

**PISA 2021 Unit Submission Guidelines:
Mathematical Literacy**

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PISA 2021 SUBMISSION GUIDELINES: MATHEMATICAL LITERACY

Introduction

Mathematical Literacy is the major assessment domain in the 2021 cycle of PISA. As such, the Core a Contractor must develop a set of new Mathematical Literacy items that will be added to the current pool of trend items. During the spring of 2018, the Core a Contractor will conduct specific item-writing workshops with participating countries. In order to maximize the effectiveness of these workshops, we invite country teams to submit draft units or stimuli ideas (i.e., text and any associated graphics) prior to the workshop.

This document contains a brief overview of the draft 2021 Mathematical Literacy Framework¹, including the mathematical content categories, processes, and contexts. The information contained within this document is not meant to replace what is covered in the framework. Therefore, the draft framework is being sent to you along with these guidelines. Participants are encouraged to read through the framework for a more detailed explanation of mathematical literacy for PISA 2021. It is not necessary to master all aspects of this framework in advance of the workshop; we have included the information in order to focus on the key features to think about as you identify/draft ideas for units and items.

Finally, it contains the PISA 2021 Mathematical Literacy Unit Submission Form in Annex 1.

Mathematical Literacy Framework²

The updated definition of Mathematical Literacy from the draft 2021 framework is:

Mathematical literacy is an individual's 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 assists individuals to know the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective 21st century citizens.

Based on the first meetings of the Mathematics Expert Group (MEG), the 2021 Mathematical Literacy framework features a new process of reasoning, as well as some areas of emphasis within the existing content categories.

Content Categories

Four major content categories provide the foundation for the Mathematical Literacy assessment:

1. *Quantity*
2. *Uncertainty and Data*
3. *Change and Relationship*
4. *Space and Shape*

¹ As of April 2018.

² Information in this section is taken from the 2021 Mathematics Literacy framework developed by Core B1 and the PISA 2021 Mathematics Expert Group. Details and terminology used are subject to revision pending finalization of the 2021 framework.

While the definition of the content categories remains unchanged for 2021, for each content category the MEG identified an area within the category that they would like to see emphasized this cycle. What follows is some additional information about these areas of emphasis.

Quantity – Computer simulation

Computers, in addition to being able to perform large calculations quickly, are also being used to solve complex quantitative problems based on a set of assumptions, which can be manipulated and will produce different outcomes. The user of a simulation needs to have a level of understanding of how to interpret the different results with respect to the assumptions being made in the simulation.

Uncertainty and Data – Conditional decision making

Involves making decisions in a probabilistic environment; meaning the decision is not based on a known value or outcome, but rather the probability of certain outcomes or with regards to some error measurement.

Change and Relationships – Non-linear growth

Recognizing that many real-world phenomena do not follow a linear relationship can be critical to solving a problem. For example, assuming an infectious disease is spread at a constant rate would severely underestimate how many people could become sick, which could have a negative impact on measures taken to slow or eliminate its spread.

Space and Shape – Geometric approximations

Being able to work with irregular geometric shapes is becoming more common in the world around us. Finding the amount of carpet needed to cover the floor of a room that is not a regular shape is one such example where there is no direct way to compute the desired quantity, so the problem might require dividing the room into a variety of familiar shapes with known properties first.

Mathematical Processes

There are four major mathematical processes defined in the framework. New for 2021 is a process emphasizing reasoning.

1. Reason
2. Formulate
3. Employ
4. Interpret/Evaluate

The definitions of formulate, employ, and interpret/evaluate largely remain the same and make up the “problem-solving process” that students typically invoke. However, the definitions have been extended to attempt to better describe how lower-performing students apply these processes – often via identifying and selecting an appropriate model, strategy, or argument.

In contrast, reasoning, is defined as going beyond simply solving a problem, to a deeper level that provides the insight necessary for problem solving. Reasoning allows for transforming a poorly defined problem into one that can eventually be solved through the use of mathematics via the problem-solving process described above. For purposes of item development, one such approach that could be helpful is to work backwards: start with a relatively well-defined mathematical problem to solve, then work backwards to how the problem

came to exist and what sort of considerations and decisions needed to be explored along the way before the problem could even be put into mathematical terms. For example, instead of asking students to compute the distance by which starting positions on a track should be staggered, instead have them first explore – and here is where the computer delivery platform can be leveraged through simulations – what happens if the starting positions are not staggered. Then, the unit can lead up to the question about computing the distance to stagger the starting positions.

For PISA 2021, mathematical reasoning can be viewed in terms of six “big mathematical ideas,” which provide structure and support to reasoning:

- Number systems and their algebraic properties
- Mathematics as a system based on abstraction and symbolic representation
- Mathematical structure and its regularities
- Functional relationships between quantities
- Mathematical modelling as a lens onto the real world
- Variance as the heart of statistics

Please refer to the draft framework for additional information on these six big ideas.

Lastly, a domain-general category titled computational thinking is also being introduced for PISA 2021. Computational thinking is central to both mathematical reasoning and the problem-solving process. Computational thinking is a way of formulating problems and designing their solutions in a form that can be executed by a computer, human, or by both. It allows for dynamic modelling of concepts and relationships.

Contexts

The four Contexts – Personal, Occupational, Societal, and Scientific – remain unchanged for PISA 2021. However, based on an inventory of the trend mathematics item pool, more items are needed in the Personal context, while fewer items are needed in the societal context.

Other Considerations

Authenticity – To the extent possible, units should be (or be adapted from) set in real-world settings that are appropriate for 15-year-olds. To avoid giving an unfair advantage to students from any one country, stimulus materials should not be taken directly from textbooks or other common resource materials used by students in any country. Please note that any stimulus that is published, in print or on-line, may be subject to copyright restrictions. **We want to avoid having to deal with copyrights, but if it is absolutely unavoidable, then you will be required to provide us with copyright permission information when you submit a stimulus.**

Cultural Considerations – PISA is administered in over 80 countries. Units should reflect the cultural and geographic diversity of the participating countries.

Translation Considerations – When selecting units, please remember that PISA materials will be translated into numerous languages. Any material with linguistic features unique to a particular language (e.g., puns) should be avoided.

Sensitivity Concerns – Materials should be selected with consideration to topics or language that would be offensive to test takers. Materials should avoid potentially controversial or upsetting topics (religion,

politics, violence, racism) and should not include undesirable role models (use of drugs or alcohol or suggestions of potentially dangerous activities).

Number of Items – Units should contain from 4 to 8 items.

Item Difficulty – Within a single unit, the items should have a limited range of difficulty. Submissions should consider maintaining expected item difficulties within three adjacent levels on the proficiency scale (e.g., levels 1-3, 2-4, 3-5, or 4-6).

Unit Submission Information

Units submitted prior to the workshops in May and June will be considered for use during the workshops. Units may continue to be submitted through August 2018 to accommodate the test development work being conducted in 2018 for the 2021 assessment. Units submitted after the June workshop will be considered for independent test development activities that will continue through the end of the test development cycle. The earlier units are submitted for review, the more likely it is that they can be included in the assessment.

Units should be submitted by completing the Mathematical Literacy Unit Submission Form provided in Annex 1. Please complete a submission form for each item followed by an electronic version/scanned hard copy of any associated stimulus materials, such as graphics or copyrighted source materials. Graphics should be in a high-resolution format as a .jpg or .gif file. Photos should be at least 3 megapixels. Hard-copy submissions of images and graphics must be originals rather than copies.

Units may be submitted in one of two ways:

- ▶ If you have access to the PISA 2018 Portal, please upload these materials in electronic format to the Portal at: Documents -> Materials -> 2021 Math Test Development.
- ▶ If you do not have Portal access, please email PISA-Cognitive@ets.org to make alternate arrangements.

Please name the files using the following structure:

CCC_XXXXXX

Where *CCC* is your country code (or country name if new to PISA) and *XXXXX* is the unit name.

ANNEX 1: PISA 2021 Mathematics Literacy Unit Submission Form

Please submit one file per unit. The following form needs to be completed per item in the unit.

Submitting name	
Submitting agency/country	
Unit name	
Stimulus & Interactive Features <ul style="list-style-type: none"> Please include an electronic version of any stimulus material, but also please provide a brief description of the stimulus or any interactive features for each item in the unit. 	
Item number / total items (i.e., 1/4, 2/4, etc.)	
Copyright Permission – if necessary (indicate one with <u>boldface and underlining</u>)	Not Needed (original material) Not Needed (other reason; please explain) Obtained In Process
Content Category (indicate one with <u>boldface and underlining</u>)	Quantity Uncertainty and Data Space and Shape Change and Relationships
Process (indicate one with <u>boldface and underlining</u>)	Reason Formulate Employ Interpret/Evaluate
Context (indicate one with <u>boldface and underlining</u>)	Personal Occupational Societal Scientific Note: The trend math pool is currently high on items classified as “Societal” and low on items classified as “Personal.”
Estimated difficulty level (indicate one with <u>boldface and underlining</u>)	easy medium hard

<p>Item Format (indicate one with <u>boldface and underlining</u>)</p>	<p>Single-Selection Multiple Choice Complex Multiple Choice Open Response – machine scored Open Response – human coded</p>
<p>For Single- and Complex Multiple choice items, indicate the key(s) with <u>boldface and underlining</u>.</p> <p>Please also provide rationales for the distractors in single-selection multiple-choice items.</p>	
<p>For human-coded items please provide a draft coding guide with a description and some sample responses for each score level (full credit, partial credit, or no credit).</p> <ul style="list-style-type: none"> • If not using partial credit, the codes are 1 (full) and 0 (no credit). • If using partial credit, the codes are 2 (full), 1 (partial), and 0 (no credit) 	