



University of Western Macedonia, Greece

Primary School Students' Preconceptions about the Term Nanotechnology and the Water Nano-filters

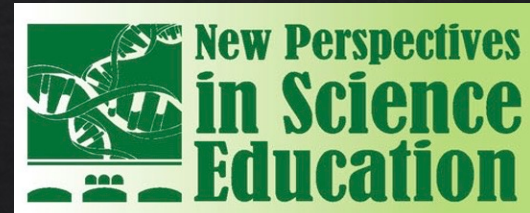
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Human Resources Development,
Education and Lifelong Learning

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Overview

Introduction

- ◇ The context of the research
- ◇ The educational significance of Nanoscience and Nanotechnology
- ◇ The content of Nanoscience and Nanotechnology in primary school
- ◇ Students' preconceptions of Nanoscience and Nanotechnology concepts

Study 1: Students' preconceptions about the meaning of the term nanotechnology

- ◇ Method
- ◇ Results
- ◇ Conclusions

Study 2: Students' preconceptions about filtration mechanism of a water nano-filter

- ◇ Method
- ◇ Results
- ◇ Conclusions

The impact of the research

The context of the research

Development of a Teaching Learning Sequence about the Nanoscience and Nanotechnology (NST) content

Identifying NST core concepts for primary school

Pilot Teaching Learning Sequence
Peikos et al. (2019)

Research on students' preconceptions

Revised Teaching Learning Sequence

(a) size, (b) tools & (c) size dependent properties: lotus effect

Peikos et al. (2020)

The meaning of the term nanotechnology & NST applications

This presentation

What is Nanoscience and Nanotechnology (NST)?

Interdisciplinary
research field

Manipulation of
matter &
exploitation of
materials' properties

Nanoscale
1 – 100nm

Unique properties e.g. physical

Applications in
everyday life

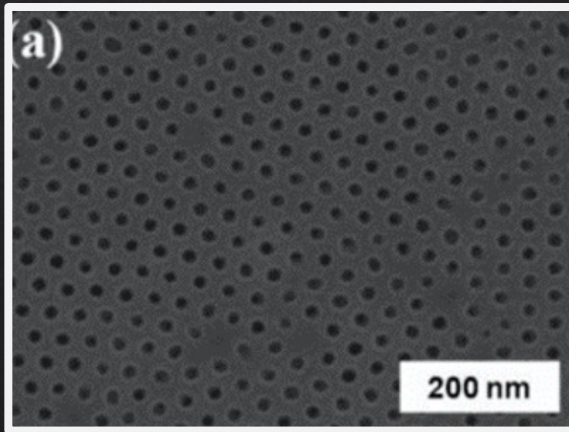
NST applications: water filtration

Applications in
everyday life

e.g. water filters using
nanoporous membranes

water shortage problem

sports and adventure



(Wang et al. 2018, page 12)

- Filtration or purification:
the process of separating the unwanted particles from the water (e.g. microbes) through pores
- Nanoporous membrane:
nanometer pores e.g. diameter 17 nm

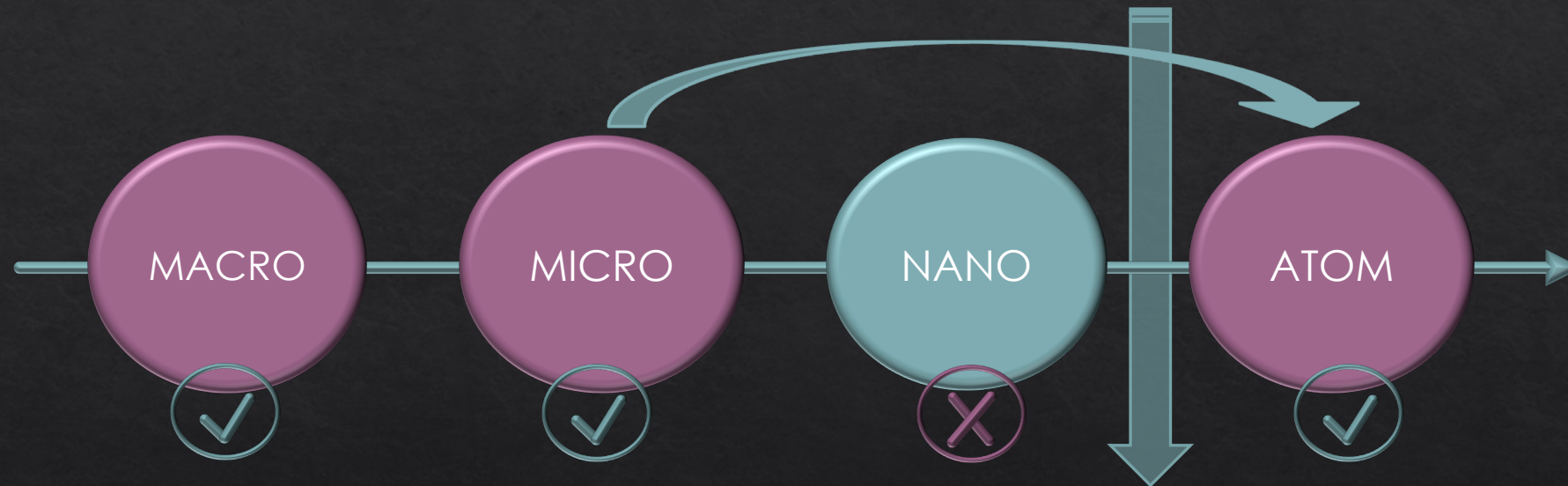
Educational significance of NST

Come up with issues of NST
related to everyday life

Nanoliteracy

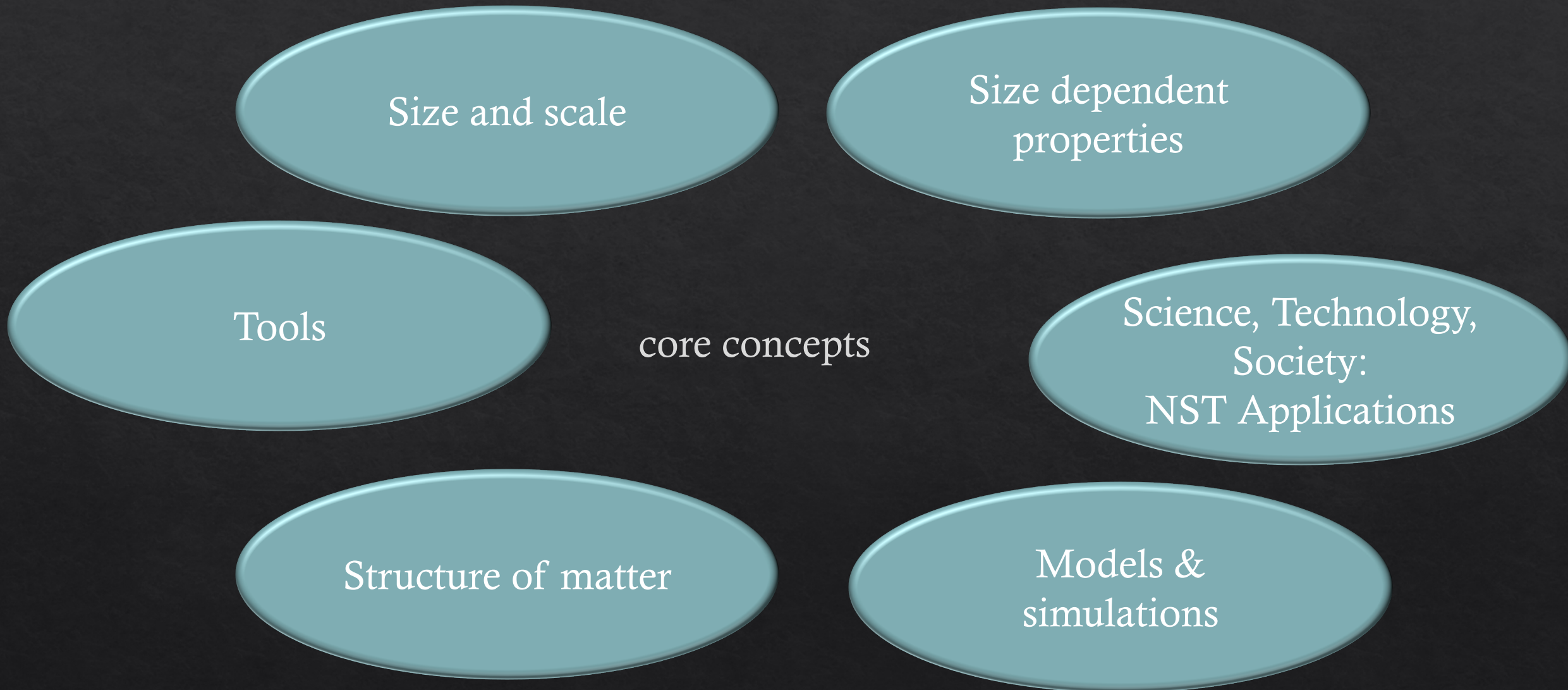
Educational significance of NST

Science curricula: gap in teaching about scales



No opportunities for developing explanations about NST applications or phenomena

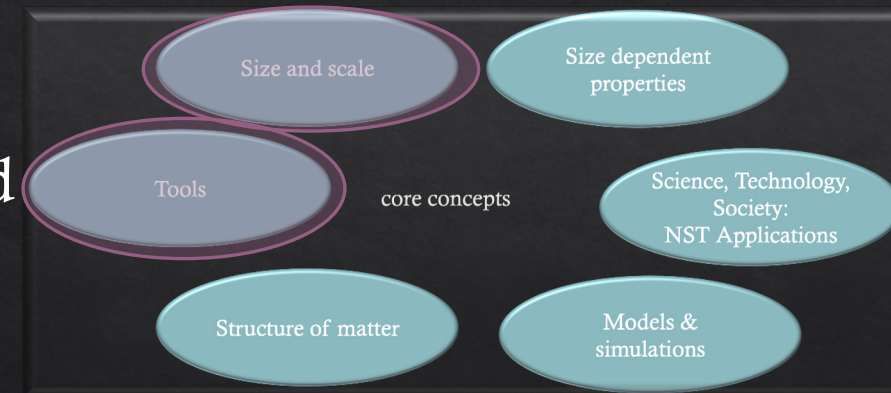
NST content in primary school



Primary school students' preconceptions of NST concepts

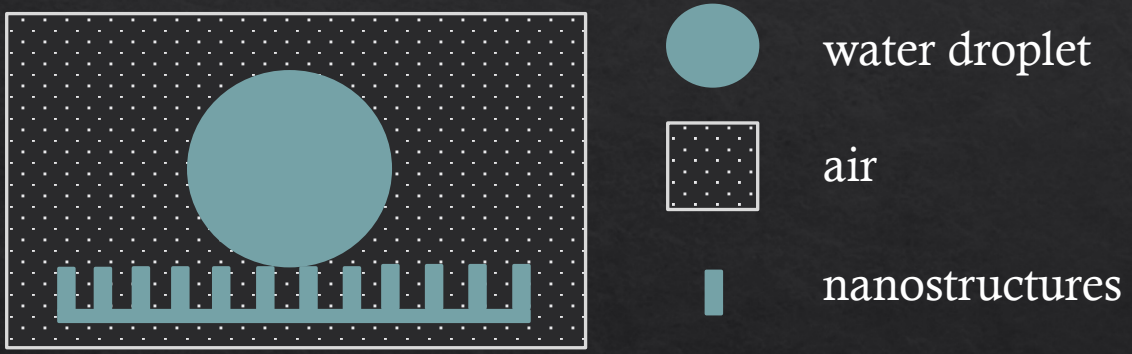
Conceptions prior to any systematic instruction

- Aware of nonvisible objects e.g. cells
- Matching correctly objects in a scale range of 1cm to 10 meters
- Difficulty in mentioning proper examples for larger and smaller scales
- Difficulty in grouping and ordering non-visible objects according to size
- Believe that it is possible to observe atoms by an optical microscope

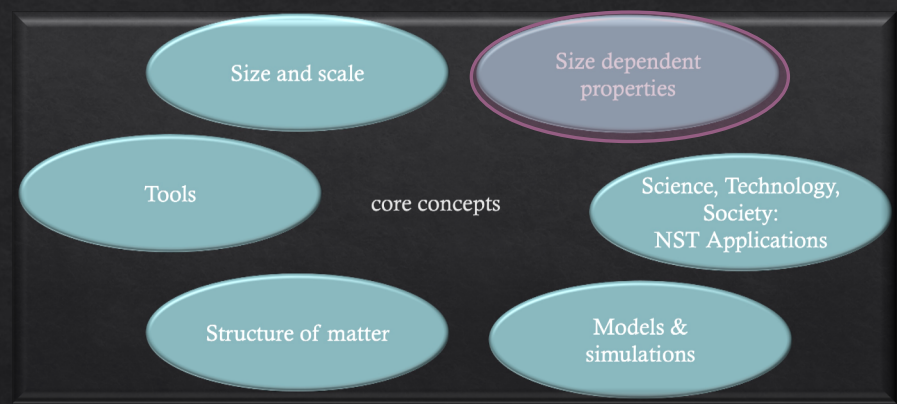


Primary school students' preconceptions of NST concepts

Lotus effect: the super hydrophobicity and self-cleaning property of a surface



- Students attribute the phenomenon to perceptual based agents
- e.g. they explain the superhydrophilicity of the leaf based on visible characteristics of the surface



Primary school students' preconceptions of the term nanotechnology

The meaning of the term nanotechnology

Only a few students relate nanotechnology to the small size

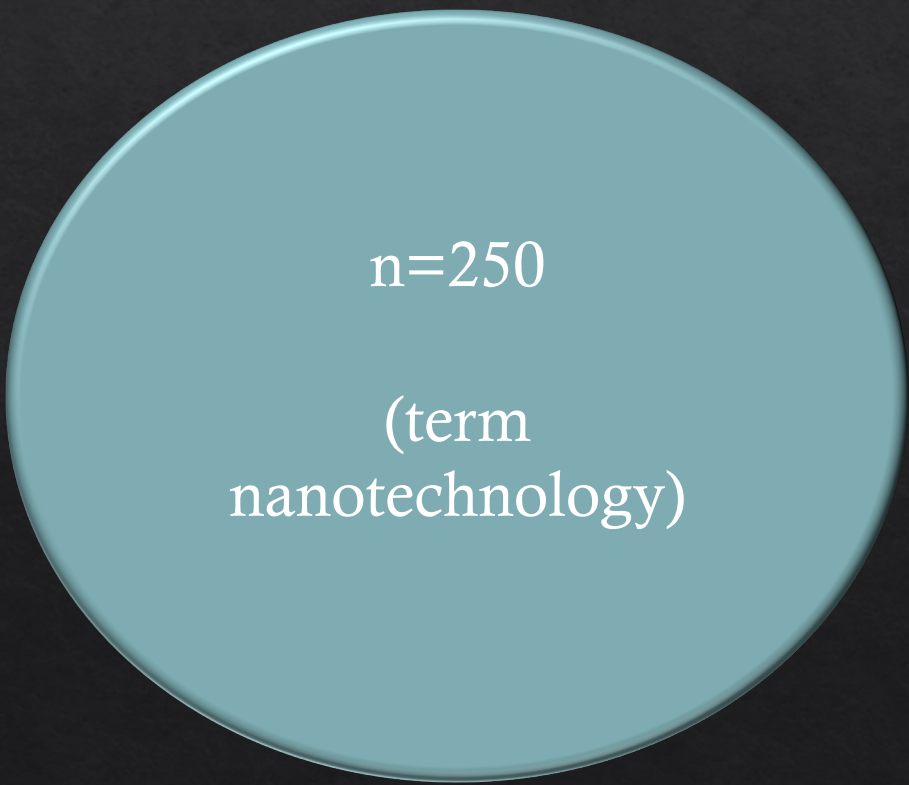
Study 1: Method

Research question

What are primary school students' preconceptions about the term nanotechnology?

Participants

5th and 6th grade students (10-12 years old) from Greece



Data collection

Written questionnaire: open-ended question

- “A student has read on the internet about the term nanotechnology and wondered what it means. How would you explain to him/her what nanotechnology is?”

Coding

Students' answers were broken down into Units of Meaning (UM)

words or phrases meaningful for the RQs

Coding process:
inductive and deductive

based on the data

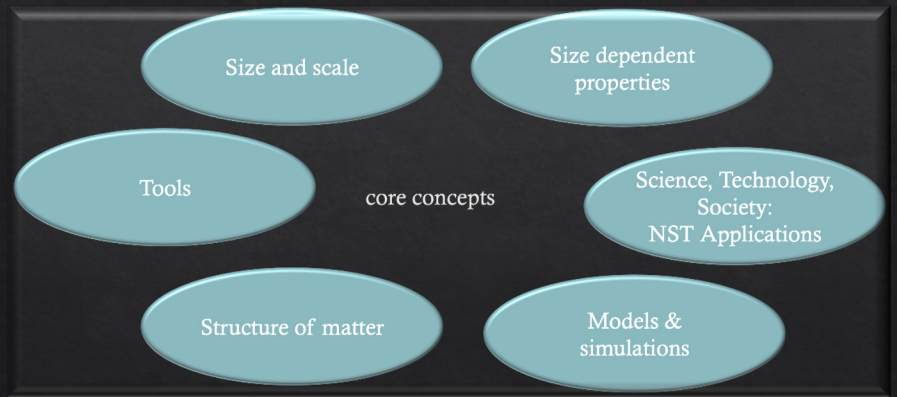
based on the literature

(Mayring 2014; Cohen, Lawrence Manion & Keith Morrison 2007)

Coding: the meaning of the term nanotechnology

Theoretical background

- Correspondences of the students' conceptions with the concepts of NST for the primary education



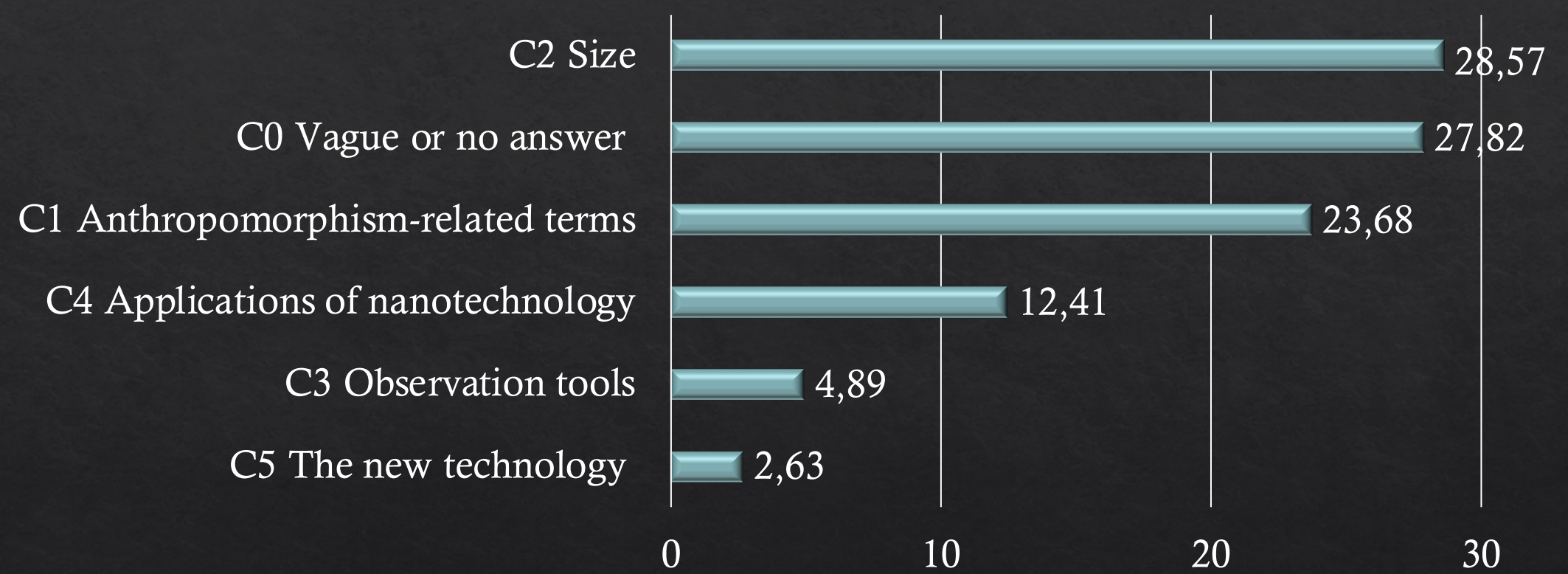
Coding rubric for the term nanotechnology

Category	Subcategory
C0 Vague or no answer	-
C1 Anthropomorphism-related terms	-
C2 Size	Sub2.1 General references to small size
	Sub2.2 Microworld or/and microworld objects
	Sub2.3 Atomic world objects
C3 Observation tools	Sub3.1 Limit of the observation tool of the macroworld (naked eye)
	Sub3.2 Observation tool of the microworld (optical microscope) or its limit
C4 Applications of nanotechnology	Sub4.1 Electronics
	Sub4.2 Medicine
	Sub4.3 Industry of water repellent textiles
	Sub4.4 General references to improvements in life
C5 The new technology	-

Study 1: Results

Preconceptions of the term nanotechnology: Categories - Percentages (%) of the UM

UM=266



Preconceptions of the term nanotechnology: Subcategories for C2 Size – Percentages (%) of the UM

Sub2.1 General references to small size

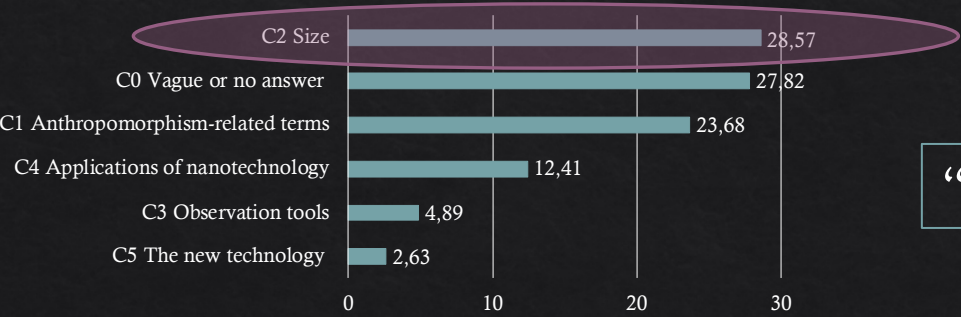
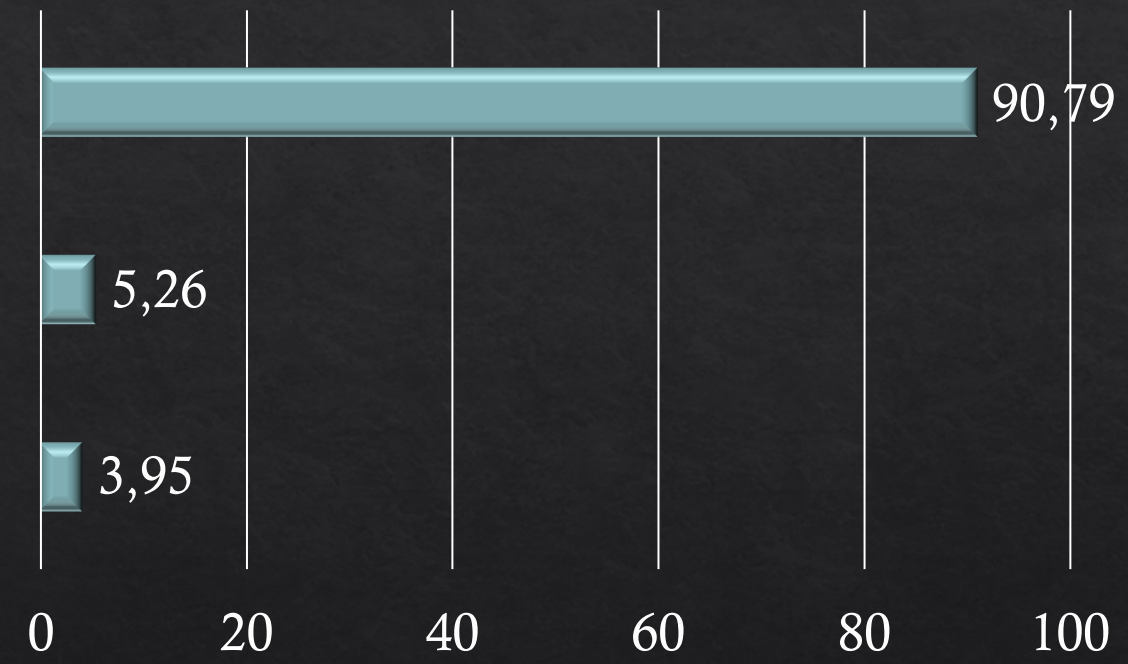
90,79

Sub2.3 References to the atomic world objects

5,26

Sub2.2 References to the term microworld or/and
microworld objects

3,95



“Nanotechnology is the technology of small things”

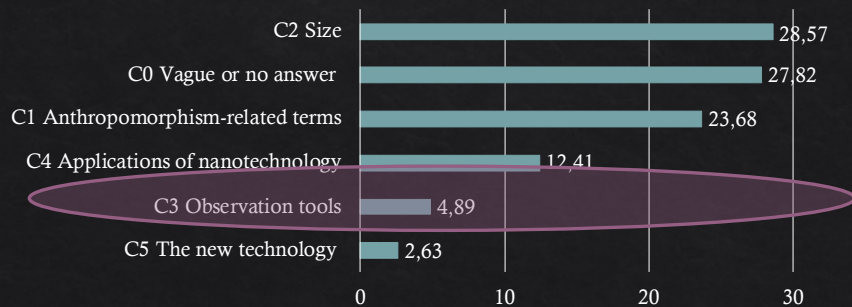
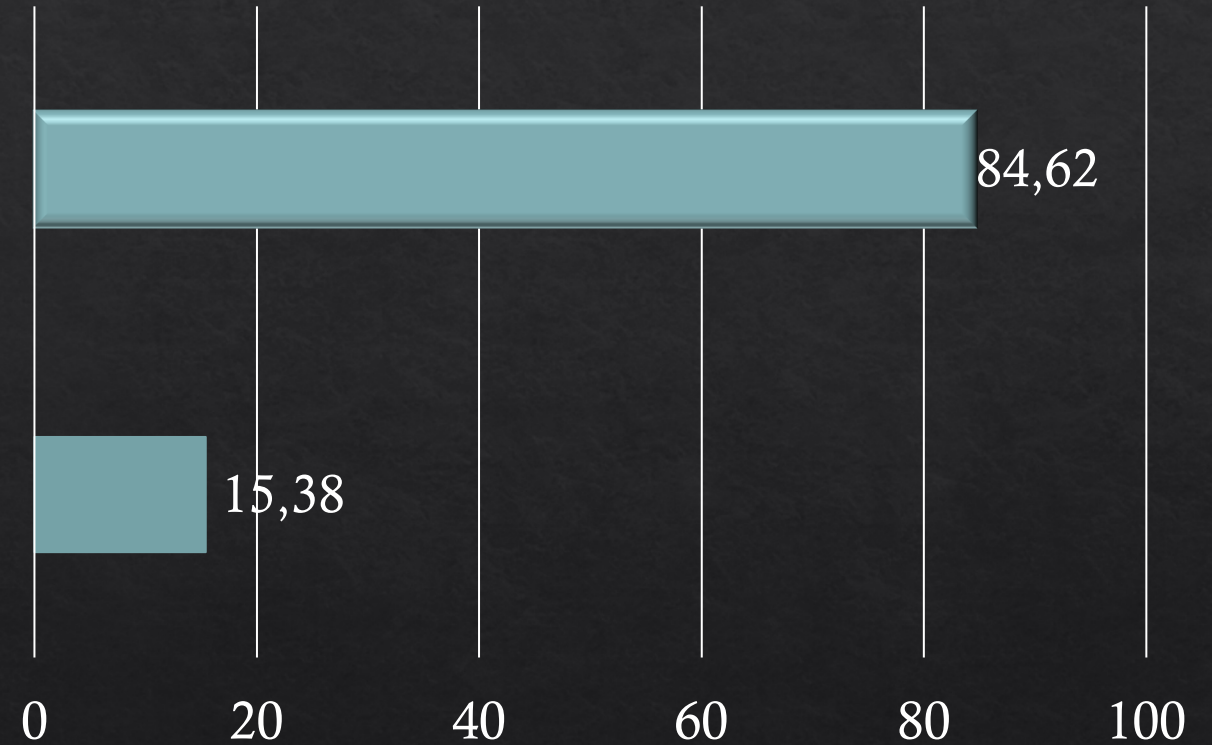
Subcategories for C3 observation tools - Percentages (%) of the UM

Sub3.2 References to the observation tool of the microworld (optical microscope) or its limit

84,62

Sub3.1 References to the limit of the observation tool of the macroworld (naked eye)

15,38



“Is the technology that uses the microscope”

Study 1 22

Preconceptions of the term nanotechnology:

Subcategories for C4 NST Applications - Percentages (%) of the UM

Sub4.1 Relating nanotechnology to electronics

87,88

Sub4.2 Relating nanotechnology to medicine

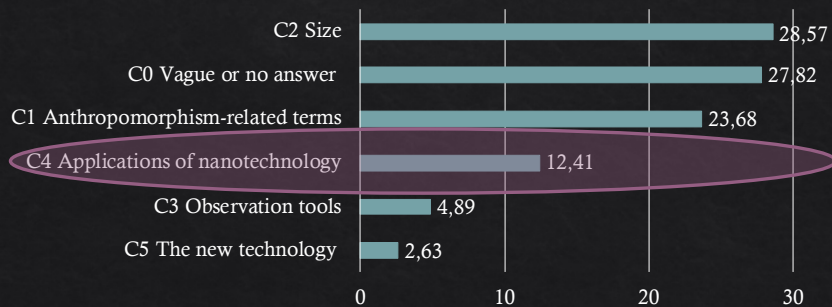
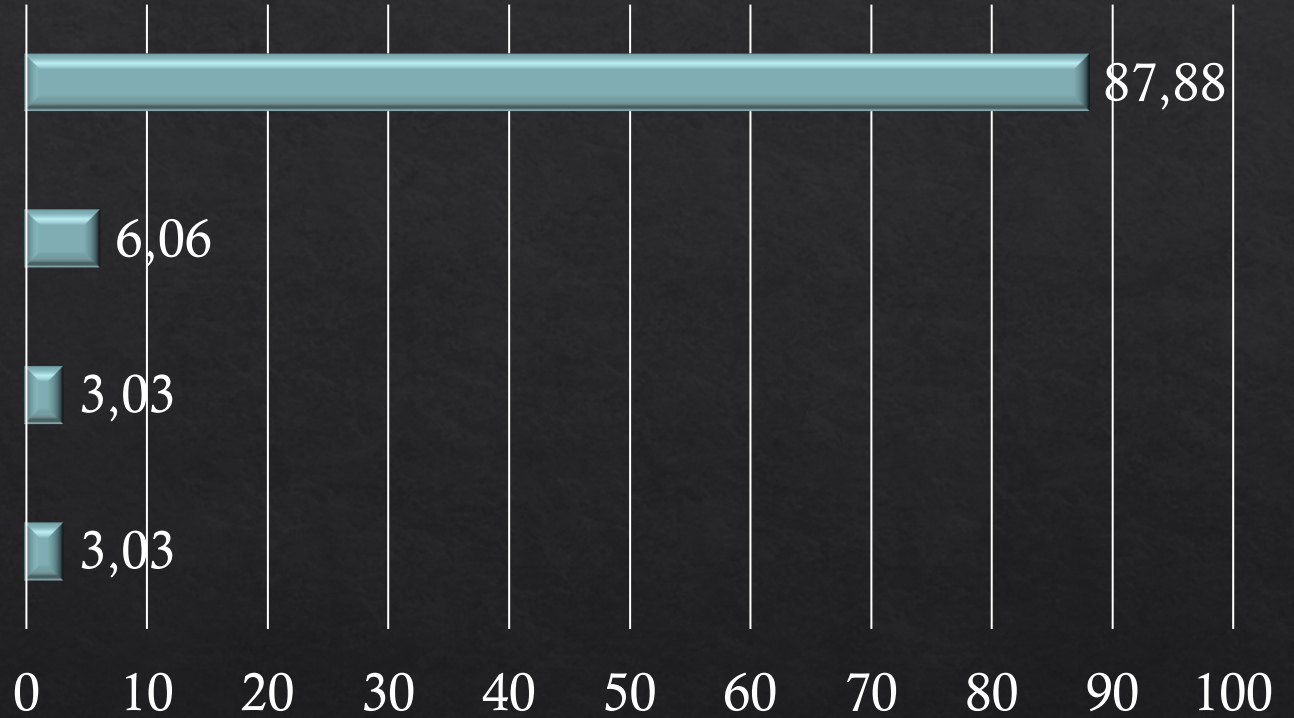
6,06

Sub4.4 General references to improvements in life

3,03

Sub4.3 Relating nanotechnology to the industry of water repellent textiles

3,03



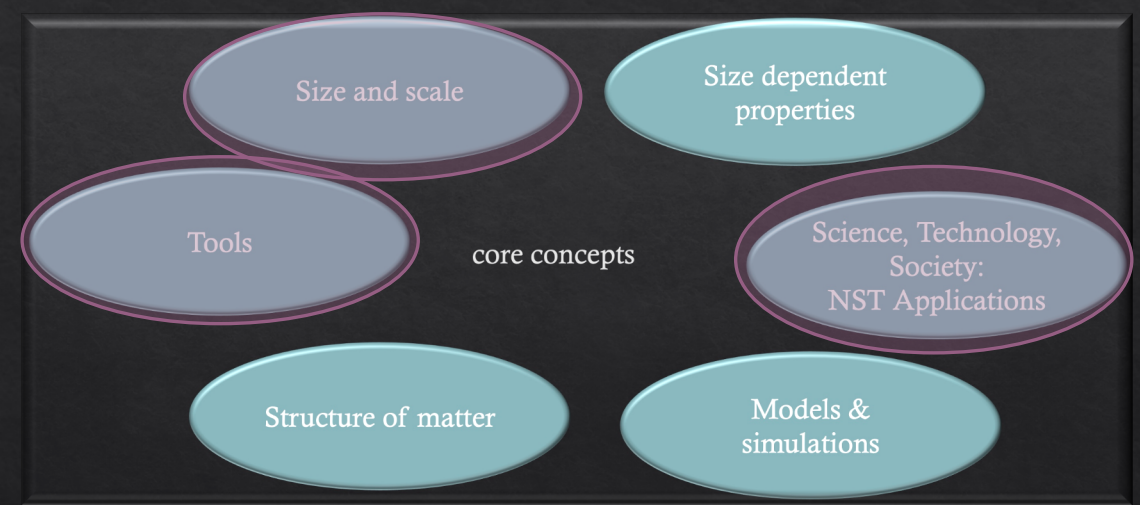
“This technology builds small chips”

Conclusions

The meaning of the term nanotechnology

Finding

Almost half of the students related nanotechnology to the size, the observation tools and the applications of NST even in a vague manner



Difference between our findings and the literature:

- More students provided answers relevant to the core concepts of NST

Conclusions

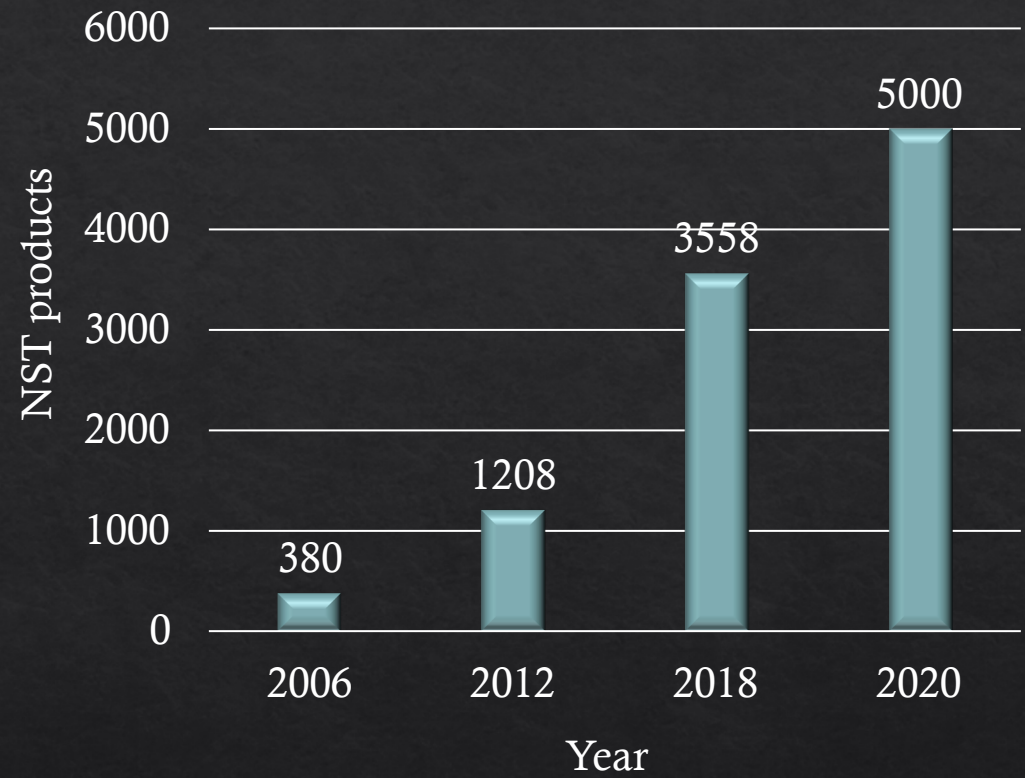
The meaning of the term nanotechnology

Explaining the difference between our findings and literature:

- The related study (Castellini et al. 2007) was conducted more than thirteen years ago
- Limited number of NST consumer products

- Nowadays: more NST consumer products

- The culture: Greek language - “nano” means small or dwarf



Conclusions

- ✓ The Study 1 revealed that students answers were related to three NST concepts.
- ✓ Concerning the applications of NST, students' responses did not reveal their preconceptions of a specific NST product, for example providing information about how it works.
- ✓ Therefore, we intended to collect additional information about students' preconceptions of a specific NST product that is already available in the market, namely the water nano-filter (Study 2).

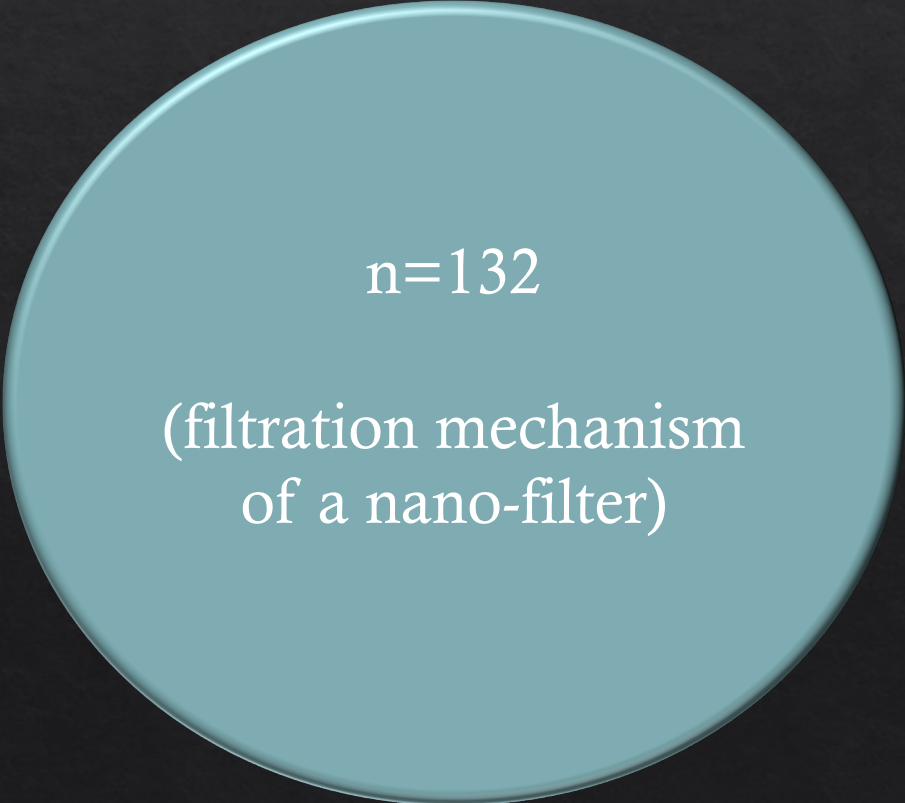
Study 2: Method

Research question

What are primary school students' preconceptions about the filtration mechanism of a water nano-filter?

Participants

5th and 6th grade students (10-12 years old) from Greece



Data collection

Written questionnaire: open-ended question

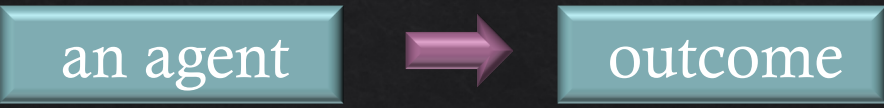
- “Suppose that you have gone fishing to a lake with your friend. You forgot to bring your water bottle but your friend has a bottle with a water nano-filter. Would you drink water from the lake using the water nano-filter? How do you think that the nano-filter works?”

Coding: Filtration mechanism of a nano-filter

Theoretical background

- Relational and linear reasoning models in combination with the accuracy of the specific information that students mentioned about the filtration

Simple linear causal reasoning



Relational causal reasoning



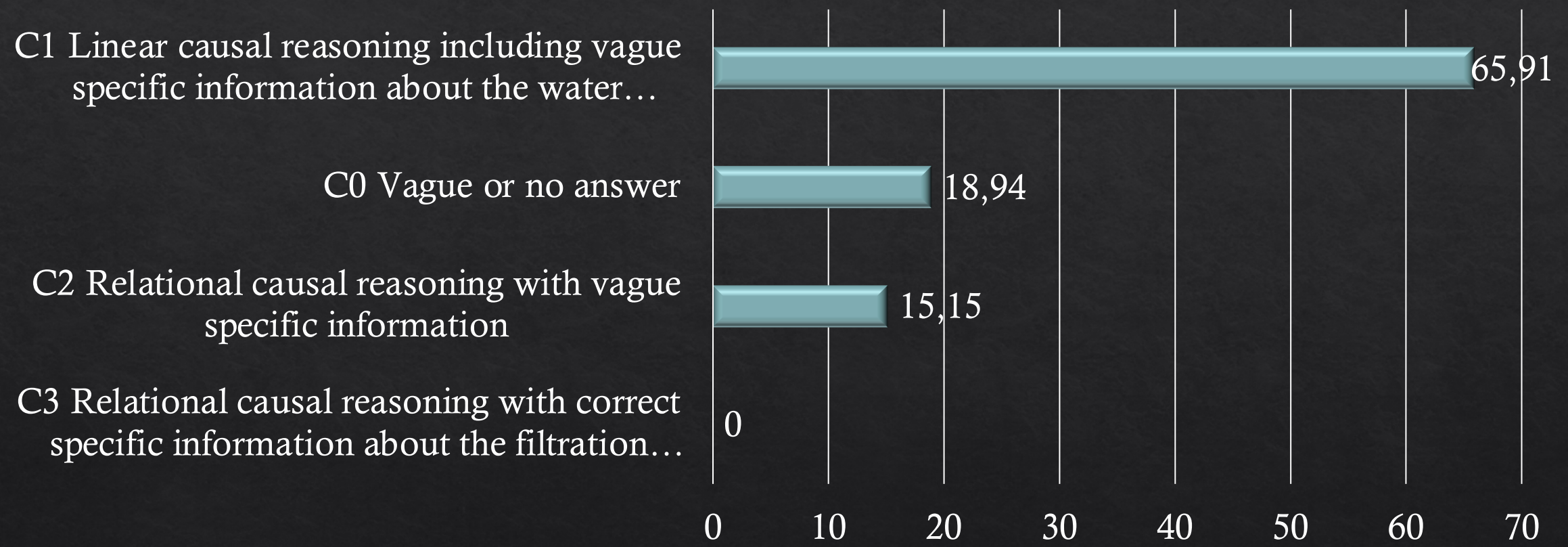
Coding rubric for the filtration mechanism of a nano-filter

Category	Subcategory
C0 Vague or no answer	-
C1 Linear causal reasoning including vague specific information about the water purification process using nano-filter	Sub1.1 Linear causal reasoning including vague specific information about the structure of the filter or/and the pattern (use of the filter)
	Sub1.2 Linear causal reasoning including incorrect information about the purification process, e.g. wrong mechanism
C2 Relational causal reasoning with vague specific information (e.g. the filter has small pores that exclude larger particles)	-
C3 Relational causal reasoning with correct specific information about the filtration (relating the size of the nanostructure to the size of the objects that excludes)	-

Study 2: Results

Preconceptions about the filtration mechanism of a nano-filter: Categories - Percentages (%) of the UM

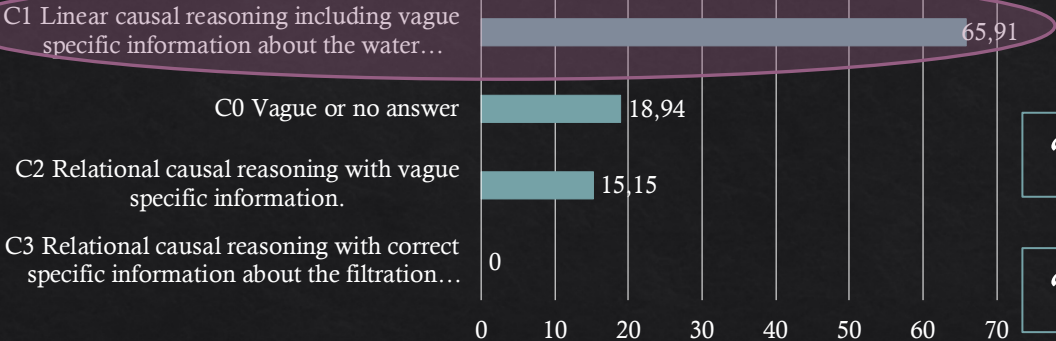
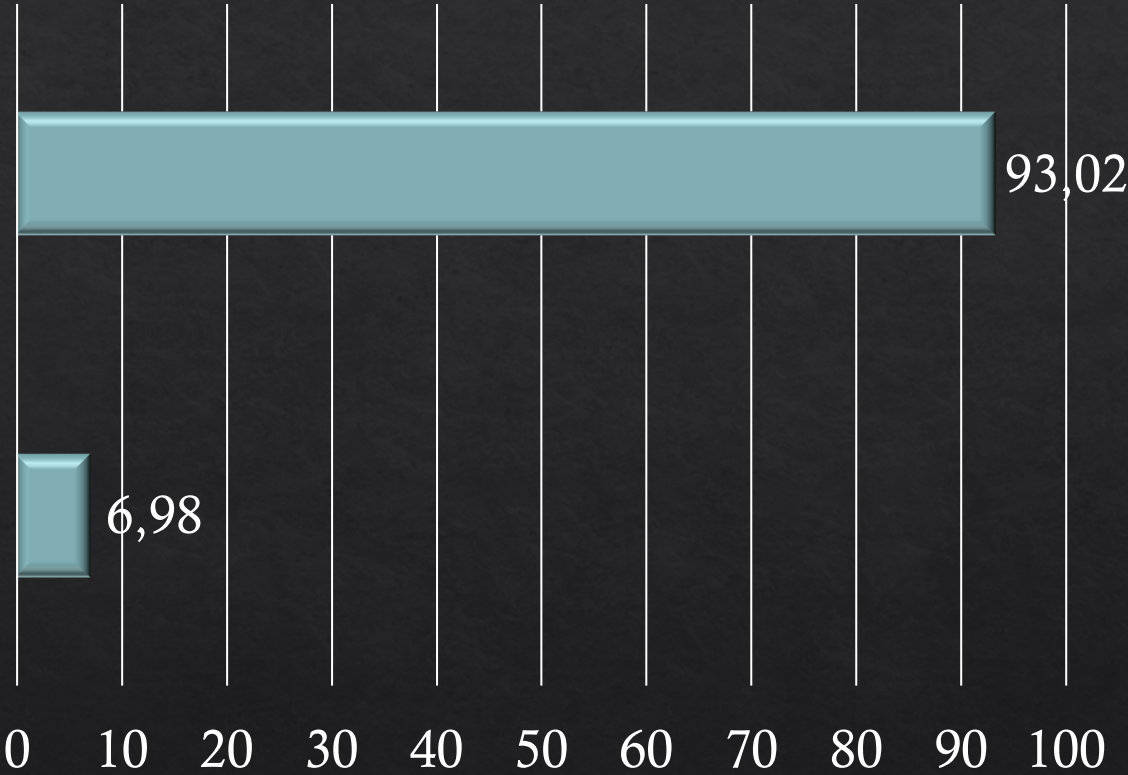
UM=132



Study 2 Preconceptions about the filtration mechanism of a nano-filter: Subcategories for the C1 - Percentages (%) of the UM 34

Sub1.1 Linear causal reasoning including vague specific information about the structure of the filter or/and the pattern (use of the filter)

Sub1.2 Linear causal reasoning including incorrect information about the purification process, e.g. wrong mechanism



“The filter has small pores that purify the water ”

“The filter includes cells that purify the water ”

Conclusions

NST applications: the filtration mechanism of a nano-filter

Linear causal explanations about the filtration process



Students mention an agent that contribute to the water purification, however, the agent is inaccurate in comparison to the scientific explanation

Students are not aware of the nanostructure of the filter and could not relate the size of the objects that are dispersed in the water to the size of the filter's pores

Impact of the Research

- ✓ The findings of this research could contribute to designing educational interventions about the NST content through the lens of the constructivist approach.
- ✓ Since students' preconceptions about the term nanotechnology were related to the three concepts of the NST (i.e. the size, the tools and the applications of NST), an instructional approach could be designed that will include all of these concepts.
- ✓ Concerning the water nano-filters, we stress the need for an educational approach for helping students to develop their relational causal reasoning about the water nanofiltration including both the size of filter's pores and the unwanted particles that could be contained in the water (e.g. viruses).

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