Educational software and visualization arithmetic's concepts
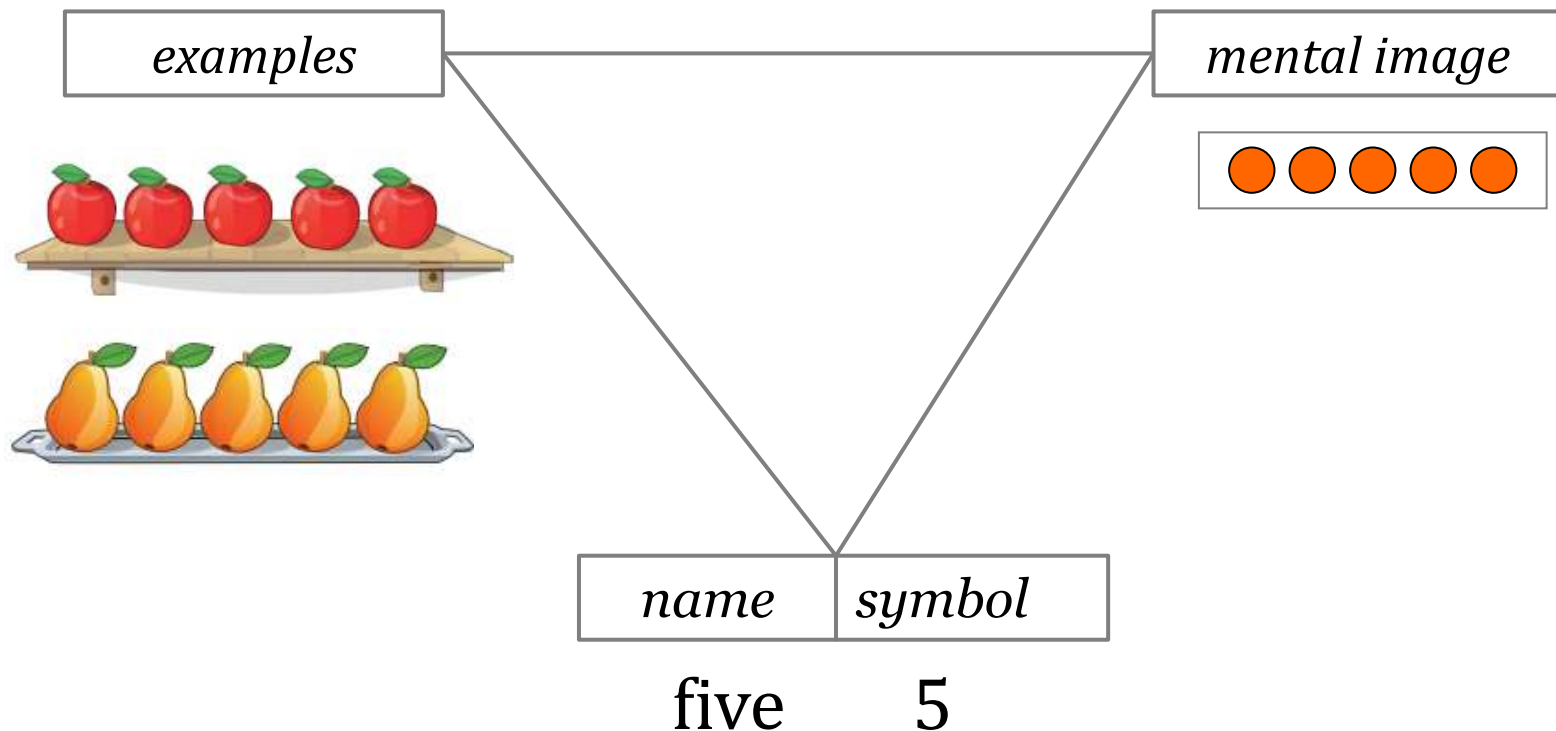
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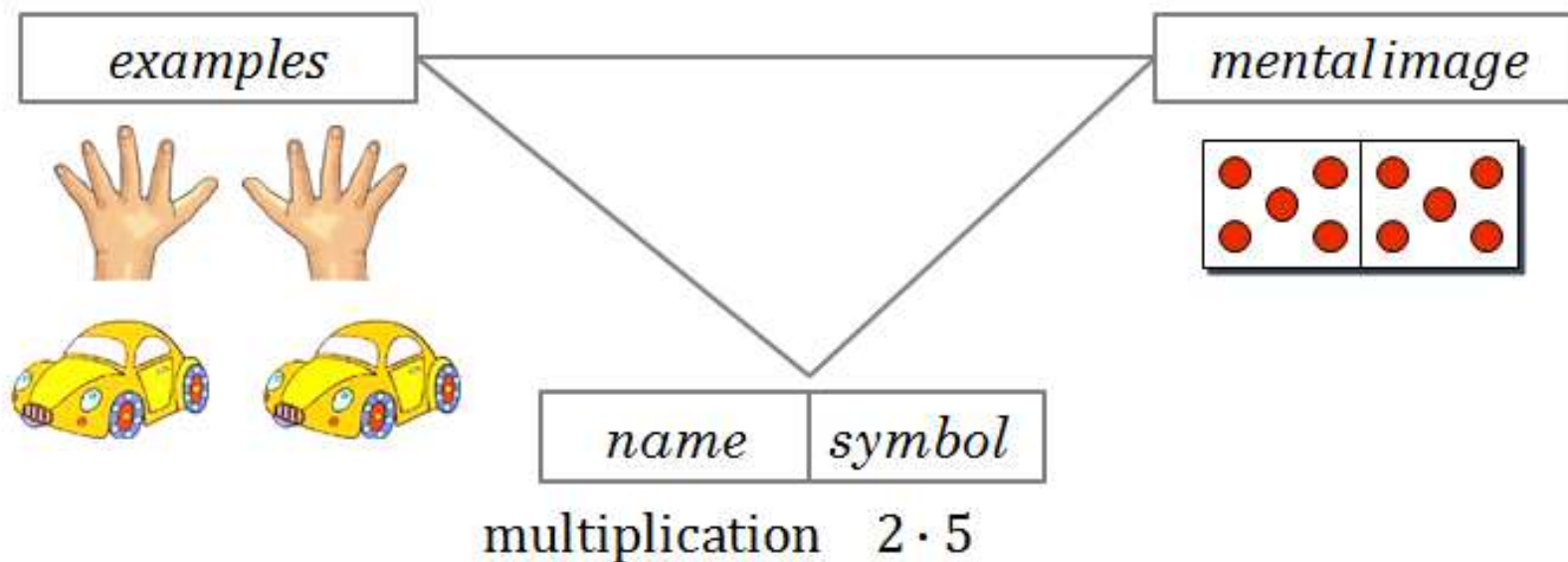Faculty of Education, Belgrade

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What is mathematical concept?

Mathematical concept consists of three components:
examples, mental image, name and *symbol*

examples

mental image

name	symbol

five   5

What is mathematical concept?

How mathematical concepts are formed?

- Mathematical concepts are formed gradually like spontaneous one. First, impressions are formed around similar objects, as long as the mind forms mental picture of the concept. Then, the concept follows name and in the end the symbol for a certain concept.
- Classification of examples and discovering of their inherent mathematical pattern result into the formation of the corresponding mental image. Names and symbols are the language codification of mathematical concepts and the drawings representing them are their iconic signs.

How mathematical concepts are formed?

- The processes of selection of invariant or essential properties, which are included into all the objects of a certain class, are called the abstracted ones.
- All properties irrelevant to a concept are called *noise.*
- So, mathematical concept cannot be reached only by perception and sensory experience, but by abstraction of concept which inevitably has its roots in sensory experience.
- The process of transmitting concrete to cognitive operations, Piaget names interiorisation of the concept.

Bruner's theory of different levels of abstraction

- Bruner observed the process of cognitive development through three ways of representation.
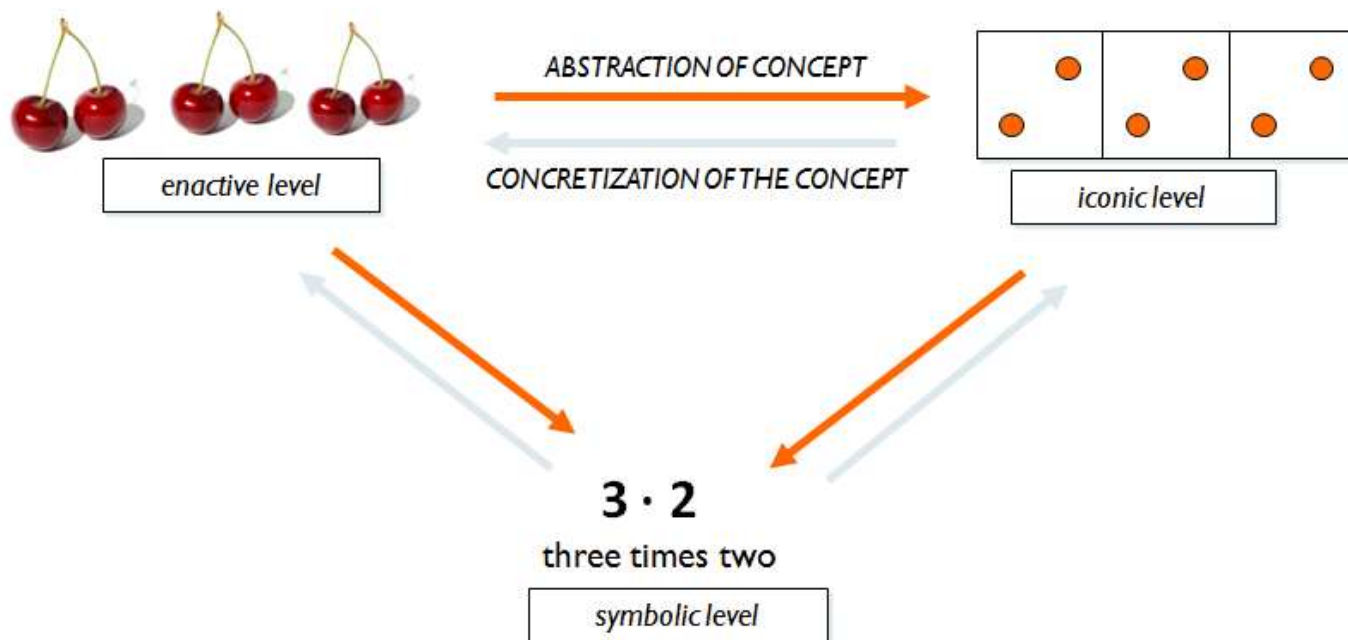
- All the passes in teaching towards the action field, Bruner names *action*, passes towards the fields of pictures *iconisation*, towards language field *verbalisation*, and those towards sign field are called *formalisation*.
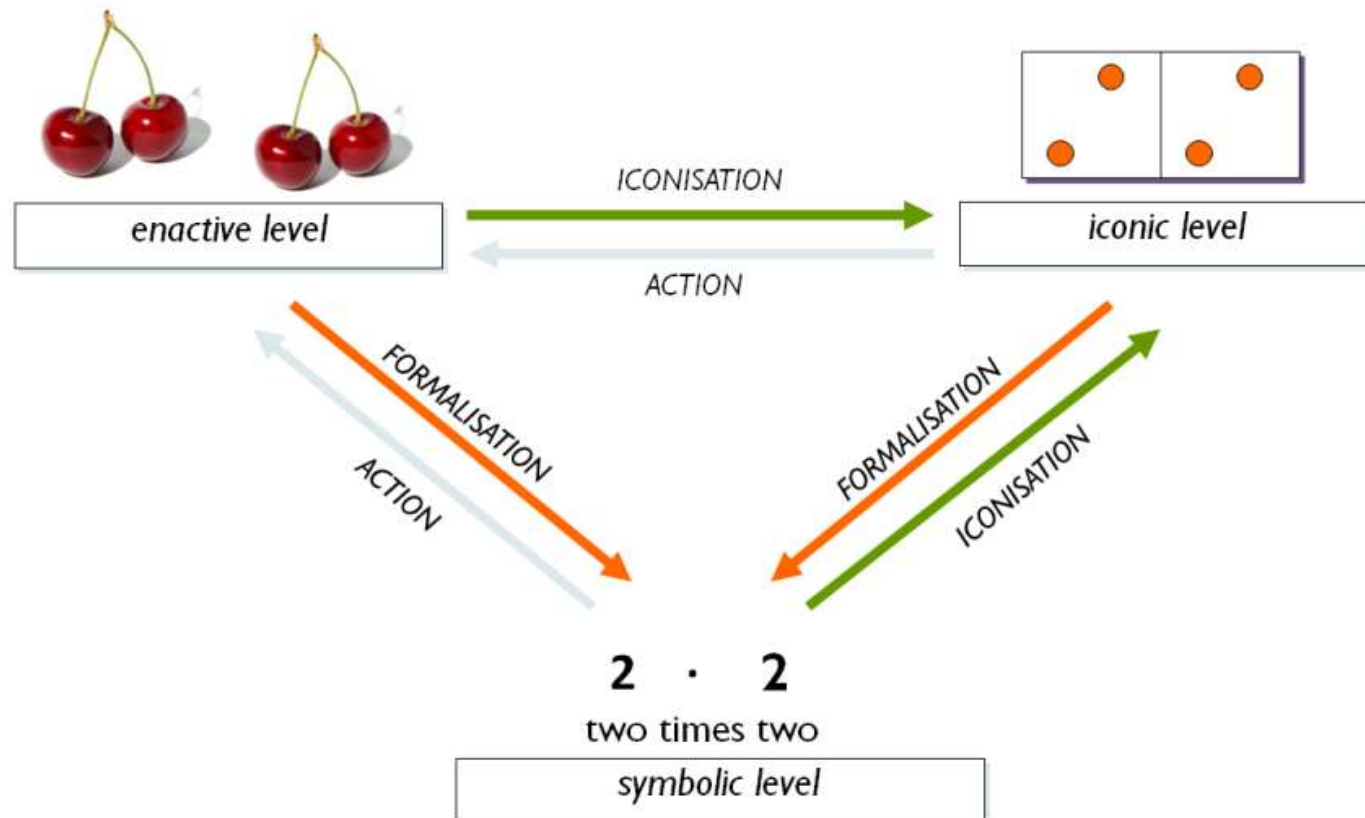
Methodological frame of the research

- *The subject* of the research was the influence of arithmetic strategies for training students to perform the operations of multiplication and correct use of calculating procedures in solving tasks.

- *The aim* of the research is to critically analyse the application of arithmetic procedures of students in solving tasks based on the structures of multiplication and to determine connectivity with the existing strategies of teaching.

Methodological frame of the research

- *The main hypothesis* of the research is*:* During solving tasks based on the multiplication structures, students more often choose calculating the product by counting and using the times table, then the counting and using times table than the procedure of calculating the sum of equal addends for application of the arithmetical procedures of the multiplication operation.

- There were 106 students included in the research from a primary school in Belgrade.

- According to the grade, the research included 54 or 50.9% of students of the first grade and 52 or 49.1% of the students of the second grade.

Methodological frame of the research

- Since our research is primarily connected to studying teaching Mathematics, we have chosen the *survey method.*

- Descriptive method of the research is known as non-experimental, non-causal method, which has the aim of observing the state of pedagogical praxis.

- Having in mind the subject, tasks and method of the research, we chose the combined techniques of *scaling* with the technique of the *interview* and *testing*.

Interpretation of the research results

- Students were given *three groups* of tasks for solving. The first group included tasks at the concrete level, the second one on the iconic level and the third one on the symbolic level.

  1. task: In the classroom, there are 3 rows of 5 desks placed in order. Students were asked to calculate: How many desks are there in the classroom?
  2. Task: There are two chairs for each desk. Students were asked to calculate: How many chairs are there in a classroom?
  3. Task: The task for students was that in paper, in the previously selected field; in circles (in an iconic way) represent the number of chairs in the classroom in the way they are placed.

Interpretation of the research results

			Z.1SUMA				Total
			1	2	3	8	
RAZRED	1	Count	49	3		2	54
		% within RAZRED	90.7%	5.6%		3.7%	100.0%
	2	Count	34	6	6	6	52
		% within RAZRED	65.4%	11.5%	11.5%	11.5%	100.0%
Total		Count	83	9	6	8	106
		% within RAZRED	78.3%	8.5%	5.7%	7.5%	100.0%

- In the second group, there are tasks of the e following type...

			Z.2SUMA				Total
			1	2	3	8	
RAZRED	1	Count	34	19		1	54
		% within RAZRED	63.0%	35.2%		1.9%	100.0%
	2	Count	37	5	7	3	52
		% within RAZRED	71.2%	9.6%	13.5%	5.8%	100.0%
Total		Count	71	24	7	4	106
		% within RAZRED	67.0%	22.6%	6.6%	3.8%	100.0%

In the third group, there are tasks of the e following type...

			Z.3SUMA				
			0	2	3	8	Total
RAZRED	1	Count	19	34		1	54
		% within RAZRED	35.2%	63.0%		1.9%	100.0%
	2	Count	7	10	27	8	52
		% within RAZRED	13.5%	19.2%	51.9%	15.4%	100.0%
Total		Count	26	44	27	9	106
		% within RAZRED	24.5%	41.5%	25.5%	8.5%	100.0%

Conclusion of the research

- Creating the concept multiplication of the second grade students should be based on the carefully chosen iconic environment, i.e. schemes which clearly show disjunctive unions of equal sets more than on concrete life situations.

- In teaching Mathematics from the first grade, we should insist on moving at all levels of abstraction and training of students for iconic repression of definite situations which will symbolically lead them to symbolic thinking.

- During studying the topic of multiplication, students should be enabled to understand connections with the operation of addition which they have studied in the previous class.

Conclusion of the research

- We should insist with the created tasks on adoption of arithmetical propreties of multiplication through invariant forms with a great number based on meaning.
- Drilling the times table leads to mechanical memorising, but not thorough understanding of the multiplication operation. This is why it is important to study the times table structurally with the support of the picture surrounding.
- Through well prepared tasks, students should be allowed to apply the gained knowledge in everyday situations, as well as creating suitable arithmetical expressions.

Educational software- presentation

- Significant influence of iconic representation on the achievement of solving tasks of the second grade students which we have approved by empirical research, directed us towards modelling educational software which will obtain to students subtle didactical transmission from one to the other level of abstraction.

- Tasks offered to students vary through all three levels of abstraction: enactive, iconic and symbolic. In this way a student can do tasks at enactive level until he/she is ready for work with paradigm pictures (iconic level) or mathematical symbols.

Educational software- presentation

- Using the advantages of the computer programming, we managed in the block of numbers to one hundred to vary all the possible examples (sets of different numeric ones) for computer operations of addition, subtraction, multiplication and division. This is impossible to achieve with the printed media.
- Students will, by using this medium do a number of examples they need, and we can be sure that no significant examples will be skipped.

Educational software- presentation

- Contents in the "Mathematical town" is adjusted to students with various pre-knowledge. Creating the option help, we enabled students who have not completely mastered the material to her the instruction once again, followed by multimedia contents. On the other hand, students who feel ready, using the given instruction, an advance faster than their peers. In this way, learning is adjusted to previous knowledge and pace of each student.

Educational software- presentation

- Degree of complexity of the task depends on the number of steps needed for its solution, using the technique of the bearer of the procedure for solving tasks, we used algorithms and this way we enabled students to adopt the contents gradually. In the end, there are varied and searched quantities such as sum of the first and the second addend. In the end, in software, there were varied and searched quantities, such as the sum, the first and the second addend, minuend, subtrahend or difference, etc, and this is one of the important factors for successful solving mathematical terms such as addition, subtraction, multiplication and division.

Pedagogical effects of multimedia software

- *"Bruner's universe"* and possibilities of varying the degree of abstraction, direction of abstraction, kinds of obvious means, searched the quantities in the tasks, are only a starting point of what we call true individualisation of Mathematics teaching.

- The essence of hyper media systems, there are multimedia (presentations of the contents with many different media: text, picture, animation, film) and hyper-textual connection supported by the branched model of structuring the mathematical contents.

- There is a high level of adaptability of hyper-media systems towards the user, and this enables students to follow their own wishes, interests, and abilities, pace a style of learning and to make decisions on their own learning and advancement.

Pedagogical effects of multimedia software

- Advantage of multimedia lies in the degree of engagement of a number of senses during learning, and according to the research contributes to continuous and applicable knowledge of students. Dynamic processes opposite the static pictures, animations and suitable sound following the pictures, contribute also to better motivation for learning. It is known to us that motives are the basic provokers to activities. Good motivation means successful learning. This is why our opinion is that advantages o multimedia expression of contents must be used in teaching Mathematics.

Conclusion

- Introducing mathematical operation of multiplication in the early school age should be the base on carefully chosen iconic environment.

- Mental pictures, which children from at that time, represent the platform for future symbolic cognition and establishing times table as a flexible structure.

- Iconising real life situations, mathematical expressions and arithmetic rules get their full sense and meaning.

- Understanding multiplication as a union of he sets o the same numbers with adoption of suitable arithmetical rules in their invariant form, leads to gradual adoption of table values without drilling and not much mechanical repetition.

- Educational software, which we created, offers support to this concept of learning and encourages individual activities of students in this direction.
- Following individual steps of the students' activities gives continuous, up-to-date information about their achievement.
- The software model is based on the principles of hybrid expert systems in which we have assumed following, measuring and evaluating of each step of students through all three abstraction levels towards the final solution.
- The basic idea of educational, hybrid systems of artificial intelligence is raising the success and degree of understanding in solving tasks, and adjusting learning to individual developmental characteristics and former knowledge of all students, their cognitive styles and pace of advancement.