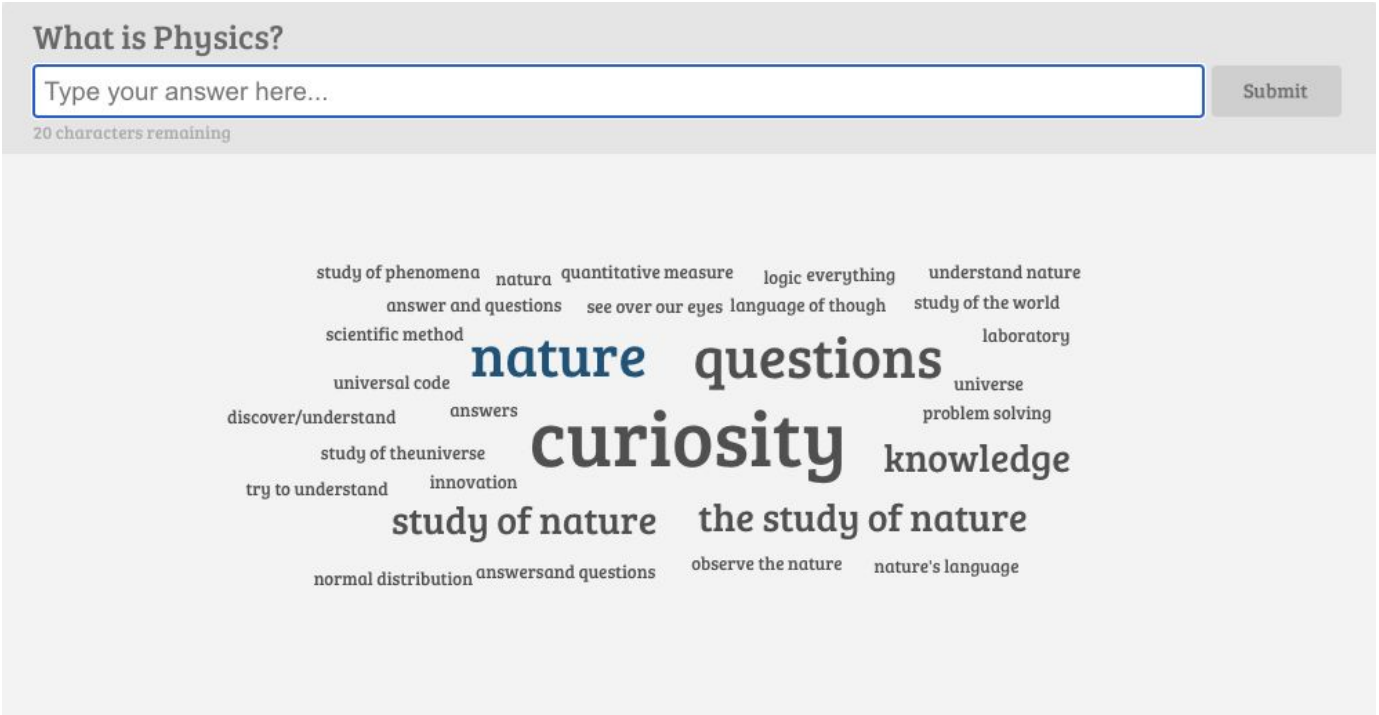
# Physics Education Laboratory Lecture 02

Francesco Longo • 22/09/2025

# Brainstorming



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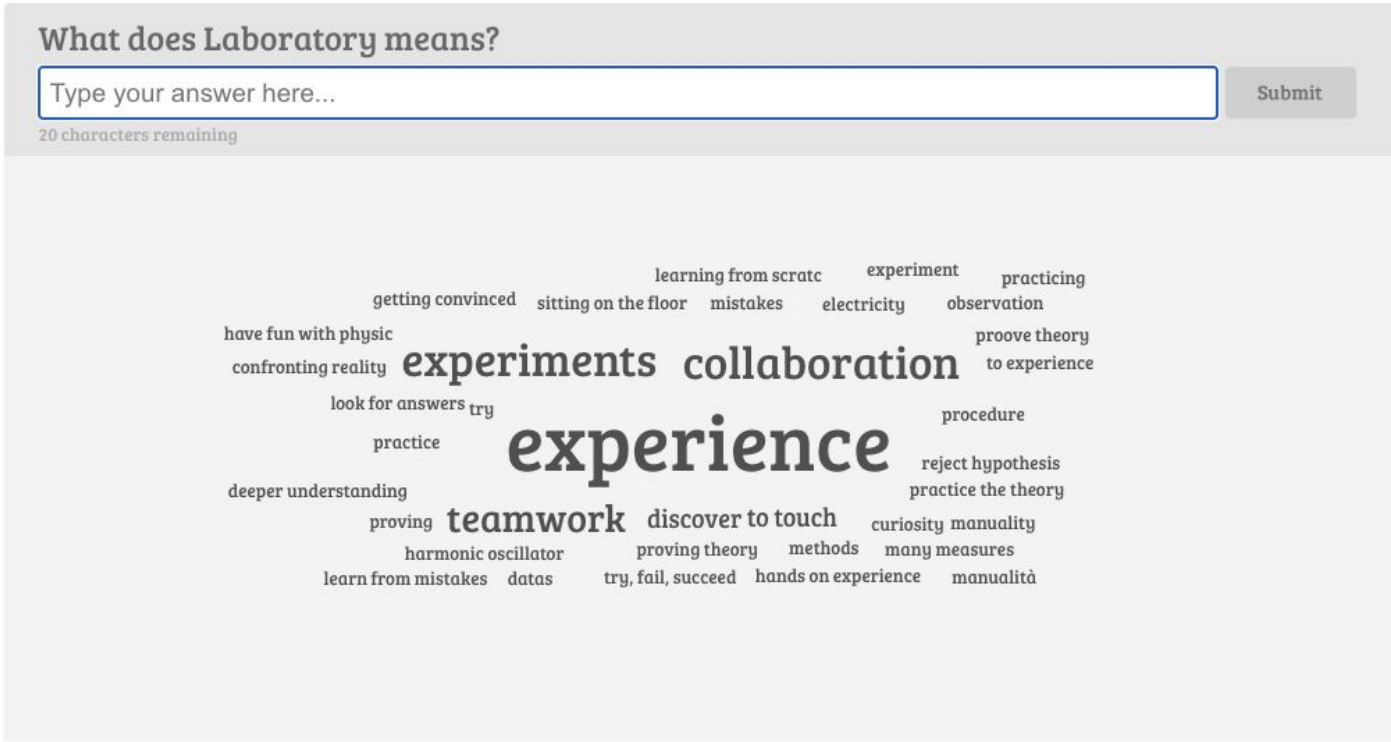

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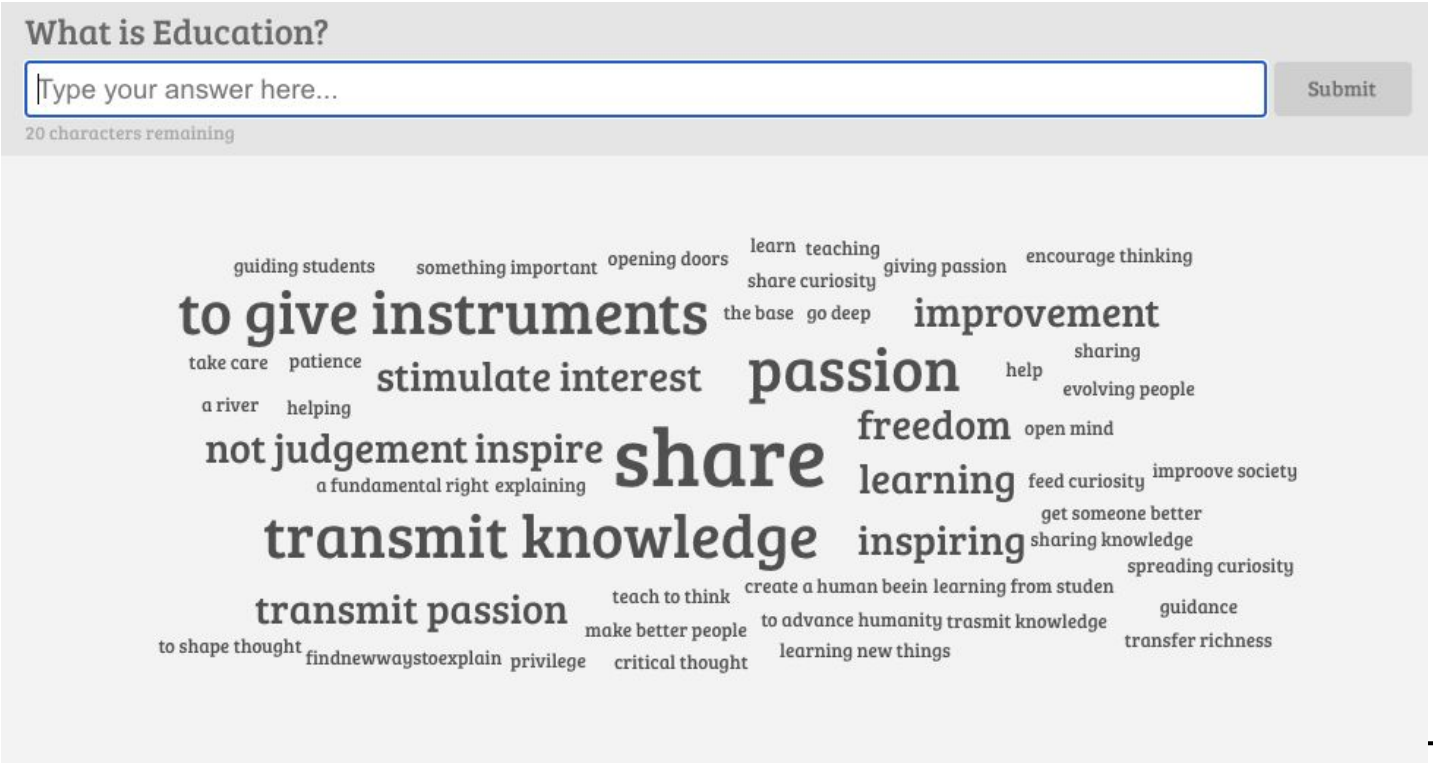


# Lesson outline

## Observation

- Video - lessons

## Discussion

- Teacher's perspective
- Student's perspective
- Discipline's perspective

## Conceptual Frame

- Content's details
- Main conceptual difficulties

## Teaching Approach

- Methodologies
- Educational

## Laboratory

- Educational experiments
- Case studies

# Main topics

Kinematics
Dynamics
Energy
Fluidodynamics
Calorimetry/thermodynamics
Optics
Electrostatics
Magnetism
Electromagnetism
Quantum Mechanics
Special relativity

# Useful education tools in PER

Early Physics
Multiple Representations in Physics
Historical approaches
Problem-solving; Jeopardy problems
Physics of everyday Thinking
Project Based Education
Modelling instruction
Simulation for Educational Physics
ISLE - Investigative Science Learning Environment
IBSE - Inquiry Based Science Education
Bayesian updating method
On line educational tool-kit

# Course Final Exam

1. Choose a subject
2. Choose a teaching approach
3. Discuss the adopted teaching approach based on PER literature search
4. Create your own educational case
5. Elaborate a report
6. Prepare a laboratory to test it

https://forms.gle/rbxLyGwZCGoVYwk16

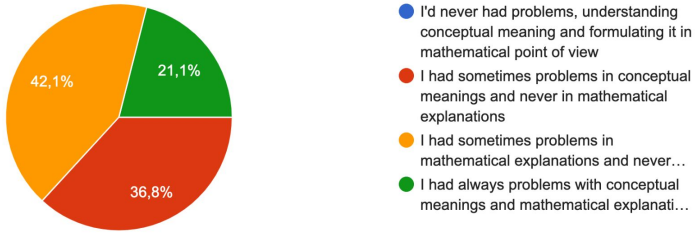
# 2022-2023

## Which kind of physics learner are you?

19 risposte


## What do you think about the way you learned Physics (in university course)

19 risposte

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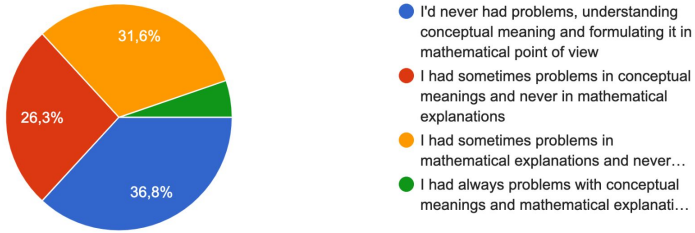

# 2023-2024

Which kind of physics learner are you?

18 responses


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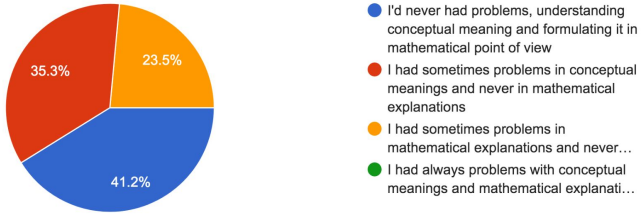
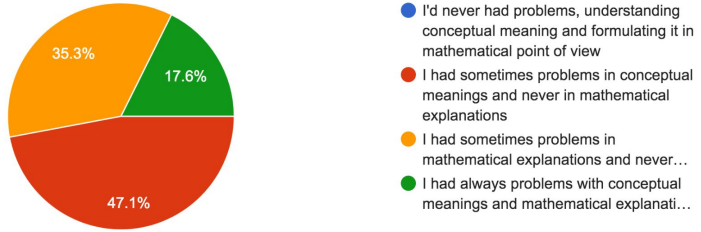
17 responses




What do you think about the way you learned Physics (in university courses)

17 responses



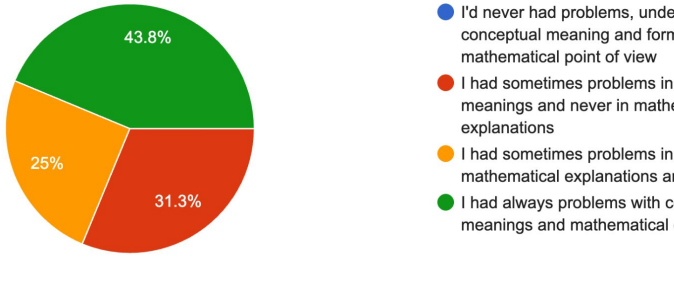
# 2024-2025

## Which kind of physics learner are you?

16 responses


## What do you think about the way you learned Physics (in university course)

16 responses

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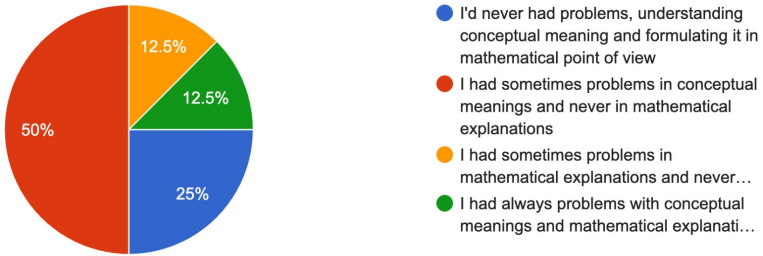
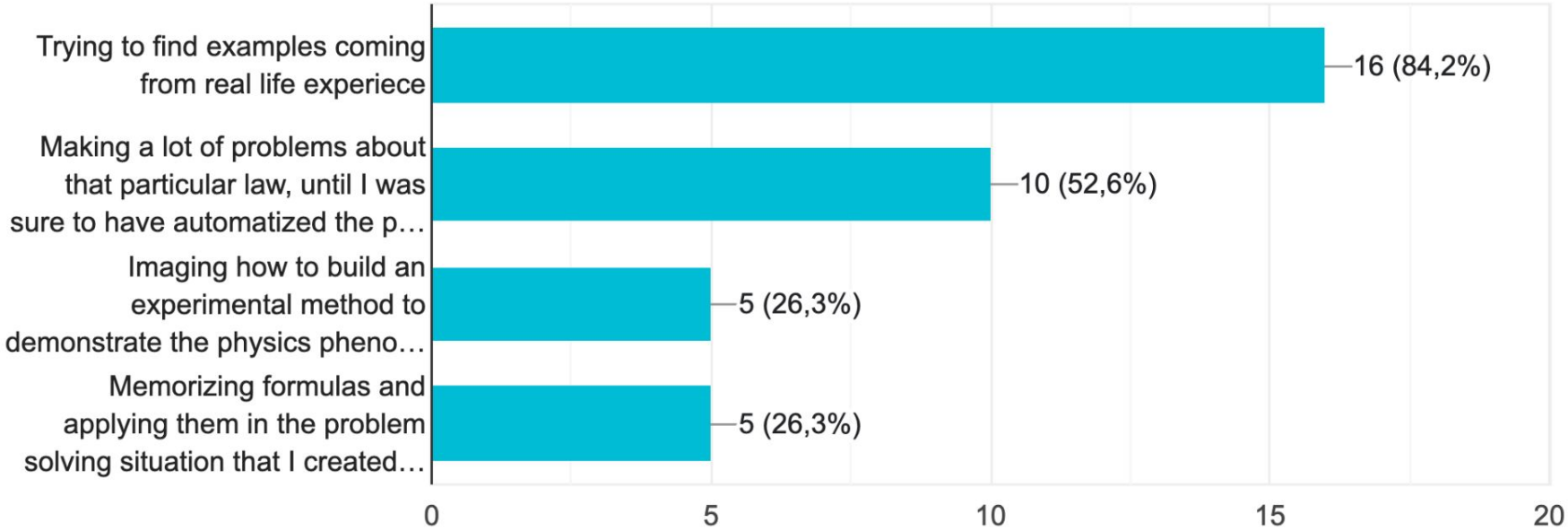


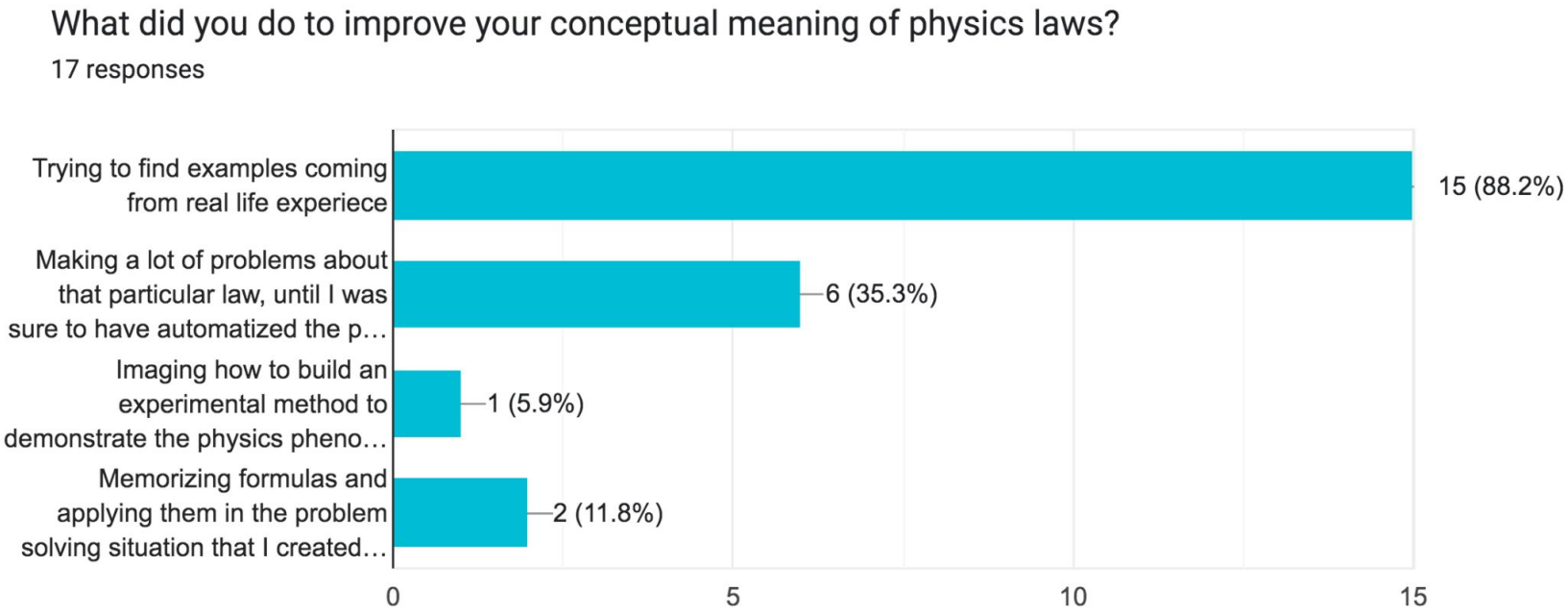
2022-2023

## What did you do to improve your conceptual meaning of physics laws?

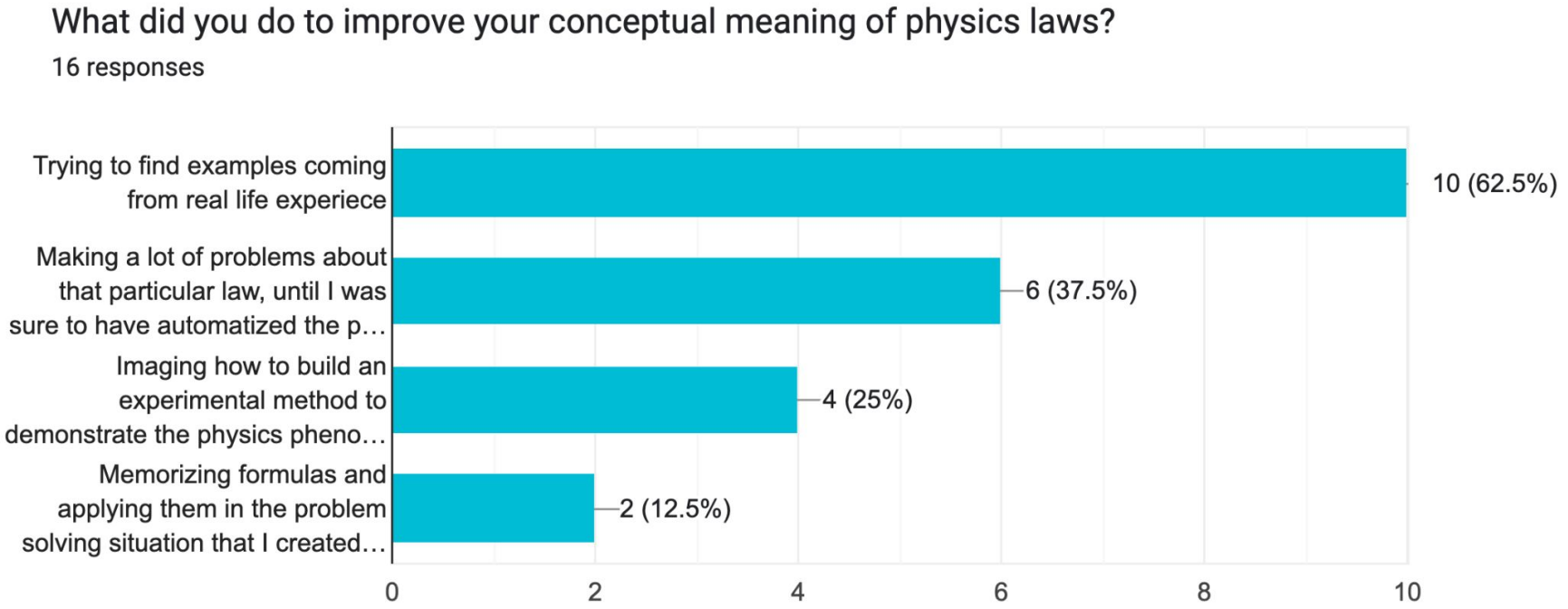
19 risposte



2023-2024

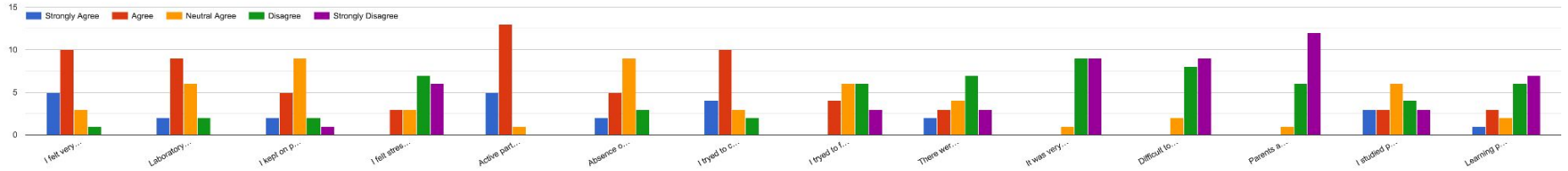

What did you do to improve your conceptual meaning of physics laws?
17 responses
Trying to find examples coming from real life experiece
15 (88.2%)
Making a lot of problems about that particular law, until I was sure to have automatized the p…
6 (35.3%)
Imaging how to build an experimental method to demonstrate the physics pheno…
1 (5.9%)
Memorizing formulas and applying them in the problem solving situation that I created…
2 (11.8%)
0
5
10
15

2024-2025

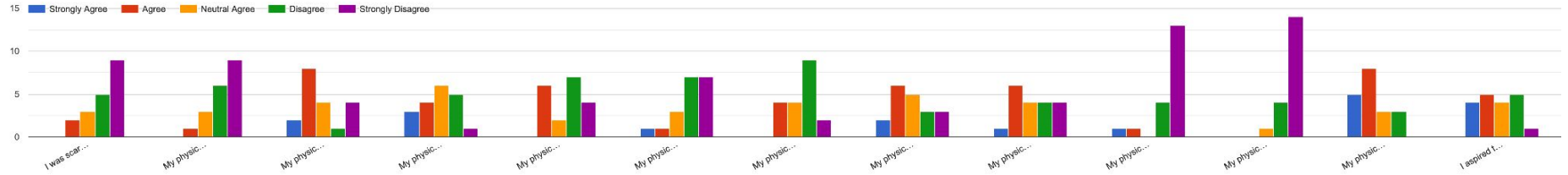

What did you do to improve your conceptual meaning of physics laws?
16 responses
Trying to find examples coming from real life experiece
10 (62.5%)
Making a lot of problems about that particular law, until I was sure to have automatized the p…
6 (37.5%)
Imaging how to build an experimental method to demonstrate the physics pheno…
4 (25%)
Memorizing formulas and applying them in the problem solving situation that I created…
2 (12.5%)
0
2
4
6
8
10

# 2022-2023

Physics learning experience (referring to your secondary school course)




Physics teaching observation (referring to your secondary school course)



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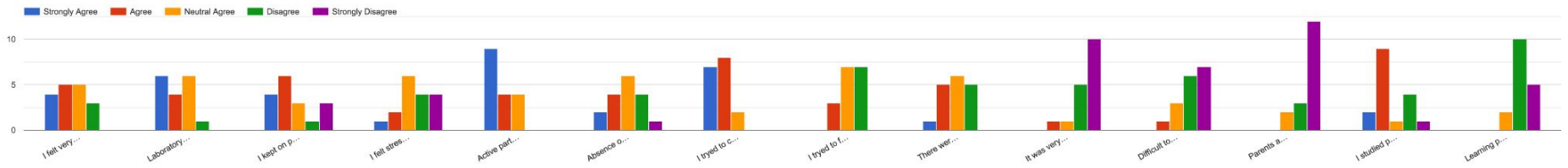


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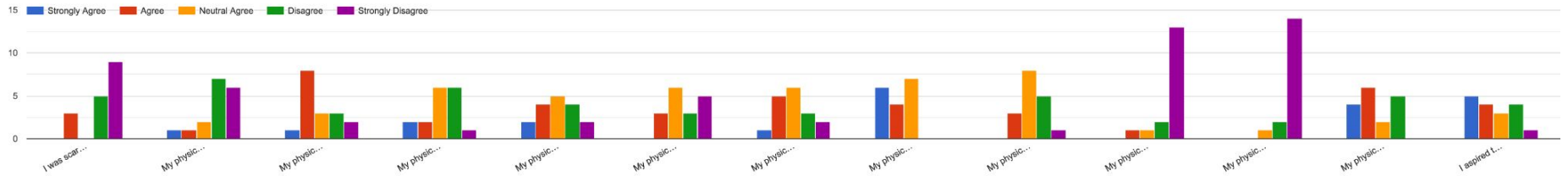

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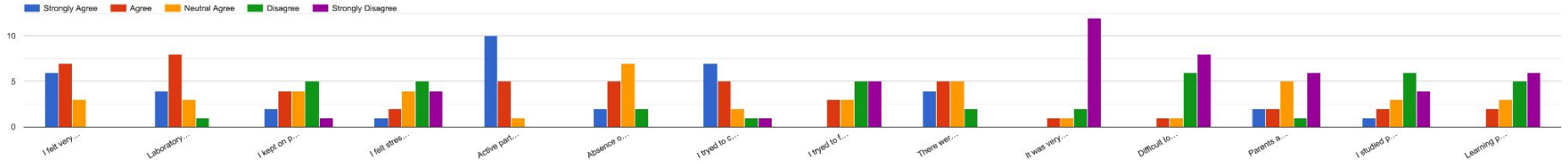


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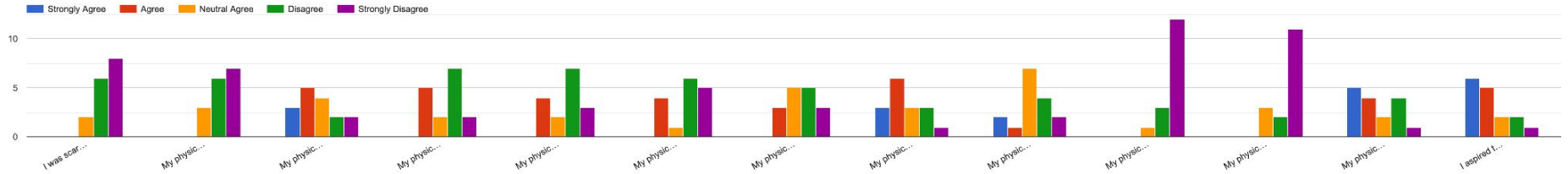
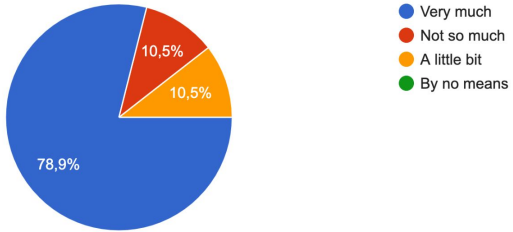


# 2022-2023

Did your Physics learning experience change during your university course?

19 risposte




Of the following test formats, which is best for measuring how well students understand the material in physics?

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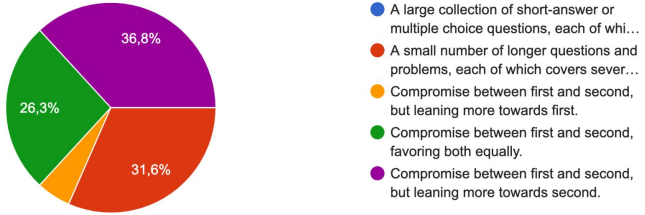


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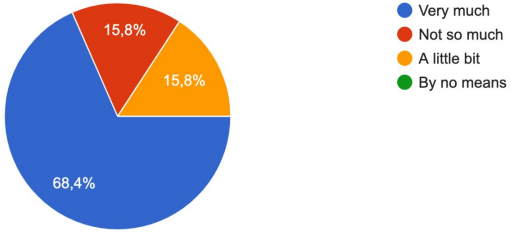

# 2023 - 2024

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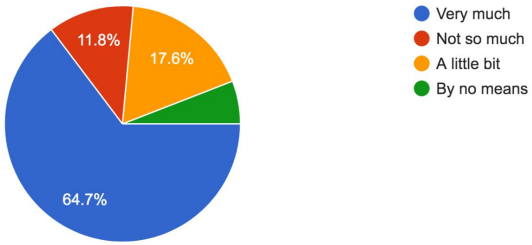


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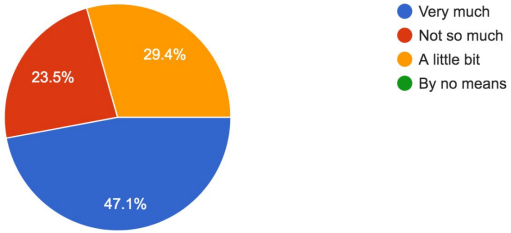


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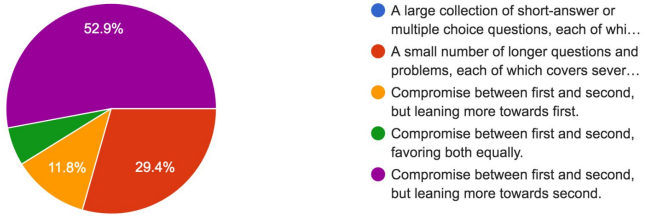

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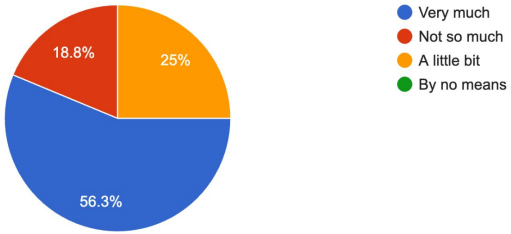


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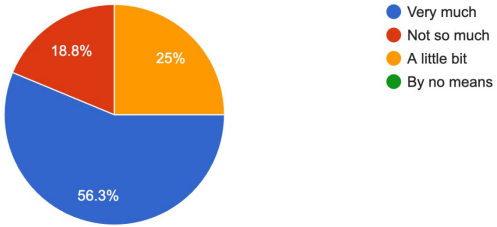


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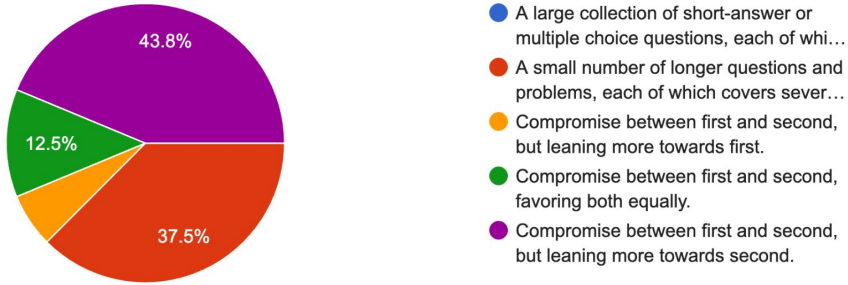

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Brandon: "A good physics textbook should show how the material in one chapter relates to the material in other chapters. It shouldn't treat each topic ... With whom do you agree?

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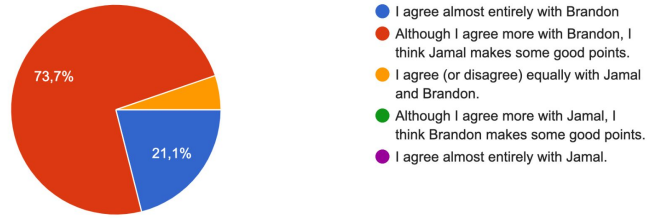


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19 risposte


Imagine you are teaching physics at high school and you want to make your students familiar with the concept of block and tackle. Would you do so by:

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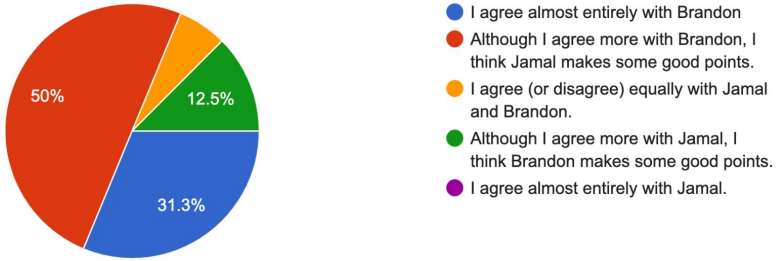


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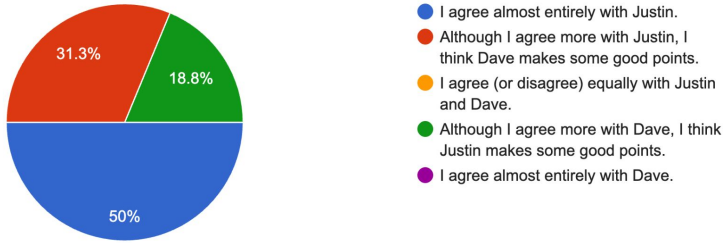


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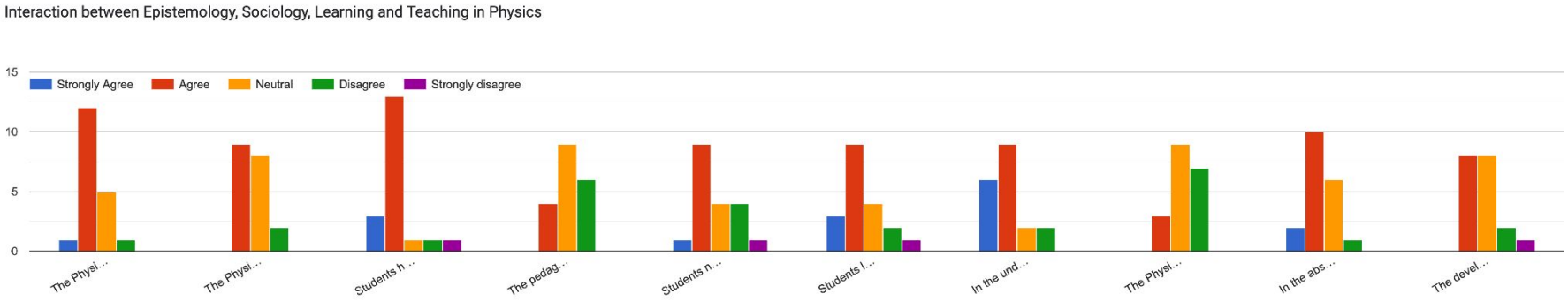
Interaction between Epistemology, Sociology, Learning and Teaching in Physics
Strongly Agree
Agree
Neutral
Disagree
Strongly disagree
15
10
5
0
The Physi...
The Physi...
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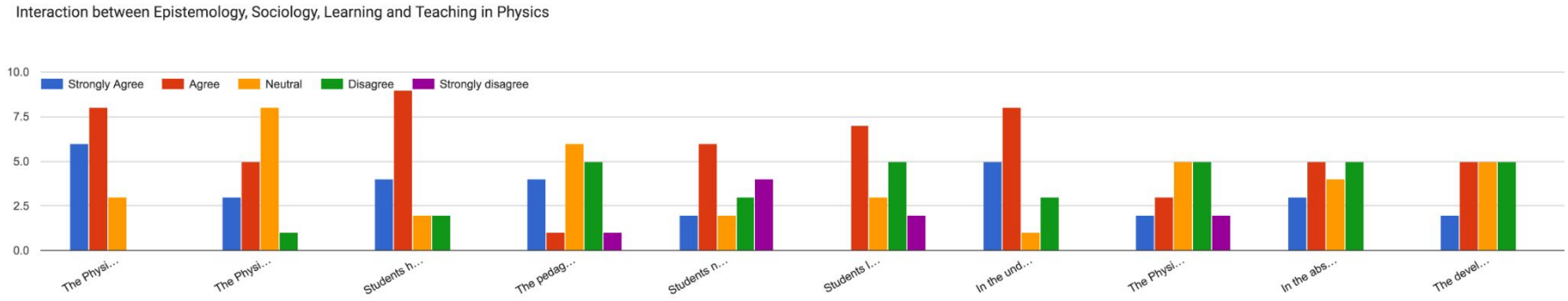
# 2023-2024


Interaction between Epistemology, Sociology, Learning and Teaching in Physics
Strongly Agree
Agree
Neutral
Disagree
Strongly disagree
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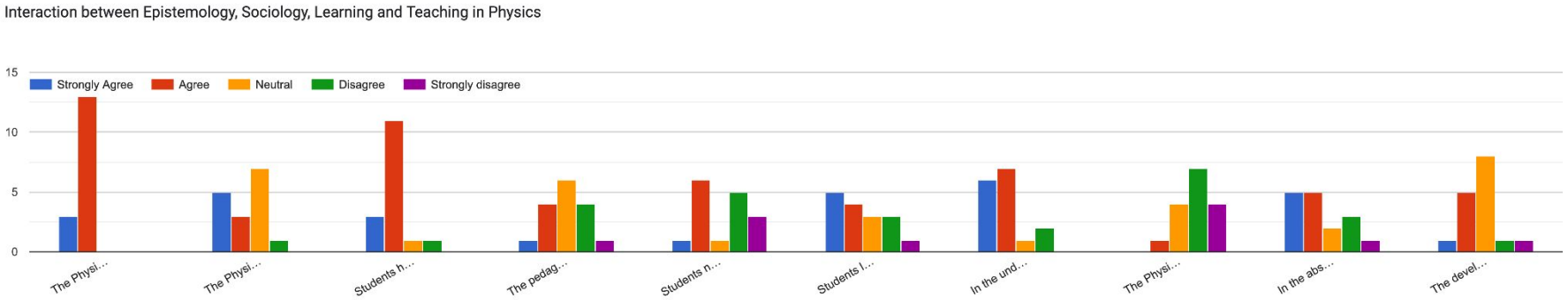
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Students h...
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The devel...

# Observing teaching videos

https://www.youtube.com/playlist?list=PLAA7AA6B0E433653C

https://www.youtube.com/watch?v=CDEDBXuwYvo

https://www.youtube.com/watch?v=AsNxXS3kYho

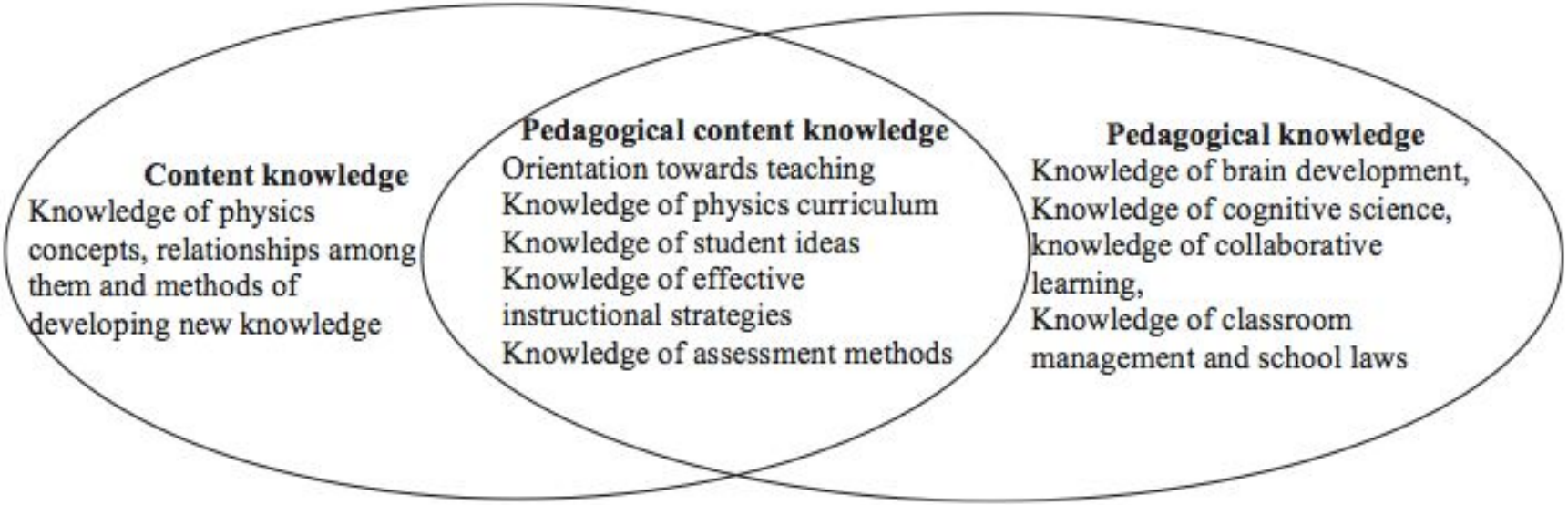
https://www.youtube.com/watch?v=kxHdVw-mh24

https://www.youtube.com/watch?v=282D-YkMxyI

“What shall I do with my students to help them understand this physics concept? What materials are there to help me? What are my students likely to already know and what will be difficult for them? How best shall I evaluate what my students have learned?" These questions are common for every teacher, and central to describe the knowledge that distinguishes a teacher from a subject matter specialist.

# The Structure of Physics Teacher Knowledge

**(Fazio, 2010)**



# Features of this tripartite structure

## Content Knowledge
or Subject Matter Knowledge

**Deep content knowledge** is a necessary condition for the development of PCK.

If teachers themselves do not understand the nuances of a concept, the deep relationships between this particular concept and other concepts, and the ways through which this concept was constructed by the physics community, then translating these nuances into students' understanding is impossible.

## Pedagogical Knowledge

**Understanding of the processes of learning** is crucial for the development of the orientation toward teaching, assessment methods, understanding of the role of student ideas, etc.

For example, the awareness of the complex nature of brain activity should affect how teachers deal with what is widely perceived as "student misconceptions"

## Pedagogical Content Knowledge

**PCK is highly domain specific**; therefore, it is *critical that future teachers develop teachers' PCK in the specific topics that they will be teaching.*

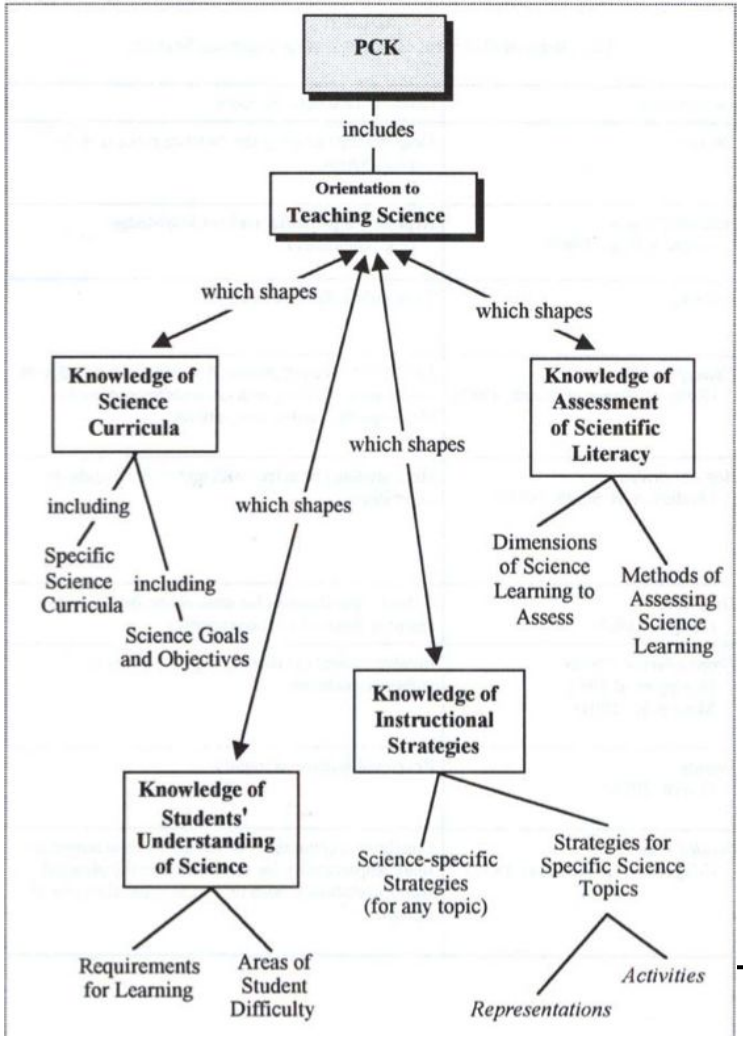
This is particularly relevant in the sciences; the different disciplines such as biology, physics, and earth science have distinct teaching methodologies, curricula, and instructional sequences.

PCK represents a teacher ability to convey the relevant constructs of the content knowledge in a manner that makes it accessible to their students.

*The most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations ... including an understanding of what makes the learning of specific concepts easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning. (Shulman, 1986b, p. 9)*

# PCK definition in Science Teaching

(Magnusson et al., 1999)




- orientations toward science teaching
- knowledge and beliefs about science curriculum
- knowledge and beliefs about students' understanding of specific science topics
- knowledge and beliefs about assessment in science
- knowledge and beliefs about instructional strategies for teaching sciences

# Five aspects of PCK and their relationship to Physics Teaching

(Etkina et al., 2010, p.3)

# Orientations toward Science Teaching

Beliefs regarding the role of students' prior knowledge in their learning, the purpose of problem solving, the roles of experiments in the classrooms, what motivates students in the classroom, etc.

# Knowledge of curricula

The knowledge of the sequence of topics that allows a student to build the understanding of a new concept or skill on what she or he already knows.

## Knowledge of students' prior understandings about and difficulties with key concepts and practices in science.

Knowledge of students' pre-instruction ideas when they are constructing a new concept. Knowledge of difficulties students may have interpreting physics language that is different from everyday language.

## Knowledge of instructional strategies to scaffold students' learning of key concepts and practices in science.

Knowledge of multiple methods or specific activity sequences that make student learning more successful and an ability to choose the most productive strategy or modify a strategy for a particular group of students or an individual.

## Knowledge of what to assess and specific strategies to assess students' understandings of key concepts and practices.

Knowledge of ways to assess student conceptual understanding and problem solving and general scientific abilities; knowledge of how to help students self-assess their work and to engage in a meaningful reflection.