

Mathematical Competencies

MC have been defined to follow the Mathematics Literacy framework published by the OECD Program for International Students Assessment (PISA). Here is a nonhierarchical list of general mathematical competencies that are meant to be relevant and pertinent to all education levels.

1. Competence in mathematical thinking
 - a. Posing question characteristic of mathematics n- Does there exist ... ? If so, how many? How do we find ... ?
 - b. Knowing the kind of answers that mathematics offers to such questions.
 - c. Distinguishing between different kinds of statements (e.g. definitions, theorems, conjectures, hypotheses, examples, conditioned assertions).
 - d. Understanding and handling the extent and limits of given mathematical concepts.
2. Competence in mathematical argumentation
 - a. Knowing what mathematical proof is and how it differs from other kinds of mathematical reasoning.
 - b. Following and assessing chains of mathematical arguments of different types.
 - c. Possessing a feel of heuristics (what can happen, what cannot happen, and why).
 - d. Creating mathematical arguments.
3. Competence in modelling
 - a. Structuring the field of situation to be modelled.
 - b. Mathematizing (i.e. translating from “reality” to “mathematics”).
 - c. De-mathematizing (i.e. interpreting within the mathematical models in terms of “reality”).
 - d. Tackling the model (working within the mathematics domain).
 - e. Validating the model.
 - f. Reflecting, analyzing, offering critique of models and model results.
 - g. Communicating about the model and its results (including the limitations of such results).
 - h. Monitoring and control of the modelling process.
4. Competence in problem posing and solving
 - a. Posing, formulating, and making precise different kinds of mathematical problems (e.g. pure, applied, open-ended, closed).
 - b. Solving different kinds of mathematical problems in a variety of ways.
5. Competence in representation
 - a. Decoding, interpreting, and distinguishing between different forms of representations of mathematical objects and situations, and the interrelations between the various representations.
 - b. Choosing and switching between different forms of representation according to situation and purpose.
6. Competence in using symbols and formal language

- a. Decoding and interpreting symbols and formal language and understanding its relations to natural language.
 - b. Translating from natural language to symbolic or formal language.
 - c. Handling statements and expressions that contain symbols and formulas.
 - d. Using variables, solving equations, and performing calculations.
7. Competence in Communication
- a. Expressing oneself in a variety of ways on matters with mathematical components, in oral as well as in written form.
 - b. Understanding others' written or oral statements about such matters.
 - c. Knowing about and being able to make use of various aids and tools (including information technology tools) that may assist mathematical ability.
 - d. Knowing about the limitations of such aids and tools.

Components Levels

In order to operationalize mathematical competencies, it is helpful to organize the skills into three levels. They were successfully operationalized in the National Dutch option of TIMMS and the ongoing longitudinal study on the effects of a middle-school curriculum and have also been adapted for the OECD study. The three levels are: (1) Reproduction, definitions, computations; (2) Connections and integration for problem solving; (3) Mathematization, mathematical thinking, generalization, and insight.

Higher level (reasoning)

Middle level

Lower level (reproduction)

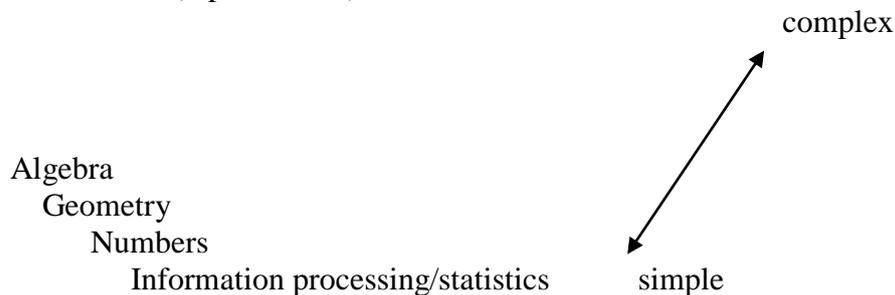


Figure. 1. Assesment Pyramid (Jan de Lange)