tasks. In contrast, over 40% of students in Uzbekistan did (Table V.B1.8.1).

Other 21st-century mathematics tasks are reported on average by about one in five students or less. Notably, coding/programming computers is the least reported skill, with less than 10% of students, on average across OECD countries, indicating frequent exposure. This falls to around 6% or less in countries and economies such as Australia*, Estonia, Germany, Hong Kong (China)*, Ireland*, the Netherlands*, Portugal, Singapore and Chinese Taipei. The low exposure to coding tasks highlights a significant gap in preparing students for the technological demands of the modern workforce (Figure V.8.7 and Table V.B1.8.1).

Differences in exposure to essential 21st-century mathematical skills across different education systems can have profound implications for lifelong learning. However, exposure should take into account not only the frequency with which students are exposed to these tasks and skills but the quality and content of exposure. Ensuring that students are frequently exposed to rich and relevant mathematical content during their formative years is key. When students are provided with the right content and appropriate support, they can be better equipped to pursue further education and navigate the labour market successfully (OECD, 2019[4]).

Box V.8.3. Reading fluency for unpacking mathematical content

In today's information-rich world, text, whether printed or spoken, serves as the main carrier of content, meaning and context. This extends to texts on social networks, media articles, advertisements, etc. The ability to understand and work with text is crucial not only for general literacy but mathematical literacy. Text comprehension, in particular, reading fluency, is fundamental to students' excelling in various areas, including mathematics (OECD, 2023[5]).

Reading fluency involves the accurate and automatic decoding of words, allowing readers to devote more cognitive resources to comprehension rather than the mechanical aspects of reading (Kuhn and Stahl, 2003[11]). When students struggle with decoding, they use a significant portion of their cognitive capacity on basic reading tasks, leaving fewer resources for comprehension and problem solving. Fluent readers who can decode words effortlessly are better able to grasp the full meaning of a text (Ehri, 2005[12]). This enhances their learning in all subject areas (OECD, 2023[5]).

In the 2022 PISA assessment, about 78% of students across OECD countries were classified as fluent readers while 15% were either slow or inaccurate readers (Tables V.B1.8.35 and V.B1.8.36). The remaining 7% were students who did not engage meaningfully with the reading fluency test[5]. This highlights the significant number of students who may be disadvantaged in their learning due to suboptimal reading fluency.

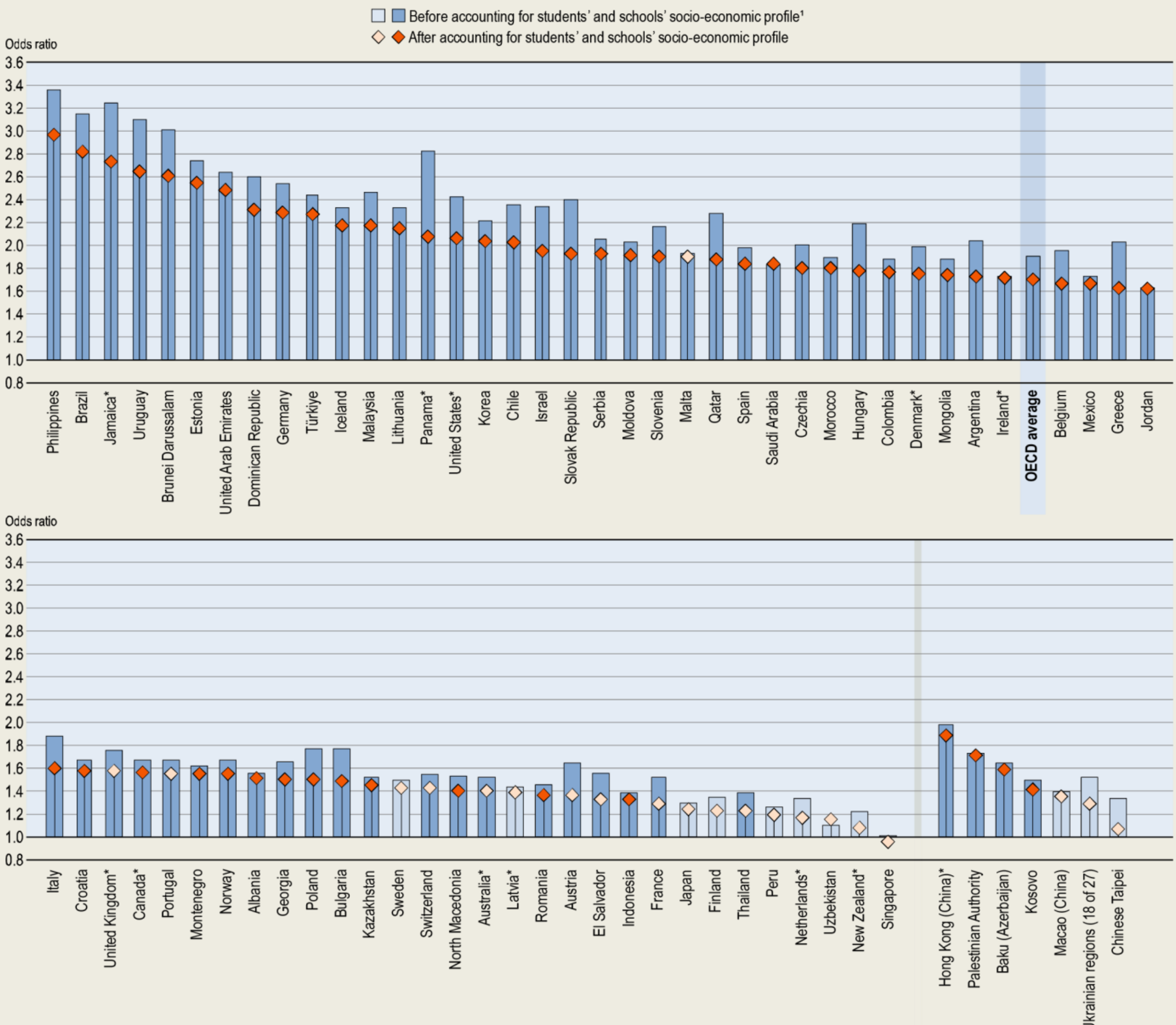
PISA data show that fluent readers are generally more confident extracting mathematical information from diagrams, graphs, and simulations than their slow and inaccurate reading peers. This is particularly evident in countries such as France, the United Arab Emirates and the United States*, where fluent readers are more than twice as likely as slow and inaccurate readers to report confidence in this 21st-century mathematics task (Table V.B1.8.40). The ability to quickly understand and integrate textual labels, legends, and annotations with visual information is critical for the accurate extraction of information (Holsanova, Holmberg and Holmqvist, 2008[13]) – a task that is key for sustained learning throughout life. This is also relevant given that, as shown in this chapter, confidence in extracting mathematical information relates positively and strongly with mathematics performance (Table V.B1.8.8).

However, increased confidence extracting information from visual data does not necessarily extend to other mathematical reasoning tasks, such as interpreting solutions in real-life situations or representing situations mathematically. These tasks may require abstract reasoning that is less directly related to reading fluency.

When the socio-economic profile of students and schools is taken into account, the relationship between reading fluency and confidence in extracting mathematical information becomes not significant in most countries and economies (Table V.B1.8.40). This suggests that socio-economic factors play a critical role in both the development of reading fluency and students' confidence applying 21st-century mathematical skills (Tables V.B1.8.7 and V.B1.8.36). As discussed earlier in this report, students' socio-economic status is an important component in their attitudes and use of strategies for sustained learning. This is also the case for reading fluency, as these analyses reiterate the importance of addressing socio-economic inequalities in education.

Figure V.8.8. Motivation to do well in mathematics class and reading fluency

Likelihood of agreeing or strongly agreeing to wanting to do well in mathematics class when students are fluent readers



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).
Notes: Only countries and economies with available data are shown.
Odds ratio coefficients that are statistically significant are shown in a darker tone (see Annex A3).
Students classified as "hasty readers" are excluded from this analysis.
Countries and economies are ranked in descending order of the odds ratio, after accounting for students' and schools' socio-economic profile.
Source: OECD, PISA 2022 Database, Table V.B1.8.40. See Table V.8.1 for StatLink at the end of this chapter.

Fluent readers are, across OECD countries and PISA 2022 participating countries and economies, more likely to report being motivated to do well in mathematics class than slow and inaccurate readers. This relationship holds even after accounting for students' and schools' socio-economic profile. Motivation to do well in class is crucial, as it has the second strongest association with confidence in 21st-century mathematics tasks and in some countries/economies it is the most strongly related (Figure V.8.8 and Table V.B1.8.22). While fluency alone does not entirely explain all the difference in motivation, the relationship between fluency and motivation remains, regardless of students' and school's socio-economic profile. One possible interpretation is that fluent readers are more likely to see the value in mathematics tasks because they can understand and complete them more efficiently. Fluent readers who find it easier to cope with the reading aspects of mathematical problems are more likely to recognise and appreciate the value of these tasks, and feel more motivated to do well in mathematics.

While fluent readers may be more motivated to do well in mathematics class, this does not necessarily translate into a greater intrinsic love of learning in all subjects or a stronger belief in the practical utility of schooling for future employment (Table V.B1.8.40). Intrinsic motivation is influenced by a wider range of factors, including personal interests, curiosity and the learning environment while instrumental motivation can often be shaped by other factors including career aspirations and socio-economic profile (Deci and Ryan, 1985[14]; Wigfield and Eccles, 2000[15]).

Reading fluency also shows an important relationship with performance in mathematics. Across most language groups represented in PISA 2022, between 7% and over 20% of the variation in mathematics performance is accounted for by students' reading fluency[6] (Table V.B1.8.39). Students who score at the lower proficiency levels in PISA are likely to read at a significantly slower rate or be more inaccurate than higher-performing students. In some countries, such as Jamaica*, Panama*, and Peru, more than 30% of low-performing students are slow readers compared to an OECD average of 13% (Table V.B1.8.38).

When the proportion of inaccurate readers is added, over a half of low mathematics performers in Jamaica*, Morocco, Peru and the Philippines turn out to be either slow or inaccurate readers – 25% on average across the OECD (Table V.B1.8.38). At the other end of the scale, Finland has the smallest proportion of slow readers among low performers in mathematics and when the proportion of inaccurate readers is added, the total does not exceed 17% (Table V.B1.8.38). For comparison, most skilled performers students (i.e. who scored at Level 3 or above) are fluent in reading (89% on average across the OECD) (Table V.B1.8.38 and Figure V.8.9a online).

Low performers in mathematics who are also slow readers or show high levels of inaccuracy face important challenges that may affect their lifelong learning trajectories. The main issue highlighted by these PISA data is the potential for reduced reading efficiency and comprehension, which can affect their ability to process and understand complex information quickly.

This double disadvantage can hinder their ability to extract the relevant information from a range of support and data sources, which is important academically, professionally and in everyday life. Improving reading fluency can increase students' motivation to engage in class and acquire the necessary skills for the 21st century. Policies and programmes to improve reading fluency can be implemented throughout the school years at different grade levels, and with adapted and concrete objectives (see Box V.8.4 for an example of such programmes in France).

It is not just about frequency but the nature of exposure to 21st-century mathematics tasks

It is important to note that in most countries/economies, greater exposure to 21st-century mathematics tasks is not automatically associated with better learning outcomes, even after accounting for students' and schools' socio-economic profile. The relationship between performance in mathematics and exposure to 21st-century mathematics tasks is positive in only 16 out of all PISA-participating countries. Only in Australia*, the Philippines, and Singapore is the performance gap about 10 score points, after accounting for students' and schools' socio-economic profile (Table V.B1.8.3).

Various reasons could explain this. First, students' reports of their frequent exposure to some of the tasks measured in PISA may be influenced by their understanding of the tasks themselves. This is likely to be reflected in differences in how low and skilled performers reported their exposure to different tasks. For example, in Australia*, Brunei Darussalam, Denmark*, Malta, the Netherlands*, Singapore and the United Kingdom*, over 50% of skilled performers reported being frequently exposed to extracting mathematical information from diagrams, graphs, or simulations while about a third or less of low performers did[7] (Table V.B1.8.23). Other significant variations can be seen across countries/economies (Tables V.B1.8.24, V.B1.8.25 and V.B1.8.26).

Second, the relationship between instructional time and learning outcomes has been analysed in previous PISA volumes with data showing that while more hours spent in regular lessons and homework do not always correlate with higher scores, on average, performance in mathematics is positively associated with each additional hour of regular lessons per week up to a certain point (OECD, 2023[1]). This suggests that other factors may be at play, such as teaching approaches and student engagement, and that the relationship between instruction time and learning outcomes is not linear.

In countries where students reported the most exposure to extracting mathematical information, representing a situation mathematically and interpreting mathematical solutions[8], associated performance gaps can vary widely, after accounting for students' and schools' socio-economic profile. For example, among these countries, exposure to extracting mathematical information is associated with positive performance gaps of at least 40 score points in Denmark*, Singapore, the United Arab Emirates and the United Kingdom*, but is not significant in Uzbekistan. Similarly, it is above 40 score points in the United Arab Emirates for representing situations mathematically and is not significant for interpreting mathematical solutions in Kazakhstan, the Dominican Republic and Saudi Arabia. In a large number of countries and economies, these relationships are not significant or even negative, as can be the case for the OECD average (Tables V.B1.8.3, Table V.B1.8.23, Table V.B1.8.24 and Table V.B1.8.26).

This suggests that, at least in some systems, students who struggle with traditional teaching methods are given more teaching time and innovative approaches. While this tailored support is intended to help these students, it may distort the overall relationship between teaching time and learning outcomes (Hattie, 2008[16]). This is because the extra time compensates for learning difficulties rather than improving learning for all students. In other words, the extra time may be needed simply to bring these students up to a baseline level rather than to take them to higher levels of achievement.

In conclusion, the nuanced relationship between exposure to 21st-century mathematics tasks and learning outcomes underscores the importance of focusing on both the quality and the content of educational experiences. These PISA 2022 results suggest that simply increasing exposure may not be enough: effective learning hinges on other relevant aspects too, including how well these tasks are integrated into the curriculum and how they are taught. They also highlight the need for innovative teaching approaches along with strong student motivation and effective learning strategies to fully maximise the benefits of students' opportunities to learn. Moreover, the disparity in task exposure between skilled and low performers suggests that more personalised and equitable teaching methods are essential to ensure that all students can acquire a solid foundation in critical mathematical skills. To truly enhance learning outcomes, educational systems must go beyond increasing instruction time and focus on improving the overall learning process.

Box V.8.4. France: Reading fluency test of sixth-grade students

Fluency tests can be easily implemented in the classroom and do not take much time. Since 2020, all sixth-grade students in France are assessed in their reading fluency at the beginning of the school year. This reading fluency test is part of a 60-minute French test that assesses students on their writing, comprehension, and knowledge. The test provides teachers with an overview of students' skills. It helps teachers identify students who may need additional help and put in place appropriate remedial measures to aid the transition from elementary to middle school.

During the reading fluency test, students are asked to read aloud text for one minute. The teacher then reports the number of words that were correctly read. This simple test can detect severe reading difficulties very early on in the school year.

Students who require additional support may benefit from programmes and plans by the Ministry of Education, such as the Plan d'Accompagnement Personnalisé (PAP). The PAP enables students to have personalised learning plans, which are put together by a team of educators, parents and professionals, and is revised yearly. Examples of learning accommodations for mathematics lessons include allowing the use of calculators even when prohibited, provision of useful tool sheets such as on definitions and theorem, and the use of different colours (e.g. units are coloured in red, tens in blue, hundreds in green).

Source: (Ministère de l'Éducation Nationale, 2015[17]; Ministère de l'Éducation Nationale, 2022[18]; Ministère de l'Éducation Nationale, 2022[19]; Ministère de l'Éducation Nationale, 2024[20])

Table V.8.1. Chapter 8 figures: Confident mathematics learners: Preparing for the future

Figure V.8.1	Performance in mathematics, by confidence in 21st-century mathematics skills
Figure V.8.2	Frequently connecting new material to what is learned in previous mathematics lessons, by confidence in 21st-century mathematics skills
Figure V.8.3	Confidence in 21st-century mathematics skills, by learning strategies
Figure V.8.4	Confidence in 21st-century mathematics skills, by social and emotional skills
Figure V.8.5	21st-century mathematics domains and social and emotional skills
Figure V.8.6	Confidence in 21st-century mathematics skills, by student motivations
Figure V.8.7	Exposure to mathematical reasoning and 21st-century mathematics tasks
Figure V.8.8	Motivation to do well in mathematics class and reading fluency
Figure V.8.9a	Fluent, slow, inaccurate and hasty readers, by proficiency levels in mathematics
Figure V.8.9b	Fluent, slow, inaccurate and hasty readers, by proficiency levels in reading

StatLink https://stat.link/lh67zs

Notes

[1] This index includes students' frequency ratings of how often they engage in behaviours indicative of effort and persistence in mathematics (e.g. "I actively participate in group discussions during mathematics class", "I put effort into my assignments for mathematics class"). Each of the eight items included in this scale had five response options ("Never or almost never", "Less than half of the time", "About half of the time", "More than half of the time", "All or almost all of the time").

[2] The correlation between the two indices is relatively similar when looking at the average across OECD countries (correlation coefficient=0.25), and across all countries and economies participating in PISA 2022 (correlation coefficient=0.21).

[3] The index comprises students' frequency ratings of how often they encounter a range of different types of mathematics tasks related to mathematical reasoning and 21st-century mathematics tasks at school (e.g. "Extracting mathematical information from diagrams, graphs, or simulations", "Using the concept of statistical variation to make a decision"). Each of the 10 items included in this scale had four response options ("Frequently", "Sometimes", "Rarely", "Never").

[4] This index includes students' ratings of how confident they felt about having to do a range of mathematical reasoning and 21st-century mathematics task (e.g. "Extracting mathematical information from diagrams, graphs, or simulations", "Using the concept of statistical variation to make a decision"). Each of the 10 items included in this scale had four response options ("Not at all confident", "Not very confident", "Confident", "Very confident") s.

[5] The PISA reading fluency test consisted of presenting students with a series of simple sentences, one at a time, and asking them to determine whether each sentence made sense. These sentences were all relatively simple and there was no ambiguity about whether they made sense or not. To determine if low-achieving students can read fluently, language-specific norms for response time on reading fluency tasks were established based on the reading pace for the median response time of Level 3 students (at least 50%), which is the baseline for skilled performers in this report. Based on the accuracy of their sensitivity judgments and the time taken to complete the test, students were categorised into four groups:

- Fluent readers: Made no more than one mistake in their sensitivity judgments and took at most twice as long as the language-specific norm.
- Slow readers: Took more than twice as long as the norm, regardless of accuracy.
- Inaccurate readers: Made more than one mistake but did not complete the test unusually quickly or slowly.
- Hasty test-takers: Made more than one mistake and completed the test faster than 99% of their peers who made, at most, one mistake, indicating rapid guessing.

These categories cover the totality of test-takers and are mutually exclusive (i.e. every student falls into one category). Hasty test-takers are not included in the analyses in this box as they did not engage with the reading-fluency test as expected.

[6] This analysis only considers language groups within countries/economies with at least 1 000 students.

[7] PISA 2022 data show that this type of variation in reports between low and skilled performers holds in both, academically segregated and comprehensive systems alike, as measured by the PISA index of academic inclusion (OECD, 2023[21]). For example, among the countries mentioned above, Denmark* and the Netherlands* are at opposite ends of the index of academic inclusion.

[8] The countries and economies whose relationships are considered here are:

- Extracting mathematical information: countries/economies where more than 45% of students reported exposure to this task.
- Representing situations mathematically: countries/economies where at least 40% of students reported exposure to this task.
- Interpreting mathematical solutions: countries/economies where at least 33% of students reported exposure to this task.

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9 Students' readiness for self-directed learning

This chapter looks at students' confidence in their self-directed learning skills. Based on students' experiences during the COVID-19 pandemic, four aspects are considered: confidence in planning their schoolwork, in their ability to motivate themselves to do schoolwork, in their ability to find resources online autonomously, and in their ability to assess their own progress. The chapter identifies which of these areas are most in need of improvement and explores their relationship with the use of key learning strategies, motivation to learn and performance in mathematics. The chapter also explores the relationship between confidence in self-directed learning and social and emotional skills.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

Student capacity to direct and regulate their own learning is the key skill in sustained lifelong learning (Dignath, Buettner and Langfeldt, 2008[1]; Council of the European Union, 2002[2]).

Lifelong learning requires a change in mindset from being a passive recipient of knowledge to an active participant in the learning process (Candy, 1991[3]). Self-directed learning capabilities and competencies can spur this on. It is taking responsibility for controlling one's own learning by autonomously setting what, when and how to learn and maintain motivation (Zimmerman, 1998[4]). Education systems can help students become effective lifelong learners by helping them develop their own agency in learning with adapted approaches (Cazan and Schiopca, 2014[5]; Douglass and Morris, 2014[6]).

Against the backdrop of the COVID-19 pandemic, PISA 2022 asked students to report on how confident they are about self-directing their learning in case schools had to close again in the future. This section focuses on how prepared students are to learn outside the traditional school environment and, by extension, how prepared students and education systems are for lifelong learning. Students' confidence in their abilities and motivation to learn are central to their ability to learn outside and beyond school settings. When interpreting these results, however, it should be borne in mind that students' experiences of the pandemic, such as school closures, vary from country to country. Conclusions drawn in this chapter may apply differently in different contexts.

Key findings

Fifteen-year-olds feel most comfortable finding resources online on their own. While they are confident about planning their working schedules, they feel less assured about motivating themselves to follow through on them. Moreover, many low performers are not confident they can find resources online or plan their schoolwork on their own: these are strong barriers to learning autonomy.

In close relation to this, intrinsic motivations are strongly linked to students' confidence in self-directed learning. While instrumental motivations are important, they play a secondary role. Gaps in motivation between confident self-directed learners and their less confidence peers are consistent across most countries and economies, underscoring the constant relationship between motivational aspects and confidence in self-directed learning.

Confident, self-directed learners reported using several key strategies for sustained learning. They tend to be more meticulous in their approach to learning. They pay careful attention to details in their schoolwork and ensure they thoroughly understand the material by frequently asking questions. These learners are also more likely to consider different perspectives before forming their own opinions and are proactive in their learning behaviours. In particular, proactive students in Hong Kong (China)* are about twice as likely as their less proactive peers to be self-directed learners. They are confident they can plan their schoolwork on their own; motivate themselves to do schoolwork; and assess their own learning progress if ever their school were to close again in the future. This holds even after accounting for students' and schools' socio-economic profile.

Students that reported strong social and emotional skills are consistently more confident in their ability to self-regulate their learning behaviours. For example, the most persistent students are significantly more likely to report confidence in such behaviours than the least persistent. The gap is particularly large for students who feel confident being able to motivate themselves to do their schoolwork, especially in Australia*, Hong Kong (China)*, the Netherlands* and New Zealand*. Student persistence is a key component of autonomous lifelong learning. Cooperative students are also more confident in their self-directed learning strategies, especially in motivating themselves to do schoolwork on their own. This is particularly so in Colombia, Croatia, El Salvador, Mexico and Peru.

What PISA tells us about self-directed learning

Analyses in previous PISA 2022 volumes found that students in education systems that were most resilient throughout the pandemic did not necessarily have above-average confidence in their self-directed learning abilities (OECD, 2023[7]).

If we look more closely at the relationship between self-directed learning and performance in each education system, skilled performers are more confident self-directing their learning than low performers in most countries/economies (Table V.B1.9.1). Moreover, findings from PISA 2022 reveal that, on average across OECD countries, socio-economically advantaged students were more confident in their capacity to learn autonomously and remotely compared to disadvantaged students. Similarly, girls have greater confidence in their self-directed learning abilities than boys in about a third of all participating education systems (OECD, 2023[7]).

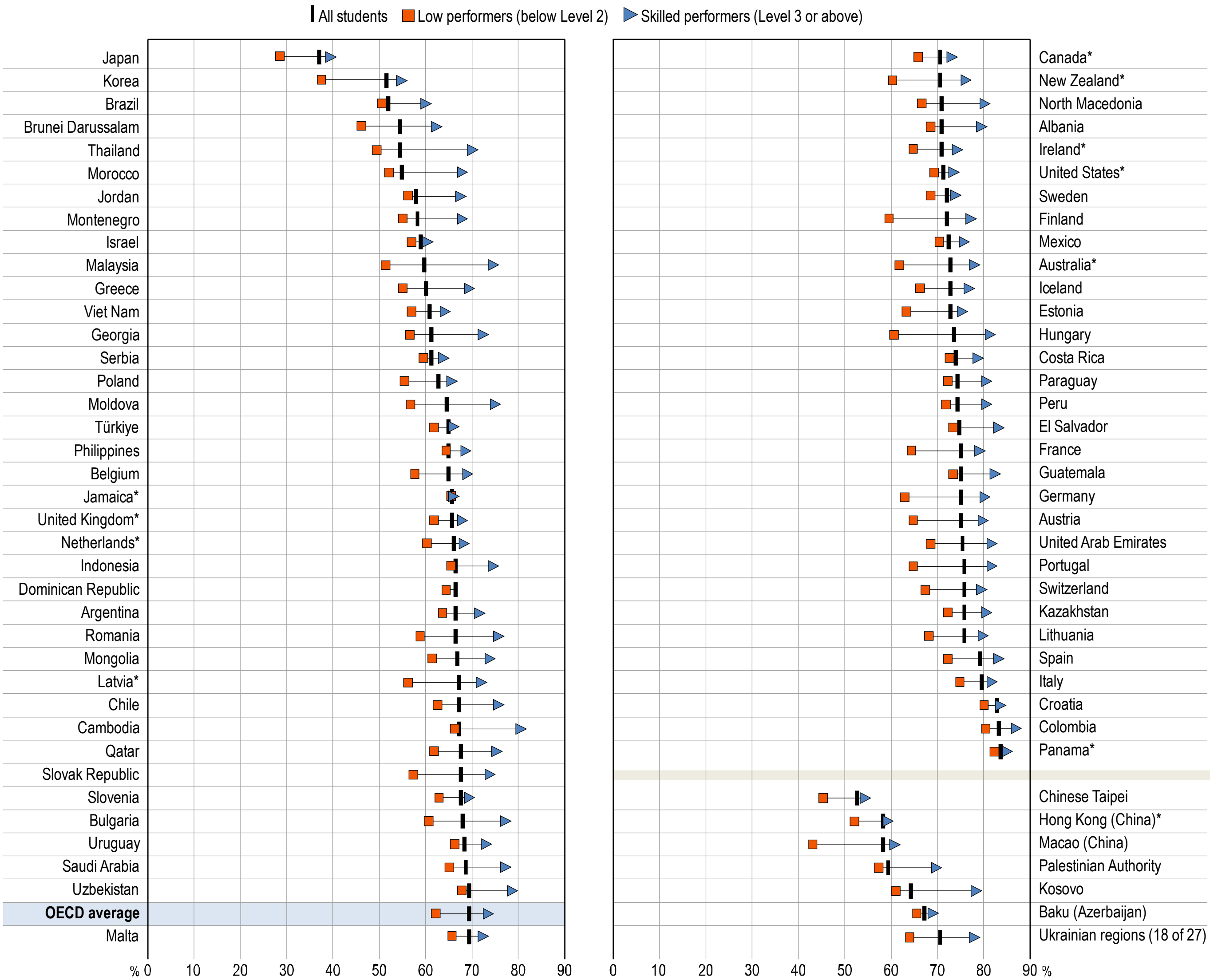
To analyse this further, four aspects that "scaffold" self-directed learning are observed in detail: students' confidence in planning their schoolwork; their capacity to motivate themselves to do schoolwork; their ability to autonomously find resources online; and assessing their own progress[1] in case schools have to close again in the future. These four aspects are the building blocks of autonomous learning.

Students feel confident about planning their working schedules but less confident about motivating themselves to see them through

Most students feel confident about planning their own study schedules (69%). This helps students develop organisational skills and time management, essential for managing their educational responsibilities effectively. PISA data show that skilled performers are more inclined to feel confident in that area, with 73% reporting this, on average – and the share is at least 80% in 15 countries with available data. Among low performers, about 62% reported being confident planning their schoolwork. There is a wide variation across countries/economies. In Colombia and Panama* the share is at least 80% while in Japan and Korea less than 40% reported such confidence. Among skilled performers, up to 87% reported confidence in Colombia. Only in Japan did less than half of skilled performers report feeling confident (Figure V.9.1).

Figure V.9.1. Self-directed learning: Planning when to do schoolwork on my own, by students' level of performance in mathematics

Percentage of students who responded that they feel confident or very confident planning when to do schoolwork on their own if their school closes again in the future



Note: Only countries and economies with available data are shown.
Countries and economies are ranked in ascending order of the percentage of all students.
Source: OECD, PISA 2022 Database, Table V.B1.9.3. See Table V.9.1 for StatLink at the end of this chapter.

About motivation, however, only slightly over half of students reported confidence motivating themselves to do schoolwork (58%), irrespective of their level of performance in mathematics, on average across OECD countries. Students' confidence in motivating themselves varies a great deal from country to country, ranging from 35% in Japan to over 80% in Cambodia and El Salvador among skilled performers, and 32% in Japan and over 80% in Colombia among low performers (Figure V.9.1b [available online]). Self-motivation is crucial for maintaining engagement and persistence, especially when facing challenges or less interesting tasks.

Fifteen-year-olds feel most comfortable finding resources online on their own

Students reported feeling confident or very confident about finding resources online on their own – a critical skill in the digital age. On average, 73% of students reported feeling confident finding learning resources online by themselves, with 79% of skilled performers and about 62% of low performers, on average. Over 90% of skilled performers reported confidence in Croatia and Italy, as did over 75% of low performers in these two countries as well as in Colombia and Panama*. In Japan, 36% of skilled performers and only about one in five low performers did (Figure V.9.1c [available online]). It is important to note that assessing the relevance and reliability of resources found online is a different matter – one that requires a specific set of skills addressed in Chapter 8.

Finally, the ability to assess one's progress is a form of reflective learning, enabling students to identify areas for improvement and adjust their strategies accordingly. This is one key element of self-directed learning. While an average of 65% of students reported being confident in this practice, with 67% of skilled performers and 62% of low performers, the share is as high as 80% or more of skilled performers in Croatia, Colombia, El Salvador, Iceland, Kazakhstan and Panama*. Only in Japan did less than 40% of skilled and low performers report confidence in assessing their progress (Figure V.9.1d [available online]).

Substantial variation in confidence in self-directed learning practices across education systems suggests cultural, educational, and systemic factors at play in student responses[2]. However, overall, these results point to three important findings. First, a substantial share of students need to improve their capacity to assess their own progress, on average and across countries and economies. Second, many low performers lack confidence in their ability to plan their schoolwork on their own and find resources online in many systems (Figure V.9.1and Figure V.9.1c [available online]). Third, all students can benefit from improved motivation to work autonomously outside of traditional school settings, on average and across countries and economies.

These and previously analysed findings suggest that if schools were to physically close again in the future, some students would face more challenges than others, exacerbating disparities in learning. The following analysis explores the positive relationships between strategies for sustained learning, motivations, and social and emotional skills, providing insights that can help educators enhance students' confidence in self-directed learning.

What strategies for sustained lifelong learning do confident, self-directed learners use the most?

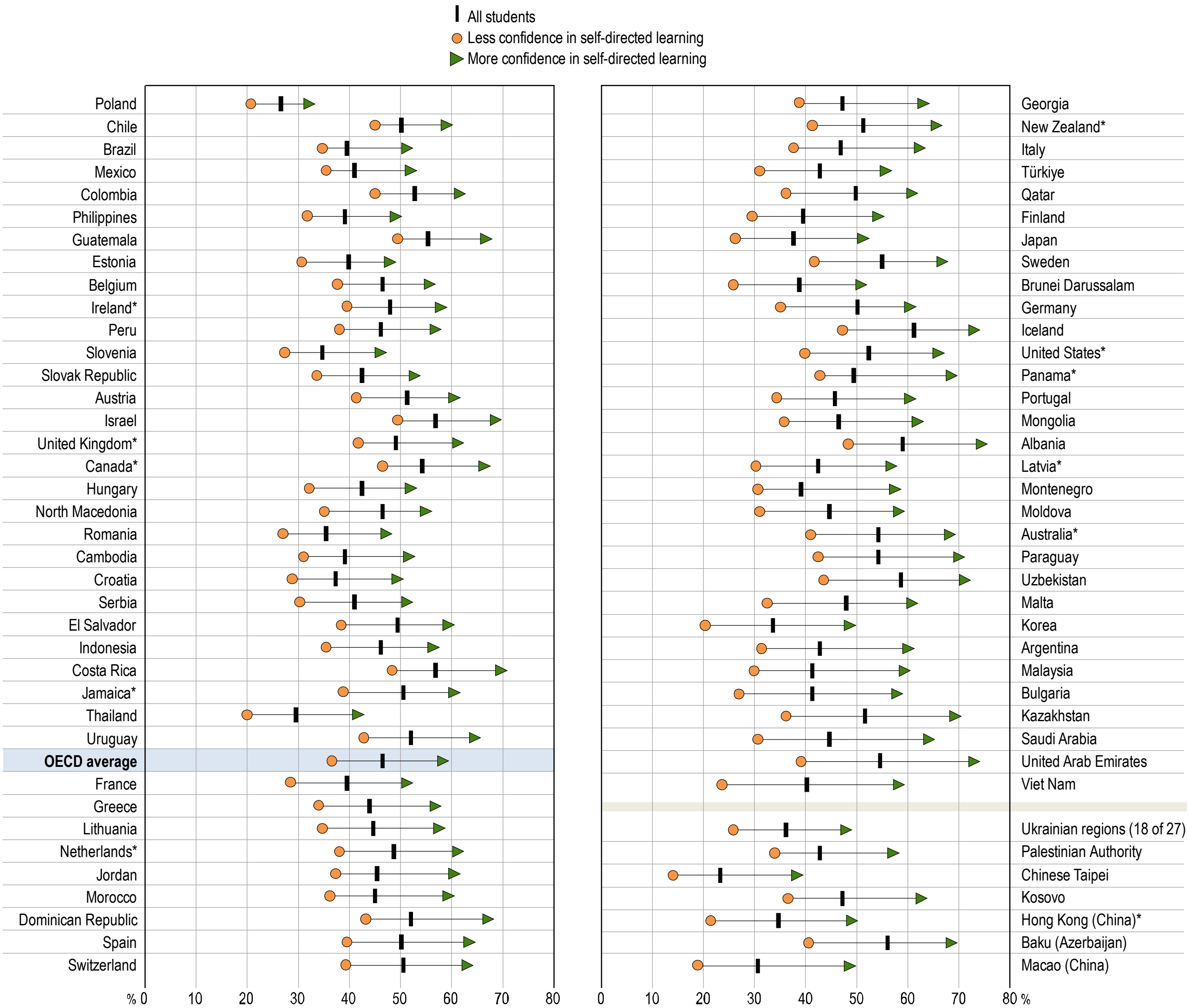
PISA data show positive relationships between students' confidence in self-directed learning and the strategies for sustained learning analysed in this report, even after accounting for students' and schools' socio-economic profile (Figure V.9.1e [available online]).

Confident, self-directed learners are more meticulous than their less confident peers

PISA data show that students who are confident about their self-directed learning capacities (as measured by the PISA index of confidence in self-directed learning[3], where a positive value indicates students feel more confident in their self-directed learning than the OECD average while a negative value suggests the opposite) frequently ask questions in class when they do not understand what is being taught – significantly more than their less confident peers (22 percentage-point gap, on average) (Figure V.9.2). This gap is significant and large in all countries and economies, ranging from 12 percentage points in Poland to 35 in Viet Nam. Similarly, more confident, self-directed students check their work, in general, for mistakes (20 percentage-point difference) and check their homework before handing it in (24 percentage points), on average as well as across countries. The gap between confident and less confident students in these two types of meticulousness are the largest in New Zealand*, at 39 and 37 percentage points, respectively. These findings show the interconnectedness of self-directed learning, meticulousness and self-monitoring, highlighting the need for learning environments that foster student autonomy and positive mindsets (Tables V.B1.9.12, V.B1.9.13 and V.B1.9.17).

Figure V.9.2. Confidence in self-directed learning when asking questions when not understanding the class material

Percentage of students who reported asking questions at least half of the time they did not understand the mathematics material that was being taught



Notes: Only countries and economies with available data are shown.
All percentage-point difference between students with more confidence in self-directed learning and those with less are statistically significant (Annex A3).
Students who reported less (more) confidence in self-directed learning are those in the bottom (top) quarter of the index of confidence in self-directed learning in their own country/economy.
Countries and economies are ranked in ascending order of the percentage-point difference between students with more confidence in self-directed learning compared to those with less.
Source: OECD, PISA 2022 Database, Table V.B1.9.17. See Table V.9.1 for StatLink at the end of this chapter.

The relationships between these self-monitoring strategies, and confidence in self-directed learning are positive and hold after accounting for students' and schools' socio-economic profile and students' performance in mathematics across countries. This is especially so for carefully checking homework before submitting it, which is strongest in Germany – only in Panama* is the relationship not significant (Figure V.9.1e [available online] and Table V.B1.9.10).

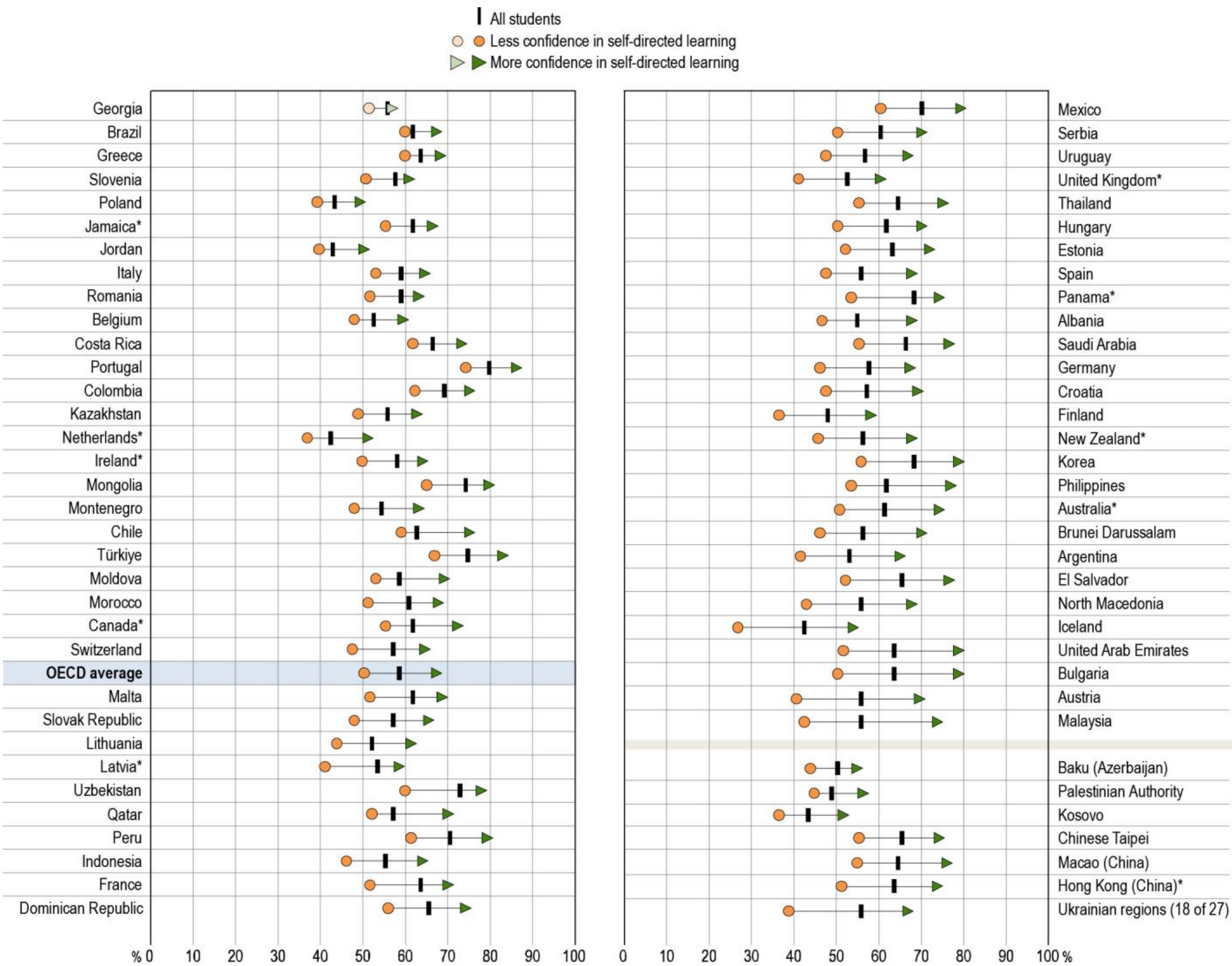
Confident, self-directed students are more likely to consider different perspectives before forming their own opinions

Students with greater self-directed learning confidence are more likely to consider different perspectives before forming their own opinions, with a 17 percentage-point average difference (Figure V.9.3). The gap is the largest at over 28 percentage points in Austria, Bulgaria and Malaysia, and the smallest in Brazil and Greece at under 10 percentage points – and is not significant only in Georgia. Confident students also reported seeing issues from different angles to a larger extent than their less confident peers (19 percentage-point gap, on average). These differences are significant across most countries and economies (Tables V.B1.9.14 and V.B1.9.15).

Critical thinking (perspective-taking) enables students to evaluate and integrate diverse viewpoints before making their own decisions. Perspective-taking encourages learners to move beyond superficial comprehension and consider multiple angles and perspectives. This is crucial for robust information-processing and informed decisions.

Figure V.9.3. Confidence in self-directed learning when considering everybody's perspective

Percentage of students agreeing or strongly agreeing they try to consider everybody's perspective before they take a position



Notes: Only countries and economies with available data are shown.
Percentage-point difference between students with more confidence in self-directed learning and those with less that are statistically significant are shown in a darker tone (Annex A3).
Students who reported less (more) confidence in self-directed learning are those in the bottom (top) quarter of the index of confidence in self-directed learning in their own country/economy.
Countries and economies are ranked in ascending order of the percentage-point difference between students with more confidence in self-directed learning compared to those with less.
Source: OECD, PISA 2022 Database, Table V.B1.9.14. See Table V.9.1 for StatLink at the end of this chapter.

Interestingly, belief that there can be more than one correct position in a disagreement is where the relationship is the weakest with self-directed learning capacities, on average and across countries. Indeed, the relationship is non-significant across most countries. In line with findings discussed in Chapter 2, this relationship is largely driven by mathematics performance (Table V.B1.9.10). Top performers in mathematics are generally more comfortable with complex reasoning. The gap between students who think there can be more than one correct position in a disagreement and those who do not reflects the abstract thinking and particular types of reasoning needed for strong mathematics performance – more so than self-directed learning skills. While self-directed learning is important, it is students' ability to engage in particular types of reasoning and abstract thinking that most shapes their views on how many correct positions there can be in disagreements.

Proactive learning behaviours are strongly associated with confident, self-directed learning

The positive relationship between confidence in self-directed learning and proactive mathematics study behaviour is noteworthy (Figure V.9.3c [available online]). Students who exhibit proactive behaviours are more likely to report more self-directed learning confidence in key areas, on average, and this relationship holds even after accounting for students' and schools' socio-economic profile and students' mathematics performance. Most notably, in Hong Kong (China)*, proactive students are about twice as likely to be confident in planning when to do schoolwork on their own, motivating themselves to do schoolwork and assessing their progress with learning, if their school would close again in the future, than their less proactive peers (Table V.B1.9.8).

This relationship is also evident when examining specific proactive behaviours. Students with the greatest self-directed learning confidence put more effort into their mathematics assignments in all countries and economies. Over three-quarters of confident, self-directed learners reported making an effort compared to about half of their less confident peers. The gap is particularly pronounced – exceeding 40 percentage points – in Korea, Malaysia, and Chinese Taipei, and is the smallest in Guatemala with 15 percentage points (Table V.B1.9.18).

Furthermore, confident, self-directed learners are more apt to connect new material to previously learned mathematics lessons in all countries and economies. About 60% of these students reported this proactive behaviour compared to only 35% of their less confident peers, on average across OECD countries. In Albania, Kazakhstan, Korea and Moldova, there are substantive gaps of over 35 percentage points while in Argentina and Belgium the gaps are significant but under 15 percentage points (Table V.B1.9.19).

These findings highlight key areas where students with low confidence in self-directed learning can be supported and activated. Encouraging students to develop control and self-monitoring strategies, critical thinking (perspective-taking) and proactive behaviours can significantly enhance their ability to learn on their own. This is crucial to lifelong learning.

While students take the initiative in cultivating some self-directed learning strategies and attitudes, many are developed in school with the guidance and input of teachers (see Chapter 2). Though weaker, there are, nonetheless, positive relationships between these self-directed behaviours and the cognitive activation practices teachers teach – after accounting for students' and schools' socio-economic profile and students' performance in mathematics (Table V.B1.9.9).

Previous PISA 2022 analyses have shown that students whose teachers were available to help during COVID-19 school closures have greater confidence in their self-directed learning capacities (OECD, 2023[7]). Teacher support in fostering students' self-directed learning is important and, with one's eye on lifelong learning, an outcome of schooling in its own right. One way in which teachers can support students to become strong lifelong learners is by integrating problem-based learning into their teaching. An example of such an ambitious initiative is Japan's Fourth Basic Plan for the Promotion of Education (see Box V.9.1).

Box V.9.1. Japan's Fourth Basic Plan for the Promotion of Education

Japan's Fourth Basic Plan for the Promotion of Education sets out the goals for the education system and defines a comprehensive approach to policy implementation.

Under this plan, the first of five policies focuses on developing individuals of all ages to continue to learn for the sustainable development of a globalised society. For example, it highlights the importance of moving away from methods such as rote memorisation towards an approach that fosters the development of competencies and attitudes for lifelong learning. Cultivating the foundations for lifelong learning can start as early as early childhood education. Active learning is encouraged through problem-based learning at schools and, even, in universities. This promotes "learner-oriented education" and the growth of independent and self-directed learners. It also emphasises working adults' lifelong learning by providing opportunities for reskilling. These include digital education initiatives tailored towards the elderly, for instance, and individuals with disabilities.

Under this plan, the government aims to create an environment that facilitates adult learning by providing more learning opportunities. Programmes such as "Brush up Program for Professionals" and "Career Development Promotion Program" are held in collaboration with universities and industry partners, and offer weekend, evening and online classes. This provides more opportunities for adults with other responsibilities to participate. The Open University of Japan will serve as a hub for lifelong learning by offering adult learning programmes in collaboration with universities, companies, and government agencies.

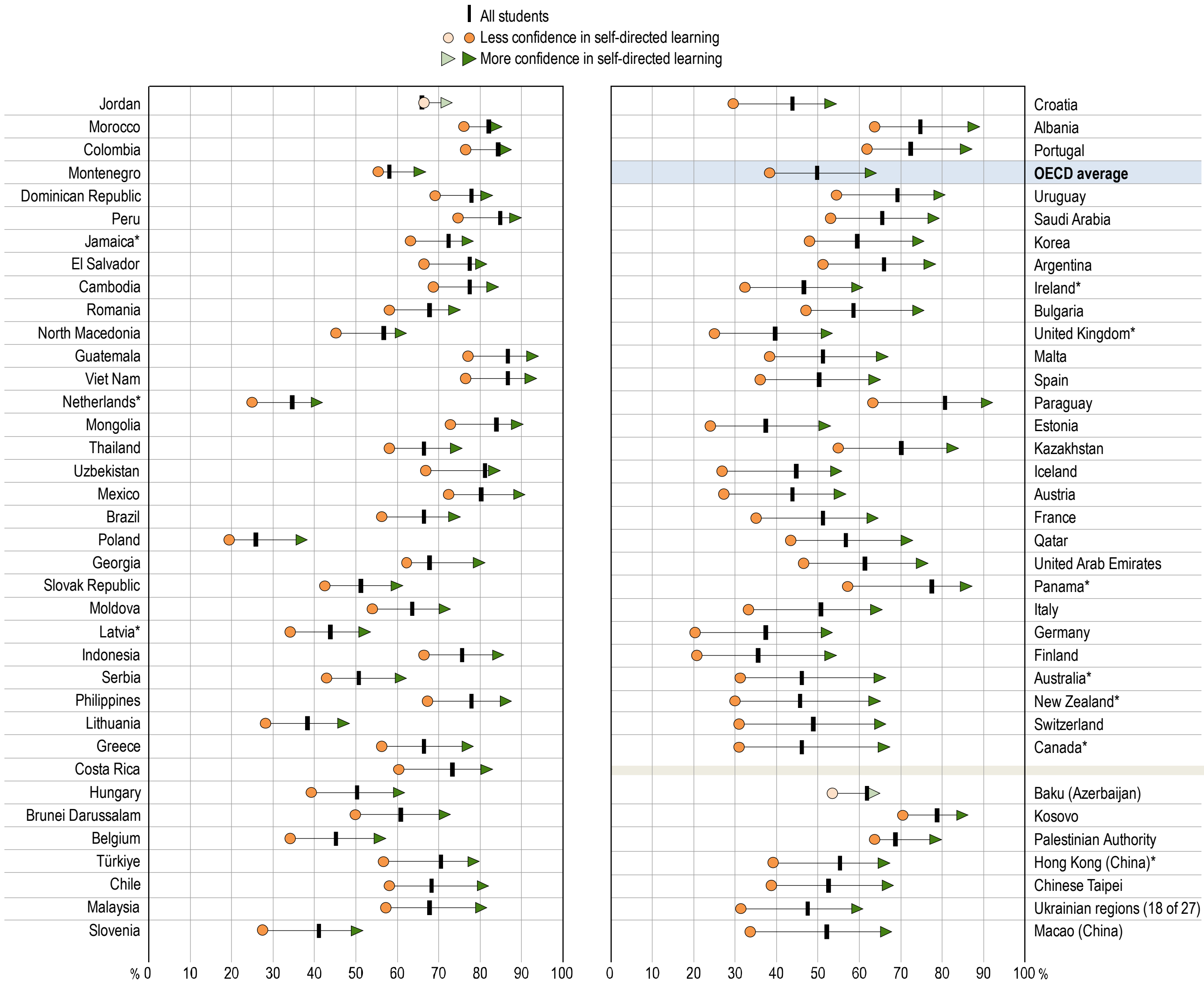
Source: (MEXT, 2023[8])

Student motivations for self-directed learning

Another learning behaviour this report looks at are students' motivations to learn and take an active role in their learning. The biggest gap between confident, self-directed learners and their less confident peers is connected to *intrinsic motivations* in most participating countries and economies (Figure V.9.4). Enjoying learning new things in school and liking challenging schoolwork show respective gaps of 25 and 26 percentage points between the most and least confident students, on average. These gaps are significant and above 10 percentage points in most countries. The enjoyment of learning new things in school is considerably higher among confident, self-directed learners in Australia*, Canada*, Finland, Germany, Italy, Macao (China), New Zealand* and Switzerland compared to less confident learners (over 30 percentage points). In terms of liking schoolwork that is challenging, gaps between students who are the most and least confident are the largest and go beyond 35 percentage points in Korea and Malta (Tables V.B1.9.20and V.B1.9.21).

Figure V.9.4. Confidence in self-directed learning when enjoying learning new things in school

Percentage of students agreeing or strongly agreeing they love learning new things in school



Notes: Only countries and economies with available data are shown.
Percentage-point difference between students with more confidence in self-directed learning and those with less that are statistically significant are shown in a darker tone (Annex A3).
Students who reported less (more) confidence in self-directed learning are those in the bottom (top) quarter of the index of confidence in self-directed learning in their own country/economy.
Countries and economies are ranked in ascending order of the percentage-point difference between students with more confidence in self-directed learning compared to those with less.
Source: OECD, PISA 2022 Database, Table V.B1.9.20. See Table V.9.1 for StatLink at the end of this chapter.

Intrinsic motivations are strongly linked to students' confidence in self-directed learning

The relationship between liking challenging schoolwork and learning new things in school, and students' confidence in self-directed learning is the strongest as well, on average and across countries. In both cases, the relationship holds after accounting for students' and schools' socio-economic profile and students' performance in mathematics (see Table V.B1.9.23).

Students with greater self-directed learning confidence also have greater instrumental or extrinsic motivation. Confident, self-directed learners who believe school teaches them things that can be useful in a job show a 17 percentage-point gap, on average across OECD countries, when compared to their less confident peers. The gap stretches to over 25 percentage points in Albania, Croatia and the United Kingdom*. The average gap is smaller, at 10 percentage points, among students reporting to being motivated in their subject class and having self-directed learning confidence. This relationship is strong, although it is driven by mathematics performance in several countries. (Figures V.9.4d and V.9.4e [available online]). But the consideration that what one learns in school can be useful for jobs still shows a comparatively weaker relationship, suggesting that while instrumental motivations are important, they play a secondary role to intrinsic motivations in driving students' confidence in self-directed learning (Figures V.9.4c and V.9.4d [available online]).

That said, gaps between confident self-directed learners and their less confident peers are consistent across most countries and economies, underscoring the persistent relationship between motivational aspects and confidence in self-directed learning (Table V.B1.9.23). These findings are in line with analyses discussed in Chapter 3 on the relationship between motivations and strategies for sustained lifelong learning.

In conclusion, the relationship between self-directed learning confidence and student motivation is both strong and multifaceted (see Box V.9.2). Intrinsic motivations play a particularly crucial role in fostering confidence in self-directed learning. Educational strategies that enhance both intrinsic and instrumental motivations will help develop self-directed lifelong learners. These insights can shape educational policies and practices that cultivate motivated, independent learners who pursue sustained learning throughout their lives.

Box V.9.2. Motivations and proactive behaviours

The COVID-19 pandemic underscored students' need for strong self-directed learning skills. While many 15-year-olds are confident in their ability to navigate online learning and plan their work, effective self-directed learning requires a range of proactive behaviours. Students must actively monitor their progress, connect new and previous knowledge, seek feedback, and be ready to put effort into their assignments. Additionally, self-motivation to persevere in spite of difficulties is essential.

To what extent do student motivations, both intrinsic and instrumental, mediate the relationship between these proactive behaviours and students' confidence in self-directed learning? Further analyses – as measured by the index of proactive mathematics study behaviour[4] – show that the association of these proactive attitudes with different student motivations can be positive and significant for student autonomy, as measured by its indirect effect on student's confidence in self-directed learning.

About 11% to 13% of the difference in self-directed learning confidence among more proactive students could be interpreted as the indirect result of differences in intrinsic motivations like enjoying learning new things in school and challenging schoolwork, respectively. The share is as high as 7% among students who are instrumentally motivated by the idea that school teaches things that are useful in a job[5] (Table V.B1.9.11).

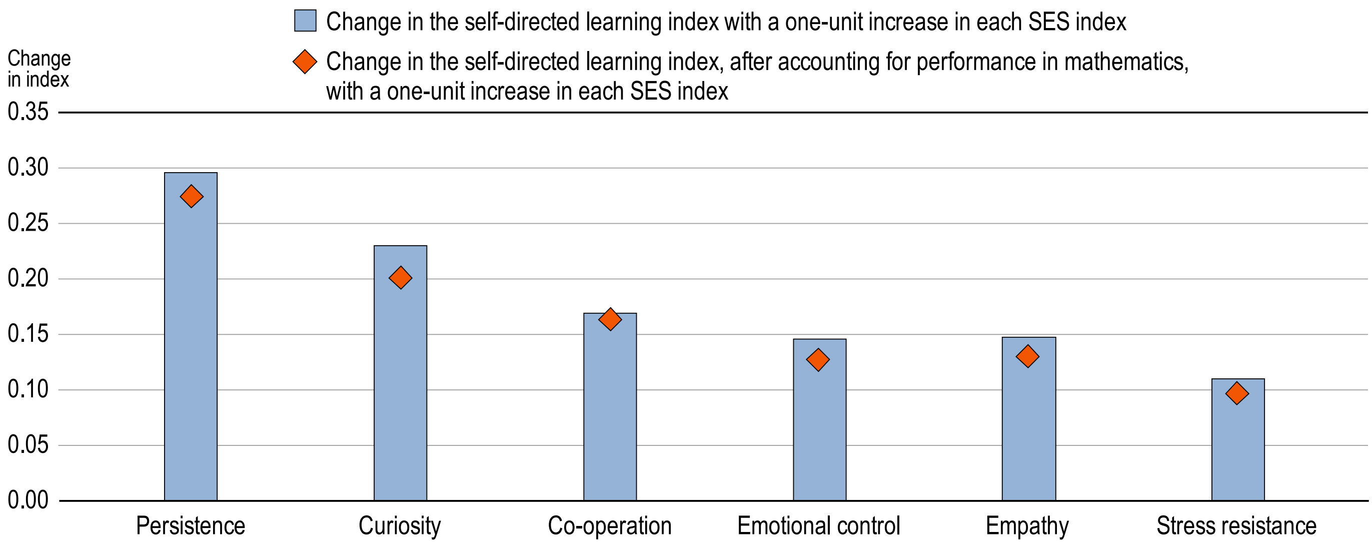
These findings underscore the complex interplay between student motivation, engagement with learning strategies, and confidence in self-directed learning capacities. They also suggest that, just like learning strategies, motivations do not act alone. It is likely that students are variously incentivised to direct their own learning, combining intrinsic and instrumental motivations.

Social and emotional skills

Social and emotional skills (SES) can help shape students' self-directed learning behaviours. PISA data show a positive association between students' confidence in self-directed learning and their SES, a relationship that remains robust even after controlling for mathematics performance. This indicates that SES independently contribute to students' self-directed learning confidence (Figure V.9.5).

Figure V.9.5. Confidence in self-directed learning and social and emotional skills

Change in the mean index of confidence in self-directed learning with a one-unit increase in each of the social and emotional skills (SES) indices; OECD average

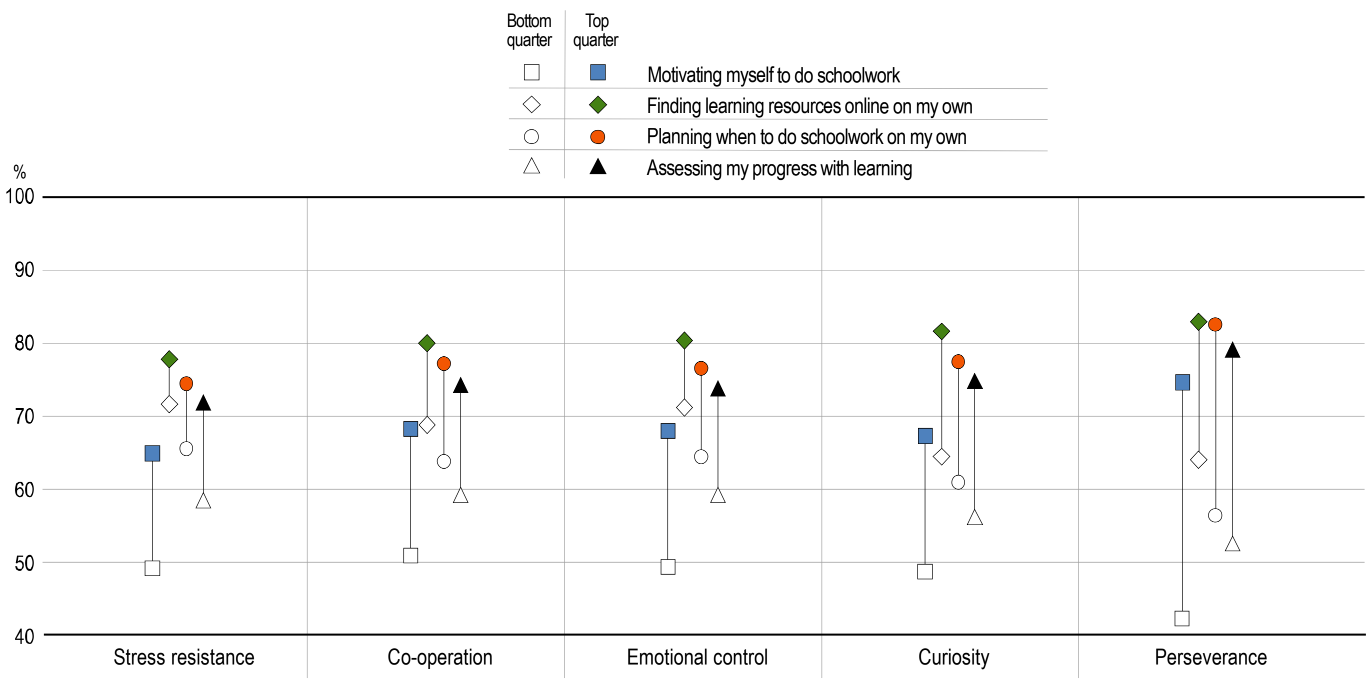


Note: Changes in the index of confidence in self-directed learning are all statistically significant (see Annex A3).
Items are ranked in descending order of the change in the index of confidence in self-directed learning, after accounting for mathematics performance and students' responses to learning strategies items.
Source: OECD, PISA 2022 Database, Table V.B1.9.24. See Table V.9.1 for StatLink at the end of this chapter.

Of the five SES considered in this section – stress resistance, co-operation, emotional control, curiosity and persistence – students with high SES consistently have more confidence in their ability to autonomously employ the four self-directed learning behaviours analysed: finding resources online, planning schoolwork, motivating oneself, and assessing one's own progress. Notably, students with high SES are most confident in finding resources online, followed by planning schoolwork, assessing progress, and lastly, motivating themselves, on average (Figure V.9.6).

Figure V.9.6. Students' self-directed behaviours and social and emotional skills

Percentage of students reporting four self-directed behaviours, by bottom and top quarter of social and emotional skills indices; OECD average



Source: OECD, PISA 2022 Database, Tables V.B1.9.25-V.B1.9.29. See Table V.9.1 for StatLink at the end of this chapter.

Student persistence drives autonomous lifelong learning

The most persistent students are significantly more inclined to report confidence in the four self-directed behaviours than their least persistent peers (as measured by the index of persistence[6] – positive values in the index indicate that students reported more persistent behaviours than did students on average across OECD countries). Interestingly, the gap is particularly large among students who feel confident motivating themselves to do schoolwork, averaging 32 percentage points. The gap is the largest in Australia*, Hong Kong (China)*, the Netherlands* and New Zealand*, where it exceeds 40 percentage points, and is the smallest in Serbia and Montenegro at under 20 percentage points (Table V.B1.9.27).

Conversely, students with the highest stress resistance reported the least confidence in motivating themselves to do schoolwork[7]. They are also separated from their less stress-resistant peers by an average only of 16 percentage points. Interestingly, in Finland, the gap between the two groups of students is one of the largest across countries and more than three-quarters of students with high stress resistance reported that they are confident in their ability to motivate themselves to do schoolwork. These findings highlight the varying impacts of different SES on self-directed learning behaviours and confidence (Figure V.9.6).

Persistence stands out as having the strongest overall relationship with confidence in self-directed learning both before and after accounting for mathematics performance. This also holds true for each of the four specific self-directed behaviours. The gaps in motivating oneself, assessing progress, and planning schoolwork are particularly large, each showing at least 27 percentage-point differences. Persistence consistently shows the strongest relationship with these attitudes, on average and across most countries with available data. In other words, students with the greatest persistence are more likely to report being confident in finding learning resources on their own, motivating themselves to do schoolwork, planning it ahead of time and assessing how they progress. Persistence drives self-directed learning confidence the most effectively (Table V.B1.9.32).

Curiosity also shows substantial gaps and strong relationships with self-directed learning behaviours, with differences ranging from 17 to 19 percentage points, on average across OECD countries. These gaps are consistent across countries. Curiosity significantly contributes to students' confidence in engaging in autonomous learning activities (Tables V.B1.9.29 and V.B1.9.34).

Cooperative students are also more confident about their self-directed learning strategies, especially in motivating themselves to do schoolwork on their own. This area shows the largest gap between the most and least cooperative students measured by the PISA index (17 percentage points). In Croatia, Mexico and Peru, the gap is over 20 percentage points and at least 80% of the most cooperative students reported feeling confident motivating themselves to do schoolwork (Table V.B1.9.25). This is an interesting finding because students who are more cooperative, along with those who demonstrate higher persistence, emotional control, and stress management, far outstrip peers with fewer SES in terms of motivation to work autonomously. While causality cannot be attributed from these analyses, by promoting SES, schools can cultivate environments where students are better equipped to thrive in diverse and evolving future contexts.

Interestingly, of the five SES analysed, the smallest average gaps are found in students' confidence in finding resources online. These gaps range from 6 to 19 percentage points, with the smallest gap observed among students in the top and bottom quarters of stress resistance. This behaviour shows the weakest relationship with most SES, suggesting that student confidence about finding resources online has been largely assimilated in school and out (Figure V.9.6).

PISA 2022 shows a significant relationship between SES, and students' mathematics performance in all countries/economies with available data (OECD, 2023[7]). Educational practices would do well to develop students' SES of persistence, curiosity, and co-operation to help them learn on their own and outside of the classroom throughout their lives.

Table V.9.1. Chapter 9 figures: Students' readiness for self-directed learning

Figure V.9.1	Self-directed learning: Planning when to do schoolwork on my own, by students' level of performance in mathematics
Figure V.9.1b	Self-directed learning: Motivating myself to do schoolwork, by students' level of performance in mathematics
Figure V.9.1c	Self-directed learning: Finding learning resources online on my own, by students' level of performance in mathematics
Figure V.9.1d	Self-directed learning: Assessing my progress with learning, by students' level of performance in mathematics
Figure V.9.1e	Confidence in self-directed learning and learning strategies
Figure V.9.1f	Confidence in self-directed learning among students who check for mistakes
Figure V.9.1g	Confidence in self-directed learning among students who check their homework
Figure V.9.2	Confidence in self-directed learning when asking questions when not understanding the class material
Figure V.9.3	Confidence in self-directed learning when considering everybody's perspective
Figure V.9.3b	Confidence in self-directed learning when not agreeing that there is only one correct position in a disagreement
Figure V.9.3c	Students' confidence in self-directed learning and proactive mathematics study behaviour
Figure V.9.3d	Confidence in self-directed learning when putting effort into mathematics class assignments
Figure V.9.3e	Confidence in self-directed learning when connecting new material to previous learning
Figure V.9.4	Confidence in self-directed learning when enjoying learning new things in school
Figure V.9.4b	Confidence in self-directed learning when enjoying challenging schoolwork
Figure V.9.4c	Confidence in self-directed learning and students' motivation to learn
Figure V.9.4d	Students' self-directed behaviours and motivations
Figure V.9.4e	Confidence in self-directed learning when agreeing that school teaches things that can be useful in a job
Figure V.9.5	Confidence in self-directed learning, and social and emotional skills
Figure V.9.6	Students' self-directed behaviours, and social and emotional skills

StatLink https://stat.link/8knphf

Notes

[1] The four aspects are formulated in the PISA 2022 student questionnaire as follows: “Finding resources online on my own”, “Planning when to do schoolwork on my own”, “Motivating myself to do schoolwork” and “Assessing my progress with learning”. Students were asked to indicate how confident they would be doing these things if their school building closed again in the future (i.e. not at all confident, not very confident, confident or very confident). These four items are also included in the PISA index of confidence in self-directed learning.

[2] Indicators in this report are based on students’ reports, which are susceptible to several possible measurement errors: memory decay; social desirability; reference group bias; and response style bias. These biases may operate differently in different cultural contexts, limiting the cross-national comparability of responses see (PISA 2018, Volume 3, Chapter 2).

[3] In PISA, the index of confidence in self-directed learning includes students’ reports of how confident they felt about having to do a range of self-directed learning tasks ranging from “Finding learning resources online on my own” to “Assessing my progress with learning” should their school building close again in the future. Students with higher scores on the index are more confident in their ability to be self-directed learners, and the opposite is true for students with lower scores.

[4] The proactive mathematics study behaviour index used in PISA measures the frequency of students’ engagement in such activities. It includes the three questions mentioned here, and a number of others, including “I put effort into my assignments for mathematics class”, “I made time to learn the material for mathematics class” and “I put effort into my assignments for mathematics class”.

[5] The indirect effects described here are based on the coefficients resulting from two linear regressions: (1) the total effect of the PISA index of proactive mathematics study behaviour on confidence for self-directed learning, controlling for students' and schools’ socio-economic profile (measured by the PISA index of economic, social and cultural status [ESCS]), and (2) the effect of the index of proactive mathematics study behaviour on confidence for self-directed learning, when accounting for the indirect effect of students agreeing with the different motivations to learn, controlling for students' and schools’ socio-economic profile. These coefficients are reported in the Table V.B1.9.11

[6] Students’ ratings of their agreement with statements about a range of behaviours indicative of persistence (e.g. “I keep working on a task until it is finished”, “I give up after making mistakes”). Each of the 10 items included in this scale have five response options (“Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree”, “Strongly agree”).

[7] While stress resistance may prove important when working under pressure or in complex circumstances, one way to interpret the fact that students with the highest stress resistance report comparatively less confidence in motivating themselves to do schoolwork is that their ability to manage stress effectively may reduce the urgency or pressure that could drive motivation. Because they are less affected by stress, they may not experience the same level of internal or external pressure to complete tasks, leading to a lower sense of urgency and consequently less self-directed motivation.

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10 Students' readiness for learning in the digital age

This chapter explores how students use digital resources and how confident they are in doing so. It also examines how students evaluate, manage and share information on digital platforms and how this relates to strategies for sustained learning and motivation to learn. The chapter looks at how interested students are in learning more about the use of digital resources in order to understand digital literacy-related motivations, which can strengthen the way students use digital tools and promote responsible behaviour with online information and a commitment to lifelong learning. Finally, it analyses how students perceive their teachers' digital competence.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader's Guide, Annexes A2 and A4).

Introduction

The COVID-19 pandemic brought radical changes to education around the world. While the performance of 15-year-old students had already begun deteriorating before the pandemic, PISA 2022 shows a drastic skills drop in mathematics in most countries/economies between 2022 and the last round of PISA testing in 2018 (OECD, 2023[1]). The reasons for this decline are many, including challenges like the sudden urgency to integrate digital technology into teaching and learning. Another is how prepared students were to take over their own learning when schools shut down (see Chapter 9 of this report and PISA 2022 Volume II).

Add to the lessons of COVID-19 the rapid rise of generative AI and the question becomes unavoidable: how can we best use these digital tools to help students meet their learning needs? How will they shape future learning? This section looks at digital literacy skills for lifelong learning and draws on findings from the PISA 2022 questionnaire on information and communication technology (ICT).[1]

The analyses explore how students use digital resources and how confident they are doing so. They also examine how students evaluate and manage, transform, create and share information on digital platforms, and how this relates to strategies for sustained learning and other outcomes such as mathematics performance. These findings are crucial for understanding how ready students are for lifelong learning in a digital world.

Key findings

Most students can easily find relevant information online, reflecting their basic proficiency with digital tools. But, only about half of students can easily judge the quality of online information. Most low performers (60%) cannot easily gauge online information quality. Only in Costa Rica and the United States* did slightly over half of low performers report they can. This reveals a significant challenge for independent lifelong learning.

Cautious online learners who evaluate online information quality are usually meticulous, critical thinkers and proactive learners. They are also more likely to be intrinsically and instrumentally motivated to learn. Students in Ireland* demonstrate a particularly strong relationship between the ability to critically evaluate online information and various positive learning strategies, especially double-checking their homework and proactively relating new material to previously acquired knowledge. In Macao (China), the relationship between critical thinking and this type of digital literacy is particularly strong even after accounting for students' socio-economic status and performance in mathematics.

Students who frequently use digital resources for school-related activities are more likely to be confident in their ability to use these tools effectively. And, students' perceptions of their teachers' digital proficiency positively relate to their online information habits. Education systems that provide professional development for teachers so they can smoothly integrate technology into learning experiences could strengthen students' digital literacy. At least around 70% of students reported that teachers at their school have good digital skills in the classroom and integrated digital resources into their teaching, on average, across OECD countries. The fewest number of students to report that their teachers are digitally literate are in Argentina, Germany, Greece, Israel, Italy, Morocco, and Poland (between 50% and 60%).

Regarding gender, gaps persist in how interested students are in digital fields in several countries and economies. Boys express more interest in computer programming in 41 countries and economies. However, more girls than boys are interested in programming in Albania, the Dominican Republic, Jordan, Morocco and Thailand.

Box V.10.1. What aspects of digital literacy are considered here?

Digital literacy is a broad concept that encompasses a wide range of skills needed to navigate and engage effectively in the digital world. One critical area of digital literacy is the ability to distinguish between reliable and unreliable information online. This requires a combination of skills to assess the credibility of sources, understand bias and cross-reference information across multiple sources. Measures to achieve this include teaching students how to check facts, identify misinformation and use reliable sources. Developing these skills is essential in today's digital age, where the amount of information is overwhelming and often misleading (OECD, 2021[2]; Burns and Gottschalk, 2020[3]).These are the aspects considered in the analyses presented in this chapter.

The important role of teachers and schools in developing these aspects of digital literacy cannot be overstated. Educators are in a unique position to guide students through the complexities of the digital landscape. Teachers can provide students with the tools they need to critically evaluate online information and develop healthy digital habits. Schools can support this by providing professional development for teachers, integrating technology into learning experiences, and fostering an environment that encourages curiosity and critical thinking. This approach ensures that students are not only proficient in using digital tools but able to navigate the digital world responsibly and effectively (McKnight et al., 2016[4]; Paniagua and Istance, 2018[5]).

How do students use digital resources at school and how confident are they doing so?

PISA 2022 asked students about their use of digital resources[2] for class activities and doing homework. Tasks include creating multimedia presentations and finding information online[3]. The data provide important insights into how these digital practices relate to students' confidence in their digital skills.

Frequency of use is positively related to students' confidence

Students who frequently use digital resources for school-related activities tend to be more confident in their ability to use these tools effectively.[4] This relationship holds after accounting for students' and schools' socio-economic profile and performance in mathematics, on average, and across countries and economies. This is particularly true for two activities: finding information about real-world problems (e.g. climate change, oil spills) and writing/editing text for school assignments (Tables V.B1.10.32 and V.B1.10.33).

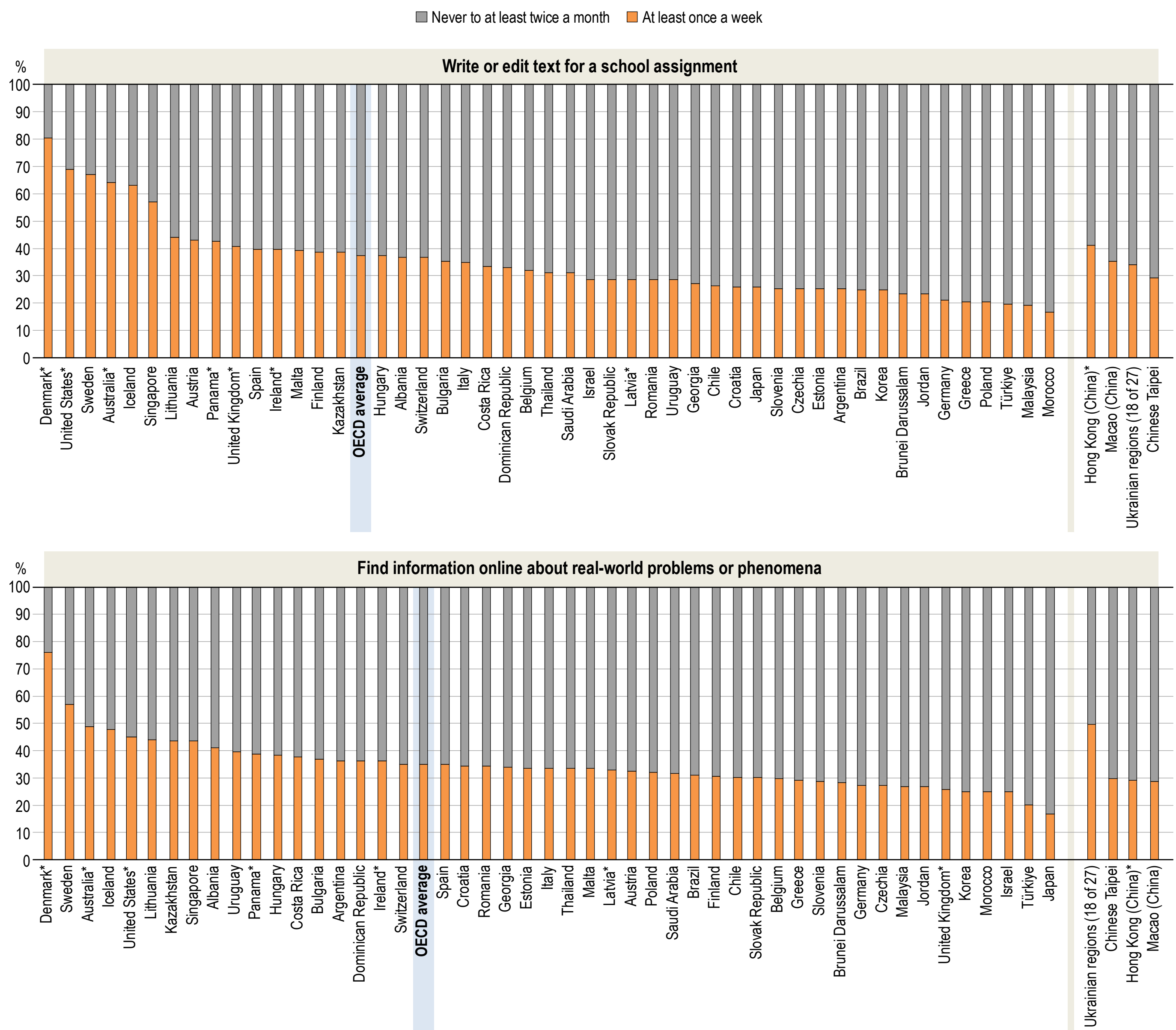
That said, the regular use of digital devices for schoolwork is culturally embedded. Education systems can have very different approaches to digital technologies in everyday learning. Moreover, the availability of digital resources can vary considerably, with socio-economically advantaged students in most countries and economies reporting higher digital use in enquiry-based learning activities than their disadvantaged peers. Only in Czechia is this difference non-significant (Table V.B1.10.5).

Across OECD countries, weekly use of digital resources appears to be the norm, regardless of students' performance level. For example, an average of 9% of students in OECD countries reported using digital resources to find information about real-world problems every day for school-related activities but 26% do so weekly. In contrast, 17% never or almost never use digital resources for this. In Korea, Morocco, Chinese Taipei, and Türkiye, over 30% of students reported never doing so. In Japan, over half of students reported never or almost never doing so (52%) (Figure V.10.1 and Table V.B1.10.4).

Low performers reported similar behaviours, with about 8% using digital resources daily, 21% weekly, and 23% never or almost never, on average. In Korea and Chinese Taipei, about 45% of low performers never use digital resources to find information about real-world problems, rising to 66% in Japan. Skilled performers also show varied engagement, with 10% doing so daily, 28% weekly, and 14% never or almost never. Denmark* stands out with at least 40% of skilled performers using digital resources for this activity daily or weekly (Table V.B1.10.23)

Figure V.10.1. Frequency of use of digital resources: Writing or editing text for a school assignment and finding information on real-world problems

Percentage of students reporting they use digital resources to conduct the following activities



Note: Only countries and economies with available data are shown.

For each graph, countries and economies are ranked in descending order of the percentage of students reporting doing the above activities at least once a week, when using digital resources.

Source: OECD, PISA 2022 Database, Table V.B1.10.4. See Table V.10.1 for StatLink at the end of this chapter.

When it comes to writing or editing texts for school assignments, an average of 11% of students in OECD countries reported doing this everyday but 27% do so weekly. In contrast, 14% never or almost never engage in this activity, with higher rates in Brazil, Japan, Malaysia, Morocco, and Türkiye (Figure V.10.1 and Table V.B1.10.4). Among low performers, 22% reported writing or editing text on a weekly basis and 21% never or almost never do so. Lastly, 29% of skilled performers do this weekly while only 10% never or almost never do so (Table V.B1.10.22).

Policy makers should target support for students' digital literacy, especially disadvantaged students. Ensuring equitable access to digital resources and integrating the use of ICT in inquiry-based learning activities can help bridge the digital divide between advantaged and disadvantaged students. By focusing on these inequalities, education systems can better prepare students for lifelong learning and success in a digital world.

Most students can easily find relevant information online

When we look more in detail at students' confidence using digital resources for their own learning and for completing school tasks, there are significant differences between certain activities and between countries/economies (Table V.B1.10.15). A focus on two fundamental tasks of digital literacy – searching for and finding relevant information online, and assessing the quality of the information found – provides remarkable insights. These tasks are key indicators of students' ability to navigate effectively and engage critically with digital content.

On average, 64% of students in OECD countries reported that they can easily search for and find relevant information online while 21% can do so with some effort. In contrast, 6% of students have difficulty, 6% are unable to do so and 3% are unfamiliar with the task (Figure V.10.2 and Table V.B1.10.15). Countries such as Denmark* and Singapore have the highest proportions of students who can easily find information online (at least 75%) whereas in Jordan and Morocco, at least one in five students reported that they are unable to do this (Figure V.10.2b [available online]). Education systems might focus on students who struggle most with digital tasks. They can be numerous in some countries and economies.

A more granular look at the relationship between students of different performance levels and their ability to find information online shows interesting disparity. Among low performers, 45% said they can easily find information online, 27% can do so with some effort but 14% are unable to, on average. In comparison, 76% of skilled performers find it easy, 17% can do it with some effort and only 3% are unable to. This emphasises the need for targeted support for low performers to bridge the digital divide (Figure V.10.2 and Table V.B1.10.18).

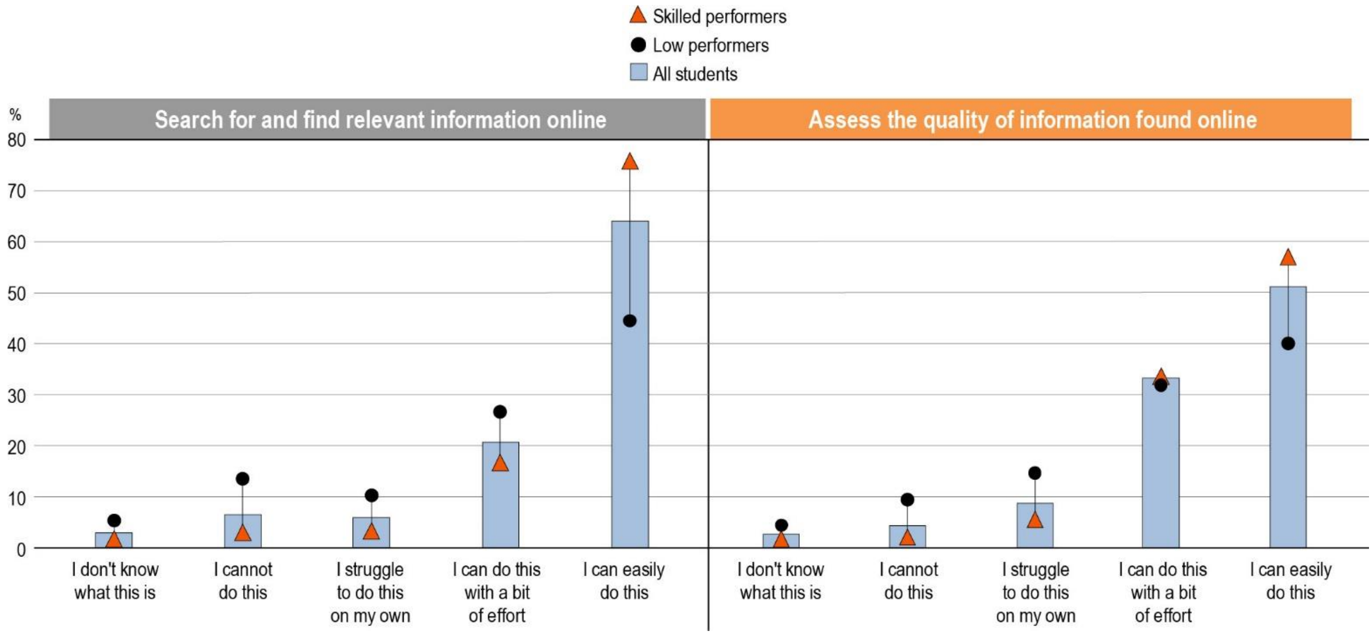
Only about half of students can judge the quality of online information

Being able to tell if information online is credible and of good quality is critical. Only 51% of students in OECD countries reported they can easily assess the quality of online information and 33% reported they can do so with some effort. Some 9% struggle and 4% are unable to judge the quality of online information at all (Figure V.10.2). In countries like Brunei Darussalam, Croatia, Estonia, Japan, Macao (China), and Slovenia, at least 40% of students reported being able to evaluate information quality with some effort (Figure V.10.2b [available online] and Table V.B1.10.15). Developing students' ability to identify reliable online information sources should be a priority for education systems.

Strikingly, most low performers (60%) cannot easily judge the quality of information found online while 57% of skilled performers are able to do so easily, on average across OECD countries (Figure V.10.2). Only in Costa Rica and the United States* did slightly over half of low performers report they can easily do so. A significant proportion of students, especially low performers, lack the necessary skills to navigate the vast amount of information available on the Internet (Table V.B1.10.19). Policy approaches can support students to develop these skills by adapting curricula. For example, the Learn to Discern: Media Literacy programme in Ukraine aims to improve students' ability to navigate digital spaces and has shown positive results (see Box V.10.2)

Figure V.10.2. Students' self-efficacy in digital competencies

Percentage of students reporting they are able to do the following tasks when using digital resources; OECD average



Source: OECD, PISA 2022 Database, Tables V.B1.10.15, V.B1.10.18 and V.B1.10.19. See Table V.10.1 for StatLink at the end of this chapter.

Confident students are more likely to evaluate the quality, credibility, and accuracy of online information

Further analyses show that students' confidence about their digital skills is positively related to their ability to evaluate the quality, credibility, and accuracy of online information, even after controlling for students' and schools' socio-economic profile, and students' mathematics performance (Table V.B1.10.28). This underlines the importance of developing students' digital literacy and confidence to combat disinformation. Being able to tell the difference between good and bad information is a crucial aspect of lifelong learning, especially among low performers who already struggle finding the information they need online. As generative AI capabilities grow, the ability to distinguish accurate information from misinformation and deliberate disinformation in the online sphere becomes increasingly important. The implications of this are important for both school-based and lifelong learning.

Box V.10.2. Ukraine: Learn to Discern in Education (L2D-Ed)

Learn to Discern, which was developed by IREX – an international organisation focusing on development and education – aims to improve media and information literacy by building the agency and skills of individuals who interact with information in the digital sphere. This approach has been adapted to various countries, including Serbia, North Macedonia, Jordan, Tunisia, Guatemala, Peru, Sri Lanka, and Indonesia.

First launched in Ukraine as a pilot project in 2015 in response to misinformation, the "Learn to Discern: Media Literacy" programme integrates critical information-consumption skills into existing secondary school curricula across five subjects for students in Grades 8 to 10. These include Ukrainian language and literature, Ukrainian and world history, and art. More than 300 lessons and 400 exercises have been developed as part of the programme.

Since its launch, the programme has evolved into various projects and reaches a wide audience, including secondary education institutions, higher education institutions, post-graduate teacher education institutions, as well as civil servants, internally displaced persons, and the general public. By early 2024, the programme had reached more than 20 000 educators, civil servants, journalists and community leaders, and more than 84 000 students, 3 612 teachers, 864 principals, and 1 558 schools.

Evaluations reveal that students showed better performance in skills such as distinguishing facts from opinion, detecting false stories and hate speech, and demonstrating deeper knowledge of the news media sector.

Source: (IREX, n.d.[6]; Ministry of Education and Science of Ukraine, n.d.[7]; Murrock et al., 2018[8])

Are strategies for sustained learning related to carefulness with online media information?

With the development of digital technology and the acceleration of AI-created content, students need to be able to question sources, authorship, reliability, and credibility of information. These skills go beyond identifying fake news and disinformation; they are essential for making the informed decisions that are the foundation of functioning societies and democracies (OECD, 2024[9]; OECD, 2021[2]).

Teachers, schools and education systems play a central role in teaching students how to navigate digital learning environments by providing effective tools for searching for information online. The motivations and strategies students draw on for sustained lifelong learning are the same that make for informed decision making in the digital world.

Evaluating online information aligns with intrinsic and instrumental motivations

PISA 2022 data show that the ability to critically evaluate online information[5] is positively related to students' motivation to learn, particularly intrinsic motivations driven by curiosity. Students who check the quality, credibility and accuracy of online information; compare different sources; or discuss the accuracy of online information are more likely to be those who enjoy solving problems creatively, and developing and testing hypotheses based on what they observe. In Malaysia, students who critically evaluate online information are almost twice as likely to be those who enjoy thinking up new ways to solve problems. When looking at developing and testing hypotheses, the relationship is the strongest in Denmark*, Estonia and Ireland*. Students who critically evaluate online information are also more likely to express a love of learning new things at school, especially for students in Denmark* and Ireland*. This holds after accounting for students' and schools' socio-economic profile, and students' mathematics performance. (Table V.B1.10.27).

Students who diligently check online information are also more likely to have instrumental or extrinsic motivations like wanting to do well in their mathematics class and thinking that school teaches things which could be useful in a job, after accounting for students' and schools' socio-economic profile, and performance in mathematics. These relationships are positive and significant across all countries and economies, and are the strongest for both instrumental motivations in Brunei Darussalam and Thailand (Table V.B1.10.27).

Critically evaluating online information not only fosters students' deeper engagement with learning, it aligns with both their intrinsic and instrumental motivations, strengthening them along with their curiosity for lifelong learning.

Cautious online learners are also likely to be meticulous critical thinkers and proactive learners

Students who check the quality, credibility and accuracy of online information are more likely to be meticulous students, critical thinkers and proactive learners who make connections between what they learn and what they know.

Meticulousness, particularly when checking homework, involves attention to detail. Students who verify the quality, credibility and accuracy of online information are more likely to be those who double-check their homework before handing it in. The relationship is positive and strong across all countries and economies after accounting for students' and schools' socio-economic profile, and students' mathematics performance. Interestingly, the relationship is the strongest in Ireland* and it is so regardless of performance in mathematics (Table V.B1.10.26).

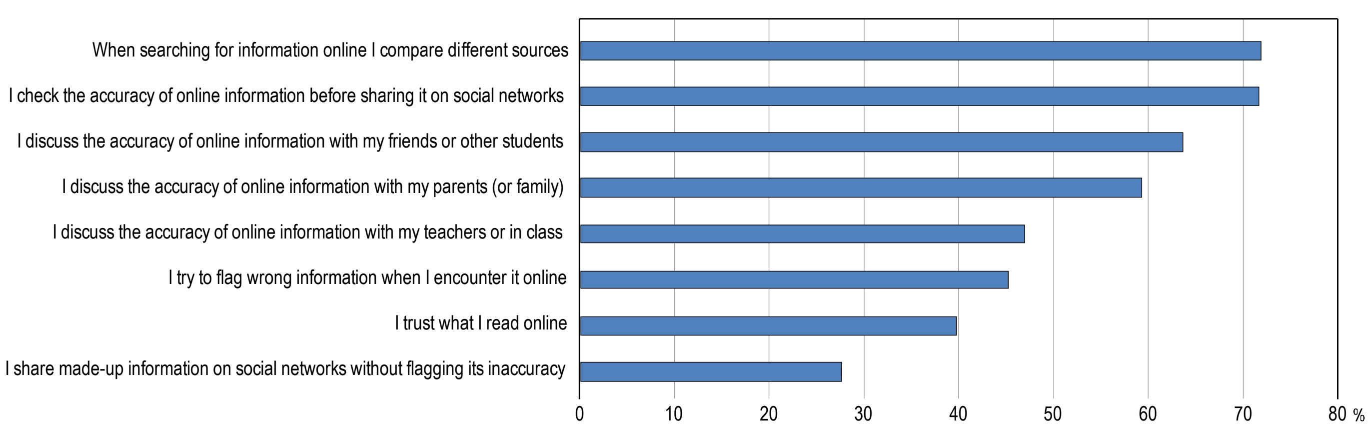
Clearly, critical thinking is essential for this type of digital literacy. Students who check the quality, credibility and accuracy of online information are more likely to look at things from different angles and consider everybody's perspective before taking a position. Both relationships are positive in all countries and economies after accounting for students' and schools' socio-economic profile, and students' mathematics performance. In Macao (China) the relationship is the strongest for both critical thinking (perspective-taking) strategies (Table V.B1.10.26).

Evaluating online information aligns with connecting new and prior learning

Another interesting finding is that students who check the quality, credibility and accuracy of online information are more likely to proactively relate new material to what they have previously learned. This practice of building on solid, acquired knowledge is a powerful tool for distinguishing valid information from falsehood. Again, the relationship is positive and strong across all countries and economies after accounting for students' and schools' socio-economic profile, and students' mathematics performance. In Ireland* we find the strongest relationship: students who critically evaluate online information are the most likely to be those who try to make connections between new and previously learned material (Table V.B1.10.26).

Figure V.10.3. Students' practices regarding online information

Percentage of students agreeing or strongly agreeing with the following statements; OECD average



Items are ranked in descending order of the percentage of students.
Source: OECD, PISA 2022 Database, Table V.B1.10.7. See Table V.10.1 for StatLink at the end of this chapter.

On average, 72% of students in OECD countries compare different sources when searching for information online. But, 28% share made-up information on social networks without flagging its inaccuracy (Figure V.10.3). If we look at students at different performance levels, 79% of skilled performers compare sources when searching for information while 60% of low performers do. Additionally, 41% of low performers share false information without flagging it whereas only 19% of skilled performers do (Tables V.B1.10.7 and V.B1.10.24). Careful online information habits are positively related to performance in mathematics (Table V.B1.10.9). Schools and teachers have a crucial role to play in helping students, especially those who are struggling, to develop the critical practices to evaluate online information, enabling them to distinguish credible sources from misinformation in an increasingly digital world.

Sustained lifelong learning abilities and dispositions like critical thinking, proactive learning habits, meticulousness, and intrinsic and instrumental motivations are also those that strengthen responsible behaviour around online information. Education systems that pay attention to these skills and attitudes will be contributing to lifelong learners who are properly informed and responsible online citizens.

Are 15-year-olds interested in learning more about digital resources?

Understanding students' digital literacy-related motivations can strengthen the way students use digital tools and promote responsible behaviour around online information and commitment to lifelong learning.

PISA asked students about their interest in learning more about digital resources and computer programming, and how useful they think digital skills are for future employment.

Most 15-year-olds want to learn more about digital resources but gender gaps persist

About 62% of students in OECD countries want to learn more about digital resources[6], 51% are interested in learning computer programming and 66% see digital resources as useful for job prospects, on average. But there are gender differences in these interests: in 29 out of 52 countries and economies with available data, more boys than girls reported interest in learning about digital resources. Conversely, in 15 countries (Albania, Argentina, Brazil, Brunei Darussalam, Bulgaria, the Dominican Republic, Georgia, Jordan, Kazakhstan, Malaysia, Morocco, Romania, Saudi Arabia, Thailand and Türkiye) more girls than boys expressed interest in these areas (Figure V.10.4 and Tables V.B1.10.10 and V.B1.10.11).

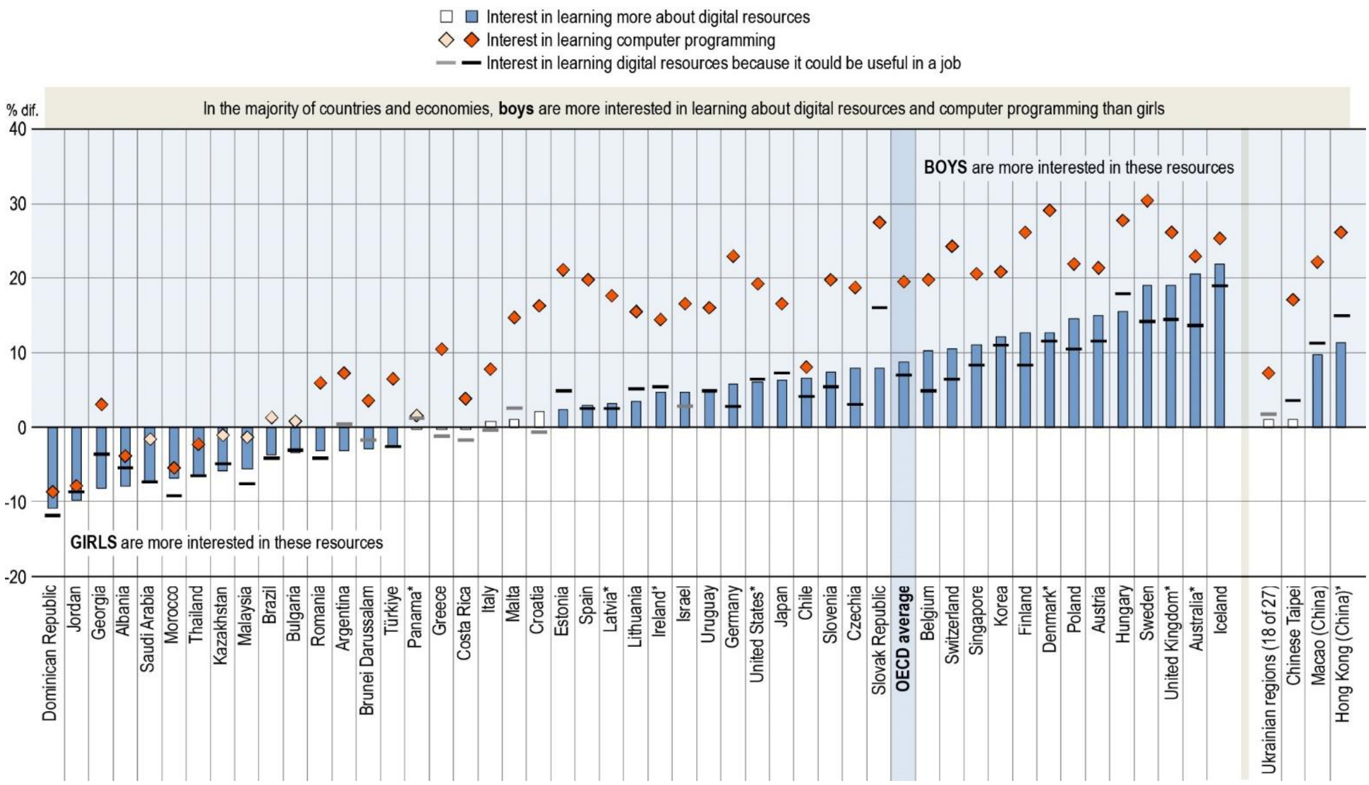
Boys consider digital resources to be useful for future jobs to a greater degree than girls in 29 countries and economies but the opposite is true in 13 countries (Albania, Brazil, Bulgaria, the Dominican Republic, Georgia, Jordan, Kazakhstan, Malaysia, Morocco, Romania, Saudi Arabia, Thailand and Türkiye). Interest in computer programming also reveals a gender gap, with boys expressing more interest in 41 countries and economies. However, in Albania, the Dominican Republic, Jordan, Morocco and Thailand, more girls than boys are interested in programming (Figure V.10.4 and Table V.B1.10.13).

Schools need to put more effort into breaking down gender stereotypes. The persistent gender gap in the digital sphere in several countries suggests that societal and cultural factors continue to influence students' perceptions of appropriate fields of study and, even, career paths. This limits opportunities for both boys and girls, and reinforces damaging ideas about gender roles and abilities (Wang and Degol, 2016[10]; Cheryan et al., 2017[11]).

Gender stereotypes that prevent students from developing digital skills pose significant challenges for lifelong learning, as well. Encouraging both boys and girls to engage with digital literacy and resources can help close the gap. This ensures that all students have equal opportunities to develop these essential skills for the future learning required to thrive in a digitally-driven world.

Figure V.10.4. Students' interest in computer programming and digital resource useful for a job, by gender

Percentage-point difference between boys and girls (boys - girls) agreeing or strongly agreeing with the following types of interest



Notes: Only countries and economies with available data are shown.
Percentage-point differences between boys and girls that are statistically significant are shown in a darker tone (Annex A3).
Countries and economies are ranked in ascending order of the gender gap of agreeing or strongly agreeing they are interested in learning more about digital resources.
Source: OECD, PISA 2022 Database, Tables V.B1.10.11, V.B1.10.12 and V.B1.10.13. See Table V.10.1 for StatLink at the end of this chapter.

There is room for boosting interest in ICT skills among low-performing students

An average of 67% of skilled performers in mathematics in OECD countries want to learn more about digital resources and 72% of them want to because they see the potential for a future job. A little more than half of skilled mathematics performers (53%) are interested in computer programming (Table V.B1.10.25).

Only just above half of low performers (54%) want to learn more about digital resources and 48% are interested in computer programming, on average. Slightly more see the interest of digital skills for a future job (57%) (Table V.B1.10.25). Schools and teachers can encourage students' interest in the digital sphere, especially low-performing students. One lever to consider is that students' interest in digital resources is positively related to their performance in mathematics, with strong differences between skilled and low performers (Table V.B1.10.14).

Finally, analyses suggest that students who are interested in learning about digital resources are more likely to be meticulous critical thinkers, creative problem-solvers and proactive learners who make connections between new and prior knowledge. They recognise the usefulness of these skills for future employment and, to a lesser extent, show interest in learning computer programming (Tables V.B1.10.34, V.B1.10.35 and V.B1.10.36).

Creative problem-solvers are likely to be interested in learning more about digital resources

Students interested in learning more about digital resources are also more likely to report that they enjoy thinking about new ways to solve problems and that classroom activities and tasks encourage them to do this. This positive relationship holds even after controlling for students' and schools' socio-economic profile, and students' performance in mathematics (Table V.B1.10.34).

How do students feel about digital resources in their schools and how teachers work with them?

PISA asked students about the availability, accessibility and quality of digital resources in their school. The results[7] show that students' perceptions of their school's digital resources are positively related to their habits of ensuring the accuracy of online information even after controlling for the socio-economic profiles of students and schools. This relationship holds true even with schools whose principals reported that instruction is hindered by a lack of digital resources or poor quality digital resources (Table V.B1.10.30).

How students perceive their school's digital resources can help with their online information practices

Good access to ICT resources at school not only enhances students' learning outcomes but equips them with essential skills for lifelong learning. Education systems that invest in their schools' digital infrastructure and equipment will be better positioned to support their students' future learning endeavours. Still, equipment is not everything: how teachers use digital resources in their classroom is as important.

PISA data show that students who believe that their teachers have the skills to use digital tools in the classroom and integrate these resources into their teaching are better at evaluating the quality, credibility and accuracy of online information. This is true even after accounting for students' and schools' socio-economic profile, and principals' reports of instructional hindrances due to the lack or poor quality of digital resources (Table V.B1.10.30).

Students' perceptions of their teachers' digital proficiency relate positively to their online information habits

Students who believe that the teachers in their school have the necessary skills to use digital devices in class are more likely to compare different sources when searching for information online. They are also more likely to check the accuracy of online information before sharing it on social networks (Table V.B1.10.31). This holds even after accounting for students' and schools' socio-economic profile, and students' performance in mathematics. Students believing their teachers have sufficient digital literacy seems to be important for their own digital literacy, and this is crucial for lifelong learning.

The good news is that most students reported that teachers at their school have good digital skills in the classroom (70%). They also said teachers at their school integrated digital resources into their teaching (77%). Even in Argentina, Germany, Greece, Israel, Italy, Morocco, and Poland, where the least number of students reported that their teachers were only digitally literate, at least half still think their teachers do have some level of competence. This suggests that teachers widely recognise the importance of digital skills, while highlighting areas where professional development and support are needed (Table V.B1.10.1).

PISA 2022 findings support the notion that teachers are essential in developing students' digital literacy and critical-thinking skills. And, schools must prioritise equipping teachers with the necessary skills and resources to effectively integrate digital technologies into their teaching practices. This not only enhances students' traditional learning outcomes but prepares them for the complexities of the digital age and the lifelong learning that will accompany them.

Table V.10.1. Chapter 10 figures: Students' readiness for learning in the digital age

Figure V.10.1	Frequency of use of digital resources: Writing or editing text for a school assignment and finding information on real-world problems
Figure V.10.2	Students' self-efficacy in digital competencies
Figure V.10.2b	Students' self-efficacy in digital competencies, by countries and economies
Figure V.10.3	Students' practices regarding online information
Figure V.10.3b	Students' practices regarding online information, by countries and economies
Figure V.10.4	Students' interest in computer programming and digital resources useful for a job, by gender

StatLink https://stat.link/3l0qw7

Notes

[1] The optional PISA 2022 questionnaire on information and communication technology (ICT) was administered to 54 out of the 81 participating countries and economies.

[2] Analyses in this chapter are based on the optional PISA 2022 information and communication technology (ICT) questionnaire, which asked students about the digital resources they use both inside and outside school. Digital resources refer specifically to digital devices or 'hardware' (e.g. computers, tablets, smartphones, 3D printers), software (e.g. programs, apps, communication tools, educational learning tools) and online resources (e.g. websites, web portals).

[3] The index of use of ICT in enquiry-based learning activities covers students' responses of how often they use digital resources for various school-related activities (e.g. "Create a multi-media presentation with pictures, sound or video", "Track the progress of your own work or projects"). Each of the 10 items included in this scale had five response options ("Never or almost never", "About once or twice a year", "About once or twice a month", "About once or twice a week", "Every day or almost every day").

[4] The PISA index of self-efficacy in digital competencies groups students' responses on how well they can do various tasks using digital resources (e.g. "Search for and find relevant information online", "Write or edit text for a school assignment"). Each of the 14 items included in this scale have four substantive response options ("I cannot do this", "I struggle to do this on my own", "I can do this with a bit of effort", "I can easily do this") and an additional response option "I don't know what this is", which was recoded as missing prior to scaling.

[5] As measured by the PISA index of students' practices regarding online information, which covers students' ratings of their agreement with various statements about their practices regarding online information (e.g. "When searching for information online I compare different sources", "I discuss the accuracy of online information with friends or other students"). Each of the six items included in this scale had four response options ("Strongly disagree", "Disagree", "Agree", "Strongly agree").

[6] As part of the ICT familiarity questionnaire, students were asked about digital resources they might use both inside and outside of school.

Digital resources in this context refer to the following:

- digital devices or 'hardware' (e.g. computers, tablets, smartphones, 3D printers)
- Software (e.g. programmes, apps, communication tools, educational learning tools); and
- online resources (e.g. websites, web portals)

[7] The index of quality of access to ICT covers students' agreement with various statements about ICT resources at their school (e.g. "There are enough digital devices with access to the Internet at my school", "The school's Internet speed is sufficient"). Each of the nine items included in this scale had four response options ("Strongly disagree", "Disagree", "Agree", "Strongly agree").

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11 From data to insights

Results from PISA offer a wealth of data points that can highlight aspects of education policy that merit further investigation and reflection. This chapter provides a summary and interpretation of the key messages highlighted throughout the volume, with a view to suggesting how policies and practices might be improved to support students' needs. It emphasises the need for students to acquire and develop the right set of strategies, motivation and self-belief to become positive lifelong learners and to be prepared for a challenging and uncertain future.

For Australia*, Canada*, Denmark*, Hong Kong (China)*, Ireland*, Jamaica*, Latvia*, the Netherlands*, New Zealand*, Panama*, the United Kingdom* and the United States*, caution is advised when interpreting estimates because one or more PISA sampling standards were not met (see Reader’s Guide, Annexes A2 and A4).

Introduction

How prepared are 15-year-olds for lifelong learning? This report analyses their use of learning strategies, motivation to learn and self-beliefs. Students' attitudes about learning and whether or not they use learning strategies are not only likely to be related to the support they receive at school but to other aspects of their background.

Learning strategies, motivation, and self-belief form a crucial triangle in the learning process, each playing a unique role in student success. Learning strategies encompass techniques for searching for, understanding and retaining information while motivation drives student effort and engagement. Students who have self-belief or confidence in their abilities accept challenges and persevere in spite of setbacks, making them resilient. Together, these three elements promote lifelong learning in students.

PISA data show that learning strategies, motivation, and self-belief correlate positively with performance in mathematics. Students with weak performance in mathematics (i.e. scoring below Level 2) are often doubly challenged. Not only are they lower academic achievers, but they are less motivated and less self-confident, and lack strategic learning skills. That said, students do not have to be top performers (at Level 5 or 6) to be positive lifelong learners. PISA 2022 data show that skilled performers (i.e. students whose scoring begins at Level 3) also show strong motivation to learn, confidence in their abilities, and use of a variety of learning strategies. What is important is to identify students' strengths and weaknesses early on and provide the kind of support that meets their individual learning needs. This creates multiple pathways to success.

Lifelong learning is not just about updating and upgrading one's skills and knowledge but about better overall well-being. Because continuous learning helps us become more cognitively flexible, adaptable and resilient we are, as a result, better primed for social engagement and personal achievement. We have greater self-esteem, life satisfaction, and personal growth (Hammond, 2004[1]; Schuller and Watson, 2009[2]). The relationship between lifelong learning and well-being is a reciprocal one, with the benefits of learning improving quality of life and a strong sense of well-being motivating individuals to continue learning.

This report offers valuable insights for lifelong learning on at least six different axes:

Not all students use learning strategies for sustained lifelong learning

This report analyses three student learning strategies that involve processing and encoding information, and active participation in one's own learning:

- students' active questioning when they do not understand something as well as their meticulous schoolwork, both of which indicate control of one's own work and learning processes;
- using critical-thinking (perspective-taking) skills to analyse issues from different perspectives and to consider different opinions;
- proactive learning behaviours such as connecting new information with previously acquired knowledge, carrying out tasks diligently, and managing workload efficiently.

Students rarely ask questions when they are unsure of something

Students who ask questions when they are not sure of something are involved in their learning process and readjust their learning when needed. PISA data show that less than half of students (47%) on average across OECD countries frequently ask questions when they do not understand something being taught in mathematics (i.e. over half of the time they have doubts).

Skilled performers do not ask questions enough either

An average of only 52% of skilled performers ask questions frequently when they are unsure of something being taught. In Macao (China), Poland and Chinese Taipei, only about 32% or less of skilled performers ask questions frequently. In contrast, over 70% of skilled performers in Albania, Iceland and Uzbekistan do (Figure V.2.1 and Table V.B1.2.7).

Low performers not only lack basic mathematics skills but lifelong learning strategies

Less than 40% of low performers (scoring below Level 2 in mathematics) frequently ask questions when they do not understand what is being taught, on average. This suggests that those who need the most support are the ones most reluctant to ask questions when they need to. This is especially so in Czechia, Hong Kong (China)*, Korea, Macao (China), Poland, Chinese Taipei and Thailand, where less than 30% of low performers reported frequently asking questions. Only in Albania, Colombia, Costa Rica, the Dominican Republic, Guatemala, Israel, Jamaica*, Paraguay and Uzbekistan do at least half of low performers frequently ask questions when unsure of the material (Table V.B1.2.7).

Two-thirds of all students are meticulous and double-check their work for mistakes

Double-checking for mistakes is a typical control or self-monitoring strategy used to evaluate how one is doing compared to the learning objectives one has set for oneself. PISA 2022 data show that 64% of students, on average, agreed or strongly agreed with the statement “I like to make sure there are no mistakes” (Table V.B1.2.1).

Skilled performers especially check for errors (71% on average) (Figure V.2.2 and Table V.B1.2.3). The share of skilled performers is at least 60% in all countries and economies except for Croatia and top-performing Estonia, Hong Kong (China)* and Macao (China). However, only about half of low performers double-check for errors, on average. Yet, there is wide variation across countries: slightly over one-third in Estonia and New Zealand* reported checking compared to over 80% in Indonesia, Korea and Mongolia (Table V.B1.2.3).

Open-mindedness is something that needs improving

Slightly over half (54%) of students did not challenge the notion there is only one correct position in a disagreement and only in 12 countries did at least half of students disagree with this statement. Instead, the most widespread perspective-taking strategies in most countries and economies are trying to consider everybody’s perspective before forming one’s own opinions and viewing issues from different angles, which over half of students say they do. Only in Iceland, Jordan, Kosovo and the Palestinian Authority did less than half of students report both these strategies.

Skilled performers often consider multiple perspectives (over 60% on average) and about half of low performers do the same. Yet, only 31% of low performers rejected the notion that there is only one correct position in a disagreement, on average, compared to 57% of skilled performers (Tables V.B1.2.11, V.B1.2.13 and V.B1.2.15).

Top performers readily integrate information from diverse sources, a flexible thinking strategy that should be strengthened in all students

Of the students who try to consider everyone's perspective before taking a position, about half surprisingly still believe there is only one correct position in a disagreement. As many as 67% of low performers hold these two contradictory positions but only 38% of skilled performers do, on average. When looking at top performers alone, only 27% consider everyone’s perspective while still believing there is only one correct position in a disagreement, suggesting that it is because of top performers that there is a relatively small percentage of skilled performers who hold these contradictory positions (Figure V.2.4, Figures V.2.4b and V.2.4c (available online), and Table V.B1.2.28)

It is unusual for students to connect to make their own connections between what they are learning and what they already know

Connecting what you are learning to what you already know is an essential proactive study habit. Yet, less than half of students (46%) in OECD countries try to relate new material to what they have learned in previous mathematics lessons more than half of the time on their own. The same share reported that they often start their work on mathematics assignments right away – another proactive study habit. In both cases, about half of skilled performers reported frequently connecting new and previous things learned, and starting mathematics assignments right away. Less than 40% of low performers did (Tables V.B1.2.22 and V.B1.2.24).

Low performers need extra help from teachers connecting new and prior learning

Teachers would do well to reinforce students' habit of making links between something they are learning to something they have already learned. Only 31% of students say their teachers encourage them to do this in mathematics, on average (Table V.B1.3.20). Roughly the same percentage of both low and skilled performers on average across OECD countries – slightly more than 30% – reported their teachers encourage them to connect new information to what they have already learned. When adding this to the already small percentage of low performers who proactively do this on their own, this suggests that teachers should focus on helping low performers internalise this strategy (Table V.B1.3.27).

Students' attitudes towards learning are positively related to their commitment to learn

A major part of students' commitment to learning, intrinsic motivations can boost students' uptake of learning strategies

Students who are positive about learning tend to employ effective learning strategies. Intrinsic motivations such as enjoying learning new things in school consistently relate to the uptake of learning strategies. For example, students who are intrinsically motivated are more likely to employ control and self-monitoring strategies as well as critical-thinking (perspective-taking) strategies like viewing things from different angles, demonstrating a robust association between them (Figure V.3.1).

At the country level, these relationships are largely positive, particularly for intrinsic motivations such as enjoying learning new things in school. It is also so for the more instrumental motivation of wanting to do well in mathematics class – this is strongly related to the study behaviour of asking questions when one does not understand something (Figures V.3.1b-V.3.1g [available online]).

There are similar relationships between intrinsic and instrumental motivations, and learning strategies that make up students' proactive mathematics study behaviours (e.g. connecting new and prior knowledge, actively participating in group discussions, and doing mathematics assignments right away). Yet, the main driver for proactivity is wanting to do well in mathematics class even though liking schoolwork that is challenging is a stronger driver in two OECD countries, Mexico and the Slovak Republic (Table V.B1.3.50).

These relationships remain broadly consistent even after controlling for students' and schools' socio-economic profile. This highlights the importance of fostering all students' motivation to learn, regardless of their socio-economic status or academic achievement.

Fostering social and emotional skills like persistence goes hand-in-hand with the development of learning strategies

PISA 2022 data highlight the relationship between social and emotional skills (SES) and learning strategies for sustained lifelong learning. Persistence is the SES with the strongest relationships (Figure V.3.6**)**. With a one-unit increase in the persistence index, students are almost twice as likely to be meticulous about their schoolwork. This relationship is particularly strong in Bulgaria and Hong Kong (China)*. Persistent students are also more proactive, particularly in linking new material to previous lessons. This is especially so in Australia*, where persistent students are almost twice as likely to engage in such practices (Table V.B1.3.56).

Curiosity and co-operation also coincide with learning strategy use

Students who are curious as well as those who manage their emotions well are more likely to proactively connect new material to prior knowledge. This deepens their understanding of what is being taught (Table V.B1.3.60). Likewise, co-operation is most strongly related to critical-thinking attitudes such as considering multiple perspectives before forming an opinion. This relationship is particularly strong in top-performing systems like Hong Kong (China)*, Korea, Singapore and Chinese Taipei, suggesting there is a strong cultural and educational emphasis on cooperative learning and considering multiple perspectives there (Table V.B1.3.57). These relationships remain broadly consistent even after controlling for students' and schools' socio-economic profile, and students' mathematics performance.

Growth mindset is strongly linked to using learning strategies

Self-belief in the form of a growth mindset in mathematics is strongly associated with higher persistence, greater confidence (self-efficacy) in mathematics, and proactive study behaviour in mathematics. These relationships are robust across countries and economies but, in many, are influenced by mathematics performance (Table V.B1.3.46). This suggests that success in mathematics helps sustain growth mindset and related behaviours.

Parents, teachers and schools should cultivate a growth mindset in students of all achievement levels. Students who are resilient and believe they can develop their abilities – and make the effort to do so – can maintain motivation and effective learning strategies no matter what kind of performers they are.

But, there are large margins for improvement in students' self-beliefs

Across the OECD, 58% of students reported having a growth mindset but this varies significantly by country. When looking at mathematics-specific growth mindset, only 35% of students reported they disagree that "Some people are just not good at mathematics, no matter how hard they study". In countries like Georgia, New Zealand*, Peru, Singapore, and Sweden, at least half of their students reported having a mathematics growth mindset while in Czechia, Japan, Poland, and Slovenia, fewer than 20% did (Table V.B1.3.43).

Even when they say they have a growth mindset in general, many students still hold on to negative mathematics-learning stereotypes (Figure V.3.3 and Table V.B1.3.44). Slightly over half of students with a general growth mindset reported a fixed mindset in mathematics. Argentina, Georgia, Peru, Singapore, and the United Arab Emirates show the smallest share of students with a contradictory combination of a general growth mindset and fixed mathematical mindset.

Confident students are also more intrinsically motivated

Students who are motivated to learn and enjoy challenging schoolwork are more likely to be confident they can succeed. Mathematics self-efficacy or confidence is positively associated with all forms of motivation even after considering socio-economic factors and performance (see Table V.B1.4.10). The largest association is found between mathematics self-efficacy and liking schoolwork that is challenging. Students who like challenging schoolwork are particularly likely to feel confident they can solve mathematics tasks.

Australia*, Canada*, Denmark*, Finland, Hong Kong (China)*, Ireland*, Macao (China), New Zealand*, Norway and the United Kingdom* show wider differences between their shares of confident and less confident students liking challenging schoolwork. Differences range between 40 and 48 percentage points compared to 30 percentage points on average across OECD countries. On the contrary, Albania, Brunei Darussalam, Colombia, Georgia, Serbia, the Slovak Republic, Slovenia and Uruguay show smaller differences between confident and less confident students, ranging between 11 and 20 percentage points (see Figures V.4.3 and V.4.3b [available online], and Table V.B1.4.8).

Confidence, however, is just one measure of self-belief. Student self-beliefs also include anxiety about failing in mathematics.

Students feel more anxious about mathematics in 2022 than they did 10 years ago, impacting their readiness for lifelong learning

Fifteen-year-olds in most countries and economies are more anxious about mathematics than they were in 2012, the last time this was measured (Figure V.4.4). Students are anxious not only about their grades and failing in mathematics but about dealing with mathematical tasks in general (see Table V.B1.4.12).

Since 2003, PISA has shown a negative association between mathematics anxiety and mathematics performance in every education system that has participated in PISA. A one-point increase in the index of mathematics anxiety on average across OECD countries is associated with a decrease in mathematics achievement of 18 score points after accounting for students' and schools' socio-economic profile (see Table V.B1.4.14).

Systems can work against this trend. While anxiety levels rose sharply, especially in most European and Latin American countries, it fell significantly from 2012 levels in Korea.

Students need different kinds of support to develop the right set of strategies and attitudes for sustained lifelong learning

Girls and boys perceive and engage with learning strategies differently – sometimes very differently

Girls consistently exhibit higher control and self-monitoring strategies, particularly in checking for mistakes and reviewing homework before submission. Among skilled performers, girls outstrip boys by 8 percentage points in checking for mistakes and 14 percentage points in checking homework, on average across OECD countries. Among low performers, these differences are 7 and 10 percentage points, respectively (Table V.B1.3.48).

Gender differences persist in critical thinking (perspective-taking) as well. Girls generally reported assimilating multiple viewpoints before taking a position more than boys. Among skilled performers, girls outstripped boys by 8 percentage points in terms of considering everyone's perspective and 5 percentage points in being able to see things from different angles, on average across OECD countries. For low performers, these gaps increase to 11 and 9 percentage points, respectively. Additionally, girls are more likely to disagree with the notion that there is only one correct position in a disagreement, with gaps favouring girls by an average of 14 percentage points among skilled performers and 7 percentage points among low performers (Table V.B1.3.49).

Girls and boys perceive their capacity to work hard to improve in mathematics differently, suggesting mathematics gender stereotypes

Unlike a general growth mindset, gender differences in mathematics growth mindset are more pronounced across most countries and economies. Boys are more likely to report a growth mindset in mathematics than girls by an average of 7 percentage points. This gap can be as sizeable as over 15 percentage points in Jordan and the Palestinian Authority (Table V.B1.3.42).

Similar results can be seen in mathematics anxiety. In most countries and economies, 15-year-old girls reported significantly higher levels of mathematics anxiety than boys. While this partly reflects differences in mathematics performance related to gender, the gender gap in anxiety persists even among top-performing students, suggesting that girls feel more anxious than boys even when they perform at similarly high levels (Table V.B1.4.16). This suggests that focusing solely on performance cannot reduce students' anxiety. Neither is it an effective way to tackle gender gaps. Instead, schools would do well to help girls perceive learning outcomes like performance in mathematics *not* as something inherently difficult or beyond their capabilities. This is key to both lifelong learning and equity in learning in general.

Socio-economically advantaged students use learning strategies for sustained lifelong learning more than their disadvantaged peers

Socio-economically advantaged students consistently check for mistakes, review homework, ask questions, show proactive study behaviours and use critical thinking more than their socio-economically disadvantaged peers.

For example, while an average of 52% of advantaged students in the OECD often ask questions when they do not understand the material, only 40% of disadvantaged students do. This difference is particularly large in Denmark*, Iceland, Korea, Lithuania, Saudi Arabia, and the United States* (at least 20 percentage points) while it is around 7 percentage points in Kazakhstan (Table V.B1.2.6).

Similarly, advantaged students exhibit higher proactive mathematics study behaviour in several areas. About half of advantaged students in the OECD try to connect new material to what they have previously learned (52%) while only 39% of disadvantaged students do. This difference is most significant in Australia*, Greece, Korea, Malta, Poland and the Ukrainian regions (18 of 27) (at least 20 percentage points), and smallest in Argentina and Mexico (slightly less than 6 percentage points) (Table V.B1.2.21).

Students suffering from food insecurity are less likely to employ certain self-regulated learning strategies and, generally, are more passive learners

Students suffering from food insecurity are somewhat less likely to carefully check their homework, on average across the OECD, even after considering students' and schools' socio-economic profile, and students' mathematics performance. In general, these students also show lower levels of proactive study behaviour (Figure V.7.4). Economic deprivation seems to distract students from schoolwork as they are less likely to have the time or energy for proactive and self-regulated learning, suggesting they are more passive learners.

PISA data suggest that long-term absenteeism for economic reasons could be particularly related to less control of one's own learning

Students who miss school for an extended period for economic reasons not only have lower learning outcomes but use sustained learning strategies less. For example, they are less likely to make sure there are no mistakes in their work or check their homework before turning it in (31% and 27% less likely, respectively, among OECD countries after accounting for socio-economic background and mathematics performance). The widening of the gap between students who have missed a great deal of school for economic reasons and those who have not can be attributed to differences in students' controlling their own learning (Figure V.7.8).

Yet, economically deprived students have positive attitudes towards learning, and are motivated to learn and interested in learning

While economic deprivation in the form of food insecurity is related to negative self-beliefs about learning, students holding part-time jobs, on the other hand, tend to feel more positive about learning, especially in mathematics class.

Students with part-time jobs often feel more motivated to learn than students without (Figure V.7.6). Likewise, students who experience food insecurity are just as curious and open-minded about the world as their peers who do not have food insecurity when accounting for both socio-economic profile and mathematical performance on average across OECD countries (Tables V.B1.7.7 and V.B1.7.8).

Enabling economically disadvantaged students to combine their studies with work or re-entry points into schooling can prevent them from dropping out of formal education.

Students' confidence learning outside the classroom tells us about their readiness for lifelong learning

PISA 2022 asked students how confident they would be learning on their own if schools ever had to close as they did during the COVID-19 pandemic. Data show that students with confidence in their self-directed learning capacities are often the same as those who use learning strategies for sustained lifelong learning.

Students who are most confident in their self-directed learning skills are the most meticulous and often ask questions in class when they are not sure of something

PISA data show that students who are confident about their self-directed learning frequently ask questions in class when they do not understand what is being taught – significantly more than their less confident peers (22 percentage-point gap, on average) (Figure V.9.2). This gap is significant and large in all countries and economies, ranging from 12 percentage points in Poland to 35 in Viet Nam. Similarly, more confident, self-directed students check their work for mistakes (20 percentage-point difference) and check their homework before handing it in (24 percentage points), on average as well as across countries. The gap between confident and less confident students in these two types of meticulousness are the largest in New Zealand*, at 39 and 37 percentage points, respectively (Tables V.B1.9.12, V.B1.9.13 and V.B1.9.17). The relationships between these self-monitoring strategies and confidence in self-directed learning are positive and hold after accounting for students' and schools' socio-economic profile, and students' performance in mathematics across countries (Table V.B1.9.10).

Findings in this report show the interconnectedness of self-directed learning, meticulousness and self-monitoring, highlighting the need for learning environments that foster student autonomy and positive mindsets (Figure V.9.2 and Figures V.9.1f and V.9.1g [available online]).

Intrinsic motivations are strongly linked to students' confidence in self-directed learning

The relationship between students' confidence in self-directed learning and intrinsic motivations like enjoying challenging schoolwork and learning new things in school is positive and strong on average and across countries and economies. These relationships hold after accounting for students' and schools' socio-economic profile, and students' performance in mathematics (Table V.B1.9.2).

Students with greater self-directed learning confidence also have greater instrumental motivation. Confident, self-directed learners who believe school teaches them things that can be useful in a job show a 17 percentage-point gap, on average, when compared to their less confident peers. The gap stretches to over 25 percentage points in Albania, Croatia and the United Kingdom* (Figures V.9.4d and V.9.4e [available online]). Still, believing that what one learns in school can be useful for jobs has a comparatively weaker relationship with confidence than intrinsic motivations. While instrumental motivations are important, they are secondary to intrinsic motivations in driving students' confidence in self-directed learning, on average across the OECD countries (Figures V.9.4c and V.9.4d [available online]).

Young people need help learning how to judge online information quality

Accessing and assessing information are key skills for lifelong learning in the digital age. Students must be comfortable finding information online and able to judge its reliability. PISA 2022 data show that while 73% of students have no trouble finding learning resources online by themselves (Figure V.9.1c [available online] and Table V.B1.9.2), what they do find more difficult is judging the quality of this information. Only 51% of students in OECD countries can easily evaluate the quality of online information and 33% reported they can do so with some effort. Some 9% struggle and 4% are unable to judge the quality of online information at all (Figure V.10.2). In countries like Brunei Darussalam, Croatia, Estonia, Japan, Macao (China), and Slovenia, at least 40% of students can evaluate information quality with some effort (Figure V.10.2b [available online] and Table V.B1.10.15). Developing students' ability to identify reliable online information sources should be a priority for education systems.

Strikingly, most low performers (60%) cannot easily judge the quality of information found online while 57% of skilled performers are able to do so easily, on average across OECD countries (Figure V.10.2). Only in Costa Rica and the United States* can slightly over half of low performers easily do so. This tells us that a significant proportion of students, especially low performers, are unable to navigate the vast amount of information available on the Internet (Table V.B1.10.19).

Reinforcing students' meticulousness could help them better judge online information quality

The relationship between readily judging online information quality and checking homework before handing it in is positive and strong across all countries and economies after accounting for students' and schools' socio-economic profile, and students' mathematics performance. The strongest relationship is in Ireland* (Table V.B1.10.26).

Students who can gauge the quality of online information tend to be critical thinkers

Students who check the quality, credibility and accuracy of online information are more likely to look at things from different angles and consider everybody's perspective before taking a position. Both relationships are positive in all countries and economies after accounting for students' and schools' socio-economic profile, and students' mathematics performance. In Macao (China) the relationship is the strongest for both critical-thinking (perspective-taking) strategies (Table V.B1.10.26).

Proactive learners who make connections between what they learn and what they know are also those who ably assess the quality of online information

The practice of building on solid, acquired knowledge is a powerful tool for distinguishing valid information from falsehood. This relationship is positive and strong across all countries and economies after accounting for students' and schools' socio-economic profile, and students' mathematics performance. In Ireland* we find the strongest relationship: students who critically evaluate online information are the most likely to be those who try to make connections between new and previously learned material (Table V.B1.10.26).

Students' perceptions of their teachers' digital proficiency relate positively to their online information habits

Students' perception that their teachers are sufficiently digitally literate seems to relate positively to their own digital literacy, which is important for lifelong learning. Students who believe their teachers have the necessary skills to use digital devices in class are more likely to compare different sources when searching for information online. They are also more likely to check the accuracy of online information before sharing it on social networks. This holds even after accounting for students' and schools' socio-economic profile, and students' performance in mathematics (Table V.B1.10.31).

How are students being empowered for future learning and educational or professional pathways?

PISA 2022 asked students about their confidence completing a range of 21st-century mathematical tasks. These tasks include their ability to interpret and analyse mathematical data, apply real-world problem-solving, use statistical reasoning and engage in mathematical modelling, among other key skills. These skills are crucial for thriving in the data-driven, technology-rich environments and workplaces of the 21st century.

Just over a third of students in the OECD have been introduced to tasks that involve extracting mathematical information

Students reported the highest exposure to tasks that involve extracting mathematical information, with just over a third of students across the OECD (35%). In some education systems such as in Canada*, Denmark*, Kazakhstan, the Netherlands*, Singapore and the United Kingdom*, about half of students reported frequent exposure to this task. Conversely, in Czechia and Slovenia, less than one in five students did (Figure V.8.7 and Table V.B1.8.1).

Fewer than a third of students frequently represent situations mathematically

Representing situations mathematically, reported by just under a third of students (31%), is crucial for translating real-world problems into a mathematical framework. This is an important step in effective analysis, solution, and communication of complex situations. In Canada*, Singapore and the United States*, about half of students reported teachers had introduced them to this technique. In Estonia, Finland, Iceland and Poland, however, less than one in five students reported exposure (Figure V.8.7 and Table V.B1.8.1).

Only one in five students frequently interpret mathematical solutions in real-life contexts in class

On average, only about 20% of students reported being frequently asked to interpret mathematical solutions in the context of a real-life challenge. This percentage is notably low in Czechia, Hong Kong (China)*, Korea, Macao (China) and Poland, where only about 11% of students have encountered this task. In contrast, over 40% of students in Uzbekistan have (Table V.B1.8.1).

Other 21st-century mathematics tasks have been presented to about one in five students or less. Notably, coding/programming computers is the least widespread task, with less than 10% of students, on average, indicating frequent exposure. This falls to around 6% or less in countries such as Australia*, Estonia, Germany, Hong Kong (China)*, Ireland*, the Netherlands*, Portugal, Singapore and Chinese Taipei (Figure V.8.7 and Table V.B1.8.1).

Exposure to 21st-century mathematics tasks is important for student confidence but there are other aspects at play too

PISA 2022 data suggest that student confidence and how frequently they encounter 21st-century mathematics tasks are positively related. But, frequent exposure to tasks does not guarantee confidence, at least not in every education system. PISA data reveal a statistically significant but moderate correlation between the frequency of exposure to 21st-century mathematics tasks and students' confidence completing them. This suggests that exposure alone does not substantially boost confidence and that other aspects are at play.

The way teachers present these tasks in the classroom, for instance, may also help improve students' confidence.

Confidence in 21st-century mathematics is related to teaching practices like cognitive activation

Cognitive activation practices such as teachers encouraging students to think about how to solve mathematics problems in different ways and asking students to explain their reasoning when solving a mathematics problem are positively and strongly related to confidence in 21st-century mathematics skills (Figure V.8.3).

Explaining the chain of reasoning involved in solving a mathematics problem is driven by students’ performance in mathematics in some countries but remains positive for all participants in PISA 2022. This is something that over half of confident learners reported being exposed to (54%) compared to only 38% of learners who are not confident, across OECD countries. The gap between the two groups is the largest in Albania and the Dominican Republic, where it is at least 30 percentage points, and the smallest in Hungary, Japan, the Netherlands* and the Slovak Republic, where it is about 10 percentage points or less (Table V.B1.8.10).

Learning strategies for sustained lifelong learning are positively related to confidence in 21st-century mathematics

Critical-thinking (perspective-taking) strategies, including considering others' perspectives and seeing issues from different angles, are positively related to confidence in 21st-century mathematics skills. Confident learners consider others' perspectives before taking a position to a greater extent than their less confident peers, with an average difference of 10 percentage points across OECD countries, rising to 23 in Albania, Saudi Arabia and the United Arab Emirates. Only in Chile and Latvia* is the difference between the two groups not significant (Table V.B1.8.10).

Students with strong social and emotional skills are more mathematically confident

Persistent, stress-resistant and curious students are, on average, the most confident in their 21st-century mathematics skills. The relationship holds for all three SES after accounting for performance in mathematics, which positively influences the relationship (Figure V.8.4).

Confident mathematics students enjoy challenging schoolwork

Liking challenging schoolwork stands out as the type of motivation with the strongest link to confidence in 21st-century tasks. While more instrumental motivations such as wanting to do well in mathematics class also show a strong relationship, they are, unsurprisingly, strongly driven by performance in mathematics. Similarly, seeing school as a place that teaches useful skills for future jobs is positively related to confidence in 21st-century tasks, but to a lesser degree (Figure V.8.6).

At the country level, enjoying challenging schoolwork is strongly related to confidence in Hong Kong (China)* while the relationship is the weakest, albeit positive, in Italy and Spain, after accounting for students' and schools' socio-economic profile, and students' performance in mathematics. Viewing school as a place that teaches useful skills for future jobs, while positive and significant, is the least relevant of these four motivations in most countries after accounting for students' and schools' socio-economic profile, and students' performance in mathematics. While in the Dominican Republic we find the strongest relationship, it is not significant in Colombia and Indonesia. (Figure V.8.6).

Students who know what job they would like to have in the future are more likely to be both intrinsically and instrumentally motivated

Students who have a strong idea about careers are especially more likely to enjoy schoolwork that is challenging and to learn new things. These motivations can encourage students to think about the future and how they can apply what they have learned to new challenging situations. In Malaysia, Malta, North Macedonia and the Philippines, the likelihood of students having a clear idea about future jobs when reporting loving learning new things is higher than in other countries (see Table V.B1.6.14).

Students who know what job they want are also more likely to want to do well in class and think that school has taught them things that could be useful for a job. These associations are found even when accounting for students' and schools' socio-economic profile, and students' mathematics performance. Students who see the link between school and the world of work, and between their grades and consequences for their future can probably better project themselves into the future and are more likely to ask themselves what job they would like to do when they are older. In the Dominican Republic, Malaysia and the Ukrainian regions (18 of 27), the likelihood of students having a clear idea about future jobs when reporting that school has taught them things that could be useful for a job is higher than in other countries and economies.

Students in vocational education probably better understand how their education relates to future jobs

Vocational programmes prepare students for the labour market and train them for a specific occupation. Not surprisingly, more vocational students than general students agreed that school has taught them things that could be useful in a job. This is especially true in Austria, the Dominican Republic, El Salvador, Korea, Poland and Chinese Taipei, where the difference between vocational and general students who think that school has taught them things that could be useful in a job is more than 10 percentage points (see Figure V.6.1). This suggests that students in vocational education have more opportunities to see the relationship between their education and future jobs, and to be duly motivated. This can be fundamental later in life, both for finding a job that they enjoy and re-entering education or upskilling.

On the other hand, a larger share of general students than vocational students are motivated to do well in mathematics class. This difference is more pronounced in Greece, Hungary, Lithuania and Thailand, where it is more than 15 percentage points (see Figure V.6.1). Students enrolled in general education might be more motivated in mathematics than vocational students, but their focus may be more on grades rather than learning as they are generally more oriented towards entering tertiary education with the requisite grades for acceptance.

Being able to search for information about future jobs and study is an important life skill for young people, especially in a rapidly changing world

Interestingly, students in OECD countries who do research about their futures scored 3 points below those who do not in mathematics. In 48 countries and economies that participated in PISA, seeking information about one's future is negatively related to mathematics performance even when accounting for students' and schools' socio-economic profile. In Greece, Israel, the Philippines, and Switzerland, students who research future opportunities performed more poorly than those who do not by a score-point difference of between 9 and 13 points. Only in Denmark*, Korea and Chinese Taipei is the relationship positive, though small (see Table V.B1.6.3). This suggests that students' academic performance is not always a good indicator of how future-oriented and prepared for lifelong learning they are.

How can parents and teachers work together to support students?

PISA 2022 data show a positive relationship between parental support and students' motivation to learn and use learning strategies for sustained lifelong learning. Students whose parents take an interest in what they learn at school enjoy learning new things more than those whose parents are less involved. Similarly, students who are supported by their teachers show greater motivation to learn.

Students who interact often with their parents are more proactive in mathematics learning

Students whose parents interact regularly with them have higher levels of proactive learning attitudes towards mathematics than those whose parents interact less (Figures V.5.2 and V.5.2b [available online]). This is true even after accounting for students' and schools' socio-economic profile. Learning-focused conversations (e.g. about what students are learning, what problems they may be facing, their relationships with other students) show the strongest associations with students' proactive mathematics behaviours and is positive across all countries and economies – Albania, Cambodia, Paraguay, the Philippines and the United Arab Emirates show the strongest relationships (Table V.B1.5.3).

Future-oriented conversations between parents and children (e.g. about future education) are more weakly associated with students' proactive mathematics learning behaviours but the relationships are still positive. These results suggest that students whose parents simply show interest in their learning are more actively engaged in their own learning. And, students who have ordinary everyday interactions with their parents (e.g. eating meals together) are more likely to be proactive in learning mathematics than those who do not. These relationships hold true even after accounting for students' and schools' socio-economic profile (Tables V.B1.5.2 and V.B1.5.3).

Students who regularly interact with their parents are more meticulous about their schoolwork and report more critical thinking

Students whose parents frequently interact with them are also more meticulous about their learning (e.g. more careful about their schoolwork and careful not to make mistakes). An average of at least 45% of students in OECD countries who interact with their parents often carefully check their homework before turning it in. This is 9 to 14 percentage points higher than students with fewer parental interactions (Figures V.5.3 and V.5.3b [available online], Tables V.B1.5.7, V.B1.5.9, V.B1.5.10 and V.B1.5.12).

Parental interactions are also positively associated with students' critical thinking (perspective-taking). Approximately 60% of students whose parents generally interact with them often try to consider everybody's perspective before taking a position and can view almost all things from different angles, compared to around 50% of students with less frequent parental interactions, on average across OECD countries (see Figure V.5.4). In most countries and economies, students who have more frequent daily routine interactions with their parents reported critical-thinking strategies more, even after accounting for students' and schools' socio-economic profile. A similar relationship can be seen among those who have more frequent learning-oriented and future-oriented conversations with their parents albeit weaker compared to daily routine interactions. This suggests that frequent communication with parents – particularly around daily routines could help create an environment that supports students' consideration of other opinions and perspectives (Tables V.B1.5.22, V.B1.5.24, V.B1.5.25 and V.B1.5.27).

Parents interacting with their children especially encourages low performers to use learning strategies

Among low performers, there is a large and significant gap in the use of learning strategies between students who interact more often with their parents and those who do so less in most countries and economies. For all forms of parental interaction (daily routine; learning-oriented conversations about school; and future-oriented conversations about education), low performers show a greater use of learning strategies when they interact more often with their parents. However, this gap is mostly non-significant among skilled performers in most countries and economies. This suggests that students who are at the lower end of the performance scale, may benefit the most from parental interactions.

Teacher support is key to lifelong learning skills: Supported students are more proactive in learning mathematics

Education systems can do a great deal to help teachers cultivate lifelong learning skills in their students. PISA 2022 data show a strong and positive relationship between support from teachers and 15-year-old students' proactiveness in learning mathematics (Figures V.5.7, V.5.7b [available online] and V.5.8). Students with more teacher support pay more attention and put more effort into their assignments for mathematics class (around 78% and 67%, respectively; among students who receive teacher support less often, this is 68% and 53%, respectively, on average across OECD countries). Students who have less teacher support say they give up when they do not understand the learning material and lose interest during mathematics lessons (around 26% and 40%, respectively; among students who receive teacher support more often, this is 18% and 25%, respectively, on average across OECD countries) (Tables V.B1.5.67, V.B1.5.69, V.B1.5.71 and V.B1.5.79).

Teacher-supported students use critical-thinking skills and take control of their learning

Teacher support also relates positively to students' critical thinking and control of their own learning even after accounting for students' and schools' socio-economic profile. Approximately 60% of students who have more support of any kind from their teachers try to consider everybody's perspective before taking a position and can view almost all things from different angles, on average across OECD countries. Interestingly, students who try to consider everybody's perspective reported, on average, more teacher support than students who agreed or strongly agreed that they can view almost all things from different angles. And, around 47% of students who reported more teacher support carefully check their homework before turning it in compared to less than 40% of students with less teacher support, on average across OECD countries (Tables V.B1.5.64, V.B1.5.66, V.B1.5.84, V.B1.5.86, V.B1.5.87 and V.B1.5.89).

Teacher support is also related to students' love of learning and motivation

Students with supportive teachers are more motivated. More specifically, teacher support is associated with students' love of learning at school. Across all types of teacher support, around 55% of students with more support like to learn new things in school compared to 43% of students with less support, on average across OECD countries (Table V.B1.5.96).

Students who have supportive teachers also want to do well in mathematics class more than students with less frequent support, even after accounting for students' and schools' socio-economic profile. This is true across most countries and economies. The difference in the percentage of students who want to do well in mathematics class is more than 10 percentage points across all forms of teacher support in Finland, Hong Kong (China)* and Kazakhstan. And an average of more than 90% of students in OECD countries who have very supportive teachers want to do well in mathematics class (Tables V.B1.5.101 and V.B1.5.103).

Positive teacher-student relationships can encourage students to use learning strategies and believe in themselves

Students who have good relationships with their teachers reported using all learning strategies more than those who do not and they are also more motivated (Tables V.B1.4.25 and V.B1.4.26). Good teacher-student relationships are also associated with less mathematics anxiety in all countries and economies (Table V.B1.4.29). Conversely, the more students feel intimidated by teachers at school the greater their anxiety about mathematics (Figure V.4.7).

Box V.11.1. How can teachers adapt to students' different needs, and teachers and parents collaborate to make positive learning environments for students?

For a whole host of reasons, students feel differently about learning and have different approaches to learning strategies. Socio-economically advantaged and disadvantaged students, and boys and girls, for example, differ in their beliefs about whether they can improve their skills and knowledge through effort and persistence. This is especially true of mathematics, which in some contexts, seems influenced by stereotypes about who is or can be a good learner of mathematics.

Teachers and parents have a role to play in building students' unique strengths and opening up multiple pathways to success. Creating a holistic support system for young people's individuated and continuous growth is important. But, teachers also need time resources to put in place the right approach for each student's learning. What follows are three ways teachers and parents can work together and schools can better respond to students' varying needs. Homework brings parents, teachers and students together, and so does promoting young people's social and emotional skills in the classroom and the home. And lastly, adjusting depth and breadth in the curriculum can adapt teaching to students' different needs.

Interacting through homework

Homework is a broad concept that encompasses different educational practices in different education systems. The complex relationship between homework and academic performance has been extensively explored in the literature, highlighting its positive and negative aspects (Cooper, Robinson and Patall, 2006[3]; Trautwein, 2003[4]). This report focuses on homework not just as a means of improving students' performance but a way to enhance their willingness to learn and refine their learning strategies and self-directed learning skills. As a way for students, teachers and parents to interact, homework helps develop independent lifelong learners.

While teachers are an integral part of the homework process, parents and tutors are also crucial. Studies suggest that when parents provide guidance in the homework process – not necessarily through direct intervention – it may help students develop better self-directedness (Núñez et al., 2015[5]). But, not all parents are equally equipped to support their children. Socio-economically disadvantaged parents, non-native speakers, and those with lower educational backgrounds often have difficulties providing academic support (Hill et al., 2004[6]). Socio-economic inequalities also limit access to books, the Internet and a quiet place to study, which students need to work well (OECD, 2013[7]). For these reasons, it is important to emphasise that parental support does not necessarily mean parents have to sit down with their children and help them with homework. Other types of support and guidance are positive and improve students' learning outcomes too. Simply eating dinner together, spending time just talking and parents asking what their children have done at school that day all relate positively to performance in mathematics (OECD, 2023[8]).

Still, there are ways to help disadvantaged parents better support their children directly. Workshops can improve parents' understanding of the curriculum and what their children should be learning. Research suggests that workshops positively influence parental involvement and improve student learning outcomes, starting as early as the preschool years (Starkey and Klein, 2000[9]; Chrispeels and González, 2004[10]).

Other ways to make up for inequalities in parental support are free tutoring and mentoring programmes at school. These provide individual academic support and personalised guidance tailored to students' needs (Kraft and Falken, 2021[11]).

As for the homework itself, here are three ways to make it most effective:

- **Make it relevant**: Students become more interested when they perceive homework as meaningful and connected to their personal challenges, interests and goals (Xu, 2009[12]). Homework that encourages students to be autonomous by allowing them to choose from a variety of tasks or determine the order in which they complete them will boost students' motivation and independence (Patall, Cooper and Wynn, 2010[13]). So does detailed feedback, which helps students reflect on their learning and make adjustments.
- **Extend concepts outside of the classroom**: Homework that requires students to apply classroom concepts to new situations and encourages students to use metacognitive strategies can enable students to take control over their educational journey. It can also help them to develop confidence in their self-directed learning skills (Zimmerman and Kitsantas, 2005[14]) and better manage their time, set goals proactively, and develop independent critical thinking and problem-solving skills.
- **Keep homework regular and short**: Research has found that the overall amount of homework may be positively associated with performance but the time each person spends on homework has diminishing returns (Fernández-Alonso et al., 2017[15]). Assigning excessive homework can overwhelm students, particularly those with greater learning difficulties or from less privileged backgrounds. Regularly assigning short homework assignments provides reasonable benefits without exacerbating inequalities (Fernández-Alonso et al., 2017[15]).

Homework design is a crucial part of the educational process. Teachers should consider not only the purpose and format of homework but students' skills, abilities, needs and the characteristics of their households (Epstein and Van Voorhis, 2001[16]). By taking these factors into account, teachers can create homework that is meaningful and supportive, and allow parents to get involved. To do this, teachers need time and resources to combine curricular elements and individual learning needs. Homework is not just a supplement to teaching or a remedial element but another component of the whole learning process.

Fostering social and emotional skills

The use of learning strategies, motivation to learn, and confidence in self-directed learning constitute the lifelong learning triangle at the centre of this report. But, it is very much bolstered by one other element: students' social and emotional skills (SES).

Effective school-based SES learning programmes can be most effective when there is a strong partnership between educators and families (Weiss et al., 2009[17]) (Zins et al., 2007[18]). While teachers provide structured opportunities for students to develop social and emotional skills in the classroom, parents reinforce these skills at home by providing consistency and a supportive environment, and engaging in practices that promote emotional intelligence.

When teachers and parents work together, students experience a cohesive and supportive learning environment, which significantly enhances their social and emotional development (Weiss et al., 2009[17]). Children get consistent messages about the importance of social and emotional skills at school and at home. It can help students apply SES to different contexts while keeping routines (Jones, Bouffard and Weissbourd, 2013[19]), leading to more effective learning and personal growth, and better learning outcomes (OECD, 2023[8]).

It is important to consider, as well, the role of teachers' own social and emotional skills in fostering a positive learning environment. Research suggests that teachers who are emotionally competent are better equipped to model and teach SES effectively (Jones, Bouffard and Weissbourd, 2013[19]). Their ability to manage their own emotions, empathise with students, and create a supportive classroom atmosphere is crucial to the success of SES learning programmes.

To support the development of students' social and emotional skills, educational policies could encourage strong partnerships between teachers and parents. And, professional development can help teachers enhance their own social and emotional skills, and equip them with strategies for effectively implementing SES curricula. Schools could also provide resources to help parents actively support their children's SES at home. Open communication and shared goals between educators and families create a more cohesive and supportive learning environment for students.

Balancing depth and breadth in education curricula

Debate over the right balance between depth and breadth in educational curricula highlights the fact that an overly broad coverage of topics can lead to superficial rather than deep understanding (Schmidt, McKnight and Raizen, 2007[20]). A balanced curriculum prioritises core concepts, enabling in-depth exploration of key areas. It allows teachers to use adaptive teaching methods to meet the diverse learning needs of students. It also allows students to gain a broad overview of essential topics and a deeper understanding of the principles. This enhances students' retention and application of knowledge in the long term (Schmidt, McKnight and Raizen, 2007[20]).

When teachers have the flexibility to use adapted strategies, learning can go beyond content knowledge. It can encompass students' self-belief, motivation to learn and learning strategies. Cognitive activation practices like asking students to think about how new and previously learned mathematics topics and materials are related require substantial teacher preparation and content knowledge, and are more effective in less academically segregated classrooms. Interestingly, while a similar percentage of low and skilled performers in OECD countries reported that their teachers use cognitive activation methods, few low performers use this strategy on their own without prompting from their teachers. This suggests that low performers may struggle to internalise cognitive activation and need more support.

There is a case to be made for an optimal balance between covering necessary content and allowing time for in-depth exploration. Effective mathematics teaching and student learning strategies are part of this balanced time model. Not only should adjustments be made to learning and teaching time but policy changes need to allow for curricular flexibility and teachers' professional development focused on adaptive teaching techniques. This approach ensures that teachers can balance comprehensive content coverage with in-depth learning opportunities and adapted support. Learning outcomes, including the three core aspects of sustained learning analysed in this report, stand to benefit.

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Annex A1. Construction of indices

Explanation of the indices

This section explains the indices derived from the PISA 2022 student, well-being and Information and Communication Technology (ICT) familiarity questionnaires used in this volume. Several PISA measures reflect indices that summarise responses from students to a series of related questions. The questions were selected from a larger pool on the basis of theoretical considerations and previous research. The PISA 2022 Assessment and Analytical Framework (OECD, 2023[1]) provides an in-depth description of this conceptual framework. Item response theory (IRT) modelling and classical test theory were used to test the theoretically expected behaviour of the indices and to validate their comparability across countries. For a detailed description of the methods, see the section "Statistical criteria for reporting on scaled indices" in this Annex, and the *PISA 2022 Technical Report* (OECD, 2024[2]).

This volume uses four types of indices: simple indices, complex composite indices, new scale indices and trend scale indices. In addition to these indices, several single items of the questionnaires are used in this volume. The volume also uses data collected on students' performance in mathematics, reading and science. These assessments are described in the *PISA 2022 Assessment and Analytical Framework* (OECD, 2023[1]), the *PISA 2022 Technical Report* (OECD, 2024[2]) and in Volume I of *PISA 2022 Results* (OECD, 2023[3]).

Simple indices are constructed through the arithmetic transformation or recoding of one or more items in the same way across assessments. Here, item responses are used to calculate meaningful indices, such as the recoding of the four-digit ISCO-08 codes into "Highest parents' socio-economic index (HISEI)" or teacher-student ratio based on information from the school questionnaire.

Complex composite indices are based on a combination of two or more indices. The PISA index of economic, social and cultural status (ESCS) is a composite score derived from three indicators related to family background.

Scale indices are constructed by scaling multiple items. Unless otherwise indicated, the two-parameter logistic model (2PLM) (Birnbaum, 1968[4]) was used to scale items with only two response categories (i.e. dichotomous items), while the generalised partial credit model (GPCM) (Muraki, 1992[5]) was used to scale items with more than two response categories (i.e. polytomous items).[1] Values of the index correspond to standardised Warm likelihood estimates (WLE) (Warm, 1989[6]).

For details on how each scale index was constructed, see the *PISA 2022 Technical Report* (OECD, 2024[2]). In general, the scaling was done in two stages:

1. The item parameters were estimated based on all students from approximately equally weighted countries and economies;[2] only cases with a minimum number of three valid responses to items that are part of the index were included. For the trend scales, the scaling process began by fixing the item parameters of the trend items to the parameters that had been estimated for each group in the previous assessment, a procedure called fixed parameter linking. To compute trends, a scale needed to have at least three trend items, but some trend scales consisted of both trend items and new items. In this case, the item parameters for the trend items were fixed at the beginning of the scaling process, but the item parameters for the new items were estimated using the PISA 2022 data.
2. For new scale indices, the Warm likelihood estimates were then standardised so that the mean of the index value for the OECD student population was zero and the standard deviation was one (countries were given approximately equal weight in the standardisation process[2]). For the trend scales, to ensure the comparability

of the scale scores from the current assessment to the scale scores from the previous assessment, the original WLEs of PISA 2022 were transformed using the same transformation constants of the original WLEs from the assessment to which the current assessment was linked.

Sequential codes were assigned to the different response categories of the questions in the sequence in which the latter appeared in the student, school, ICT or well-being questionnaire. For reversed items, these codes were inverted for the purpose of constructing indices or scales.

Negative values for an index do not necessarily imply that respondents answered negatively to the underlying questions (e.g. reporting no support from teachers or no school safety risks). A negative value merely indicates that a respondent answered more negatively than other respondents did on average across OECD countries. Likewise, a positive value on an index indicates that a respondent answered more favourably, or more positively, on average, than other respondents in OECD countries did (e.g. reporting more support from teachers or more school safety risks).

Some terms in the questionnaires were replaced in the national versions of the student, school, ICT or well-being questionnaire by the appropriate national equivalent (marked through brackets < > in the international versions of the questionnaires). For example, the term < qualification at ISCED level 5A > was adapted in the United States* to "Bachelor's degree, post-graduate certificate program, Master's degree program or first professional degree program". All the context questionnaires, including information on nationally adapted terms, and the PISA international database, including all variables, are available through www.oecd.org/pisa.

Statistical criteria for reporting on scaled indices

The internal consistency of scaled indices and the invariance of item parameters are the two approaches that were used to decide on the reporting of indices. All indices reported in this volume met the criteria of both approaches. Indices were omitted for countries and economies where one or more of the criteria were not met. For countries/economies with more than one language version (e.g. Finland offered versions of the student questionnaire in Finnish and Swedish), the criteria were judged independently for each language version.[3] Details about the scaling procedures and the construct validation of all context questionnaire data are provided in the *PISA 2022 Technical Report* (OECD, 2024[2]).

Internal consistency of scaled indices

The internal consistency was used in PISA 2022 to examine the reliability of scaled indices and as a criterion for reporting. Internal consistency refers to the extent to which the items that make up an index are inter-related. Cronbach's Alpha was used to check the internal consistency of each scale within countries/economies and to compare it across countries/economies. The coefficient of Cronbach's Alpha ranges from 0 to 1, with higher values indicating higher internal consistency. Similar and high values across countries/economies indicate reliable measures across countries/economies. Commonly accepted cut-off values are 0.9 for excellent, 0.8 for good, and 0.7 for acceptable internal consistency. Indices are not reported for countries and economies with values below 0.6.

Cross-country comparability of scaled indices

The invariance of item parameters was used in PISA 2022 to examine the cross-country comparability of scaled indices and as a criterion for reporting. It determined whether the item parameters of an index could be assumed to be the same or invariant across countries/economies and across language versions (international item parameter).

In a first step, item parameters were estimated using data from all individuals with available data from all countries/economies. In a second step, the fit of the international parameters for each item was evaluated for each country/economy and language version using the root mean square deviance (RMSD). Values close to zero signal a good item fit, indicating that the international model accurately describes student responses within countries/economies and across language versions. In 2022 PISA used an even more conservative approach than in previous assessments: any country/economy and language version that received a value above 0.25 was flagged. In 2018 and 2015, a cut-off of 0.3 was used. For any flagged item specific parameters were calculated. Steps were repeated until all items exhibited RMSD values below 0.25.

For each index, a country/economy needed to have at least three items with international parameters to be considered comparable to the results of other countries/economies and language versions. Indices are not reported for countries/economies in which one or more language version had fewer than three items with international parameters. For the reporting on trends for indices, a country/economy needed to have at least three trend items with international parameters in order to be considered comparable to the results of the previous assessment to which the current assessment was linked. Results for the trends of indices were not reported for countries/economies in which one or more language groups had fewer than three trend items with international parameters for the index.

The different indices used in this volume are described in the following sections. Those countries/economies and language versions that received specific item parameters are highlighted. The *PISA 2022 Technical Report* (OECD, 2024[2]) provides more details on the cross-country comparability of indices, including the items concerned and the specific item parameters for each country/economy and language version listed.

Complex composite indices

The PISA index of economic, social and cultural status (ESCS)

The PISA index of economic, social and cultural status (ESCS) is a composite score derived, as in previous assessments, from three indicators related to family background: parents' highest education, in years (PAREDINT), parents' highest occupational status (HISEI) and home possessions (HOMEPOS).

Parents' highest level of education, in years (PAREDINT): The index of the highest education of parents, in years, was based on the median cumulative years of education associated with completion of the highest level of education attained by parents (HISCED). Parents' highest level of education was derived from students' responses to questions about their parents' education (ST005 and ST006 for mother's level of education, and ST007 and ST008 for father's level of education). Responses were classified according to ISCED-11 (UNESCO, 2012[7]) using the following categories: (1) Less than ISCED Level 1, (2) ISCED level 1 (primary education), (3) ISCED level 2 (lower secondary), (4) ISCED level 3.3 (upper secondary education with no direct access to tertiary education), (5) ISCED level 3.4 (upper secondary education with direct access to tertiary education), (6) ISCED level 4 (post-secondary non-tertiary), (7) ISCED level 5 (short-cycle tertiary education [at least two years]), (8) ISCED level 6 (Bachelor's or equivalent first or long first-degree programme [three to more than four years]), (9) ISCED level 7 (Master's or equivalent long first-degree programme [at least five years]) and (10) ISCED level 8 (Doctoral or equivalent level). In the event that students' responses to the two questions about their mothers' and fathers' level of education conflicted (e.g. if a student indicated in ST006 that their mother has a postsecondary qualification but indicated in ST005 that their mother had not completed lower secondary education), the higher education level provided by the student was used. This differs from the PISA 2018 procedure where the lower level was used. Indices with these categories were provided for a student's mother (MISCED) and father (FISCED). In addition, the index of parents' highest level of education (HISCED) corresponded to the higher ISCED level of either parent.

The index of parents' highest level of education was recoded into the estimated number of years of education (PAREDINT). This international conversion was determined by using the PISA 2018 measure of cumulative years of education associated with parents' completion of the highest level of education across countries/economies for each ISCED level. The correspondence is available in the *PISA 2022 Technical Report* (OECD, 2024[2]).

Parents' highest occupational status (HISEI): Occupational data for both the student's father and the student's mother were obtained from responses to open-ended questions (ST014 and ST015). The responses were coded to four-digit ISCO codes (ILO, 2007) and then mapped to the international socio-economic index of occupational status (ISEI) using the 2008 version of both (Ganzeboom and Treiman, 2003[8]). Three indices were calculated based on this information: father's occupational status (BFMJ2); mother's occupational status (BMMJ1); and the highest occupational status of parents (HISEI), which corresponds to the higher ISEI score of either parent or to the only available parent's ISEI score. For all three indices, higher ISEI scores indicate higher levels of occupational status.

Home possessions (HOMEPOS): Home possessions were used as a proxy measure for family wealth. In PISA 2022, students reported the availability of household items at home, including books at home and country-specific household items that were seen as appropriate measures of family wealth in the country's context. HOMEPOS is a summary index of all household and possession items (ST250, ST251, ST253, ST254, ST255, ST256). Some HOMEPOS items used in PISA 2018 were removed in PISA 2022 while new ones were added (e.g. new items developed specifically with low-income countries in mind). Furthermore, some HOMEPOS that were previously dichotomous (yes/no) items were revised to polytomous items (1, 2, 3, etc.) making it possible to capture a greater variation in responses. Note that all countries/economies and language versions received unique item parameters for the country/economy-specific items (i.e. no international parameters were estimated for these items) and that for some items, the response categories were collapsed to align with the response categories used in previous assessments (see Tables 19.15 and 19.16 of the *PISA 2022 Technical Report* (OECD, 2024[2]) for details).

For the purpose of computing the PISA index of economic, social and cultural status (ESCS), values for students with missing data on one of the three components (PAREDIND, HISEI or HOMEPOS) were imputed (see (OECD, 2020[9]; Avvisati, 2020[10]; OECD, 2024[2]) for details). If students had missing data for more than one component, the ESCS was not computed; a missing value was assigned instead. In PISA 2022, ESCS was computed by attributing equal weight to the three components. The final ESCS variable is standardised, so that 0 is the score of an average OECD student and 1 is the standard deviation across approximately equally weighted OECD countries.[2]

ESCS scores for PISA 2012, PISA 2015 and PISA 2018 were recomputed to be comparable to the respective scores for PISA 2022. More details are provided in the *PISA 2022 Technical Report* (OECD, 2024[2]).

Simple indices

Education level

PISA collects data on study programmes available to 15-year-old students in each country/economy. This information is obtained through the student tracking form and the Student Questionnaire (ST002). All study programmes were classified using the International Standard Classification of Education (ISCED 1997). From this information, a study programme level and orientation index (ISCEDP) was derived: a three-digit index that describes whether students were at the lower or `upper secondary` level (ISCED 2 or ISCED 3) and the type of programme in which they were enrolled. This index was used to classify students into those attending upper vs. lower secondary education programmes.

Immigrant background

Information on the country of birth of the students and their parents was collected from students (ST019). Three binary country-specific indices indicate whether the student (COBN_S), mother (COBN_M) and father (COBN_F) were born in the country of assessment or elsewhere. The index on immigrant background (IMMIG) is calculated from these indices, and has the following categories: (1) native students (those students who had at least one parent born in the country of assessment); (2) second-generation students (those born in the country of assessment but whose parent[s] were born in another country); and (3) first-generation students (those students born outside the country of assessment and whose parents were also born in another country). Students with missing responses for either the student or for both parents were given missing values for this variable.

Socio-economic profile of the school

The average PISA index of economic, social and cultural status (ESCS) of a school was used as an indicator of the socio-economic profile of a school. To define advantaged and disadvantaged schools, all schools in each PISA-participating education system are ranked according to their average PISA index of economic, social and cultural status (ESCS) and then divided into four groups with approximately an equal number of students (quarters). Schools in the bottom quarter are referred to as "socio-economically disadvantaged schools"; and schools in the top quarter are referred to as "socio-economically advantaged schools".

Working for pay before or after school

Students' answers on how many days during a typical school week they worked for pay before going to school and/or after leaving school in questions ST294 and ST295 were scaled into the index of "Work for pay before or after school". Each item included six response options ("0 days", "1 day", "2 days", "3 days", "4 days", "5 or more days"). Values on this index range from 0 (no work for pay) to 10 (10 or more times of working for pay per week).

Trend scale indices

Mathematics anxiety

The index of mathematics anxiety (ANXMAT) was constructed using the six student responses to question ST345. This question asked students how much they agree ("strongly agreed", "agreed", "disagreed" or "strongly disagreed") with six statements about their feelings when studying mathematics (e.g. "I often worry that it will be difficult for me in mathematics classes"; "I get very tense when I have to do mathematics homework"). Positive values in this index mean that students reported greater anxiety towards mathematics than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Baku (Azerbaijan) (Azeri, Russian), Brazil (Portuguese), Cambodia (Khmer), the Czech Republic (Czech), Georgia (Georgian, Azerbaijani, Russian), Kazakhstan (Kazakh, Russian), Malaysia (Malay), Moldova (Russian), Mongolia (Mongolian, Kazakh), the Slovak Republic (Slovak, Hungarian), the Ukrainian regions (18 of 27) (Ukrainian, Russian) and Uzbekistan (Uzbek, Karakalpak).

Teacher support in mathematics

Students were asked how often ("never or hardly ever", "some lessons", "most lessons", "every lesson") certain things happen in their mathematics classes (e.g. "The teacher shows an interest in every student's learning"; "The teacher gives extra help when students need it"). The four statements of question ST270 were combined to create an index of teacher support (TEACHSUP) with an average of zero and a standard deviation of one across OECD countries. Positive values on the indices mean that the student reported more frequent teacher support in mathematics lessons than did students on average across OECD countries.

In 2012 students answered similar statements about teacher support and disciplinary climate in mathematics lessons. One item from the scale received specific item parameters for Hong Kong (China)* (Chinese).

New scale indices

Confidence in self-directed learning

Students were asked how confident ("not at all confident", "not very confident", "confident", "very confident") they are about different aspects related to self-directed learning (e.g. "Finding learning resources on line on my own"; "Planning when to do schoolwork on my own") if their school building closed again in the future. Students' responses to the eight statements (ST355) were combined into an index of "Confidence in self-directed learning" (SDLEFF) whose average is zero and standard deviation is one across OECD countries.[4] Positive values in the index indicate that the student felt more confident than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Cambodia (Khmer), Indonesia (Indonesian), Kazakhstan (Kazakh), Mongolia (Mongolian, Kazakh), Montenegro (Montenegrin, Albanian), the Philippines (English) and Thailand (Thai).

Co-operation

Question ST343 asked students if they agree ("Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", "Strongly agree"). with statements about a range of behaviours indicative of cooperation (e.g., "I work well with other people.", "I get annoyed when I have to compromise with others."). Answers to the 10 questions were used to build the index of "Co-operation" (COOPAGR) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Each of the 10 items included in this scale had five response options. Positive values in the index indicate that the student reported co-operating more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for France (French), Korea (Korean), the Netherlands* (Dutch) and Norway (Bokmål, Nynorsk).

Cognitive activation in mathematics: Foster reasoning

Students answered a question (ST285) on how often ("Never or almost never", "Less than half of the lessons", "About half of the lessons", "More than half of the lessons", "Every lesson or almost every lesson") during the ongoing school year their mathematics teacher showed a range of behaviours indicative of fostering mathematics reasoning (e.g., "The teacher asked us to explain our reasoning when solving a mathematics problem.", "The teacher asked us to defend our answer to a mathematics problem."). Answers to the questions were used to build the index of "Cognitive activation in mathematics: Foster reasoning" (COGACRCO) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student was frequently exposed to a range of behaviours indicative of the promotion of mathematical thinking by their mathematics teachers, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Cambodia (Khmer), Guatemala (Spanish), Thailand (Thai) and Viet Nam (Vietnamese).

Creative school and class environment

Question ST335 asked students if they agree ("Strongly disagree", "Disagree", "Agree", "Strongly agree") with statements about the degree to which creative thinking is fostered and supported in their school and class environment (e.g., "My teachers value students' creativity.", "At school, I am given a chance to express my ideas."). Answers to the questions were scaled into the index of "Creative school and class environment" (CREATSCH) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported exposure to creative thinking in their school and class environment, more than did students on average across OECD countries.

Confidence in 21st-century mathematics skills

Students were asked how confident ("Not at all confident", "Not very confident", "Confident", "Very confident") they felt about having to do a range of mathematical reasoning and 21st century mathematics tasks (e.g., "Extracting mathematical information from diagrams, graphs, or simulations", "Using the concept of statistical variation to make a decision"). Students' responses to the 10 statements (ST291) were scaled into the index of "Confidence in 21st-century mathematics skills" (MATHEF21) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student felt more confident than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Baku (Azerbaijan) (Azeri), El Salvador (Spanish), Germany (German), Indonesia (Indonesian), Kazakhstan (Kazakh, Russian), Malaysia (Malay), North Macedonia (Macedonian, Albanian), Qatar (Arabic), Saudi Arabia (Arabic, English), Thailand (Thai), the United Arab Emirates (Arabic) and Uzbekistan (Uzbek, Karakalpak).

Confidence in digital skills

Question IC183 asked students asked how well ("I cannot do this", "I struggle to do this on my own", "I can do with a bit of effort", "I can easily do this" and an additional response option "I don't know what this is" which was recoded as missing prior to scaling) they can do various tasks using digital resources (e.g., "Search for and find relevant information online", "Write or edit text for a school assignment"). Answers to the 14 items were scaled into the index of "Confidence in digital skills" (ICTEFFIC) with an average value of zero and a standard deviation of one across OECD countries. Positive values in the index indicate that the student reported confidence in their digital competencies, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Bulgaria (Bulgarian), Finland (Finnish, Swedish), Hong Kong (China)* (Chinese), Israel (Arabic), Jordan (Arabic), Kazakhstan (Kazakh), Korea (Korean), Saudi Arabia (Arabic, English), Chinese Taipei (Chinese) and Thailand (Thai).

Curiosity

Question ST301 asked students if they agree ("Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", "Strongly agree") with statements about a range of behaviours indicative of curiosity (e.g., "I like to know how things work.", "I am more curious than most people I know."). Answers to the 10 questions were scaled into the index of 'Curiosity" (CURIOAGR) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported curiosity more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Baku (Azerbaijan) (Russian), Colombia (Spanish), the Dominican Republic (Spanish), El Salvador (Spanish), Georgia (Georgian, Azerbaijani, Russian), Guatemala (Spanish), Kazakhstan (Kazakh), Moldova (Russian), Mongolia (Mongolian, Kazakh), Norway (Nynorsk), Paraguay (Spanish), Peru (Spanish), the Philippines (English) and Uzbekistan (Uzbek, Karakalpak).

Emotional control

Question ST313 asked students if they agree ("Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", "Strongly agree") with statements about a range of behaviours indicative of emotional control (e.g., "I keep my emotions under control.", "I get mad easily."). Answers to the 10 questions were scaled into the index of "Emotional control" (EMOCOAGR) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported emotional control, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Finland (Finish, Swedish), Greece (Greek), Indonesia (Indonesian), Kazakhstan (Kazakh), Malaysia (Malay, English), Thailand (Thai) and Viet Nam (Vietnamese).

Empathy

Question ST311 asked students if they agree ("Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", "Strongly agree") with statements about a range of behaviours indicative of empathy (e.g., "I predict the needs of others.", "It is difficult for me to sense what others think."). Answers to the 10 questions were scaled into the index of "Empathy" (EMPATAGR) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported empathy, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Hong Kong (China)* (Chinese), Hungary (Hungarian), Korea (Korean), Macao (China) (Chinese) and the Netherlands* (Dutch).

Exposure to mathematical reasoning and 21st century mathematics tasks

Students answered a question (ST276) on how often ("Frequently", "Sometimes", "Rarely", "Never") they had encountered a range of different types of mathematics tasks related to mathematical reasoning and 21st century mathematics tasks during their time at school (e.g., "Extracting mathematical information from diagrams, graphs, or simulations", "Using the concept of statistical variation to make a decision"). Answers were scaled into the index "Exposure to mathematical reasoning and 21st century mathematics tasks" (EXPO21ST) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported frequent exposure to a range of different types of mathematics tasks related to mathematical reasoning and 21st century mathematics tasks, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Denmark* (Danish), Iceland (Icelandic), Norway (Bokmål), North Macedonia (Albanian), Qatar (Arabic), Thailand (Thai) and the United Arab Emirates (Arabic).

Family support

Family support (FAMSUP) was measured by asking students, in question ST300, how often ("never or almost never", "about once or twice a year", "about once or twice a month", "about once or twice a week", "every day or almost every day") their parents or someone in their family do different things with them indicative of family support (e.g. "Discuss how well you are doing at school"; "Eat the main meal with you"; or "Spend time just talking with you"). An index of family support with an average of zero and a standard deviation one across OECD countries is formed by combining students' responses to ten scenarios. Students with positive values on this index perceived their family as more supportive than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Denmark* (Danish), Estonia (Russian), Guatemala (Spanish), Hong Kong (China)* (Chinese), Japan (Japanese), Macao (China) (Chinese, Portuguese), the Netherlands* (Dutch), North Macedonia (Albanian), Poland (Polish), Qatar (Arabic), the Slovak Republic (Slovak, Hungarian) and Thailand (Thai).

Growth mindset

Question ST263 asked students if they agree ("Strongly disagree", "Disagree", "Agree", "Strongly agree") with a range of statements indicative of their mindset (e.g., "Your intelligence is something about you that you cannot change very much.", "Some people are just not good at mathematics, no matter how hard they study."). An index of "Growth mindset" (GROSAGR) with an average of zero and a standard deviation one across OECD countries is formed by combining students' responses to these questions. Students with positive values on this reported more of a growth mindset than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Austria (German), El Salvador (Spanish), Germany (German), Indonesia (Indonesian), North Macedonia (Albanian) and the United States* (English).

Highest expected educational level

Highest expected educational level (EXPECEDU) was measured by asking students, in question ST327, which of a list of possible educational levels they expect to complete. Answers were transformed into the index which was newly created for 2022. Values on the index can range from 1 "Less than ISCED level 2" to 9 "ISCED level 8".

ICT use in enquiry-based learning activities

Students' frequency ratings of how often they use digital resources for various school-related activities (e.g., "Create a multi-media presentation with pictures, sound or video", "Track the progress of your own work or projects") in question IC174 were scaled into the index of "ICT use in enquiry-based learning activities" (ICTENQ) with an average value of zero and a standard deviation of one across OECD countries. Each of the 10 items included in this scale had five response options ("Never or almost never", "About once or twice a year", "About once or twice a month", "About once or twice a week", "Every day or almost every day"). Positive values in the index indicate that the student reported more frequently using digital resources for these practices, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Denmark* (Danish), Kazakhstan (Kazakh), Saudi Arabia (Arabic, English), Sweden (Swedish, English) and the United States* (English).

Information-seeking regarding future career

Students' ratings of whether they had undertaken a range of possible activities to find out about future study or types of work (e.g., "I did an internship.", "I researched the internet for information about careers.") in question ST330 were scaled into the Index of "information-seeking regarding future career" (INFOSEEK) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Each of the 11 items included in this scale had three response options ("Yes, once", "Yes, two or more times", "No"). The index has an average of zero and a standard deviation one across OECD countries. Students with positive values reported had undertaken activities to find out about future study or types of work, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Argentina (Spanish), Austria (German), Brunei Darussalam (English), Bulgaria (Bulgarian), Canada* (English, French), Colombia (Spanish), Croatia (Croatian), Cyprus (Greek, English), the Czech Republic (Czech), Denmark* (Danish), the Dominican Republic (Spanish), Georgia (Georgian, Azerbaijani, Russian), Hungary (Hungarian), Jamaica* (English), Kazakhstan (Kazakh, Russian), Kosovo (Albanian, Serbian), Lithuania (Lithuanian, Russian, Polish), Macao (China) (Chinese, Portuguese, English), Mexico (Spanish), Montenegro (Montenegrin, Albanian), Morocco (Arabic), the Netherlands (Dutch), New Zealand* (English), Peru (Spanish), the Philippines (English), Poland (Polish), Saudi Arabia (Arabic, English), Switzerland (German, Italian), Chinese Taipei (Chinese), the United Arab Emirates (English), the United States* (English) and Uzbekistan (Uzbek, Karakalpak).

Mathematics self-efficacy: Formal and applied mathematics

Students were asked how confident ("Not at all confident", "Not very confident", "Confident", "Very confident") they are about having to do a range of formal and applied mathematics tasks (e.g., "Calculating how much more expensive a computer would be after adding tax", "Solving an equation like 2(x+3) = (x+3)(x-3)"). Students' responses to the nine statements (ST290) were scaled into the index of "Mathematics self-efficacy: Formal and applied mathematics"

(MATHEFF) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale was linked to the MATHEFF scale in PISA 2012 and was scaled using the PCM, in line with the model used in PISA 2012. Also, it used a within- construct matrix sampling design. Positive values in the index indicate that the student felt more confident than did students on average across OECD countries. Note that in PISA 2012, the response options were presented to the students ordered from “Very confident” to “Not at all confident” possibly eliciting different response patterns related to the format of the question, and not necessarily related the construct. Because of this, caution should be exercised when comparing scale scores across these two cycles.

One or more items from the scale received specific item parameters for Albania (Albanian), Colombia (Spanish), Israel (Hebrew), Malaysia (Malay), Mexico (Spanish), North Macedonia (Macedonian, Albanian), Paraguay (Spanish), Peru (Spanish), the Philippines (English), Uzbekistan (Uzbek, Karakalpak) and Viet Nam (Vietnamese).

Persistence

Question ST307 asked students if they agree (“Strongly disagree”, “Disagree”, “Neither agree nor disagree”, “Agree”, “Strongly agree”) with statements about a range of behaviours indicative of persistence (e.g. “I keep working on a task until it is finished.”, “I give up after making mistakes.”). Answers to the 10 questions were scaled into the index of “Persistence” (PERSEVAGR) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported persistence, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Finland (Finnish, Swedish).

Proactive mathematics study behaviour

Question ST293 asked students how often (“Never or almost never”, “Less than half of the time”, “About half of the time”, “More than half of the time”, “All or almost all of the time”) they engaged in behaviours indicative of effort and persistence in mathematics (e.g. “I actively participated in group discussions during mathematics class.”, “I put effort into my assignments for mathematics class.”). Answers to the 8 questions were scaled into the index of “Proactive mathematics study behaviour” (MATHPERS) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported proactive mathematics study behaviour, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Cambodia (Khmer), Costa Rica (Spanish), Israel (Arabic), Paraguay (Spanish), Qatar (Arabic), Thailand (Thai), Uzbekistan (Uzbek, Karakalpak) and Viet Nam (Vietnamese).

Quality of access to ICT

Question IC172 asked students asked students if they agree (“Strongly disagree”, “Disagree”, “Agree”, “Strongly agree”) with various statements about ICT resources at their school (e.g. “There are enough digital devices with access to the Internet at my school.”, “The school’s Internet speed is sufficient.”). Answers to the nine questions were scaled into the index of “Quality of access to ICT” (ICTQUAL) with an average value of zero and a standard deviation of one across OECD countries. Positive values in the index indicate that the student reported quality access to ICT resources at their school, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Kazakhstan (Kazakh).

Quality of student-teacher relationships

Students’ ratings of their agreement with the eight statements (e.g. “The teachers at my school are respectful towards me.”, “When my teachers ask how I am doing, they are really interested in my answer.”) in question ST267 were scaled into the index of "Quality of student-teacher relationships" (RELATST) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Each of the eight items included in this scale had four response options ("Strongly disagree", "Disagree", "Agree", "Strongly agree"). Positive values in the index indicate that the student reported quality student-teacher relationships, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Albania (Albanian), Denmark* (Danish), Finland (Finnish, Swedish), Georgia (Georgian, Azerbaijani, Russian), Hong Kong (China)* (Chinese), Japan (Japanese), Qatar (Arabic), Singapore (English), Sweden (Swedish, English), Thailand (Thai), the United Arab Emirates (English) and Viet Nam (Vietnamese).

Stress resistance

Question ST345 asked students if they agree ("Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", "Strongly agree") with statements about a range of behaviours indicative of stress resistance (e.g. "I remain calm under stress.", "I get nervous easily."). Answers to the 10 questions were scaled into the index of "Stress resistance" (STRESAGR) with an average value of zero and a standard deviation of one across OECD countries. Note that this scale used a within-construct matrix sampling design. Positive values in the index indicate that the student reported stress resistance, more than did students on average across OECD countries.

Social connection to parents

Social connection to parents (SOCONPA) was measured by asking students, in question WB163, how often ("Almost never", "Sometimes", "Almost always") their parents engage in various activities (e.g. "Show that they care", "Encourage me to make my own decisions"). An index of index of "Social connection to parents" with an average of zero and a standard deviation one across OECD countries is formed by combining students' responses. Students with positive values on this index perceived their social connection to their parents better than did students on average across OECD countries.

Students' practices regarding online information

Question IC180 asked students their agreement ("Strongly disagree", "Disagree", "Agree", "Strongly agree") with various statements about their practices regarding online information (e.g., "When searching for information online I compare different sources.", "I discuss the accuracy of online information with friends or other students."). Answers to the six items were scaled into the index of "Students' practices regarding online information" (ICTINFO) with an average value of zero and a standard deviation of one across OECD countries. Positive values in the index indicate that the student reported agreeing to these practices, more than did students on average across OECD countries.

One or more items from the scale received specific item parameters for Japan (Japanese) and Thailand (Thai).

Notes

[1] To keep the 2022 trend scales linked to PISA 2012 comparable, the Rasch model (Rasch, 1960[11]) was used to scale the dichotomous items, while the partial credit model (PCM) was used to scale the polytomous items, in line with the models used in PISA 2012.

2 Due to missing data from the countries/economies, countries/economies were only approximately equally weighted.

3 Different language versions were only analysed independently, if the version was distributed to a sample of over 150 and the sum of the weights was over 300. The sum of weights for all cases within a country/economy add up to a constant of 5 000 but varied on a scale-by-scale basis because missing responses varied across scales.

4 Denmark*, Norway and Singapore did not collect data for any of the questions related to students' responses and experiences during COVID-19 school closures.

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Annex A2. The PISA target population, the PISA samples, and the definition of schools

Please refer to Annex A2 of *PISA 2022 Results (Volume I): The State of Learning and Equity in Education* (OECD, 2023[1]).

References

OECD (2023), *Annex A2. The PISA target population, the PISA samples, and the definition of schools*, OECD Publishing, Paris, https://doi.org/10.1787/007f7d8e-en. [1]

Annex A3. Technical notes on analyses in this volume

Standard errors, confidence intervals, significance test and p-values

The statistics in this report represent estimates based on samples of students, rather than values that could be calculated if every student in every country had answered every question. Consequently, it is important to measure the degree of uncertainty in the estimates. In PISA, each estimate has an associated degree of uncertainty, which is expressed through a standard error. The use of confidence intervals provides a way of making inferences about the population parameters (e.g. means and proportions) in a manner that reflects the uncertainty associated with the sample estimates. If numerous different samples were drawn from the same population, according to the same procedures as the original sample, then in 95 out of 100 samples the calculated confidence interval would encompass the true population parameter. For many parameters, sample estimators follow a normal distribution, and the 95% confidence interval can be constructed as the estimated parameter, plus or minus 1.96 times the associated standard error.

In many cases, readers are primarily interested in whether a given value in a particular country is different from a second value in the same or another country, e.g. whether students with immigrant background perform better than students without an immigrant background in the same country. In the tables and figures used in this report, differences are labelled as statistically significant when a difference of that size or larger, in either direction, would be observed less than 5% of the time in samples, if there were no difference in corresponding population values. In other words, the risk of reporting a difference as significant when such difference, in fact, does not exist, is contained at 5%.

Statistical significance of differences between subgroup means, after accounting for other variables

For many tables, subgroup comparisons were performed both on the observed difference ("before accounting for other variables") and after accounting for other variables, such as the PISA index of economic, social and cultural status of students. The adjusted differences were estimated using linear regression and tested for significance at the 95% confidence level. Significant differences are marked in bold.

Statistical significance of performance differences between the top and bottom quartiles of PISA indices and scales

Differences in average performance between the top and bottom quarters of the PISA indices and scales were tested for statistical significance. Figures marked in bold indicate that performance between the top and bottom quarters of students on the respective index is statistically significantly different at the 95% confidence level.

Statistical significance of relationships between PISA items, indices and scales at the system level

Relationships between two variables at the system level (e.g. the relationship between cognitive activation practices and mathematics performance across education systems) were also tested for statistical significance. Figures marked in bold indicate that a positive or negative relationship between two variables is statistically significant at the 95% confidence level. Figures marked in italics indicate relationships between two variables that are marginally significant (90% confidence level).

Change in the performance per unit of an index

The difference in student performance per unit of an index was calculated in many tables. Figures in bold indicate that the differences are statistically and significantly different from zero at the 95% confidence level.

Odds ratios

The odds ratio is a measure of the relative likelihood of a particular outcome across two groups. The odds ratio for observing the outcome when an antecedent is present is simply:

$$\mathrm{OR} = {(p_{11}/p_{12})}\Big/{(p_{21}/p_{22})}$$

Equation I.A3.3

where p_{11}/p_{12} represents the "odds" of observing the outcome when the antecedent is present, and p_{21}/p_{22} represents the "odds" of observing the outcome when the antecedent is not present.

Logistic regression can be used to estimate the log ratio: the exponentiated logit coefficient for a binary variable is equivalent to the odds ratio. A "generalised" odds ratio, after accounting for other differences across groups, can be estimated by introducing control variables in the logistic regression.

Statistical significance of odds ratios

Figures in bold in the data tables presented in Annex B1 of this report indicate that the odds ratio is statistically significantly different from 1 at the 95% confidence level. To construct a 95% confidence interval for the odds ratio, the estimator is assumed to follow a log-normal distribution, rather than a normal distribution.

In some tables, odds ratios after accounting for other variables are also presented. These odds ratios were estimated using logistic regression and tested for significance against the null hypothesis of an odds ratio equal to one (i.e. equal likelihoods, after accounting for other variables).

Use of student weights

The target population in PISA is 15-year-old students, but a two-stage sampling procedure was used. After the population was defined, school samples were selected with a probability proportional to the expected number of eligible students in each school. Only in a second sampling stage were students drawn from among the eligible students in each selected school.

Although the student samples were drawn from within a sample of schools, the school sample was designed to optimise the resulting sample of students, rather than to give an optimal sample of schools. It is therefore preferable to analyse the school-level variables as attributes of students (e.g. in terms of the share of 15-year-old students affected), rather than as elements in their own right.

Most analyses of student and school characteristics are therefore weighted by student final weights (or their sum, in the case of school characteristics), and use student replicate weights for estimating standard errors.

Some considerations when interpreting the PISA results

Cross-national and cross-cultural comparability of the PISA data

PISA 2022 asked students and teachers to answer questions about learning and teaching practices. These are reports provided by teachers and students themselves rather than external observations, and thus may be influenced by cultural differences in how individuals respond.

While PISA aims to maximise the cross-national and cross-cultural comparability of complex constructs, it must do so while keeping the questionnaires relatively short and minimising the perceived intrusiveness of the questions. Despite the extensive investments PISA makes in monitoring the process of translation, standardising the administration of the assessment, selecting questions and analysing the quality of the data, full comparability across countries and subpopulations cannot always be guaranteed.

In order to minimise the risk of misleading interpretations, a number of reliability and invariance analyses of the PISA indices used in this report have been carried out (see Annex A1 and the PISA 2022 Technical Report ((OECD, 2024[1]) for more details), providing readers with an indication of how reliable cross-country comparisons are.

Interpreting correlations and changes over time

A correlation indicates the strength and direction of a linear relationship, either positive or negative, between two variables. A correlation is a simple statistic that measures the degree to which two variables are associated with each other; it does not prove causality between the two.

Comparisons of results between resources, policies and practices, and mathematics performance across time (trends analyses) should also be interpreted with caution. Changes in the strength of the relationship between characteristics of education systems and education outcomes (e.g. mathematics performance) cannot be considered causal because they can occur for two key reasons. First, a particular set of resources, policies and practices might have been chosen by higher-performing students (or higher-performing schools or high-performing systems) while that set of resources, policies and practices might not have existed in lower-performing students/schools/systems. Under this interpretation, the relationship between mathematics performance, and resources, policies and practices is stronger because they are available to higher-performing students/schools/systems. Second, a particular set of resources, policies and practices may have been used more extensively in 2022 than earlier, and may have promoted student learning more in 2022 than before. PISA trend data indicate where changes have occurred. However, in order to understand the nature of the change, further analysis is needed.

Interpreting results before and after accounting for socio-economic status

When examining the relationship between education outcomes and resources, policies and practices within school systems, this volume takes into account socio-economic differences among students, schools and systems. The advantage of doing this lies in comparing similar entities, namely students, schools and systems with similar socio-economic profiles. At the same time, there is a risk that such adjusted comparisons underestimate the strength of the relationship between student performance and resources, policies and practices, since most of the differences in performance are often attributable to both policies and socio-economic status.

Conversely, analyses that do not take socio-economic status into account can overstate the relationship between student performance and resources, policies and practices, as the level of resources and the kinds of policies adopted may also be related to the socio-economic profile of students, schools and systems. At the same time, analyses without adjustments may paint a more realistic picture of the schools that parents choose for their children. They may also provide more information for other stakeholders who are interested in the overall performance of students, schools and systems, including any effects that may be related to the socio-economic profile of schools and systems. For example, parents may be primarily interested in a school's absolute performance standards, even if that school's higher achievement record stems partially from the fact that the school has a larger proportion of advantaged students.

For the system-level analyses, correlations are examined before and after accounting for per capita GDP in order to account for the extent to which the observed relationships are influenced by countries'/economies' level of economic development.

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Annex A4. Quality assurance

Please refer to Annex A4 of PISA 2022 Results (Volume I): The State of Learning and Equity in Education (OECD, 2023[1]).

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Annex A5. Additional thematic literature review

The concept of lifelong learning is recognised as a fundamental pillar of individual and collective development. It is evermore important in a 21st century shaped by major environmental challenges, technological advancement and socio-economic transformation. Lifelong learning encompasses the continuous development of an individual's cognitive, metacognitive, emotional and behavioural potential through self-directed learning skills, competencies, and creative learning traits (Manea, 2014[1]). Its importance is underscored by the United Nations Sustainable Development Goal 4 (SDG4) and its call to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, 2023[2]).

Lifelong learning is a dynamic and continuous process of acquiring skills and knowledge throughout one's life (OECD, 2021[3]). The concept integrates learning into everyday life for all ages, levels of education, and learning modalities and domains, as well as for a variety of purposes (UNESCO, 2021[4]).

Lifelong learning encompasses a broad spectrum of learning experiences, ranging from formal education settings (such as formal schooling or apprenticeship programmes) to informal and non-formal educational environments (including intentional and non-intentional learning in homes, workplaces and beyond, commonly referred to as "experience") (OECD, 2019[5]; UNESCO, 2006[6]). This is underpinned by the principle of agency – the capacity and willingness of individuals to actively engage in learning activities throughout their lives. Moreover, lifelong learning requires a shift in one's mindset from passive recipient of knowledge to active participant in the learning process (Jones and Candy, 1993[7]).

Nurturing a culture of lifelong learning and tackling systemic barriers enable people to realise their potential to the fullest and to strengthen and improve one's quality of life (Demirel, 2009[8]).

The willingness to learn and early skills development are the foundation for learning processes that take place later on in life. Early childhood is a critical period for the development of foundational skills (e.g. speaking, listening, memorisation, critical and creative thinking) and learning attitudes (e.g. curiosity and interest in learning, motivation and persistence), laying the groundwork for future educational attainment and lifelong learning engagement (Cotton, 1998[9]). PISA's comparative assessment of students' learning strategies, motivations and attitudes provides a strong basis of analysis of students' preparedness for lifelong learning.

The promotion of lifelong learning is not just a matter of education policy but a fundamental imperative for a more just, equitable, and sustainable world. It is in sustainable, adaptable and inclusive societies that vulnerable and disadvantaged individuals are empowered to fully participate socially, economically, and politically, and in which there is more fluid social mobility and diminished intergenerational poverty (UNESCO, 2015[10]).

Sustained lifelong learning strategies

Sustained lifelong learning strategies are approaches and techniques that enable learners to regulate, enhance, and sustain their learning over time. More concretely, they encompass strategies and skills that enable learners to inquire, rebuild and reuse their knowledge, and be resilient and durable in challenging circumstances (Forbes et al., 2023[11]). This report focuses on long-term learning readiness and skills that extend beyond compulsory schooling. This includes students' self-control and self-monitoring of their learning process, critical thinking, proactive behaviour, cognitive activation and creative problem-solving. An effective learner uses these strategies (consciously or not); is able and motivated to navigate through resources and information; and learns from past experiences to achieve specific goals.

Cognitive activation

Cognitive activation engages students in higher-order thinking tasks that require them to evaluate, integrate, and mobilise knowledge in different contexts (Lipowsky et al., 2009[12]). This strategy not only encourages students to discover creative and alternative ways of solving problems but also enables them to communicate their thinking processes and results to their peers and teachers (Le Donné, Fraser and Bousquet, 2016[13]). Cognitive activation is a sustainable learning strategy that fosters students' engagement and self-initiated efforts in the learning process. This facilitates information processing and fosters a deeper understanding and long-term retention of knowledge (Opfer, 2016[14]). Moreover, cognitive activation practices are not merely about reflecting on challenging tasks. They can be as ordinary as memorisation; making connections between new information and previously existing knowledge; and interactive and collaborative learning (Praetorius and Charalambous, 2018[15]; Praetorius et al., 2018[16]).

Empirical studies have shown that integrating cognitive activation into teaching/learning practices helps students build a robust understanding of concepts, resulting in improved learning outcomes. Indeed, cognitive activation, especially when combined with effective classroom management enabling exploration and discussion, has been shown to enhance learning outcomes like performance in mathematics (Montague et al., 2014[17]; Opfer, 2016[14]).

Moreover, cognitive activation promotes the development of complementary skills such as collaboration, communication and autonomy (Ulaywi, 2021[18]). This is because cognitive activation strategies are usually led by the teacher, at first by showing students their exemplary applications, but the ultimate aim is for students to use the strategies independently.

Cognitive activation is a core learning strategy that cultivates deep, lasting learning that individuals can continuously build on throughout their lives. Cognitive activation strategies are transferable and therefore enable students to be effective learners in different areas and circumstances.

Controlling one's own learning and self-monitoring

The ability to control one's own learning is an essential aspect of self-regulated learning. It is not only key for academic achievement but also for learning throughout life, especially beyond traditional learning settings. Students who control their learning, actively and autonomously engage in the learning process by mobilising their cognitive, motivational and emotional abilities (Sahranavard, Miri and Salehiniya, 2018[19]; Zimmerman, 1990[20]). Research suggests that self-regulated learners set realistic goals and take necessary actions to achieve them, demonstrating control over their psychological processes and resilience towards their environment (Schunk, Zimmerman and Gettinger, 1995[21]). Individuals who can control their own learning are also able to acknowledge their limitations and seek help when needed.

Empirical studies all show the significant and positive influence of self-regulation skills on students' academic performance (Khan, Shah and Sahibzada, 2020[22]; Magno, 2010[23]; Galizty and Sutarni, 2021[24]). Studies focusing on self-correction suggest that this practice improves not only students' academic performance but increases motivation, self-efficacy, and awareness of their learning processes, strengths and weaknesses (Rana and Peerven, 2013[25]; Ramdass and Zimmerman, 2008[26]; Kearsley and Klein, 2016[27]).

Individuals capable of regulating their learning by themselves are more likely to be independent and resilient in their learning experiences and to continuously adapt, grow and thrive in various learning contexts throughout their lives.

Critical thinking

Literature defines critical thinking as a reflective thinking process (about an idea or a problem) in which individuals analyse and evaluate whether the available information, evidence and results are reasonable, logical or correct in order to draw conclusions and make informed decisions (Paul, 1992[28]; Lipman, 1988[29]; Halpern, 2013[30]; Ennis, 1989[31]). Individuals with critical thinking skills tend to be efficient learners (Moon, 2007[32]) as they question assumptions, consider multiple perspectives, and engage themselves with content, which enhances their understanding and retention of knowledge (Ben-Eliyahu, 2021[33]). Critical thinking is an essential skill that enables individuals to engage with the world in a more thoughtful way, especially in the digital age where a vast amount of data is available online.

Studies suggest that critical thinking skills can significantly improve learning outcomes (Ghanizadeh, 2017[34]; D'Alessio, Avolio and Charles, 2019[35]; Soodmand Afshar, Rahimi and Rahimi, 2014[36]; Orhan, 2022[37]), including in various disciplines like mathematics and science (Montague et al., 2014[17]) as well as in reading (Vaseghi, Reza; Gholami, Reza; Barjesteh, 2012[38]) and foreign languages (Shirkhani and Fahim, 2011[39]). Research also suggests that the positive relationship between critical thinking and academic performance is reciprocally mediated by other dispositions such as motivation, open-mindedness, and persistence (Facione, 2000[40]). Indeed, motivated students who are willing to deepen their understanding and learning are more likely to be critical thinkers and more likely to persist in challenging tasks.

However, there is some disagreement in the literature about the domain-generality or domain-specificity of critical thinking skills in learning. Some argue that the fundamental cognitive processes involved in critical thinking, although manifested in different ways, remain the same across disciplines (Lipman, 1988[29]; Ennis, 1989[41]), while others stress the importance of background knowledge in a specific domain when it comes to applying them (Facione, 2000[40]; Perkins and Salomon, 1989[42]).

Proactivity towards learning

Proactivity towards learning (or proactive study behaviour as defined in PISA 2022) is an essential characteristic that drives students to engage actively and enthusiastically in their educational pursuits. Proactivity is characterised by "a stable disposition to take initiative in a broad range of activities and situations" (Seibert, Kraimer and Crant, 2001[43]) A proactive learner seeks out learning opportunities and feedback in order to make use of them, connects new information to prior knowledge, displays a forward-looking attitude towards learning and perseveres until they see meaningful change in their situation (Bateman and Crant, 1993[44]). In contrast, learners who are less proactive are passive and tend to rely on others to act (Crant, 2000[45]).

Research has highlighted the benefits of proactive behaviours in learning for academic performance and the development of various motivational and behavioural skills. Empirical studies show that proactive students tend to achieve higher academic outcomes due to their higher academic engagement and intrinsic motivation (Cansino, Román and Expósito, 2018[46]; Chen, Bao and Gao, 2021[47]; Ogawa, 2011[48]). Research has even suggested that proactivity is a stronger predictor of motivation to learn compared to the so-called Big Five personality factors (i.e. neuroticism, extraversion, openness, conscientiousness, and agreeableness) (Major, Turner and Fletcher, 2006[49]). Furthermore, proactive students are more likely to feel greater satisfaction from their learning activities, persist in the face of difficulties, and set ambitious goals (Parker, Bindl and Strauss, 2010[50]). In the workplace, proactivity is linked with positive outcomes, career success, stress resistance, and better adaptation for newcomers (Seibert, Crant and Kraimer, 1999[51]; Parker, Williams and Turner, 2006[52]; Cooper-Thomas and Burke, 2012[53]). Thus, proactive behaviours are essential for learning and social-emotional outcomes, especially when one has left formal educational settings or when there is a lack of support. They foster individuals' mastery approach to learning and a sense of self-sufficiency regardless of the (learning) context (Major, Holland and Oborn, 2012[54]).

Problem-solving

Problem-solving is ubiquitous in everyday life, in and outside of educational settings, and is therefore a critical approach to lifelong learning. Problem-solving ability can be defined as a high-level thinking skill that enables the generation of new ideas in response to an obstacle (Oliveri, Lawless and Molloy, 2017[55]). However, the difficulty of a problem is not inherent as it varies according to the knowledge and experience of the solver. Thus, a problem might be a complex challenge for one individual but might not be for another. Steps in the problem-solving process have been outlined in the literature: 1) an appropriate mental representation of the problem (understanding of its nature, its scope, and its impact), 2) gathering information (which may involve activating prior knowledge, researching, or seeking support), 3) generating possible solutions, before 4) assessing each potential solution (involving analysis of its feasibility, risks, benefits), 5) decision-making (choosing the best option), and 6) implementing the solution (outlining the necessary steps, assigning responsibilities and goals) (Metallidou, 2009[56]; Alturki and Aldraiweesh, 2023[57]; Wang, 2021[58]).

A positive relationship between problem-solving skills and academic performance is consistently highlighted in the literature. Research suggests that students who develop strong problem-solving skills tend to perform better in mathematics, where problem-solving can account for about 70% of the variance in their performance (Sinaga, Sitorus and Situmeang, 2023[59]). Other studies have shown that problem-solving skills are associated to better performance in science, technology and engineering due to increased student engagement (Wang, 2021[58]; Alturki and Aldraiweesh, 2023[57]). Moreover, students who regularly engage in problem-solving are often more motivated, confident, and proactive in their learning (Gök and Sýlay, 2010[60]; Perveen, 2010[61]), which extends beyond immediate educational outcomes.

Problem-solving is considered a sustainable learning strategy because it equips students with skills that are applicable throughout their lives and across various contexts. It promotes their resilience and adaptability to tackle complex and unfamiliar problems as well as their stress resistance and life satisfaction (D'Zurilla, 1990[62]).

Motivation and self-beliefs in learning

Motivation and self-beliefs play a crucial role in shaping one's learning experiences and outcomes throughout life. Interest in learning, personal and instrumental motivation, growth mindset, and mathematical self-concept and self-efficacy are critical constructs in lifelong learning. They are largely self-generated by the individual and shape their engagement and resilience in learning. As malleable constructs, these motivations and self-beliefs can be cultivated and reinforced through targeted educational interventions, allowing individuals to carry them across their lives.

In this report, motivation is seen as a driving force behind learning. Self-beliefs refer to the confidence learners have in themselves, how well they believe they can perform even difficult tasks (self-efficacy), and what they believe about their own abilities (self-concept).

Personal and instrumental motivation

Personal motivation (or intrinsic motivation) is defined as the willingness to engage in a learning activity that is driven by the interest, enjoyment, or satisfaction of that particular activity (Schiefele, 1999[63]). Instrumental motivation (or extrinsic motivation), on the other hand, corresponds to the intention to engage in a learning activity when the motivation does not come from the activity itself but from external factors (e.g. rewards, pressure, parental approval, or good grades).

This distinction between types of motivations is not static. Individuals can be simultaneously intrinsically and extrinsically motivated. For instance, students may express a strong interest and motivation to learn mathematics, while having some clear career objectives. Or students who were initially extrinsically motivated might develop an intrinsic motivation as they become more involved in a subject.

Although there is no consensus on the existence of a direct effect of personal or instrumental motivation on academic performance, empirical studies tend to convey that intrinsic motivation fosters deep and meaningful learning experiences and outcomes across educational stages (Lemos and Veríssimo, 2014[64]). Highly intrinsically motivated students often exhibit greater resilience and engagement with challenges than those extrinsically motivated (Schiefele, 2012[65]). However, both motivation types can lead to sustained learning, as these motivated learners are more likely to be actively engaged, curious, and persistent in their learning endeavours beyond formal education.

Interest in learning

Interest in learning is a type of intrinsic motivation that can be defined as an individual's desire and curiosity to increase and master their knowledge, skills, and experiences. It is a multifaceted concept that acts as a powerful internal driver that stimulates students' engagement, attention, and cognitive processes. Highly interested individuals can make learning feel effortless and enjoyable.

The literature distinguishes two types of interest that are integral to the learning process: situational interest and individual or personal interest. Situational interest arises spontaneously from environmental factors, such as engaging task instructions. Individual interest denotes a more stable, ongoing relationship with specific domains, defined by dispositional motivational characteristics (Schiefele, 1999[63]; Schiefele, 2012[65]).

Interest is seen as a dynamic construct. Repeated experiences of situational interest over time can develop into an emergent personal interest (Harackiewicz, Smith and Priniski, 2016[66]; Harackiewicz et al., 2008[67]). Several empirical studies have explored the relationship between interest and academic performance, and suggest that the more interested and engaged the students are in learning, the more likely they are to invest time and effort into it (Renninger and Hidi, 2022[68]; Ainley, 2006[69]; Ainley, Hidi and Berndorff, 2002[70]; Hidi and Renninger, 2006[71]). Moreover, while interest significantly enhances cognitive activity, motivation, and learning outcomes regardless of prior knowledge, studies have shown that it has long-term influence on one's life outcomes (Harackiewicz et al., 2000[72]).

Growth mindset

Individuals with a growth mindset believe they can cultivate their abilities through work and effort. In contrast, a fixed mindset is the belief that one's abilities are innate and unchangeable. Adopting a growth mindset can foster a love for learning and adaptive learning strategies, and build the resilience needed for sustainable achievement (Dweck, 2006[73]; Dweck, 2012[74]).

Empirical studies suggest that students with a growth mindset, unlike those with fixed mindsets, are more likely to consider failures as opportunities for instructive feedback and improvement. Moreover, research shows that students with a growth mindset tend to attain better learning outcomes and often outperform those with a fixed mindset (Yeager et al., 2019[75]). Likewise, students with a growth mindset tend to have smoother progressions through education systems and into further learning opportunities (Blackwell, Trzesniewski and Dweck, 2007[76]) as they are more willing to adapt to change and challenge. In addition, research suggests that in some contexts, growth mindset could mitigate the negative effects of students' disadvantaged socio-economic situation on their academic performance (Claro, Paunesku and Dweck, 2016[77]).

As the same research suggests, growth mindsets are not innate; it is a disposition that can be nurtured and developed in and beyond educational settings. These studies have shown that teaching and promoting the concept of neuroplasticity (the idea that the brain grows with practice) with an emphasised praise for effort over prior ability is an effective way to promote growth mindset (Yeager and Walton, 2011[78]).

Mathematical self-concept and self-efficacy

Mathematical self-concept encompasses students' perceptions of their own abilities in mathematics (OECD, 2013[79]).

Empirical research shows a strong correlation between mathematical self-concept and students' performance in mathematics (Passiatore et al., 2023[80]; Huang, 2011[81]; Abu-Hilal, 2000[82]). Studies suggest that mathematics self-concept is more strongly correlated to performance than other student-based aspects (Lotz, Schneider and Sparfeldt, 2018[83]). However, a negative relationship has been found between mathematical anxiety and self-concept: the more anxious students are about mathematical tasks, the less secure they are about their competencies in mathematics (Kaskens et al., 2020[84]; Ahmed et al., 2012[85]).

Mathematical self-efficacy refers to students' confidence in their ability to perform mathematical tasks successfully (OECD, 2013[79]). It includes students' reflections on their past performance, self-assessment of their competence, and their engagement and expectations for their future performance of mathematics tasks. Mathematical self-efficacy determines their level of commitment, resilience and tolerance when faced with a difficult problem (Pajares, 1996[86]; Zakariya, 2022[87]).

Studies have shown that mathematical self-efficacy not only predicts academic performance but also mediates the effects of other constructs such as motivation, mathematics anxiety and metacognitive experiences on learning outcomes (Özcan and Eren Gümüş, 2019[88]; Zakariya, 2021[89]). Other studies have explored the positive relationship between mathematical self-efficacy and self-regulated learning, and confirmed the strength of the relationship even after accounting for personal traits (Zuffianò et al., 2013[90]).

Social and emotional skills

Open-mindedness in learning

Open-mindedness is a fundamental characteristic that drives both intellectual and psychological growth and fosters a love for learning. Open-minded individuals are not only curious but also prone to explore, question, and understand the multifaceted realities around them. This trait transcends mere tolerance as it refers to the ability and willingness to embrace diversity, consider a variety of approaches and beliefs, and think creatively to examine problems from multiple angles (Kwong, 2015[91]; Mitchell and Nicholas, 2005[92]; Baehr, 2011[93]).

Curiosity is considered as a catalyst for open-mindedness. Defined as the "motivation to acquire information regarding a particular topic", curiosity fuels intellectual exploration, making learning rewarding by virtue of its novelty or process of seeking innovative solutions to uncertainty (Singh and Manjaly, 2022[94]). In that regard, curiosity can lead individuals to delve deeper into subjects and acquire new skills throughout their lives.

The relationship between open-mindedness and academic achievement has garnered significant attention. Although research literature has not consistently found a direct correlation between open-mindedness and academic performance, it appears that this trait may act as a mediator between positive attitudes towards learning (such as motivation) and performance. In other words, students who are motivated and have positive attitudes are more likely to be open-minded, which makes them perform better compared to those who are close-minded. Moreover, while female students tend to demonstrate higher levels of curiosity and positive attitudes towards learning compared to males (Jaen and Baccay, 2016[95]), a significant and positive relationship between open-mindedness and academic achievement was observed among female students (Majeed and Rashid, 2022[96]). In contrast, such correlation was not identified among their male counterparts. Even though these results call for more in-depth research, they suggest that being open-minded might be more beneficial to girls' academic performance than boys'.

Task performance (persistence)

Persistence (synonymous with perseverance and grit) is a cornerstone for not only academic success but lifelong learning. This skill refers to one's ability to adaptively engage with challenging learning tasks until overcoming them (Bandura, Freeman and Lightsey, 1999[97]). Students who are persistent in their learning view challenges as opportunities for growth and are able to maintain their interests and exert efforts over extended periods of time (Duckworth et al., 2007[98]).

Being perseverant does not mean spending an excessive amount of time attempting to solve a problem without making substantial progress, which is defined by the notion of "wheel-spinning" (Beck and Gong, 2013[99]; Yang and Ogata, 2023[100]). In some cases, this behaviour might reflect a lack of adaptability and strategic thinking as individuals may fail to identify alternative approaches or seek assistance when faced with challenges. In contrast, persistence demonstrates one's analytical ability and resilience in the learning process.

Literature has shown that academic performance is intricately related to persistence. Students exhibiting higher levels of persistence tend to achieve higher academic scores (Rimfeld et al., 2016[101]; Hu, McCormick and Gonyea, 2011[102]). Persistence predicts better performance especially in mathematics (OECD, 2013[79]). Research has also shown that perseverance is a large part of students' (growth) mindset: indeed, the amount of effort individuals put forth during challenging tasks or for a specific objective is intrinsically associated with the extent to which they believe effort is essential for continued improvement (Dweck, 2006[73]). Other empirical studies have explored the relationship between perseverance and various psychological factors such as students' conscientiousness, self-regulation abilities, and engagement in academic activities (Muenks et al., 2017[103]).

Fostering students' persistence may enhance habits of hard work and a continuous pursuit of goals in and beyond formal school settings. This ability equips learners with the tenacity to overcome adversity and develop meaningful skills and mindset throughout life.

Emotional regulation

Emotional control

Emotional control or regulation plays a critical role in shaping our life experiences, including learning. It can be defined as the processes through which individuals influence the emotions they have, when they have them, and how they experience and express them (Gross, 1998[104]) to increase, appease or sustain these emotions (Usán Supervía and Quílez Robres, 2021[105]). Controlling emotions involves self-regulating negative emotions such as temper, irritation, impulsiveness, anger or anxiety (Kautz et al., 2014[106]; OECD, 2015[107]).

Empirical studies have explored the impact of emotional regulation ability on students' learning. In fact, several studies have found a positive although not direct relationship between emotional control skills and students' academic performance. Evidence demonstrated that within this relationship, self-efficacy plays a critical mediating role: students who are able to control their emotions are more likely to achieve higher academic scores when they believe in their own ability to perform specific tasks (Usán Supervía and Quílez Robres, 2021[105]; Morrish et al., 2017[108]). Other studies highlighted that students endowed with high emotional control ability are predisposed to experiencing enhanced psychological well-being and self-beliefs, and better engagement in their academic pursuits (more persistence) despite challenging circumstances (Lei, 2022[109]).

Regarding lifelong learning, emotional management ability is a foundational skill that empowers individuals to adapt and navigate through changing circumstances, and maintain engagement and motivation throughout their lifespan. Indeed, the resulting emotional stability is considered an important driver of lifetime success, influencing not only educational attainment but earnings, employment, crime rate, and health outcomes (Kautz et al., 2014[106]). Fostering emotional control skills from an early age equips individuals with the tenacity and resilience needed to thrive in an ever-changing world.

Stress resistance

Stress resistance, understood as the ability to manage and adapt to stressful situations or challenges effectively, enables individuals to maintain emotional and psychological well-being (OECD, 2015[107]). It is a robust social and emotional skill that facilitates the modulation of anxiety within and beyond school settings. Stress-resistant individuals use various coping strategies, which are cognitive and behavioural efforts to manage both external and internal stressors.

Literature has distinguished two coping styles: approach coping and avoidance coping (Moos, 1993). Approach coping involves a variety of cognitive and behavioural efforts including logical analysis (attempts to understand and prepare mentally for a stressor and its impacts), positive reappraisal (attempts to restructure a problem in a positive way while still accepting the reality of the situation), seeking guidance and support, and problem-solving. These strategies encourage individuals to engage directly with stressors to control or eradicate them. In contrast, avoidance copers tend to focus on emotions, with efforts to avoid thinking about stressors and their consequences. Avoidance coping strategies can make individuals rely on acceptance or even resignation (attempts to reject the problem), alternative rewards (attempts to get involved in substitute activities and create new sources of satisfaction), and emotional discharge (attempts to reduce tension by expressing negative feelings). These strategies may provide temporary relief but often fail to address the root cause of stress (Gustems-Carnicer, Calderón and Calderón-Garrido, 2019[110]).

The influence of stress resistance on students' mental health has been demonstrated by several empirical studies. The findings indicated a significant improvement in students' motivation in learning and a reduction in negative self-beliefs (Keogh, Bond and Flaxman, 2006[111]). One study revealed that stress-coping skills can account for almost one-third of the variance in overall life satisfaction among high-performing high-school students. Although there are some studies indicating that students experiencing less stress and engaging more in problem-focused approach coping performed better academically (Gustems-Carnicer, Calderón and Calderón-Garrido, 2019[110]), the literature has not reached consensus on a direct relationship between stress management skills and performance. Most results highlight the mediation of mental health (especially through an improved self-efficacy) within this relationship, making the correlation significant (Suldo, Shaunessy and Hardesty, 2008[112]).

Since it enables the adults of tomorrow to manage and adapt to an increasingly complex and demanding world, and gives them the possibility to fully employ their cognitive and emotional skills in their learning experiences, stress resistance with the underlying resilience-building strategies seems to be a major driver in lifelong learning.

Collaboration

Co-operation

At its core, co-operation signifies one's orientation towards harmonious interactions and appreciation for interconnectedness among individuals. The concept of co-operative learning is characterised by five key elements, which collectively contribute to creating an environment where students collaborate to understand and internalise academic material: positive interdependence, promotive interaction, individual and group accountability, group processing, and the development of small-group interpersonal skills. Additionally, some authors make a clear distinction between co-operative learning and collaborative learning. Unlike collaborative learning, where the instructor actively participates with students in the discovery and creation of knowledge, co-operative learning supports the traditional role of the teacher as a subject expert and classroom authority (Bruffee, 1995[113]; Yamarik, 2007[114]).

Co-operative learning is grounded in the belief that individuals can achieve more collectively than they can individually. However, the relationship between co-operation and performance seems complex. In fact, some evidence suggests that co-operation/collaboration may be negatively associated with students' academic performance (OECD, 2021[115]).

Co-operative learning methods such as Think-Pair-Share, Jigsaw, and structured controversy, have been explored extensively for their potential benefits in enhancing critical-thinking skills, especially in reading (Devi, Musthafa and Gustine, 2016[116]). Encouraging student-student interactions, providing group purposes, and stimulating students' idea generation have been identified as key mechanisms through which co-operative learning promotes critical thinking. Furthermore, co-operative learning was found to increase students' motivation and persistence in the learning process (Springer, Stanne and Donovan, 1999[117]), thereby fostering opportunities for language use and interpersonal relationship development. According to the OECD (2021), co-operative students are more likely to expect completing tertiary education, suggesting a long-term commitment to learning.

In addition, literature has demonstrated that the impact of co-operative learning extends beyond academic achievement. Research has shown that it significantly reduces bullying, with empathy serving as a mediator for this effect. Co-operative learning was also strongly associated with increased empathy, which in turn was mediated by peer-relatedness (Van Ryzin and Roseth, 2019[118]). These findings highlight the potential of co-operative learning not only to improve students' academic outcomes but foster a positive and empathetic school environment. It is also important to consider co-operation as a component of a broader educational approach that prepares students for lifelong learning.

Assertiveness

Defined as the ability to confidently voice opinions, needs, and feelings, assertiveness enables individuals to exert social influence effectively. Assertive individuals are not only confident in expressing themselves but possess the courage to take a stand and confront others when necessary without exerting coercion (OECD, 2021[115]; Kankaraš and Suarez-Alvarez, 2019[119]; Marugán de Miguelsanz, Carbonero Martín and Palazuelo Martínez, 2017[120]). An assertive individual maintains composure in face of opposition, which implies empathy and moral values, enabling them to understand different perspectives and adapt their responses accordingly.

Research has not reached a consensus on the relationship between assertiveness and academic performance. On one hand, empirical studies have revealed a negative correlation, albeit of low magnitude, between these variables in subjects like social and natural sciences, mathematics, and technology. This correlation was weaker in language subjects. Moreover, students tend to report greater assertiveness with age (Marugán de Miguelsanz, Carbonero Martín and Palazuelo Martínez, 2017[120]).

On the other hand, several studies have found that assertiveness and task performance are positively associated when students are surrounded by assertive pairs (Moneva and Bolos, 2020[121]). Some authors have explored this positive relationship by explaining it with anxiety. Students with lower assertiveness levels may experience higher levels of anxiety, leading to reduced academic performance (González Fragoso et al., 2018[122]).

Furthermore, statistically significant gender differences in both assertiveness and anxiety levels have been identified: men tend to display less assertiveness and are more prone to aggressive behaviours when facing adversity while women report higher levels of anxiety and obsessive preoccupations.

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Annex B1. Results for countries and economies

The following tables are available in electronic form only. Please click on the StatLink after each table to access them.

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StatLink https://stat.link/pvl3j8

Annex C. The development and implementation of PISA: A collaborative effort

PISA is a collaborative effort, bringing together experts from the participating countries, steered jointly by their governments based on shared, policy-driven interests.

A PISA Governing Board, on which each country is represented, determines the policy priorities for PISA, in the context of OECD objectives, and oversees adherence to these priorities during the implementation of the programme. This includes setting priorities for the development of indicators, for establishing the assessment instruments and for reporting the results.

Experts from participating countries also serve on working groups that are charged with linking policy objectives with the best internationally available technical expertise. By participating in these expert groups, countries ensure that the instruments are internationally valid and take into account the cultural and educational contexts in OECD Member and Partner countries and economies, that the assessment materials have strong measurement properties, and that the instruments place emphasis on authenticity and educational validity.

Through National Project Managers, participating countries and economies implement PISA at the national level subject to the agreed administration procedures. National Project Managers play a vital role in ensuring that the implementation of the survey is of high quality, and verify and evaluate the survey results, analyses, reports and publications.

The design and implementation of the surveys, within the framework established by the PISA Governing Board, is the responsibility of external contractors. For PISA 2022, the overall management of contractors and implementation was carried out Educational Testing Service (ETS) in the United States as the Core A contractor. Tasks under Core A also included the instrument development, development of the computer platform, survey operations and meetings, scaling, analysis and data products. These tasks were implemented in co-operation with the following subcontractors: i) the University of Luxembourg for support with test development, ii) the *Unité d'analyse des systèmes et des pratiques d'enseignement* (aSPe) at the University of Liège in Belgium for test development and coding training for open-constructed items, iii) the International Association for Evaluation of Educational Achievement (IEA) in the Netherlands for the data management software, iv) Westat in the United States for survey operations, and v) HallStat SPRL in Belgium for translation referee.

The remaining tasks related to the implementation of PISA 2022 were implemented through additional contractors – Cores B1, B2, B3, C, D and E to D. The Research Triangle Institute (RTI) in the United States facilitated the development of the mathematics assessment framework as the Core B1 contractor. ETS also facilitated the development of the background questionnaire frameworks as the Core B2 contractor. ACT/ACTNext in the United States Netherlands performed the test development for the innovative domain as the Core B3 contractor. Core C focused on sampling and was implemented by Westat in the United States in co-operation with the Australian Council for Educational Research (ACER). Core D was managed by cApStAn Linguistic Quality Control in Belgium for linguistic quality control in co-operation with BranTra in Belgium. Core E focused on country preparation and implementation support and was managed by the Australian Council for Educational Research (ACER) in Australia.

The OECD Secretariat has overall managerial responsibility for the programme, monitors its implementation daily, acts as the Secretariat for the PISA Governing Board, builds consensus among countries and serves as the interlocutor between the PISA Governing Board and the international Consortium charged with implementing the activities. The OECD Secretariat also produces the indicators and analyses and prepares the international reports and publications in co-operation with the PISA Consortium and in close consultation with Member and Partner countries and economies both at the policy level (PISA Governing Board) and at the level of implementation (National Project Managers).

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PISA 2022 Results (Volume V)

LEARNING STRATEGIES AND ATTITUDES FOR LIFE

The OECD's Programme for International Student Assessment (PISA) does more than assess what students know. PISA examines how they use their knowledge and skills to meet real-life challenges, offering invaluable insights into both the quality and equity of education worldwide. In this final volume of the PISA 2022 initial report, Volume V: Learning Strategies and Attitudes for Life takes a deep dive into one of the most critical aspects of modern education: students' readiness for lifelong learning. This volume explores how education systems prepare students to navigate and thrive in an unpredictable future, focusing on their learning strategies, motivation and self-beliefs. It also delves into the role of socio-economic background, gender and the support students receive from parents and teachers in shaping their readiness for sustained lifelong learning. As education evolves to meet the challenges of tomorrow, this volume provides crucial insights for educators and policy makers who want to foster resilient, self-directed learners who are ready to succeed in a rapidly changing world.

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