

# Phenomenography

Kristina Zuza and Danilo Catena

# Outline of the seminar

- Theoretical introduction (Kristina Zuza)

Guisasola, J., Campos, E., Zuza, K., & Zavala, G. (2023). Phenomenographic approach to understanding students' learning in physics education. *Physical Review Physics Education Research*, 19(2), 020602.

- Phenomenographic Analysis (Danilo Catena)

- Individual work
- Small group work??
- Big group discussion

- Final Remarks

# Outline of the seminar

- Theoretical introduction
  1. Introduction
  2. Ontological and epistemological assumptions
  3. Methodological characteristics
  4. Research rigor
  5. Examples

Guisasola, J., Campos, E., Zuza, K., & Zavala, G. (2023). Phenomenographic approach to understanding students' learning in physics education. *Physical Review Physics Education Research*, 19(2), 020602.

# 1. Introduction: Phenomenography

- Is an **empirical** approach to determining the qualitatively **different ways** individuals experience and understand aspects of the **world around** them [1,2]
- Is a **relatively new** approach to educational research
- In **mid-1970s** grew to improve curricula by probing student conceptions [3,4]
- **Marton** and Säljö focused phenomenography toward educational research [3]

# 1. Introduction: Martonian Phenomenography

- Focused on research into the processes of **teaching** and **learning** (physics)
- Initially emerged as a research focus from a strongly **empirical basis**
- Only **recently**, developments have clearly looked at **epistemological** and **ontological** suppositions, a **theoretical** basis, and specification of **methodological** requirements [9-11]

## 2. Ontological and epistemological assumptions

A phenomenon represents...

**“the combination of different ways in which an aspect of the world is conceived or experienced”**

...by a group of individuals

## 2. Ontological and epistemological assumptions

- Phenomenography holds a **nondualistic** (Internal/external) view, conceptualized as a human-world relationship in contrast with other ontological approaches:
  - **Objectivism** => Phenomena and their meaning are independent of social factors (external)
  - **Subjectivism** => Learning is a mental process i.e. reality lies in the mind (internal)
- For phenomenography, the **world cannot** be the **same** in the **absence** of the **person experiencing** it, and consequently, the **person cannot** be the **same** if the **world** being experience **does not exist**.

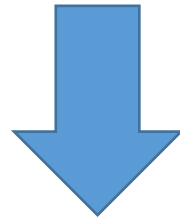
## 2. Ontological assumptions

- The ontological concern of phenomenography is the **relationship** between **awareness** and **reality**
- The only world that individuals can **communicate about** is the **world** that they **experience**
- The **reality exists** through how a **person** perceives it [15]
- This implies that the **conception** of a specific phenomenon can **change over time** because the **input** and **thought processes** depend on **experience**
- **Learning** is associated with a **change in discernment**, which entails a **change** in aspects of the **phenomenon** in the **student's awareness**



## 2. Epistemological assumptions

- Focuses on the content of **descriptions revealed by individuals** experiencing **phenomena**
- This experiential epistemology emphasizes **interaction** between the **knower** and the **known**



- It implies **creation** and **negotiation** rather than **discovery** and **verification** [18]

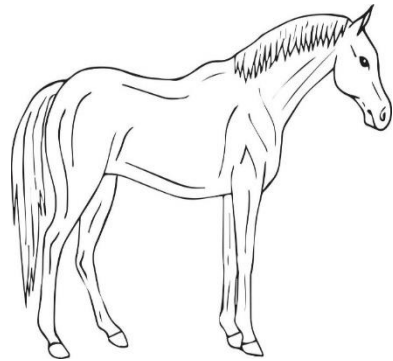
## 2. Ontological and Epistemological assumptions

- **Data** and **findings** are essentially based on the **participants' reports** coming from their awareness and conceptions of the world
- This could be why **phenomenography** has mainly been **applied** in **studies** related to **education**

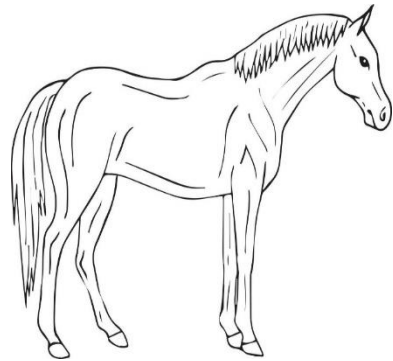
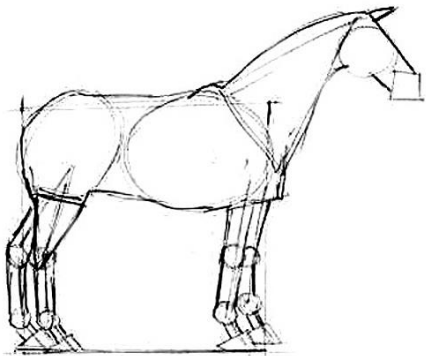
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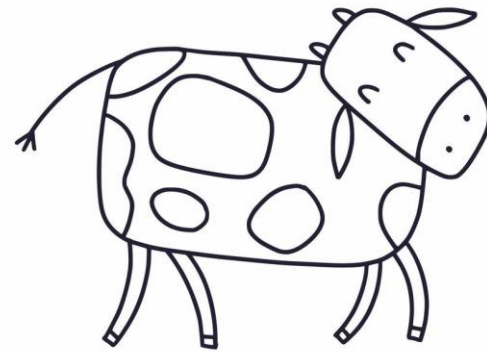
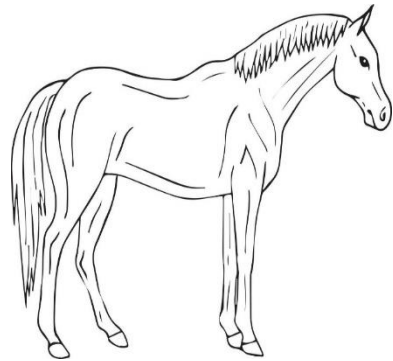
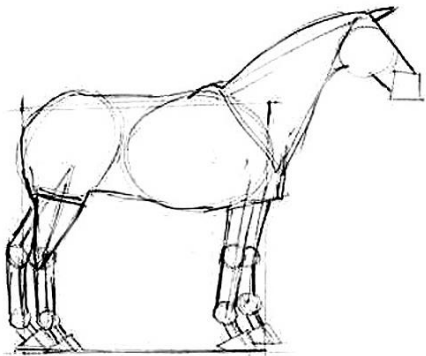
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### 3. Methodological characteristics

- A standard study **informs** the **participants** about the **phenomenon**
- The **person** is invited to **reflect** on their **experience** on the **phenomenon**
- The aim is to **categorize** the **different** ways students **experience** the phenomenon

# 3. Methodological characteristics

- **Specific methods** for data collection, analysis, and results representation:
  - **Interviews**
    - Minimal set of questions trying to get information on the experience rather than about the person or the issue
  - **Open questionnaires**
    - Allows the students to present their understanding
  - **Reports on Students' activities**
    - Due to homework's, videotape of class discussions, drawings ...

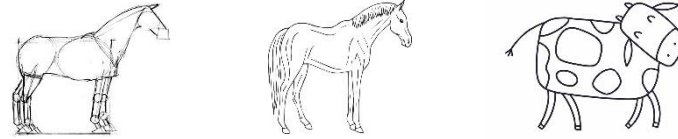


# 3. Methodological characteristics

- Selection of the **instrument**:
  - Chosen instrument must be **coherent** with the **research objectives**
  - The researches should be **aware of**:
    - **Affordances** and **risks** of the instruments
    - **No transmission of preconceived ideas** at any stages
- Selection of **sample**:
  - Phenomenon experienced individuals are chosen to act as respondents until the **required sample size** is obtained.
  - Size **depends** on the **instrument** and the **data analysis**

# 3. Methodological characteristics: Description Category and Outcome Space

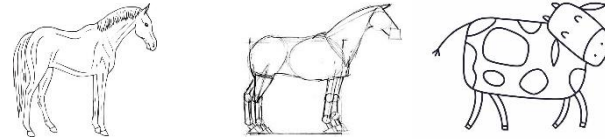
- **Description Category:**



- Analytically represented a **qualitatively different** way of **experiencing** and **interpreting** a phenomenon [5,6]
- The description **categories** are logically **related** to each other through inclusive structural relationship [15]
- Phenomenography affirms that the **ways** people experience a phenomenon, although **qualitatively different**, are **limited** in number [6,11]

# 3. Methodological characteristics: Description Category and Outcome Space

- **Outcome Space:**



- Each **category** in the outcome space reveals something **distinctive** about understanding the topic
- The categories are **logically related**, typically as a structured **hieratically** of
- The results are a **minimal set of categories** representing the **critical variation** of the experience observed in the data

# 4. Research Rigor: Validity and Reliability

- **Sample:**

- It is needed a number of people in the sample who are asked to **ensure** a reasonable change of findings a **wide variation** in **categories**.
- Between **ten** and **twenty** people are usually sufficient to **capture** the category **variation** [33]
- The **greater** the **number** of **observations**, the **greater** the data **reliability** might be, enabling verification of emergent categories.

# 4. Research Rigor: Validity and Reliability

- **Validity:**

- Must incorporate specific **strategies** for **verifying** the validity check:  
**Communicative validity.**

- **Communicative validity:** It is based on an **open dialogue** with **participants**, other members of the **professional** community and the **audience** of the research results [14,35]

# 4. Research Rigor: Validity and Reliability

- **Reliability:**

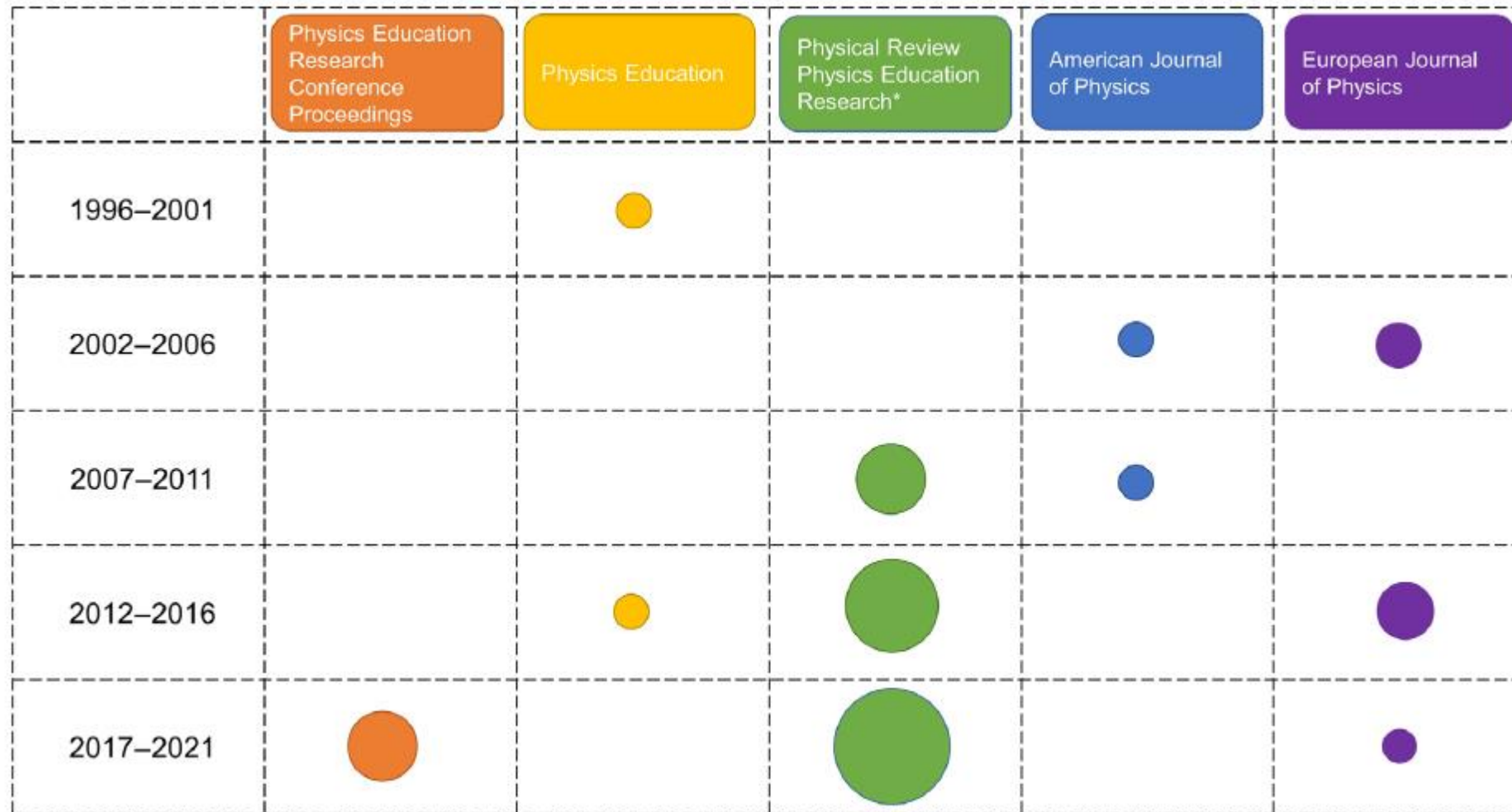
- **Two main forms of verification:**

- First form focuses on **several researchers comparing the data sample coding** [11]
- In the second, the researchers **manage to agree** on the interpretative categories through discussion and critique of the data [8]

## Creation of the Outcome Space

Steps	Description
1. Familiarization	The researcher reads and rereads transcripts or the written responses to become familiar with the content
2. Compilation	Identifies the most significant characteristics of the given answers
3. Condensation	Reduction to find the central parts of the interview or written responses
4. Classification	Initial classification of similar answers
5. Comparison	Comprises the preliminary comparison of categories
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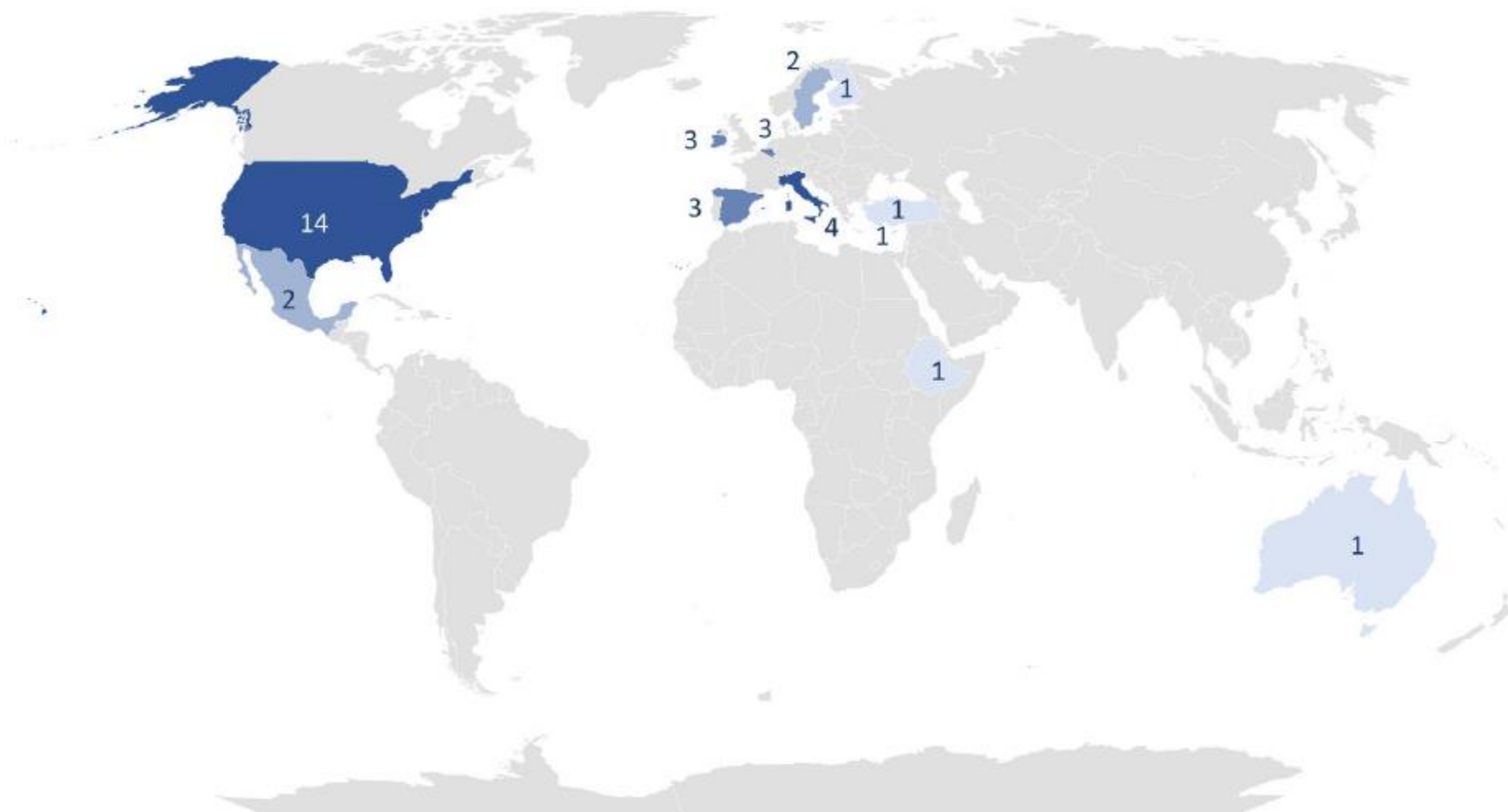
# Phenomenography in the PER literature



\*Before 2016, Physical Review Special Topics - Physics Education Research



# Phenomenography in the PER literature



# 5. Let's see some examples

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH **14**, 020117 (2018)

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## **Introductory university physics students' understanding of some key characteristics of classical theory of the electromagnetic field**

Kristina Zuza,<sup>1</sup> Paul van Kampen,<sup>2</sup> Mieke De Cock,<sup>3</sup> Thomas Kelly,<sup>4</sup> and Jenaro Guisasola<sup>1</sup>

## 5. Let's see some examples

- Introductory physics students
- After instruction
- 115 students (UPV/EHU; Spain)
- 100 students (KULeuven; Belgium)
- 114 students (DCU, Ireland)

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KC1. The electrostatic field is produced by charges and the magnetic field is produced by moving charges (currents or magnets).

KC2. The concepts of force and field are different concepts, even though they are tightly connected.

KC3. Fields exert forces only on their sources: gravitational fields exert forces only on mass, electric fields on charge, magnetic fields on moving charge.

KC4. There is no “self-interaction,” that is, the electric field created by a point charge or the magnetic field created by a moving charge does not exert a force on that position.

KC5. Changes in the fields are not instantaneous but propagate at the speed of the light.

# Let's see some examples

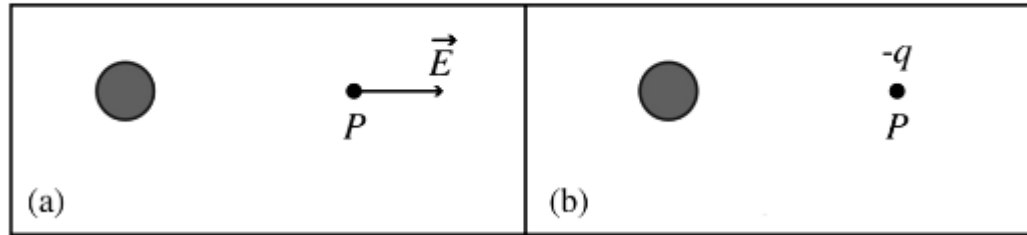
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- KC5. Changes in the fields are not instantaneous but propagate at the speed of the light.

TABLE I. Key concepts addressed by the questionnaire.

	KC1: sources	KC2: force/field	KC3: own source	KC4: no self-interaction	KC5: propagation
Electric Field	✓	✓		✓	
Magnetic Field	✓	✓	✓	✓	
Magnetic Force	✓	✓		✓	
Magnetic Needle	✓		✓		
Sudden Charge					✓
Broadcast					✓

# Let's see some examples

The electric field  $E$  due to a charge  $Q$  at a point  $P$  is represented in Figure 1a. What would be the representation if a very small negative charge is placed at point  $P$  (see Figure 1b)? Draw this representation and explain your answer.



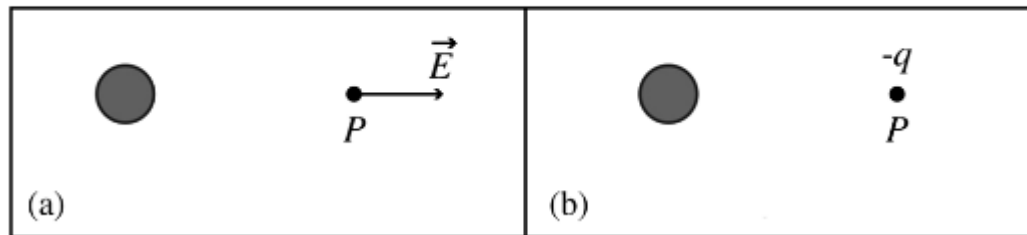
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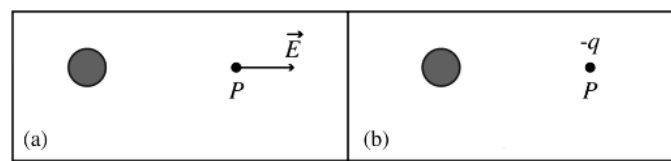


## Category

- A1. Correct Maxwellian understanding of the source of field and the relation between force and field
- A2. Correct Newtonian understanding of the source of field and the relation between force and field
- B1. Misunderstanding of the relation between force and field
- B2. Superposition or self-interaction
- C. Incoherent (rote learning and wrongly assimilated)
- D. No explanation or no answer

## Electric Field question

	UPV/BHU ( $N = 115$ ) [%]	KUL ( $N = 100$ ) [%]	DCU ( $N = 114$ ) [%]
A1. Correct Maxwellian understanding of the source of field and the relation between force and field	17	29	11
A2. Correct Newtonian understanding of the source of field and the relation between force and field	4	13	4
B1. Misunderstanding of the relation between force and field	39	35	38
B2. Superposition or self-interaction	9	1	23
C. Incoherent (rote learning and wrongly assimilated)	13	13	26
D. No explanation or no answer	18	9	0



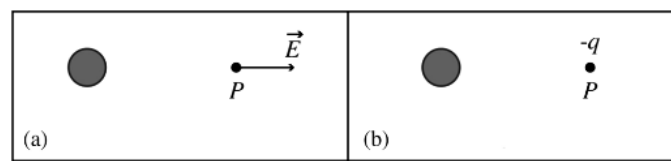
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*“At point *P*, the field of the charge  $-q$  is zero, so the field stays the same.” (Electric Field question, KU Leuven student E13)*

*“The electric field is defined as  $E = kq/r^2$ . As the charge  $Q$  and the distance don't vary the field  $E$  is the same. The test charge  $-q$  does not generate a field at point *P* since the distance is 0. Therefore, the vector drawing is the same as in Fig. 1(a).” (Electric Field question, UPV/EHU student 2).*






# Let's see some examples

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*“If we put a negative charge close to the positive, it will be attracted to it. The vector changes.” (Electric Field question, UPV/EHU student 79)*

*“A negative charge will generate an electric field [that] flows in the -ve direction compared to the field due to the charge  $Q$  at  $P$ . This electric field will cancel or reduce the electric field at  $P$  when the small charge  $-q$  is placed at  $P$ . The electric field [vector] will only get a little shorter as the charge  $-q$  is very small.” (Electric Field question, DCU student 54)*

# Let's see some examples



Analyzing the upper secondary school  
students' view of the universe

Kristina Zuza Elozegi  
Joanes Lizarraga Olano

# Let's see some examples

## 2- The study

Analyzing the upper secondary school students' view of the universe

**Sample:**  
Last year upper secondary school students

**Instruments:**  
Open ended questionnaire



122 students  
17-18 years old  
Choose physics as subject  
4 different schools (public and private)  
There is no statistical differences

**Analysis:**  
Phenomenography

Kristina Zuza Elosegi  
Joanes Lizarraga Olano

### 3- Results

Q1. There is a discussion in class about what Big Bang is. Aitor say that was the instant when the universe was born and there was nothing before. Irati, state that was a big explosion and after that materia was spread through the universe. With who are you agree?

Category	Percentages of answers
A	The birth of the universe. There was nothing before. 5%
B	There was materia before the Big Bang 19%
B1	Materia was spread in the Big Bang 38%
B2	Big velocity, pressure, temperature... generated Big Bang 5.8%
B3	Cyclical universe 6.6%
C	Bag Bang doesn't exit 2.5%
E	No answer/no coherence 23.1%

Table1. Resume of the question 1of the questionnaire. Reliability: Cohen's kappa 0.95.

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In the Big Bang the space began to be created very fast and nowadays is still growing. But it wasn't an explosion

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I think (...) stars, galaxies,... was created in an explosion. Many time ago all the materia was enclosed in a ball and then it exploded

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C	Bag Bang does not exist	2.5%
E	No answer	0.1%

As name said it was a Big Explosion and if there was nothing, nothing can't exploit so, I think Irati 's statement is more correct than Aitor's.

0.95.

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# Questions?

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Thanks to: Esmeralda Campo, Jenaro Guisasola, Genaro Zavala, Italo Testa

Let's try a phenomenographic data analysis!

# PHENOMENOGRAPHIS ANALYSIS

<b>Steps</b>	<b>Description</b>
1. Familiarization	The researcher reads and rereads transcripts or the written responses to become familiar with the content
2. Compilation	Identifies the most significant characteristics of the given answers
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# Let's try a phenomenographic data analysis!

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2. Compilation	Identifies the most significant characteristics of the given answers

15 minutes of individual work

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