
Physics Education Laboratory Lecture 04 Pedagogical Content Knowledge

Francesco Longo 02/10/2024

1

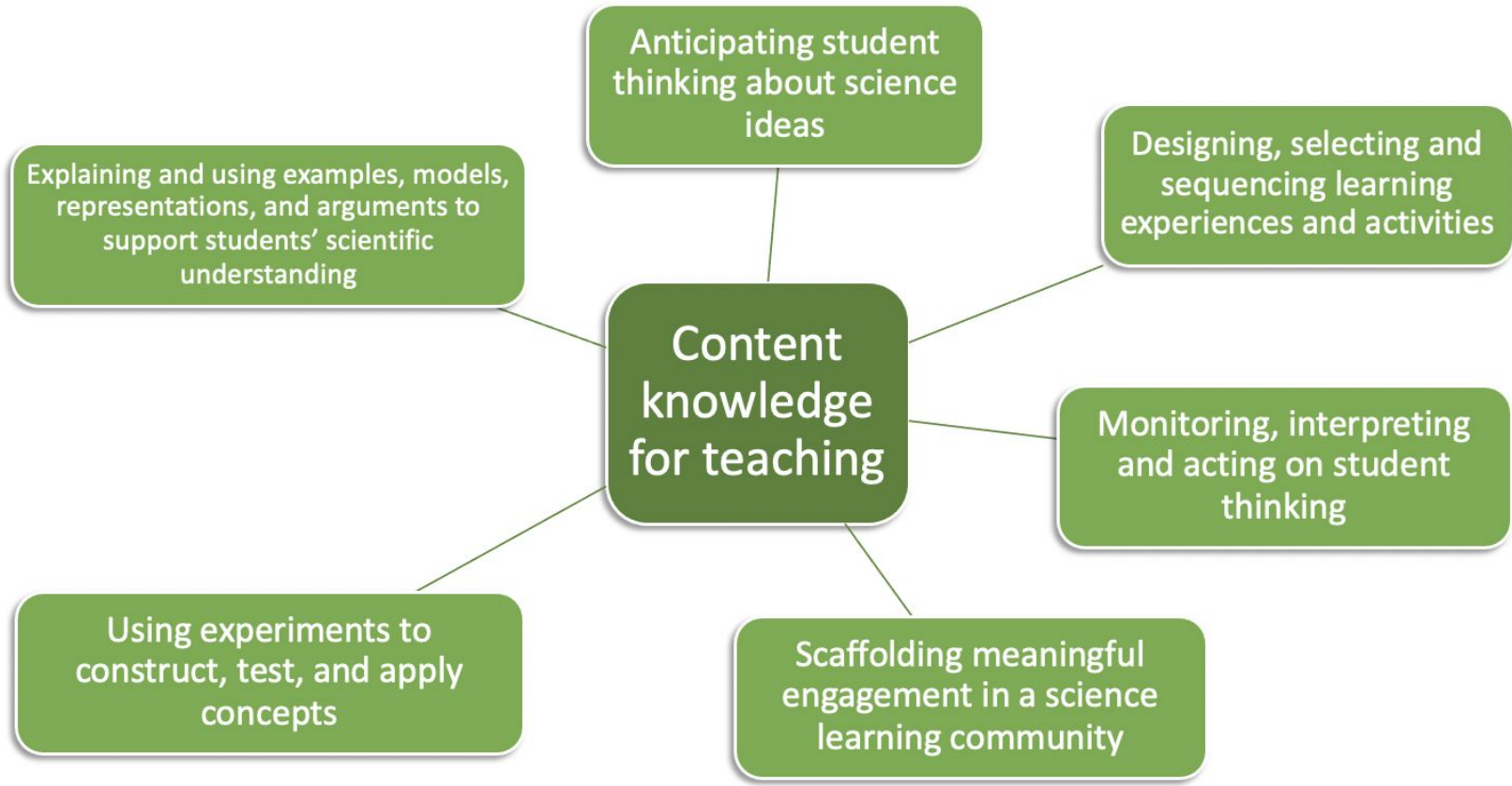
PCK FOR SCIENCE TEACHING (Magnusson et al., 1999)

2

**PCK FOR PHYSICS TEACHING (Etkina, 2010)
CONTENT KNOWLEDGE FOR PHYSICS TEACHING
(Etkina, 2018)**

3

**DECLINING PCK FOCUSED ON MATH/PHYS INTERPLAY
(Lehavi et al., 2014, 2017)**



Keep in mind

1

Exploration

Exploring within math ramifications for the physical system: borders (of validity, of approximation), extreme cases, etc.

2

Construction

Constructing and developing (from experiments or from first principles) mathematical tools to describe and analyse physical phenomena

3

Broadening

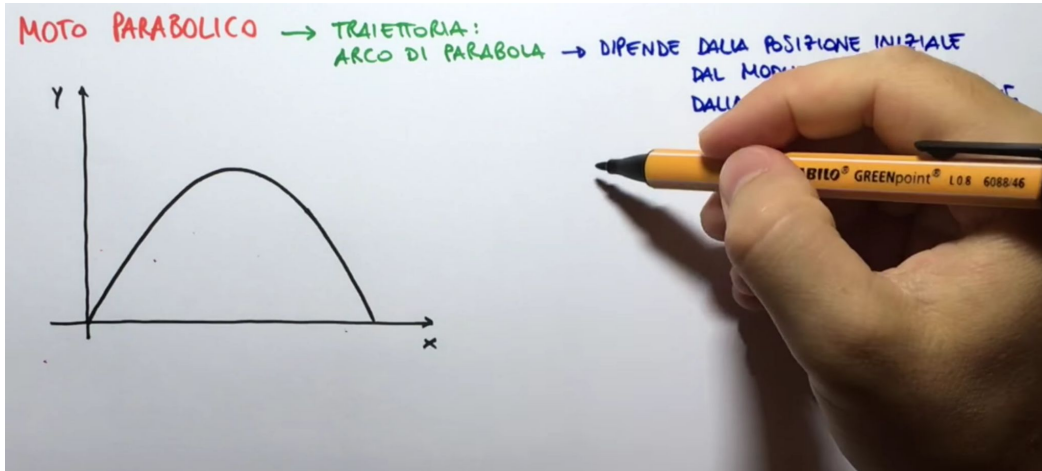
Adopting a bird's-eye view and employing general laws of physics, symmetries, similarities and analogies

4

Application

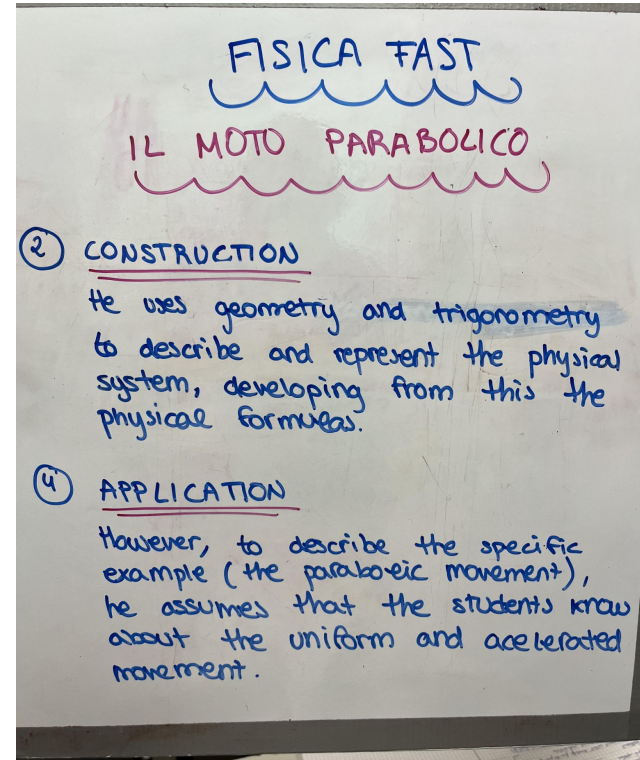
Employing already known laws and mathematical representations in problem solving

PCK for Math/Phys Interplay



Fisica Fast:

<https://www.youtube.com/watch?v=wEQ69qW8Q6I>

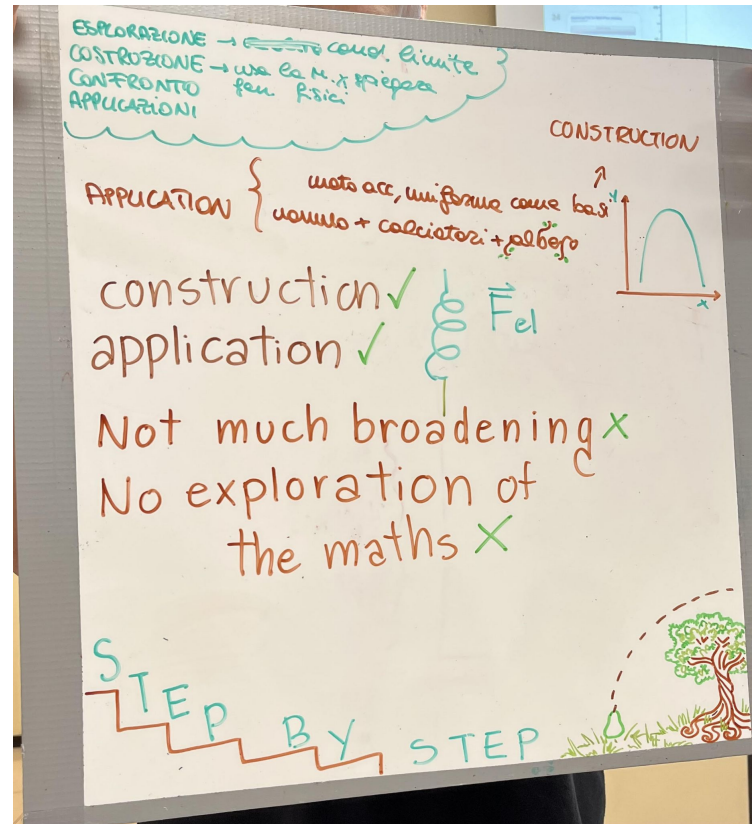


PCK for Math/Phys Interplay

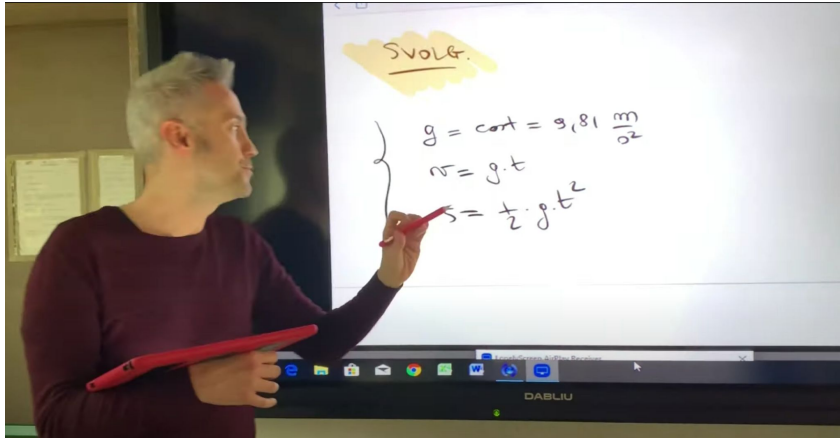


Step by step:

https://www.youtube.com/watch?v=qK3tlupN_Xw

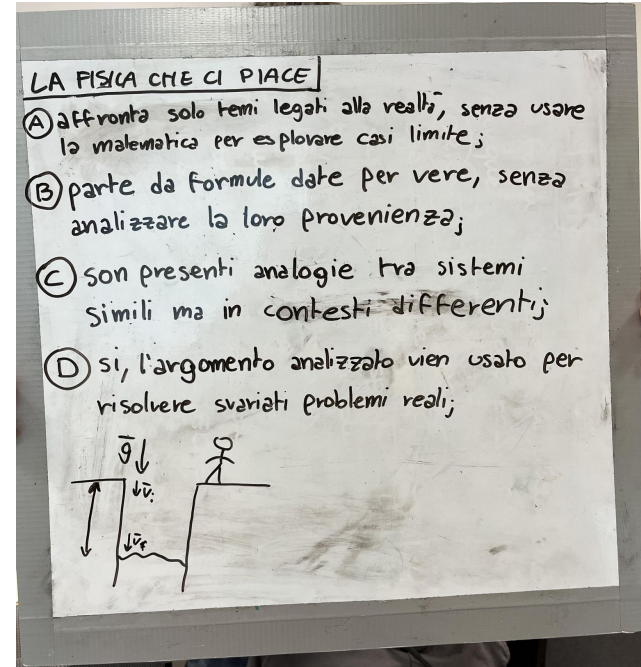


PCK for Math/Phys Interplay

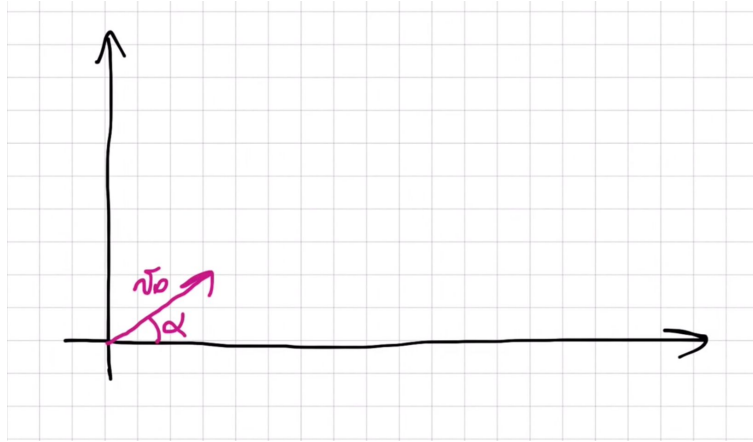


La Fisica Che Ci Piace:

<https://www.youtube.com/watch?v=xxFWe1Jl6b8>

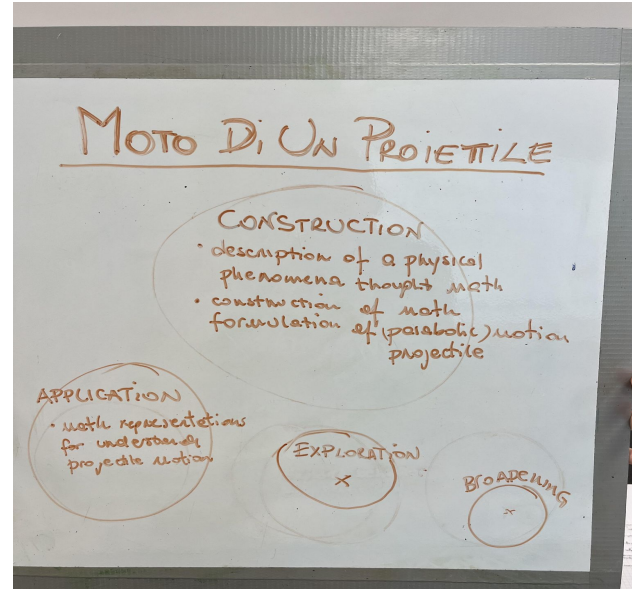


PCK for Math/Phys Interplay

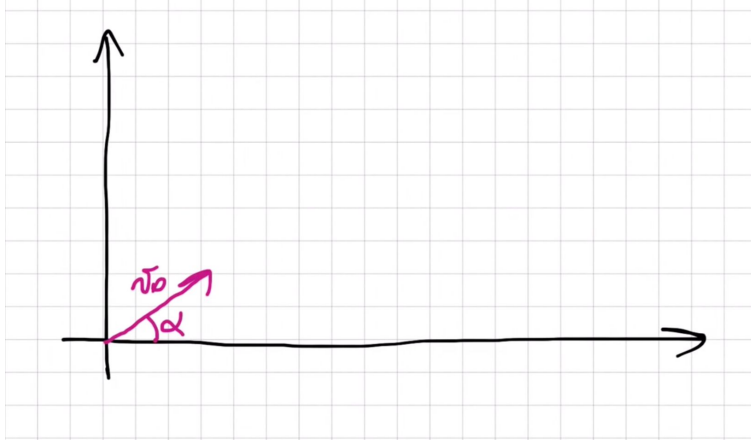


Moto di un proiettile:

<https://www.youtube.com/watch?v=xZ0WN8z3cD0>

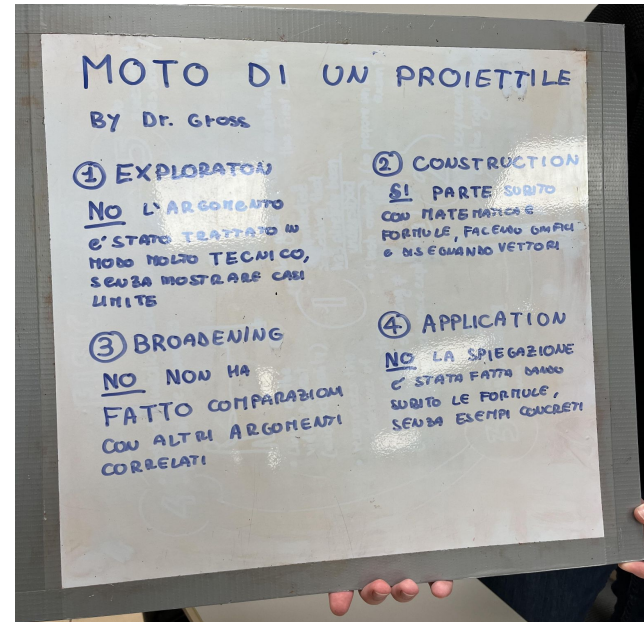


PCK for Math/Phys Interplay



Moto di un proiettile:

<https://www.youtube.com/watch?v=xZ0WN8z3cD0>



SAME TOPIC,
DIFFERENT PERSPECTIVES!

MATHS PERSPECTIVES

VS

PHYSICS PERSPECTIVES

We monitored classes at the first year of the curricular physics studies: this is an important point of our investigation, because we would like to find whether difficulties in learning and studying physics arise from a particular teacher PCK adopted at this stage, i.e. at the beginning of high secondary school, when the students' background is characterized by a basic knowledge of Math.

The main feature of this sample is the age difference among students. It happens that someone starts studying curricular physics at 14 years old and some of them later (16 years). Of course, this is relevant for the stage of cognitive development, in terms of abstraction functions and metacognitive processes. And it also would be relevant in terms of content building processes for successful learning.

We analysed our observations according to the PCK model suggested by Magnusson et al., adapted by Etkina and used in the framework of the content of the Math-Phys interplay by Lehavi et al. and Pospiech obtaining some interesting results.

Prevalent
pattern of
Math/Phys
Interplay



APPLICATION AND
FORMULAS
MANIPULATION

At the first curricular year of Physics study

Prevalent patterns of Math/Phys Interplay



APPLICATION
AND FORMULAS
MANIPULATION



MODEL
BUILDING



EXPLORATION AND BROADENING

At the last curricular year of Physics study in the high secondary school

Main results from the observation analysis

Where the lack of math competencies is relevant, the teacher adopts strategies converging to the strong use of observative/descriptive language for conceptualization.

If the teacher is aware of students difficulties in Math, or of the absence of Math-Phys interplay, he/she tries to support their learning process focusing on mathematical languages.

This causes a large use of math in the demonstration of physics laws and a great number of math exercises applied to physics phenomena, with the consequence that even the evaluation tests seem to be mathematically rather than physically oriented.

Main results from the observation analysis

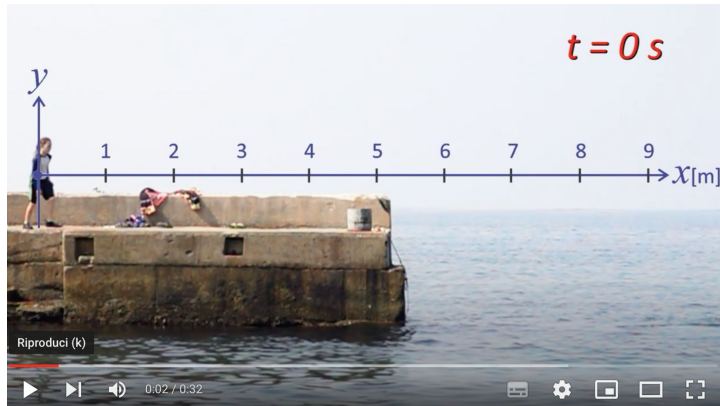
On the other side some teachers try to resolve the students difficulties in Math using improperly the different language structures (formulas, graphs...) making a conceptual reduction of Physics, separating what comes from mathematics results and what corresponds to a physical phenomenological observation.

This kind of approach tends to amplify the distance between the two disciplines instead of favouring their interplay and integration also in a form of interdisciplinarity to be thought and taught.

EXERCISE FOR REASONING

<https://www.youtube.com/watch?v=sCp1igJ3j8>

Horizontal Jump



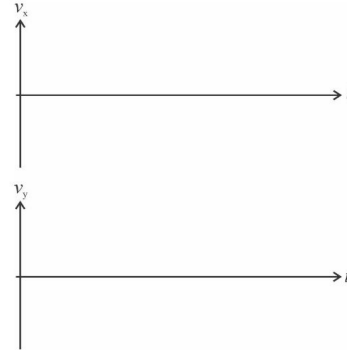
Gorazd Planinsic, University of Ljubljana, Slovenia
and Eugenia Etkina, Rutgers University, USA

0. FINN'S JUMP

The video <https://youtu.be/sCp1igJ3j8> shows Finn running along the pier and then jumping into the sea.

KINEMATICS

a. Draw a qualitative $v_x(t)$ and $v_y(t)$ graphs for Finn's motion, treating him as a point-like object that is positioned at the spot marked on the photo (let's call this point *center of mass*). Indicate any assumptions that you made.



b. Compare your graphs with the actual graphs

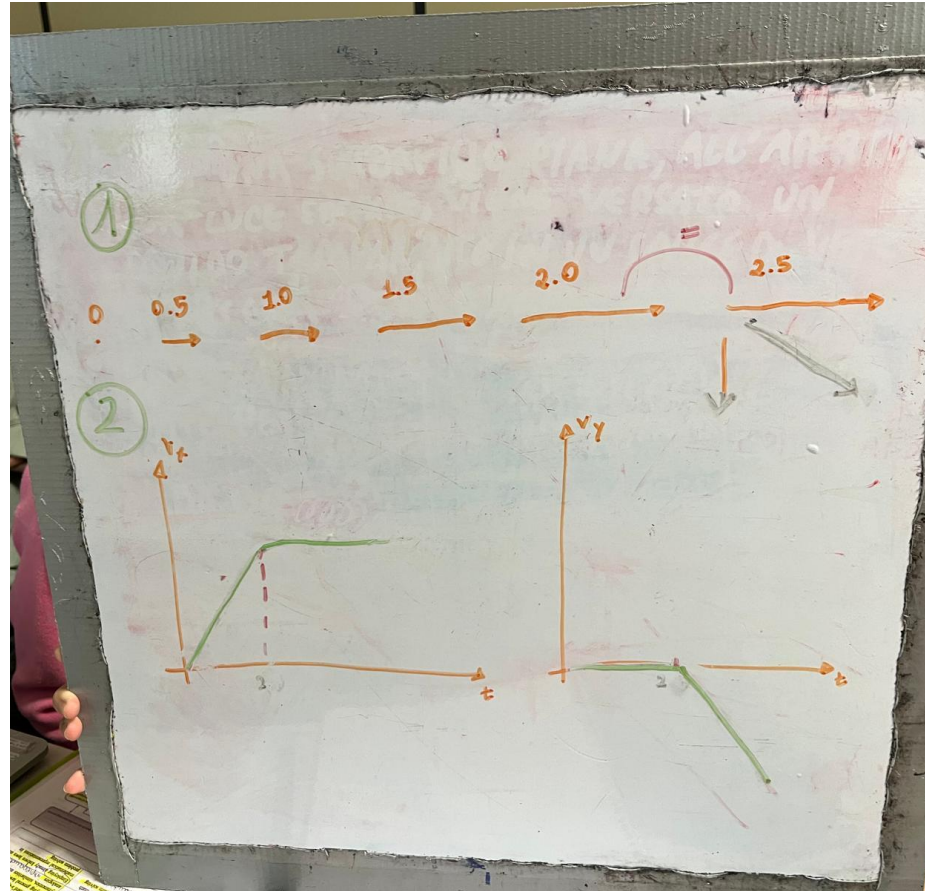
<https://drive.google.com/file/d/155Znh2lwHAfodD4CGaAQse3P3lIVBhoh/view?usp=sharing> that were obtained by tracking the Finn's motion from the video. Do they match? If not, suggest what might be the reasons for the differences (think of the assumptions that you made) and if necessary, revise your graphs.

c. Using data from the actual velocity-versus-time graphs compare the average magnitudes of Finn's acceleration while he is running along the pier and while he is falling. Which one is larger? How do you know? Are the values reasonable? How do you know?

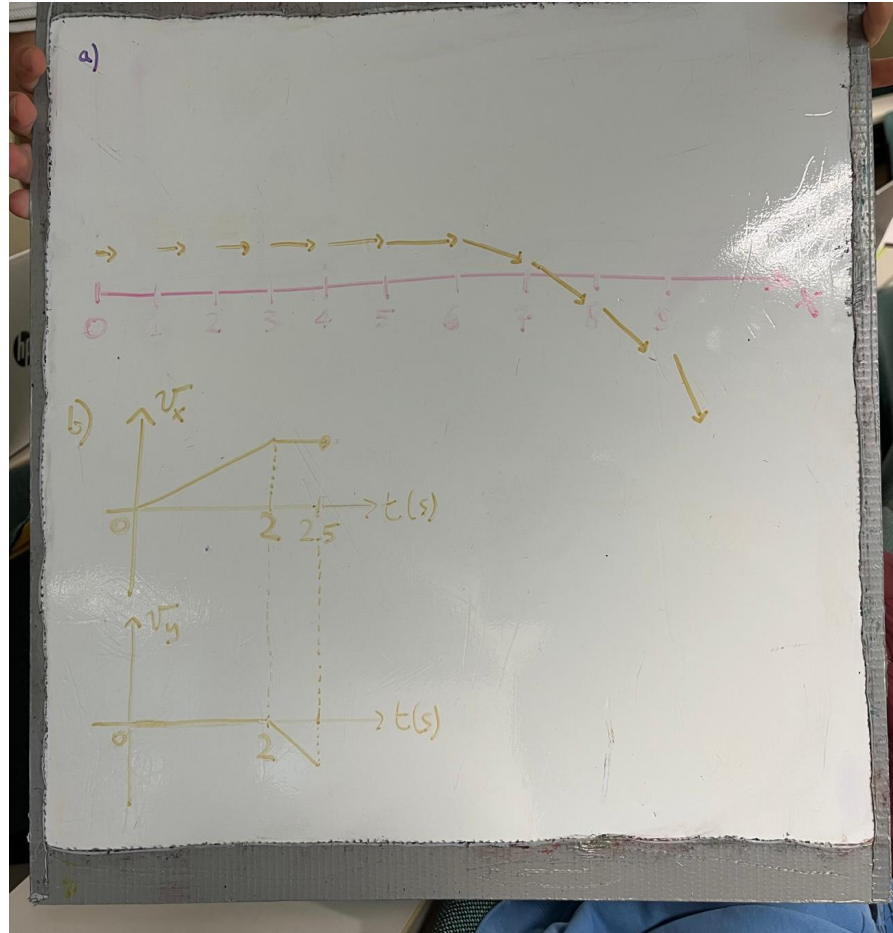
d. Using data from the actual velocity-versus-time graphs and knowing that the distance between Finn's center of mass and the water level is 2.2 m, determine how far from the pier Finn jumped into the water. Indicate any assumptions that you made.

<https://drive.google.com/file/d/1wZ71m7GWmmDTsh9dWkPoPxZ4qcLk7Go6/view?usp=sharing>

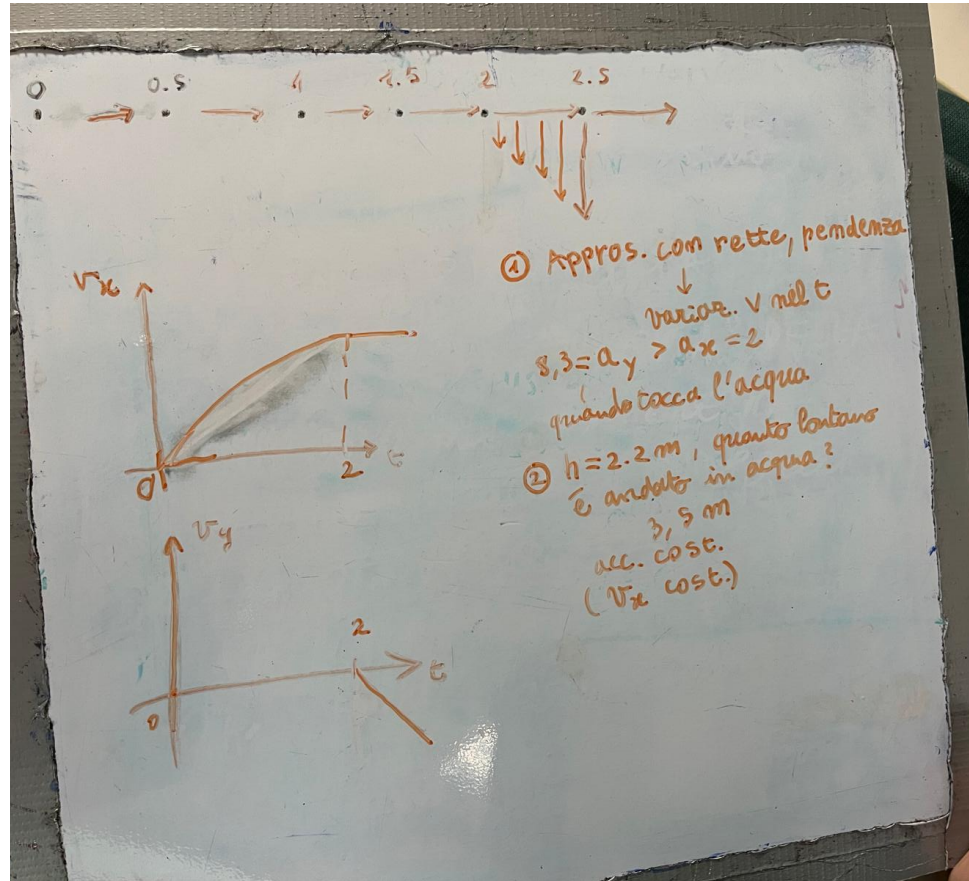
EXERCISE FOR REASONING



EXERCISE FOR REASONING



EXERCISE FOR REASONING



Developing new patterns for integrating Math/Phys Interplay

REFLECT on the EXERCISE FOR REASONING!

WHICH PATTERN IS PREVALENT?

Which are student specific target?

Which are the tasks that the teacher has in mind while teaching in the CKT frameworks?