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# Educational Research

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# Why educational research

- Indispensable element in the reform process
  - Provides crucial information for the design of educational policy
    - School effectiveness
    - Assessment
    - Teacher education
    - Design of curricula
    - Design of instruction
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# Center for Educational Research(Greece)

- Collection of systematic information about school effectiveness and student achievement
  - First nation-wide program to fund educational research
  - Organization of national conferences for educational researchers and teachers
  - PISA program and development of national assessment programs
  - Introduction of ICT and teacher preparation
  - Failures of the system
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# Evaluation of pedagogical institutions in Cyprus

- Lack of understanding of necessity of educational research by policy makers, instructors and administrators
- Strong epistemological beliefs that can hinder these groups from understanding the importance of educational research:
  - knowledge is static, certain, given by authority –
  - We learn everything we need to know at the university
  - Why should we do educational research here when we can take the results of educational research from other countries
  - Copy educational reforms from the US and Europe

## Results:

Transmission oriented model of instruction

Inflexibility, lack of innovation, inability to deal with problems

- Failure to understand and meet new challenges
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# New Challenges

- Learning in the knowledge society
  - Science and math literacy
  - Problem solving and thinking skills
  - Independent, intentional, self-regulated learning
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# Key findings from research on the development of science and math concepts

- Young children answer questions about force, matter, the earth in space, etc. mostly in a consistent way revealing the existence of narrow but coherent explanatory frameworks
  - These explanatory frameworks are different in their structure, in the phenomena they explain and in their individual concepts from the scientific theories to which children are exposed through systematic instruction.
  - The process of learning science is a slow and gradual one, during which children usually use enrichment mechanisms to add the new, scientific information to their initial explanatory frameworks, destroying their coherence and creating *synthetic models* or misconceptions.
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# The concept of the Earth

## Physical object

Earth is flat

supported by ground, water,

stationary

sky and solar objects located  
above its top

geocentric

## Solar object

Earth is spherical

surrounded by space

rotating and revolving

space & solar objects  
surround the earth

heliocentric

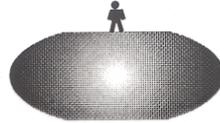
# Mental Models of the Earth

Sphere

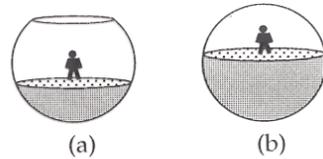


Scientific Model

Flattened Sphere

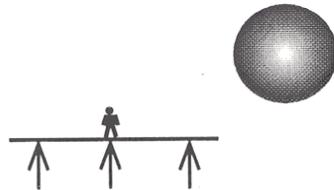


Hollow Sphere



Synthetic Models

Dual Earth

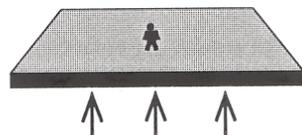


Disc Earth



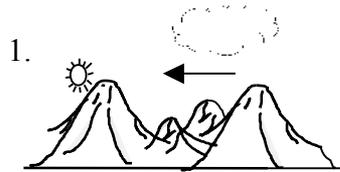
Initial Models

Rectangular Earth

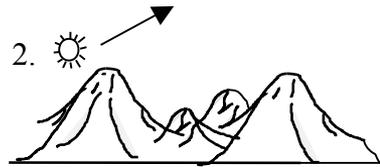


**An Example of Conceptual Case:  
The Case of the Earth Concept**

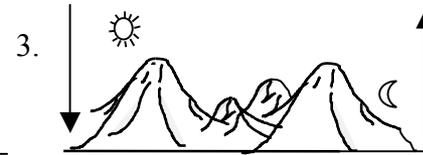
Initial Mental Model



The sun is occluded by clouds or darkness

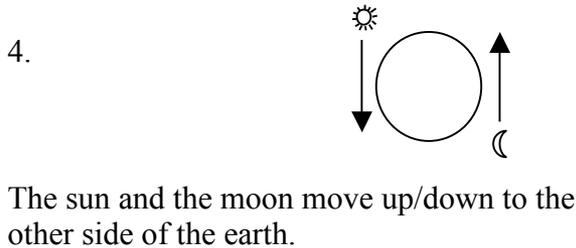


The sun moves out into space

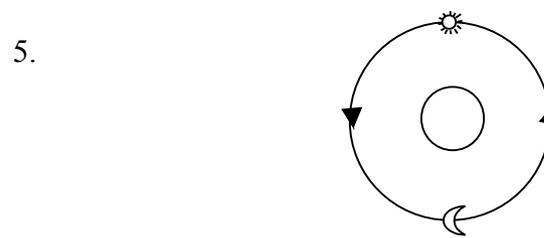


The sun and the moon move up/down on the ground

Synthetic Mental Model



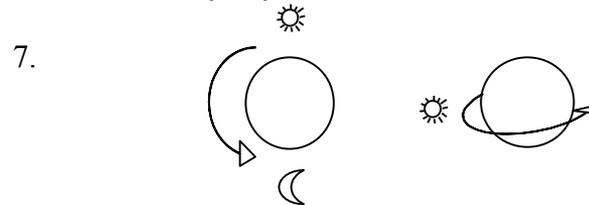
The sun and the moon move up/down to the other side of the earth.



The sun and the moon revolve around the earth once every day.



The earth and the moon revolve around the sun every 24 hours.



The earth rotates up/down or west east. Sun and moon are fixed at opposite sides.

“Scientific” Mental Models

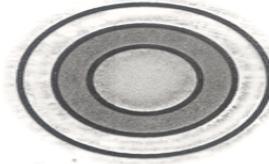


The earth rotates west/east. Sun is fixed but moon revolves around earth

# Models of the Layers & Composition of the Earth

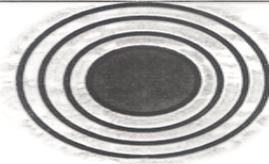
**Spherical Layers**

*Magma in the layer below the surface*



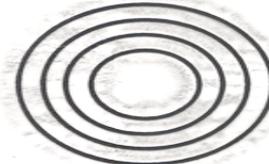
**Spherical Layers**

*Magma in the center of the earth*



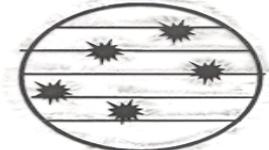
**Spherical Layers**

*Solid Materials*



**Flat Layers**

*Magma in different places inside the earth*



**Flat Layers**

*Magma in the bottom of the earth*



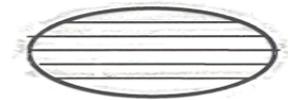
**Undetermined Layers**

*Solid Materials*



**Flat Layers**

*Solid Materials*



# Plant Development

## Initial/Naive Theory

Plants take their food from the ground (water or other nutrients) through their roots

Plants grow as food accumulates in small pieces inside them

They do not breathe.

## Scientific Theory

Plants create their own food through the process of photosynthesis

Photosynthesis is a chemical process during which solar energy is used to transform water + CO<sub>2</sub> into organic materials like glucose. Oxygen is also formed and stored in the plant or released in the atmosphere

Plants take in CO<sub>2</sub> from the atmosphere and use it in the process of photosynthesis. To this extent “breathing” in plants is related to growth and development.



**Synthetic Models**



# Synthetic models in photosynthesis

(Kyrkos & Vosniadou, 2001)

1. Initial model. Plants take food from the ground, through roots. Food accumulates inside plant and makes it grow. They do not breathe.
2. Photosynthesis as breathing. Plants take in dirty air, clean it, and they give out clean air.
3. Photosynthesis added on as a feeding process. Plants takes food from the ground and from water through their roots. They also take food from the air and light through their leaves (O, CO<sub>2</sub>).
4. Photosynthesis as a new process of feeding. Plants take food from the ground and from atmosphere and also use water and O or CO<sub>2</sub> to make the food in their leaves through the process of photosynthesis (mixture/not a chemical process)

# Natural Numbers vs Fractions

<b>Numerical value</b>	<b>Natural number</b>	<b>Fraction</b>
<b>Symbolic representation</b>	One number (that carries the presuppositions of discreteness)	Two numbers and a line (that carry the presuppositions of density)
<b>Ordering</b>	Supported by the natural numbers' sequence (counting on)	Not supported by the natural numbers' sequence
	Existence of a successive or a preceding number	There is no unique successor or a unique preceding number
	No number between two successive numbers	Infinitely many numbers between any two different numbers
<b>Relationship to the unit</b>	The unit is the smallest number	No unique smallest number

Category	Examples of synthetic models
<p><b>Discreteness</b> (the given numbers are always considered subsequent)</p>	<ul style="list-style-type: none"> <li>▪ (0.005-0.006)</li> <li>▪ (1/3-2/3)</li> </ul>
<p><b>Discreteness(+)</b> (the given numbers are not always considered subsequent, finite number of numbers)</p>	<ul style="list-style-type: none"> <li>▪ (0.0051, 0.0052, ..., 0.0059, 0.006)</li> <li>▪ (3/8, 3.1/8, 3.2/8, ..., 4/8, 4.1/8, ..., 5/8)</li> </ul>
<p><b>Intermediate</b> (infinitely many numbers in some, but not all questions)</p>	<ul style="list-style-type: none"> <li>▪ (decimal, <i>infinitely many decimals</i>, decimal) <b>and</b></li> <li>▪ (fraction, <i>finite number of fractions</i>, fraction)</li> </ul>
<p><b>Density (-)</b> (infinitely many numbers of the same symbolic representation)</p>	<ul style="list-style-type: none"> <li>▪ (decimal, <i>infinitely many decimals</i>, decimal)</li> <li>▪ (fraction, <i>infinitely many fractions</i>, fraction)</li> </ul>
<p><b>Density</b> (infinitely many numbers)</p>	<ul style="list-style-type: none"> <li>▪ (number, <i>infinitely many numbers</i>, number)</li> </ul>

# What can we gain from this type of educational research?

- ❑ They have the potential of identifying concepts and procedures in science and mathematics learning that are going to cause students great difficulty
- ❑ Can be used as a guide to providing student-centered instruction, since they provide a basis for
  - a) predicting and explaining students' systematic errors and misconceptions
  - b) providing student-centered explanations of counter-intuitive science math concepts
  - c) alerting teachers and students against the use of additive mechanisms in these cases, and
  - d) identifying appropriate mechanisms (e.g., bridging analogies) for learning that avoids the creation of misconceptions
- ❑ Can be used as a guide to curriculum development – include opportunities and experiences for children to be exposed to difficult concepts from early on