UNESCO Institute for Statistics

## SDG 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

### METADATA

**Target 4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship**

**4.4.2 Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills**

### Definition

In this document, we use data from the Program for the International Assessment of Adult Competencies (PIAAC) to estimate the proportion of youth/adults who reach the targets set by SDG Thematic Indicator 4.4.2 for each country and region with available data. To do that, we build on the Digital Literacy Global Framework (Law et al., 2018) and the Recommendations on Assessment Tools for Monitoring Digital Literacy (Laanpere, 2019). So, drawing on this body of literature we use the following working definition of Digital Literacy (DL):

> ***Digital Literacy (DL)***
> Digital literacy involves the confident and critical use of a full range of digital technologies for information, communication and basic problem-solving in all aspects of life. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.

Based on the two reports mentioned above, we establish a global content framework for indicator 4.4.2. This exercise resulted in a framework with seven competence areas and several competences within each area (see Table 1). The main competence areas are Devices and software operations, Information and data literacy, Communication and collaboration, Digital content creation, Safety, Problem-solving, and Career-related competences.

Table 1. Global Content Framework for SDG indicators 4.4.2

| Competence areas | Competences |
|---|---|
| 0. Devices and software operations | 0.1 Physical operations of digital devices |
| | 0.2 Software operations in digital devices |
| 1. Information and data literacy | 1.1 Browsing, searching and filtering data, information and digital content |
| | 1.2 Evaluating data, information and digital content |
| | 1.3 Managing data, information and digital content |
| 2. Communication and collaboration | 2.1 Interacting through digital technologies |
| | 2.2 Sharing through digital technologies |
| | 2.3 Engaging in citizenship through digital technologies |
| | 2.4 Collaborating through digital technologies |
| | 2.5 Netiquette |
| | 2.6 Managing digital identity |
| 3. Digital content creation | 3.1 Developing digital content |
| | 3.2 Integrating and re-elaborating digital content |
| | 3.3 Copyright and licences |
| | 3.4 Programming |
| 4. Safety | 4.1 Protecting devices |
| | 4.2 Protecting personal data and privacy |
| | 4.3 Protecting health and well-being |
| | 4.4 Protecting the environment |
| 5. Problem-solving | 5.1 Solving technical problems |
| | 5.2 Identifying needs and technological responses |
| | 5.3 Creatively using digital technologies |
| | 5.4 Identifying digital competence gaps |
| | 5.5 Computational thinking** |
| 6. Career-related competences | 6.1 Operating specialised digital technologies for a particular field |
| | 6.2 Interpreting and manipulating data, information and digital content for a particular field |

Once the Global content Framework was established, we carried out a mapping exercise to evaluate the extent to which the different concepts contained in the framework (i.e., competence areas and competences) can be operationalised with the instruments and procedures of existing digital literacy assessments. The digital literacy assessments evaluated were: OECD’s Programme for the International Assessment of Adult Competencies (PIAAC) (OECD, 2012), the OECD's Programme for International Student Assessment (PISA) (OECD, 2019a), and the IEA International Computer and Information Literacy Study (ICILS) (Fraillon et al., 2019).

The mapping exercise identified PIAAC as the most valuable source of information for SGD indicator 4.4.2. PIAAC was chosen due to its conceptual framework (OECD, 2012), which showed the highest coverage of the topics relevant to this indicator. Additional reasons for the selection of PIAAC were that its target population covers the two groups mentioned in the indicator (youth and adults); as well as its potential to inform long-term monitoring.
PIAAC is a programme of assessment and analysis of adult skills. This assessment measures the proficiency of adults from the age of 16 to 65 years in key information-processing skills (i.e., literacy, numeracy and problem-solving in technology-rich environments) and gathers information and data on how adults use their skills at home, at work and in the wider community.

The items used to operationalise SDG 4.4.2 were the ones corresponding to the PIAAC's dimension of Problem-solving in technology-rich environments. This skill refers to the ability to use technology to solve problems and accomplish complex tasks. It is not a direct measure of computer literacy, as it also measures the capacity to operate within a digital environment to solve the types of problems that adults face in their everyday life as users of digital technologies (see OECD, 2012 for more details).

In PIAAC, Problem-solving in technology-rich environments is conceived along three dimensions (see Figure 1), measured with 16 tasks based on problem-solving scenarios.

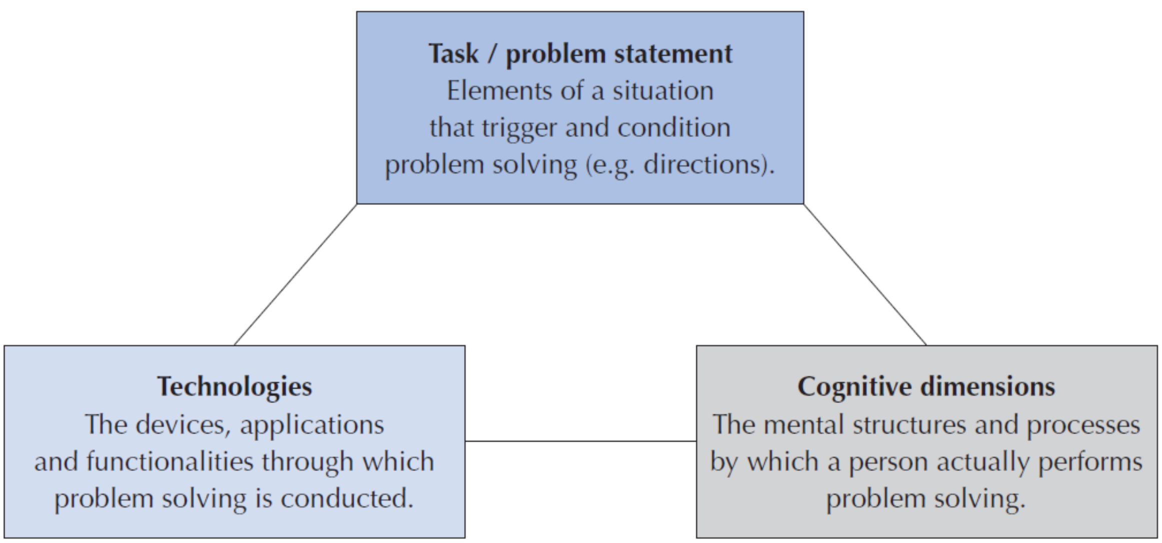


Figure 1. Core dimensions of problem-solving in technology-rich environments. Source: OECD (2012, p. 48).

The performance of the participants in PIAAC is used to produce a proficiency scale (i.e., score) that ranges from 0 to 500. This scale is then divided into four proficiency levels based on the knowledge and skills required to complete the tasks within those levels. Respondents at a particular level not only demonstrate knowledge and skills associated with that level but also the proficiencies required at lower levels. So, for example, respondents scoring at Level 2 are also proficient at Level 1.

To create the levels, an expert group in problem-solving in technology-rich environments met with psychometricians and test developers and reviewed data, looked at the tasks along the 500-point scale, and determined the requisite skills and knowledge to complete those tasks progressively increased along the scale.

By comparing the definition of SDG 4.4.2 and the description of the problem-solving in technology-rich environments, we identified level 2 as the threshold or cut-off point to estimate the proportion of respondents reaching the indicator within each country. At level 2, tasks typically require the use of both generic and more specific technology applications.

In what follows, we describe our analytical strategy, and, in order to aid the interpretation of the indicators, we present the definition of the cut-off points used to consider students to have reached the standards evaluated.

**Calculation method**

Since the test design for PIAAC is based on a variant of matrix sampling (using different sets of items, multistage adaptive testing, and different assessment modes) where each respondent was administered a subset of items from the total item pool. The responses to the subset of test items are scaled using IRT methodology and combined with other background information (provided by the respondent) and model parameters to produce a set of 10 plausible values (PVs). These PVs can be used to produce group-level estimations of proficiency values (OECD, 2013).

According to the PIAAC Technical Report (OECD, 2013), the following steps can be followed to calculate an estimate $\mathrm{T}$ of the proficiency values $\Theta$ using PVs and to calculate an estimate of the variance of $\mathrm{T}$:

1. Using the first vector of plausible values for each respondent, evaluate $\mathrm{T}$ as if the plausible values were the true values of $\Theta$. Denote the result $\mathrm{T}_1$.

2. In the same manner as in step 1 above, evaluate the sampling variance of $\mathrm{T}$, or $\mathrm{Var}(\mathrm{T}_1)$, with respect to respondents' first vectors of plausible values. Denote the result $\mathrm{Var}_1$.

3. Carry out steps 1 and 2 for the second through all 10 vectors of plausible values, thus obtaining $\mathrm{T}_\upsilon$ and $\mathrm{Var}_\upsilon$ for $\upsilon$=2,. . ., 10.

4. The best estimate of T obtainable from the plausible values is the average of the 10

values obtained from the different sets of plausible values:

$$\mathrm{T}_{.} = \frac{\sum_{v} \mathrm{T}_{v}}{10} \tag{1}$$

5. An estimate of the variance of T is the sum of two components: an estimate of Var($\mathrm{T}_v$) obtained as in step 4 and the variance among the $\mathrm{T}_v$s:

$$Var\mathrm{T}_{.} = \frac{\sum_{n} Var_{v}}{10} + \left(1 + \frac{1}{10}\right)\frac{\sum_{v}(\mathrm{T}_{v} - \mathrm{T}_{.})^{2}}{10 - 1} \tag{2}$$

   The first component in $Var(\mathrm{T}_{.})$ reflects uncertainty due to sampling from the population; the second component reflects uncertainty because the respondents' proficiencies Θ are only indirectly observed.

Then, using the cut-off points established for the scale, the proportion of students respondents reaching the corresponding standard is estimated within each country or region as a simple proportion (*P*).

$$P = \frac{X}{n} \tag{3}$$

Where $X$ is the number of respondents that reach the standard in each country and $n$ is the total number of respondents in the same country.

**Data source**
The data was sourced from the Programme for the International Assessment of Adult Competencies (PIAAC). PIAAC, also known as the Survey of Adult Skills, is a large-scale international household study conducted under the auspices of the Organization for Economic Cooperation and Development (OECD) that assesses the key cognitive and workplace skills that adults need to participate successfully in 21st-century society and the global economy. The data has been collected in 40 countries/economies over three cycles between 2011 and 2017. However, the data reported here was available only for 31 countries: Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, Germany, Ireland, Japan, Korea, Rep. of, Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Sweden, United Kingdom, Chile, Greece, Israel, Lithuania, New Zealand, Singapore, Slovenia, Turkey, Ecuador, Hungary, Kazakhstan, Mexico, Peru.

**Definition of cut-off points (standards)**

At the threshold, respondents typically require the use of both generic and specific technology applications. Adults at this level are typically able to use software they have never seen before to solve problems, even when unexpected impasses/outcomes occur. For example, they are likely able to:

- Figure out how to send an email message to a number of contacts using an unfamiliar bulk email function
- Use a sorting tool to make it easier to locate sales numbers for a specific product in a company spreadsheet
- Conduct a web search to find out how to solve a problem with other software, such as how to view a column that won't display properly in a spreadsheet
- Find an email message or file that has been "lost" somewhere on a computer hard drive

Table 2. Data disaggregation

| DEFINITION | METRICS | ITEM AND DESCRIPTION | CATEGORIES | INSTRUMENT |
|---|---|---|---|---|
| Sex | Nominal | Person resolved gender from Background questionnaire (derived) | Female, Male, Not stated or inferred (missing). | Background questionnaire (link) |
| Educational level | Ordinal | Which of the qualifications on this card is the highest you have obtained?<br>*Response categories were collapsed into 'Tertiary education' (ISCED 5A, 5B and 6); and 'Non-tertiary education' (the rest). | - No formal qualification or below ISCED 1<br>- ISCED 1<br>- ISCED 2<br>- ISCED 3C shorter than 2 years<br>- ISCED 3C 2 years or more<br>- ISCED 3A-B<br>- ISCED 3 (without distinction A-B-C, 2y+)<br>- ISCED 4C<br>- ISCED 4A-B<br>- ISCED 4 (without distinction A-B-C)<br>- ISCED 5B<br>- ISCED 5A, bachelor degree<br>- ISCED 5A, master degree<br>- ISCED 6 | Background questionnaire (link) |
| SES (parental education) | Ordinal | Highest of mother or father's level of education (derived)<br>*Response categories were collapsed into 'High SES' or at least one parent with tertiary education (ISCED 5A, 5B and 6); 'Low SES' or none of the parents with tertiary education (the rest). | - No formal qualification or below ISCED 1<br>- ISCED 1<br>- ISCED 2<br>- ISCED 3C shorter than 2 years | Background questionnaire (link) |

| Definition | Metrics | Item and description | Categories | Instrument |
| --- | --- | --- | --- | --- |
| | | | - ISCED 3C 2 years or more<br>- ISCED 3A-B<br>- ISCED 3 (without distinction A-B-C, 2y+)<br>- ISCED 4C<br>- ISCED 4A-B<br>- ISCED 4 (without distinction A-B-C)<br>- ISCED 5B<br>- ISCED 5A, bachelor degree<br>- ISCED 5A, master degree<br>- ISCED 6 | |
| Age | Ordinal | Person resolved age from Background Questionnaire (derived)<br>*Response categories were collapsed into 'Older adults' (55 plus) and 'Younger adults' (the rest). | - 24 or less<br>- 25-34<br>- 35-44<br>- 45-54<br>- 55 plus<br>- <16<br>- >65<br>- Not stated or inferred | Background questionnaire (link) |

**Limitations**

In very simple terms, cut-off scores refer to a point in a scale used to classify individuals, according to the level of the attribute being measured, between those above and below a threshold. As such, this threshold should represent a meaningful interpretation of the level of the attribute under study, in this case, "digital literacy skills". In other words, individuals scoring above the threshold should be able to demonstrate "a minimum level of proficiency in digital literacy skills". We have decided to follow the methodology proposed by the OECD to determine the thresholds for SDG 4.4.2. That is, we have selected proficiency level 2 of the scale "problem-solving in technology-rich environments" as the threshold or cut-off point. Additionally, we have provided a description of what this threshold means according to the PIAAC framework (e.g., the types of tasks that can be completed by adults who reach the threshold). The selection and interpretation of this particular threshold are, however, open to discussion among the relevant stakeholders (see OECD, 2013 for details on the methodology and description of the proficiency levels).

PIAAC data are uniquely suited to contribute to measuring SDG 4.4.2 because its methods ensure that comparable information is collected across all participating countries. This is a significant advantage compared to the alternative of compiling and harmonizing national datasets or developing a purpose-built study. However, it is important to keep in mind that PIAAC was not designed to measure SDG 4.4.2. For this reason, the information used here has limitations related to at least two areas: availability (e.g. the country coverage), and relevance (e.g. the scales produced here can only be considered as proxy measures of the concepts established in SDG 4.4.2).

Finally, it is important to consider that the "problem-solving in technology-rich environments" proficiency scores have some limitations related to the PIAAC design. As explained by PIAAC Reader's Companion (OECD, 2019b, p. 76), the populations for whom these proficiency scores are reported are not identical across countries/economies. Proficiency scores relate only to the proportion of the target population in each participating country that was able to undertake the computer-based version of the assessment, and thus meets the preconditions for displaying competency in this domain. Four groups of respondents did not take the computer-based assessment, those who:

- indicated in completing the background questionnaire that they had never used a computer (group 1)
- had some experience with computers but who "failed" the ICT core assessment (see Chapter 3) designed to determine whether a respondent had the basic computer skills necessary to undertake the computer-based assessment (group 2)
- had some experience with computers but opted not to take the computer-based assessment (group 3)
- did not attempt the ICT core for literacy-related reasons (group 4).

By definition, a minimum level of competency in the use of computer tools and applications and a minimum level of proficiency in literacy and numeracy is required in order to display proficiency in “problem-solving in technology-rich environments”. Individuals in groups 1 and 2 are, thus, treated as not meeting the necessary preconditions for displaying proficiency and have no proficiency score in the domain of problem-solving in technology-rich environments. Respondents who did not attempt the ICT core for literacy-related reasons (group 4) have not been attributed a problem-solving score due to a lack of sufficient information. Respondents who opted not to take the computer-based assessment (group 3), however, represent a different category. They are individuals who, on their own initiative, decided to take the paper-and-pencil version of the assessment without going through the process designed to direct respondents to the computer-based or paper pathways of the assessment. As a result, it is not known whether or not they possessed the computer skills necessary to complete the computer-based assessment. Three options for how to treat this group were considered: imputing their proficiency scores on the basis of their proficiency in literacy and numeracy and their background characteristics; treating them as non-respondents; or reporting them as a separate category of the group that could not display competency. The latter option was adopted. Imputation was rejected on the grounds that refusals appeared to have different characteristics to respondents taking the computer-based assessment pathway. In fact, they appeared to be more similar to the respondents who did not have computer skills than to those who took the computer-based assessment. The option of treating them as non-respondents was rejected for similar reasons.

As a result of the limitations described above, there are missing values that are not addressed through imputation or weighting—as their characteristics are different from those that did complete the assessment. The estimates reported here assume that the individuals that, for any of the three reasons described above, did not complete the assessment did not reach the target established by SDG 4.4.2. We believe that this is a reasonable assumption since those individuals who have insufficient computer or literacy skills to answer the test are extremely unlikely to reach proficiency level 2 if they had taken the test. However, there is some degree of uncertainty due to the fact that they did not take the “problem-solving in technology-rich environments” assessment.

## References


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