Most known taxonomies

|  |
| --- |
| **B. Bloom** |
| *Taxonomy of Educational Objectives: the cognitive aspect* |
| **Knowledge** Remembering or recalling information (terminology; object descriptions, facts, ways and means of actions; formulating principles, laws, concepts, theories) in approximately the same manner as it was first presented. |
| **Comprehension** Translation, explanation, summarization, rephrasing, interpretation, illustration and extrapolation of acquired information. |
| **Application**  Using acquired information in new contexts that differ from the original one. |
| **Analysis** Breaking down the material into parts, categorizing elements, establishing existing relationships, discovery of the structural principle of the whole. |
| **Synthesis** Integrating acquired information for creating new concepts, plans of actions, generalizations and patterns. |
| **Evaluation** Formulating judgments on the basis of available facts and given criteria. |
| Notes and comments Bloom’s taxonomy was conceived as an hierarchy of educational objectives organized from the simple to the complex levels. Half a century of research has confirmed the validity of this taxonomy, excluding two higher levels (Synthesis and Evaluation). Thus, Anderson and Krathwohl are of the opinion that their order must be switched (Anderson, Krathwohl (Eds.), 2001). And in Huitt’s opinion they form, in fact, only one level (Huitt, 1992). |

|  |
| --- |
| **I. Ya. Lerner** |
| *Indicators of Knowledge Acquisition Levels* |
| **Knowledge** Identification of the previously perceived object or replication of knowledge regarding it. |
| **Application** Reproduction of types of activities and application of knowledge in a known situation as per preexisting pattern, including easily recognized variations of the pattern. |
| **Creative application**  Creative application of acquired information in a new, unfamiliar situation.  (Unaided transfer of acquired knowledge and skills to a new situation; recognizing a problem in a familiar situation; recognizing a new function of an object; defining the structure of an object /problem/; recognizing an alternative solution or its variation; combining previously adopted work methods to a new one with regard to the encountered problem) |
| **Notes and comments** I. Ya. Lerner relates the acquisition levels with the stages of the acquisition process. “…Pedagogics while engaged in building up the knowledge of a person cannot be interested only in consequences of the acquisition ignoring its process, i.e. the actual activity during which acquisition happens, because such activity goes through its stages and each stage will have its own level of knowledge acquisition.” (Lerner, 1978, p.7) |

|  |
| --- |
| **V. P. Simonov** |
| *Proficiency Level Indicators* |
| **Discrimination (recognition, familiarity)** Differentiating an object, process or action on the basis of external characteristics when they are presented in a ready state. |
| **Memorizing**  Reproductive narration of the content of a text, a rule or a law. |
| **Comprehension**  Differentiating essential and non-essential characteristics of and links between objects and events; explaining formulations while using own examples. |
| **Simplest (elementary, algorithmic) skills and expertise**  Practical application of theoretic knowledge in algorithmic (typical, standard) assignments |
| **Transfer** Creative application of theoretical knowledge to new, non-standard situations while “transferring” to it acquired concepts and laws; devising new ways of activity, finding original approaches to solutions. |
| **Notes and comments** Skills are solidified methods of applying knowledge in practical activities. Creating simplest (elementary) skills and expertise is the primary basic education goal because, as per P. Ya. Galperin, “knowledge is formed without preliminary memorizing, in the process of application to solving problems”. |

|  |
| --- |
| **V. P. Bespalko** |
| *Activity Acquisition Levels* |
| **Familiarity (identification)** Reproductive activity with “prompting” (recognition) |
| **Replication (reproduction)** Reproductive activity by memory so that rules of actions are reproduced unaided and typical tasks are solved. |
| **Heuristic (application, choice of action)** Applying information in non-standard situations, transforming the problem situation in order to reduce it a typical situation; reasoning and thinking are necessary. |
| **Creative (transformation, search for action)** Using acquired information through its transformation, elaboration and creation of logically developing extensions. |
| **Notes and comments****Примечания и дополнения** “Acquisition level is thought to be the degree of mastering an activity that was achieved as a result of learning” (Bespalko, 2002, p. 117)  “The quality of information acquisition can be described by the cited parameter, i.e. ‘acquisition level’.” (ibid., p. 117)  The acquisition of a level is measured by the acquisition factor (AF) which is a ratio of acquired essential operations to their general count. Transfer to the next learning level can be undertaken is the AF of the preceding level is not lower than 0.7 (ibid., pp. 121-122).” |

|  |
| --- |
| **TIMSS (mathematics)** |
| *Types of educational and cognitive activities* |
| **Knowledge**  Reproducing the language of mathematics, mathematical facts and characteristics; performing calculation procedures and using relevant tools. |
| **Application**  Classifying mathematical objects; formulating a problem and discerning information that is necessary for its solution. |
| **Reasoning**  Intuitive and inductive reasoning based on considering sequences and dependencies in order to solve non-standard problems. |

Working on mathematical expressions, choosing a method of solution, creating mathematical models.

|  |  |
| --- | --- |
| **TIMSS (Mathematics)** |  |
| **Knowledge** |  |
| Reproduce | Reproduce definitions, terminology, number properties, geometric properties and mathematical agreements (for example, a × b = ab; a + a + a = 3a). |
| Recognize (identify) | Identify mathematical objects, forms, numbers and expressions. Identify mathematically equivalent objects (for example, equal simple and decimal fractions as well as percents; identically equal algebraic expressions). |
| Calculate | Perform algorithms of arithmetic operations (“+”, “–“, “×”, “:”) and of their combinations with natural numbers, simple and decimal fractions as well as whole numbers. Rounding off numbers in order to be able to estimate results of calculations and measurement. Perform standard arithmetic and algebraic procedures (for example, divide a number by a given ratio, increase or decrease a number by a given percent, solve an equation, find the value of expression, make formulaic calculations, simplify an expression, factorize, expand the brackets, extend algebraic and numerical expressions). |
| Extract information | Extract information from diagrams, tables and other sources; read the simplest scale of measurement. |
| Use tools | Use measuring tools (for example, draw direct lines, make angles or figures having specific properties, use ruler and compass for drawing a perpendicular from the middle point of a segment; same for drawing angle bisector; same for drawing triangles and quadrangles using the known elements of these figures); adequately use measurement units; evaluate measurement results. |
| Classify / order | Classify or group objects, figures, numbers and expressions in accordance with their common properties; make correct judgment regarding which class an object belongs to; order objects and numbers as per their properties and characteristics. |

|  |  |
| --- | --- |
| **APPLICATION** |  |
| Choose | Choosing a productive method or strategy for solving a problem—but only in case students from the parallel classes (for whom the task is compiled) should know the relevant algorithm or method of solution. Choose an appropriate algorithm, formula or measurement unit. |
| Represent | Represent mathematical information and data suing various models: diagrams, tables, charts or graphs; create equivalent forms of presenting a mathematical object or ratio (for example, based on the presentation of a certain function as an equation, note down ordered pairs of numbers that describe that function). |
| Model | Create a relevant model (equation, diagram, graph) for the prupose of solving a standard problem. |
| Perform | Follow and perform a certain sequence of mathematical directions (for example, an instruction to be followed if a certain figure must be drawn). |
| Solve standard problems | Solve standard problems (for example, such problems that the students may already have encountered since they had already done international tests), use properties of geometric figures in order to solve problems. Compare and choose the relevant form of data representation (for Grade 8 students) as well as use data presented in table form or in the form of a diagram, chart, or graph for the map of solving standard problems. |

|  |  |
| --- | --- |
| **REASONING** |  |
| Hypothesize, make assumptions, forecast | Make corresponding guesses when researching a certain sequence, discussing a certain idea, creating a model, researching some set of data; determine a possible outcome (number, type of figure, etc) when performing an operation or an experiment prior to its start. |
| Analyze | Determine and describe or use a relation between variables or objects in a certain mathematical situation; use direct relationships (Grade 4); break up a geometric figure into parts in order to make the problem solution simpler; create a net of an unfamiliar solid figure; present the result of various transformations of solid figures; compare and pick out various forms of representing the same data (Grade 4); make significant estimates of the basis of given information. |
| Generalize | Widen the area, in which results of mathematical reasoning and problem solving could be applied, by formulating results in more general terms. For example, a problem is offered, in which a number sequence 1, 4, 7, 10 appears, and thus one must describe with mathematical means the relationship between each member of this sequence and each next member of it. |
| Synthesize / Combine | Combine / bring together various methods for achieving results and combine results for achieving further results (for example, combine the results that were achieved using two separate diagrams). Establish relationships between various elements of knowledge and relevant representations; establish similarity between related mathematical ideas. |
| Validate | Prove the validity (or lack of it) for a certain assertion while referring to mathematical results or properties; advance mathematical argumentation or refer to relevant information in order to prove or disprove an assertion. |
| Solve non-standard problems | Solve problems, both purely mathematical problems or such that are related to actual situations in real life—situations which students participating in the test most certainly have not encountered in their lives; apply mathematical methods in unfamiliar or complex situations. Use properties of geometrical figures for solving problems. |