
Physics Education Laboratory Lecture 02

Francesco Longo • 22/09/2025

Brainstorming

What is Physics?

Submit

20 characters remaining

A word cloud of terms related to physics and the scientific method. The most prominent words are 'nature', 'questions', and 'curiosity'. Other visible terms include 'study of nature', 'the study of nature', 'knowledge', 'scientific method', 'laboratory', 'universal code', 'answers', 'innovation', 'observe the nature', 'nature's language', 'study of phenomena', 'natura', 'quantitative measure', 'logic everything', 'understand nature', 'answer and questions', 'see over our eyes', 'language of thought', 'study of the world', 'discover/understand', 'answers', 'universe', 'problem solving', 'study of the universe', 'try to understand', 'normal distribution', 'answersand questions', and 'study of nature'.

Brainstorming

What does Laboratory means?

Submit

20 characters remaining

A word cloud visualization of brainstorming results for the question 'What does Laboratory means?'. The words are arranged in a roughly circular pattern, with the most prominent words being 'experience', 'collaboration', and 'teamwork'. Other visible words include 'experiments', 'learning from scratc', 'experiment', 'practicing', 'observation', 'electricity', 'mistakes', 'sitting on the floor', 'getting convinced', 'have fun with physic', 'confronting reality', 'look for answers try', 'practice', 'deeper understanding', 'proving', 'discover to touch', 'curiosity manuality', 'manualità', 'hands on experience', 'try, fail, succeed', 'methods', 'many measures', 'proving theory', 'reject hypothesis', 'practice the theory', 'to experience', 'prove theory', and 'procedure'.

learning from scratc experiment practicing
getting convinced sitting on the floor mistakes electricity observation
have fun with physic prove theory
confronting reality **experiments collaboration** to experience
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proving **teamwork** discover to touch curiosity manuality
harmonic oscillator proving theory methods many measures
learn from mistakes datas try, fail, succeed hands on experience manualità

Brainstorming

What is Education?

Submit

20 characters remaining



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
-

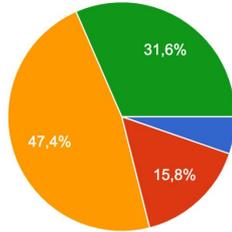
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2022-2023

Which kind of physics learner are you?

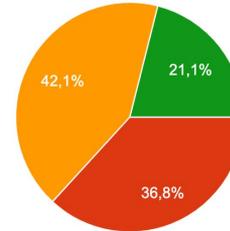
19 risposte



- To learn formulas and facts based on the authority of the instructor and text
- To make sense of the material, to integrate it with my opinion and intuitive knowledge
- A mix between the previous two, but preferring the first one, with methodical adherence to the procedures
- A mix between the first two, but preferring the second one, building ind...

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

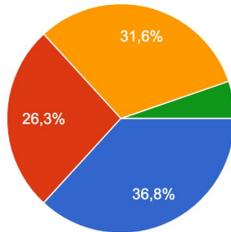
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- I'd never had problems, understanding conceptual meaning and formulating it in mathematical point of view
- I had sometimes problems in conceptual meanings and never in mathematical explanations
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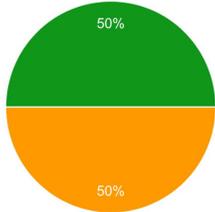


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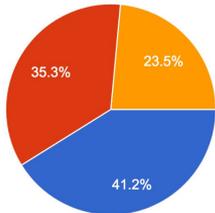
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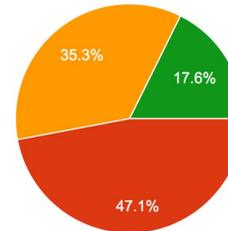
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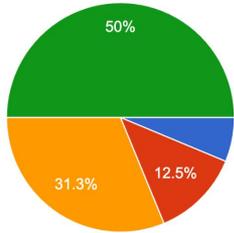


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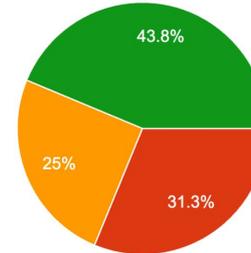
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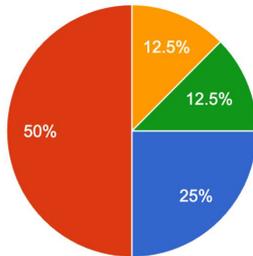
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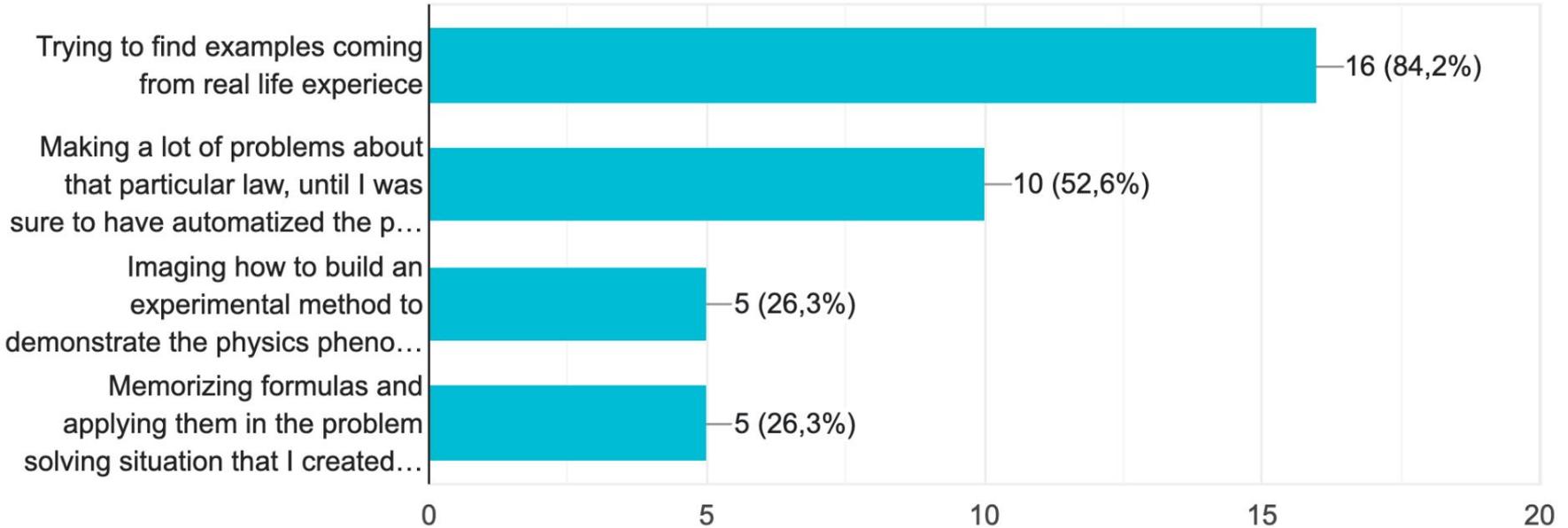


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2022-2023

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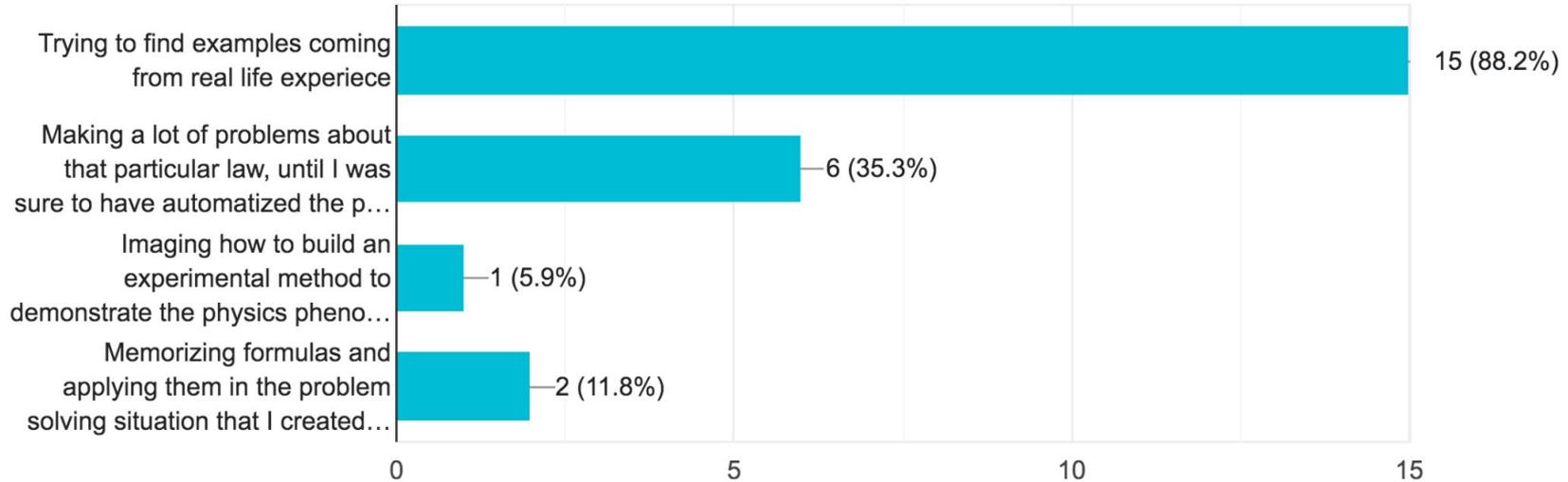
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2023-2024

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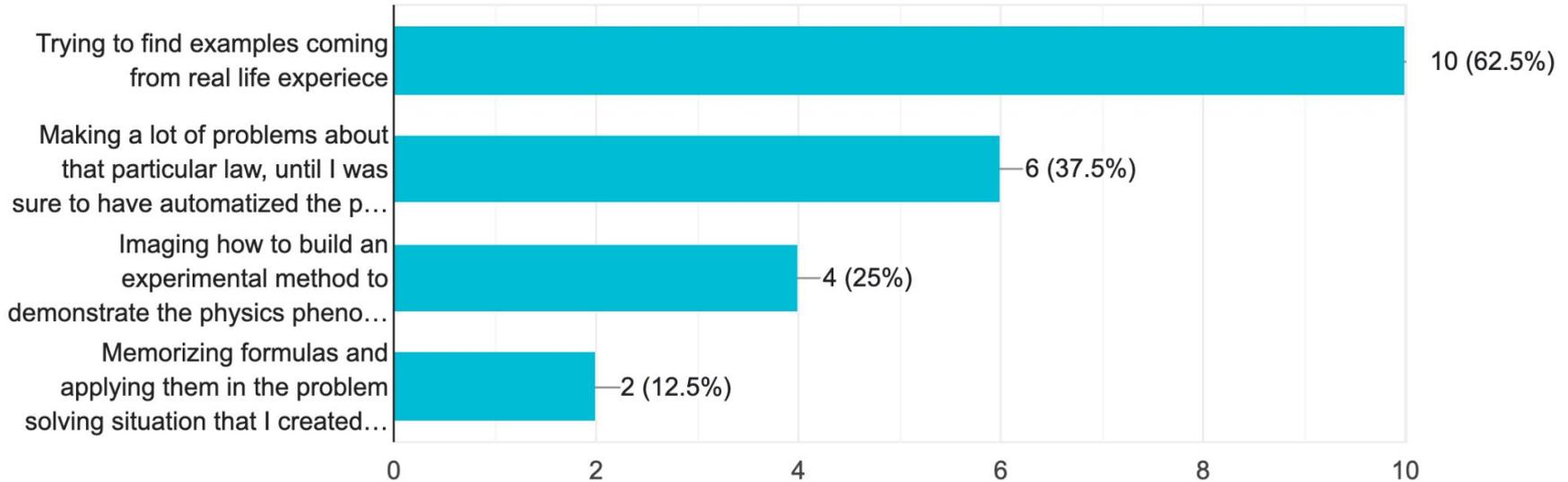
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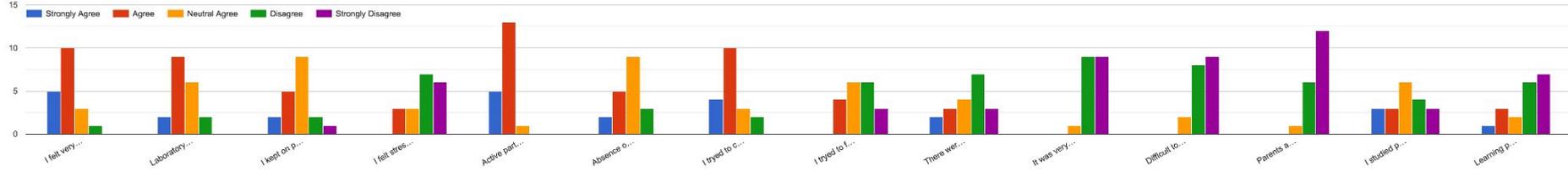
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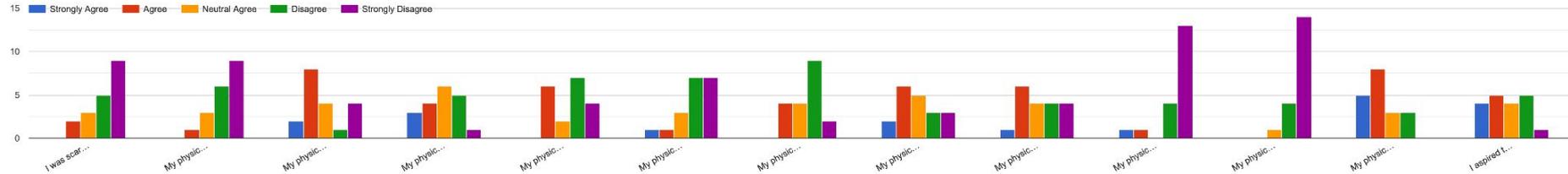


2022-2023

Physics learning experience (referring to your secondary school course)

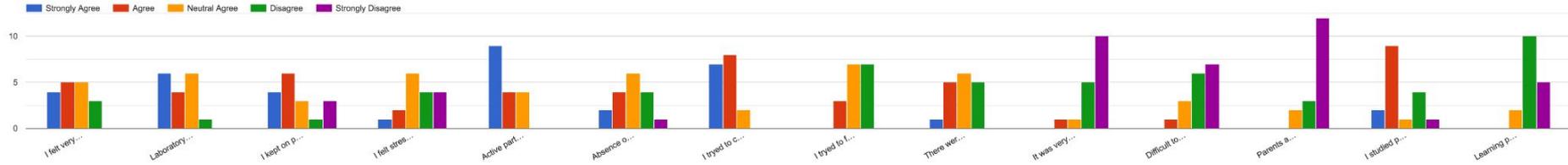


Physics teaching observation (referring to your secondary school course)

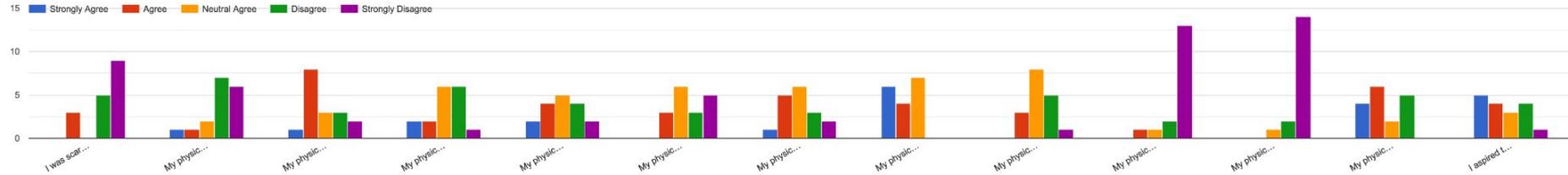


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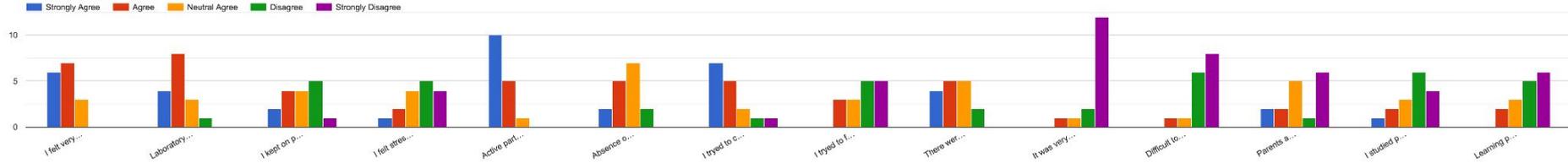


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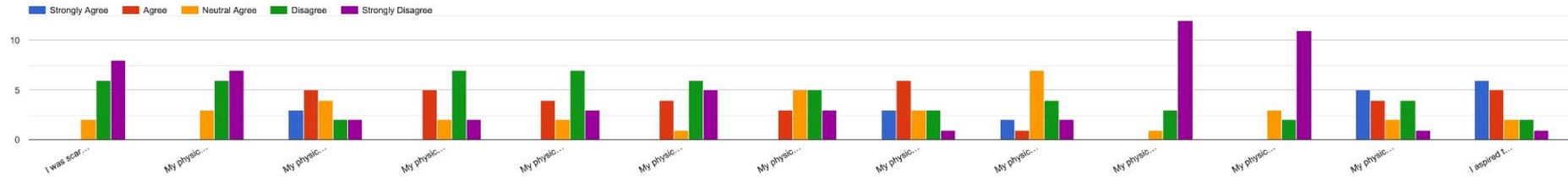


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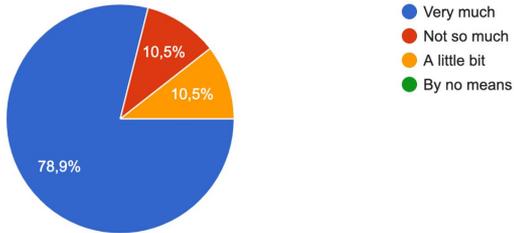
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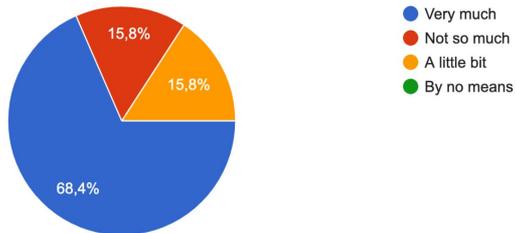
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19 risposte



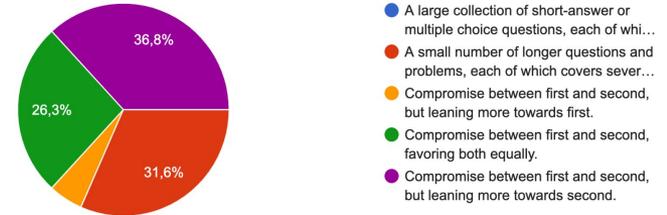
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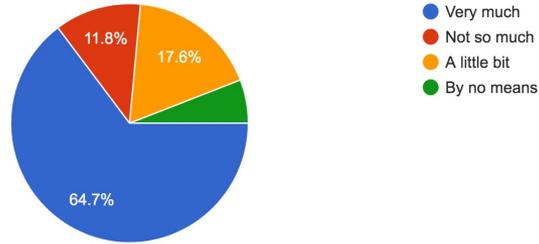
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2023 - 2024

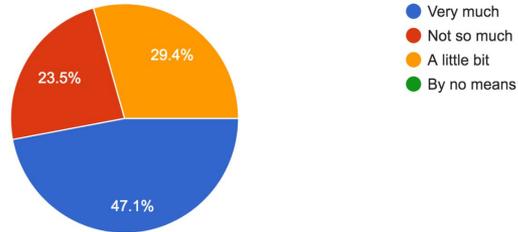
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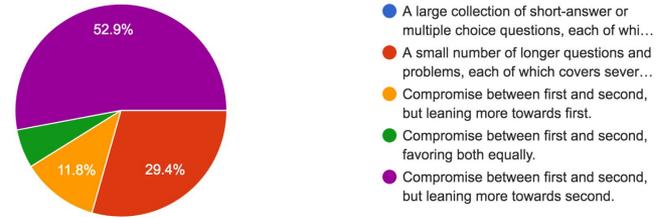
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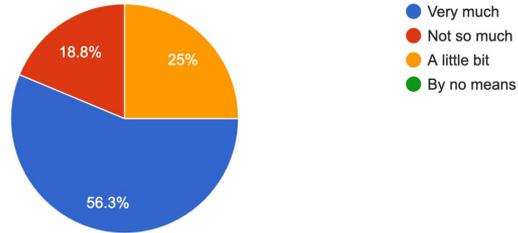
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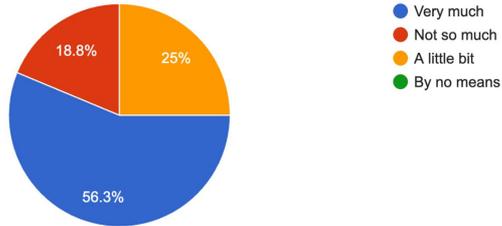
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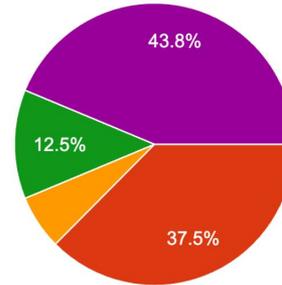
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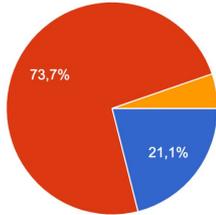


- A large collection of short-answer or multiple choice questions, each of which covers several concepts
- A small number of longer questions and problems, each of which covers several concepts
- Compromise between first and second, but leaning more towards first.
- Compromise between first and second, favoring both equally.
- Compromise between first and second, but leaning more towards second.

2022-2023

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?"

19 risposte



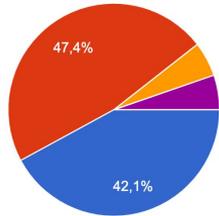
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Imagine you are teaching physics at high school and you want to make your students familiar with the concept of block and tackle. Would you do so by:

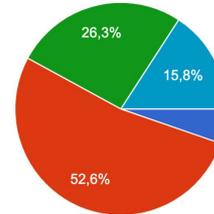
19 risposte

Justin: "When I'm learning physics concepts for a test, I like to put things in my own words, so that they make sense to me." Dave: "But putting things... learn things the way the textbook presents them."

19 risposte



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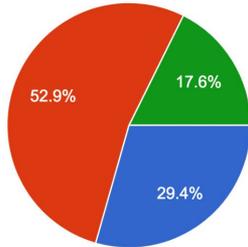
- just explaining in a verbal fashion, for instance how the lenght of the pulling...
- just showing exemplary pictures of different situations with tackles, point...
- just solving a great number of problems concerning block and tackle
- just starting with a case study, describing it in mathematical language...
- just reading from the textbook and inte...
- None of these

2023-2024

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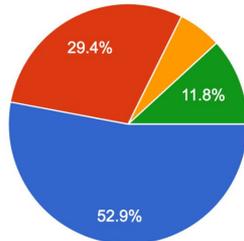
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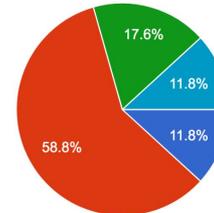
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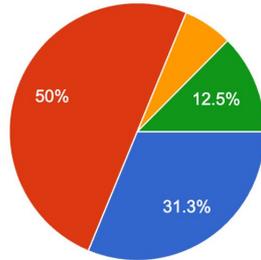
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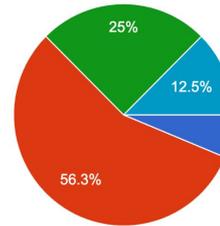
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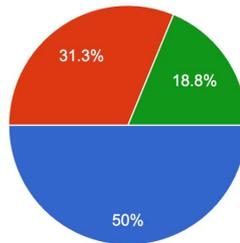
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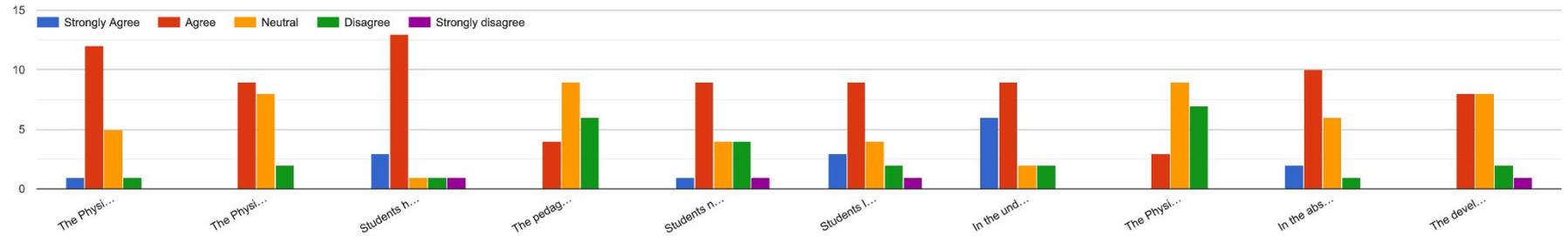
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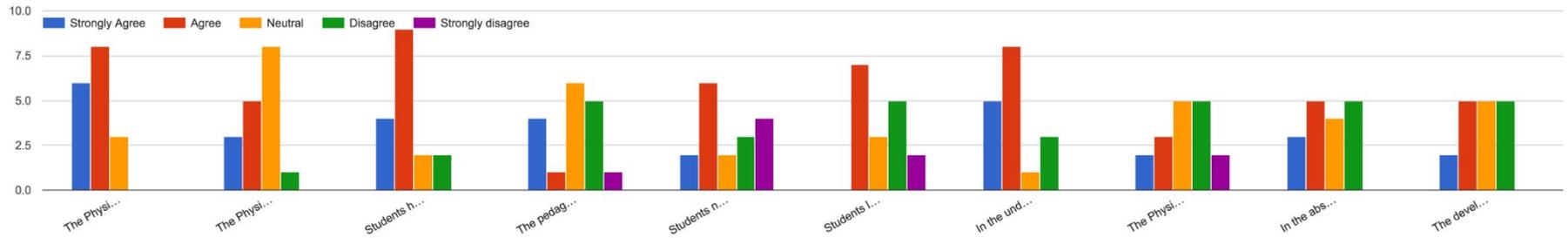
2022-2023

Interaction between Epistemology, Sociology, Learning and Teaching in Physics



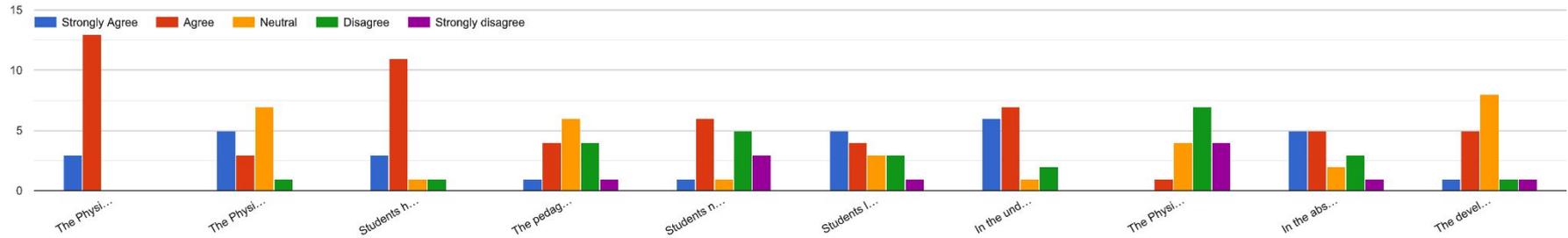
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2024 - 2025

Interaction between Epistemology, Sociology, Learning and Teaching in Physics



Observing teaching videos

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

<https://www.youtube.com/watch?v=CDEDBXuwyvo>

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

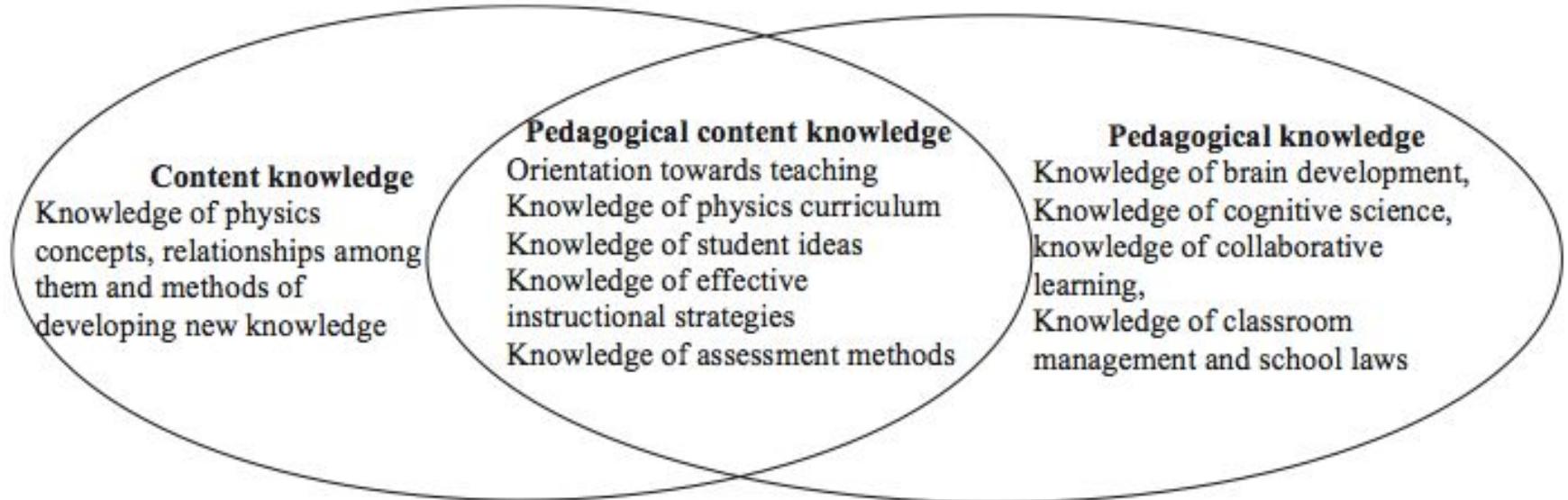
<https://www.youtube.com/watch?v=kxHdVw-mh24>

<https://www.youtube.com/watch?v=282D-YkMxyl>

“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.*

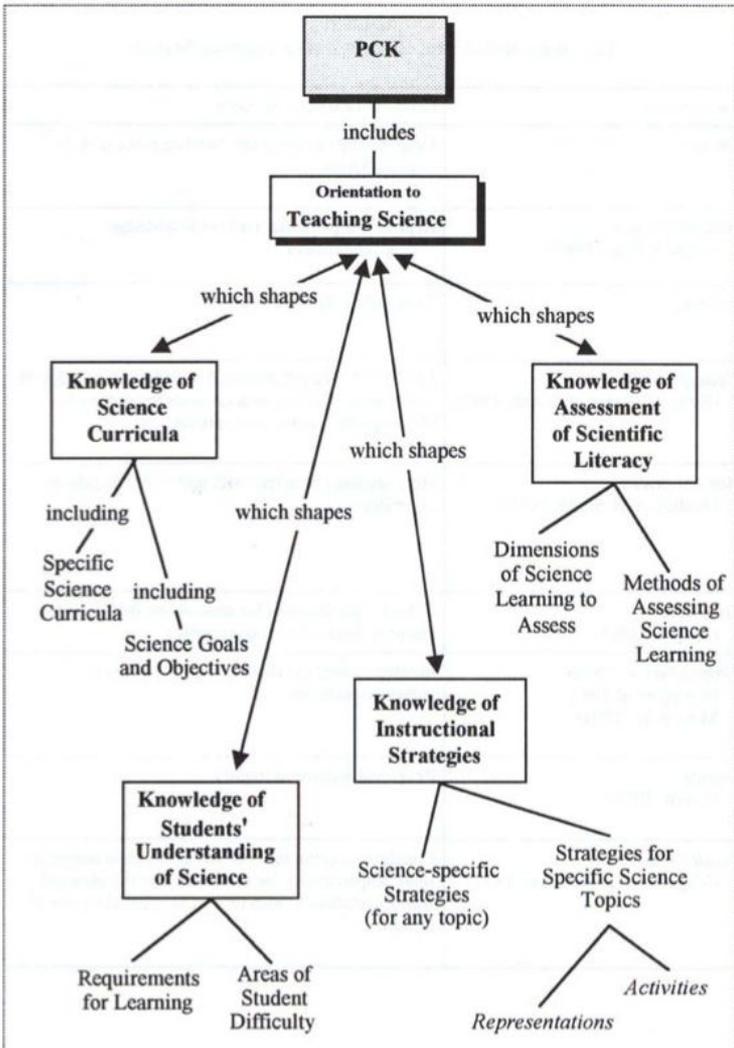
This is particularly relevant in the sciences; the different disciplines such as biology, physics, and earth science have distinct teaching methodologies, curricula, and instructional sequences.

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.
