Goal: 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Target: 4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development

Indicator: 4.7.5 Percentage of 15-year-old students showing proficiency in knowledge of environmental science and geoscience

Institutional information

Organization(s):
UNESCO Institute for Statistics (UNESCO-UIS)
UNESCO Education Sector, Division for Peace and Sustainable Development, Section of Education for Sustainable Development (UNESCO-ED/PSD/ESD)

Concepts and definitions

Definition:
In this report, we use data from TIMSS 2015 to estimate the proportion of students who reach the targets set by SDG Thematic Indicator 4.7.5 for each country and region with available data. To do that we build on previous work conducted by UNESCO and partially adopt the definitions and operationalization advanced in recent documents (e.g. Hoskins, 2016; IBE, 2016; Sandoval-Hernández & Miranda, 2018; UIS, 2017; UNESCO, 2012a, 2012b, 2013, 2014, 2015). So, drawing on this body of literature we use the following working definitions of GCED and ESD:

Global Citizenship Education (GCED): nurtures respect for all, building a sense of belonging to a common humanity and helping learners become responsible and active global citizens. GCED aims to empower learners to assume active roles to face and resolve global challenges and to become proactive contributors to a more peaceful, tolerant, and inclusive and secure world.

Education for Sustainable Development (ESD): empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and

future generations, while respecting cultural diversity. It is about lifelong learning and is an integral part of quality education.

The operationalization of these concepts is based on the work of a research team from the International Bureau of Education (IBE) and the Global Education Monitoring Report (GEMR) team that developed a coding scheme (IBE, 2016) to evaluate 78 national curricula for evidence of GCED and ESD content. The exercise involved several pilots, parallel coding with different coders coding the same documents, and resulted in a scheme with seven categories in the knowledge dimension (see Table 1): Interconnectedness and Global Citizenship; Gender Equality; Peace, Non-violence and Human Security; Human Rights; Health and Well-being; Sustainable Development; and Environmental Science. Each of these categories was further divided into sub-categories and then operationalised using the items of ILSA instruments. The first six categories are considered for indicator 4.7.4 and the last one for indicator 7.4.5.

Table 1. Global Content Framework for SDG indicators 4.7.4 and 4.7.5

	Category	Sub-category
Global Citizenship Education (GCED)	Interconnectedness and Global Citizenship	Globalization
		Global/international citizen(ship), global culture/identity/community
		Global-local thinking, local-global, think global act local, glocal
		Multicultural(ism)/intercultural(ism)
		Migration, immigration, mobility, movement of people
		Global Competition/competitiveness/globally competitive/international competitiveness
		Global Inequalities/disparities
	Gender Equality	Gender equality / equallity / parity
		Empower(ment of) women/girls (female empowerment, encouraging female participation)
	Peace, Non-violence and Human Security	Peace, peace-building
		Awareness of forms of abuse/harassment/violence (school-based violence/bullying, household-based violence, gender-based violence, child abuse/harassment, sexual abuse/harassment)
	Human Rigts	Human rights, rights and responsibilities (children's rights, cultural rights, indigenous rights, women's rights, disability rights)
		Freedom (of expression, of speech, of press, of association/organisation), civil liberties
		Social justice
		Democracy/democratic rule, democratic values/principles
Education for Sustainable Development (ESD)	Health and Well-being	Physical health/activity/fitness
		Mental, emotional health, psychological health
		Healthy lifestyle (nutrition, diet, cleanliness, hygiene, sanitation, *clean water, being/staying healthy)
		Awareness of addictions (smoking, drugs, alcohol)
		Sexual and/or reproductive health
	Sustainable Development	Economic sustainability, sustainable growth, sustainable production/consumption, green economy
		Social sustainability, (social cohesion re sustainability)
		Environmental sustainability/environmentally sustainable
		Climate change (global warming, carbon emissions/footprint)
		Renewable energy, alternative energy (sources) (solar, tidal, wind, wave, geothermal, biomass…)
		Ecology, ecological sustainability (ecosystems, biodiversity, biosphere, ecology, loss of diversity)
		Waste management, recycling
	Environmental Science (geoscience)	Physical systems
		Living systems
		Earth and space systems

Furthermore, drawing on a review of recent literature, we incorporated the three core dimensions proposed by UNESCO to measure learning outcomes in GCED/ESD in this mapping exercise (UNESCO, 2015). These dimensions are interrelated and are presented in Table 2, each indicating the domain of learning they focus on (see Sandoval-Hernández et al., 2019 for further details).

Table 2. Core conceptual dimensions of environmental education

Cognitive:
To acquire knowledge, understanding and critical thinking necessary to encompassing the range of cognitive processes involved in learning environmental science concepts, and then applying these concepts and reasoning with them.
Socio-emotional:
To have intrinsic motivation to learn environmental science.
Behavioural:
To have self-confidence or self-concept in their ability to learn environmental science.

The final selection of items was then used to produce a score for each subcategory and to estimate the proportion of the students who reached each of the standards evaluated. Finally, these proportions were combined in a global indicator indicating the proportion of students who reached any of the standards evaluated.

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.

The indicator and its methodology have been reviewed and endorsed by UNESCO's Technical Cooperation Group on the Indicators for SDG 4-Education 2030 (TCG), which is responsible for the development and maintenance of the thematic indicator framework for the follow-up and review of SDG 4. The TCG is composed of 38 regionally representative experts from UNESCO Member States (nominated by the respective geographic groups of UNESCO), as well as international partners, civil society, and the Co-Chair of the Education 2030 Steering Committee. The UNESCO Institute for Statistics acts as the Secretariat.

Analytical strategy

The analytical strategy includes five main steps: verify the availability of observed responses to the items proposed by the mapping exercise described above, test the unidimensionality of the intended constructs, fit the corresponding measurement models to obtain scores for each standard, estimate the cut-off points to identify the students who reach each of the standards evaluated.

Once the final set of items to be included in each scale was identified based on the availability of responses and the analysis of unidimensionality, we used a latent variable model approach to obtain the corresponding scores. More specifically, we use a partial credit model (Masters, 2016). Formally, this model can be described by Equation 1 (see Wu et al., 2016):

$$Pr(Y_{ip} = j|\theta_p) = \frac{\exp \sum_{k=0}^{j}(\theta_p - \delta_{ik})}{\sum_{h=0}^{m_i} exp \sum_{k=0}^{h}(\theta_p - \delta_{ik})} \quad (1)$$

Then, using the cut-off points established for each scale, we estimated the proportion of students reaching the standards within each country or region as a simple proportion (see Equation 2).

$$P = \frac{X}{n} \tag{2}$$

We also estimated the proportion of students who meet any of the standards stipulated by indicator 4.7.5, for each country and region for which data is available. To this end, we estimated a mean score that summarizes all the standards that a student has met. This mean score varies from 0 to 1, where the maximum is achievable by a student if and only if this student has met all the standards where he or she was classified. Zero was assigned if a student did not meet any of the proposed standards. Likewise, if a student satisfied two out of three standards, then he or she was attributed a score of .66 (2/3). This calculation is expressed in Equation 3.

$$\overline{D}_i = \frac{\sum_i^{n_D} D_i}{n_D} \tag{3}$$

Data Sources

The data was sourced from the latest cycles of the IEA Trends in International Mathematics and Science Study (TIMSS). TIMSS is an international assessment of mathematics and science at the fourth and eighth grades that has been conducted every four years since 1995. TIMSS 2015 is the sixth assessment in the TIMSS series monitoring 20 years of trends in educational achievement, together with comprehensive data on students' contexts for learning mathematics and science. In 2015, 57 countries and 7 benchmarking entities (regional jurisdictions of countries such as states or provinces) participated in TIMSS. In total, more than 580,000 students participated in TIMSS 2015.

Description of cut-off points (standards)

4.7.5 – Percentage of 15-year-old students showing proficiency in knowledge of environmental science and geoscience

COGNITIVE (4.7.5)

At the threshold, students apply and communicate their understanding of concepts from environmental science and geoscience in everyday and abstract situations. They communicate their understanding of ecosystems and the interaction of organisms with their environment and apply some knowledge of human health related to nutrition and infectious disease. Students show some knowledge and understanding of the composition and properties of matter and chemical change. They apply knowledge of Earth's physical features, processes, cycles, and history, and show some understanding of Earth's resources, their use, and conservation as well as some knowledge of the interaction between the Earth and the Moon.

NON-COGNITIVE (4.7.5)

Enjoy environmental science and geoscience

At the threshold, students have more than 50% chances to express high enjoyment of learning environmental science and geoscience. Most of the students at or above the cut-off score agree a lot to expressions such as "I like to conduct science experiments", "I learn many interesting things in science" or "I like Science". Complementary, most of the students at or above the cut-off score express disagreement to expressions such as "Science is boring" or "I wish I did not have to study science".

Confidence in environmental science and geoscience

At the threshold, students have more than 50% chances to report high confidence in learning environmental science and geoscience. Most of the students at or above the cut-off score highly disagree with the statement "Science makes me confused", and express agreement to statements such as "I learn things quickly in science", "I usually do well in science", or "I'm good to work out difficult science problems".

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 under study, 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 'knowledge of environmental science and geoscience'. In other words, students scoring above the threshold should be able to demonstrate 'proficiency in knowledge of environmental science and geoscience'. In this report, we have used a well-established statistical method (wright-maps) to

determine the thresholds for the scales we constructed, and we have provided a description of what these thresholds mean according to the TIMSS framework (e.g. how much students know and understand, what their perceptions about different issues are and how are they willing to act on them). Nevertheless, the exact position of the thresholds in the different scales could be open for discussion among stakeholders.

ILSA data are uniquely suited to contribute to measuring SDGs because their methods ensure that comparable student, school and system 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 TIMSS was not designed to measure SDG 7.4.5. For this reason, the information used here has limitations related to availability (e.g. the country coverage), sufficiency (e.g. there not items to cover all the dimensions established in the global content framework), and relevance (e.g. the scales produced here can only be considered as proxy measures of the concepts established in SDG 4.7.5).

Data Disaggregation

Each of the standards described above are published disaggregated by student sex, school location, socio-economic status and parental level of education. Information on the disaggregation for Indicator 4.7.4 is presented in the following table.

Table 3. Data disaggregation

Study	Definition	Metrics	Item and description	Categories	Instrument
TIMSS 2015	Sex of students	Nominal	Are you a girl or a boy?	Girl, Boy	Student questionnaire (link)
TIMSS 2015	School location	Ordinal	How many people live in the city, town, or area where your school is located? * Response categories were collapsed into 'urban' (100,0001 and above) and 'non-urban' (the rest)	- More than 500,000 people - 100,001 to 500,000 people - 50,001 to 100,000 people - 30,001 to 50,000 people - 15,001 to 30,000 people - 3,001 to 15,000 people - 3,000 people or fewer	School questionnaire (link)
TIMSS 2015	Socio-economic status	Scale	Home Educational Resources Scale (HER), which is derived based on students' responses concerning the availability of three resources: number of books in the home, number of home study supports, and highest level of education of either parent. * This index was re-coded into two categories		Student questionnaire (link) Details on the construction of the index are in the

			corresponding to above and below the mean HER within each country.		TIMSS 2015 Technical Report (link)
TIMSS 2015	Parental education	Ordinal	What is the highest level of education completed by your mother/father or <female/male guardian>? * Response categories were collapsed into 'higher education' (Bachelor's or equivalent level-ISCED Level 6 and above) and 'non-higher education' (the rest)	- Some <Primary education-ISCED Level 1 or Lower secondary education-ISCED Level 2> or did not go to school - <Lower secondary education-ISCED Level 2> - <Upper secondary education-ISCED Level 3> - <Post-secondary, non-tertiary education-ISCED Level 4> - <Short-cycle tertiary education-ISCED Level 5> - <Bachelor's or equivalent level-ISCED Level 6> - <Postgraduate degree: Master's-ISCED Level 7 or Doctor-ISCED Level 8>	Student questionnaire (link) Details on the combination of the responses for father and mother education can be found in the ICCS 2016 Technical Report (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 under study, 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 'knowledge of environmental science and geoscience'. In other words, students scoring above the threshold should be able to demonstrate '***proficiency*** in knowledge of environmental science and geoscience'. In this report, we have used a well-established statistical method (wright-maps) to determine the thresholds for the scales we constructed, and we have provided a description of what these thresholds mean according to the TIMSS framework (e.g. how students' proficiency in mathematics and science varies along the TIMSS scale). Nevertheless, the exact position of the thresholds in the different scales could be open for discussion among stakeholders.

ILSA data are uniquely suited to contribute to measuring SDGs because their methods ensure that comparable student, school and system 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 TIMSS was designed to measure SDG 7.4.5. For this reason, the information used here has limitations related to availability (e.g. the country coverage), sufficiency (e.g. there are not items to cover all the dimensions and subcategories established in the global content framework), and relevance (e.g. the scales produced here can only be considered as proxy measures of the concepts established in SDG 4.7.5).

References

Hoskins, B. (2016). Towards the development of an international module for assessing learning in Global Citizenship Education (GCE) and Education for Sustainable Development (ESD): A critical review of current measurement strategies. UNESCO. https://www.gcedclearinghouse.org/sites/default/files/resources/245620e.pdf

IBE. (2016). Global Monitoring of Target 4.7: Themes in National Curriculum Frameworks: Vol. IBE/2016/WP/CD/06. International Bureau of Education - UNESCO.

Sandoval-Hernández, A., Isac, M. M., & Miranda, D. (2019). Measurement Strategy for SDG Global Indicator 4.7.1 and Thematic Indicators 4.7.4 and 4.7.5 using International Large-Scale Assessments in Education. UNESCO Institute for Statistics. http://gaml.uis.unesco.org/wp-content/uploads/sites/2/2019/08/GAML6-REF-9-measurement-strategy-for-4.7.1-4.7.4-4.7.5.pdf

Sandoval-Hernández, A., & Miranda, D. (2018). Exploring ICCS 2016 to measure progress toward target 4.7. UNESCO.

UIS. (2017). Measurement strategy for SDG Target 4.7: Vol. GAML4/17. UNESCO Institute for Statistics.

UNESCO. (2012a). Education for Sustainable Development Sourcebook. UNESCO.

UNESCO. (2012b). Exploring Sustainable Development: A Multiple-Perspective Approach. UNESCO.

UNESCO. (2013). Global Citizenship Education: An Emerging Perspective, Outcome document of the Technical Consultation on Global Citizenship Education. UNESCO.

UNESCO. (2014). Global Citizenship Education, Preparing Learners for the 21st Century. UNESCO.

UNESCO. (2015). Global Citizenship Education, Topics and Learning Objectives. UNESCO.