Co-funded by the
Erasmus+ Programme
of the European Union

Cognitive Map – an example of practical use

Comparing two math tasks

The Cognitive Map helps us to analyze a learning experience and understand why and where the student has difficulties, thus to plan suitable mediational intervention. By describing seven different aspects of a task, we can realize the specific challenges of the task.

When considering a task to be used for either educative purposes or assessment it may be useful to analyze it using the parameters of cognitive map and relating to another task.

Bellow we are going to analyze two math tasks to realize the differences and that each task may bring a challenge.

TASK 1:
Vera has 3 skirts, 2 pairs of trousers, 4 shirts and 5 sweaters. How many different combinations of skirt-shirt, skirt-sweater, trousers-skirt and trousers-sweater can she create?

1. **Content** of the mental act

   – combinations as mathematical operations; how to count them

2. **Modality** or "language" in which the mental act is expressed (receiving information and expressing the results of the mental act)

   – combination of verbal, numeric and written (symbolic)

3. **Phases** of the mental act

   Mental acts required in the **Input phase** (data gathering):

   - clear and detailed perception of the text of the task;
   - systematic exploratory behavior;
   - well-developed verbal tools;
   - conservation of constancies;
   - well-developed need for precision and accuracy in data gathering;

Mental acts required in the **Elaboration phase** (organizing and analyzing the data:

- **ability to identify and define the problem**
- ability to distinguish between relevant and non-relevant cues
- broad mental field (when the students works in his mind only)
- need to pursue logical evidence
- internalization processes (of the strategy)
- ability to use hypothetical thinking
- well-developed summative behavior
- **well-developed planning behavior**
- **availability of verbal concepts that support reasoning processes**

Mental acts required in the **Output phase** (expressing what is concluded):

- need for precision and accuracy
- ability to project virtual relationships
- well-developed self-regulation – no trial-and-error responses, no blocking
- ability to restrain impulsive behavior

4. Cognitive **operations** (what happens during the elaboration phase; what steps does our brain in order to organize, manipulate and generate a new information)
   - Identifying the elements in the sets
   - Differentiating the sets
   - Inferring
   - Ordering the workflow
   - Identifying the proper operations to be used
   - Recording the operation
   - Applying mathematical rules
   - Analogical thinking
   - Classification
5. **Complexity** (quantity of information to be handled in a mental act, novelty or familiarity of the information):

   It depends on whether the children are familiar with the "combinations", what visual help they are offered or allowed to use and whether they already internalized the operations involved (addition and multiplication).

6. **Abstraction** (the distance between a given mental act and the object or event upon which it operates)

   If the children are not allowed to use a diagram, then the task is highly abstract: we work with symbols and a couple of mathematical operations (depending on the strategy used). If the children

may draw a diagram then the level of abstraction is lower, however, they still need to identify the problem and find the suitable strategy how to solve it.

7. **Efficiency** (matter of speed, accuracy, and an experienced amount of effort invested in the performance)

   Pupils who perform the task accurately and speedily, perform efficiently. If, for example there is a novelty in combining mathematical operations, we can observe slower performance.

TASK 2:
Mother Duck had a gaggle of baby ducks. On the way to the pond she lost half of her ducklings in the tall grass. When she found three of the lost ones, she noticed, that two of the waiting ones hid somewhere in the meantime. After long searching she finally found all four missing ducklings playing on the pond bank.
How many ducklings did Mother Duck have?

1. **Content** of the mental act

   – complex problem solving

2. **Modality** or "language" in which the mental act is expressed (receiving information and expressing the results of the mental act)

   – combination of verbal, numeric and written (symbolic)

3. **Phases** of the mental act

   Mental acts required in the **Input phase** (data gathering):

   - clear and detailed perception of the text of the task;
   - systematic exploratory behavior;
   - well-developed verbal tools;
   - well-developed temporal concepts;
   - conservation of constancies;
   - well-developed need for precision and accuracy in data gathering;
   - ability to consider two or more sources of information at once

Mental acts required in the **Elaboration phase** (organizing and analyzing the data:

- **ability to identify and define the problem**
- **ability to distinguish between relevant and non-relevant cues**
- **broad mental field**
- **need to pursue logical evidence**
- internalization processes
- ability to use hypothetical thinking
- well-developed summative behavior
- **well-developed planning behavior**
- **availability of verbal concepts that support reasoning processes**

Mental acts required in the **Output phase** (expressing what is concluded):

- ability to communicate (in whatever language or modality) well-elaborated responses
- need for precision and accuracy
- ability to project virtual relationships
- well-developed self-regulation – no trial-and-error responses, no blocking
- ability to restrain impulsive behavior

4. Cognitive **operations** (what happens during the elaboration phase; what steps does our brain in order to organize, manipulate and generate a new information)
   - Identifying the elements in the task
   - Sequencing
   - Coding and decoding
   - Inferring and deducing
   - Differentiating
   - Analyzing
   - Identifying the proper operations to be used
   - Recording the operation
   - Applying mathematical rules
   - Analogical thinking
   - Classification
5. **Complexity** (quantity of information to be handled in a mental act, novelty or familiarity of the information):

   Although for solving the task we need only addition and subtraction (if at all) the task requires to involve higher-order thinking operations. If restricted to “one possible way of solving the task” children may become blocked. If however they are allowed to find the solution applying whatever

procedure the task becomes easier and funny. Involving analysis, evaluation of situation and creating the solution is crucial.

6. **Abstraction** (the distance between a given mental act and the object or event upon which it operates)

   If the children are not allowed to use a diagram, then the task is highly abstract: we work with symbols and a couple of mathematical operations (depending on the strategy used). If the children may draw a diagram or use any other help to visualize the problem then the level of abstraction is lower, however, they still need to identify the problem and find the suitable strategy how to solve it.

7. **Efficiency** (matter of speed, accuracy, and an experienced amount of effort invested in the performance)

   Pupils who perform the task accurately and speedily, perform efficiently. If, for example there is an obstacle in differentiating relevant and non-relevant data, slower performance can be observed.

   The task requires mediation for challenge (even adult students may become blocked!) and feeling of competence (even adult students may say they cannot solve the task!)

Based on the level of efficiency we may conclude whether the task was within the zone of proximal development (the student can deal with the task with help, the task is challenging) of the student or was more difficult (the student cannot handle it at all) or the opposite, very easy with no challenge. Then we can go back to other parameters and see which parameter or parameters cause the obstacle or were at very low level.

Efficiency relates to the task as well as to the performance of a child in the parameters of the cognitive map. Different tasks require different kinds and amounts of mental effort in each phase of a mental act. Therefore, efficiency mirrors all the other aspects of the cognitive map.