
Physics Education

Laboratory

Lecture 04

Pedagogical Content Knowledge, Math/Phys interplay vs CKT

Francesco Longo 20/10/2022

1

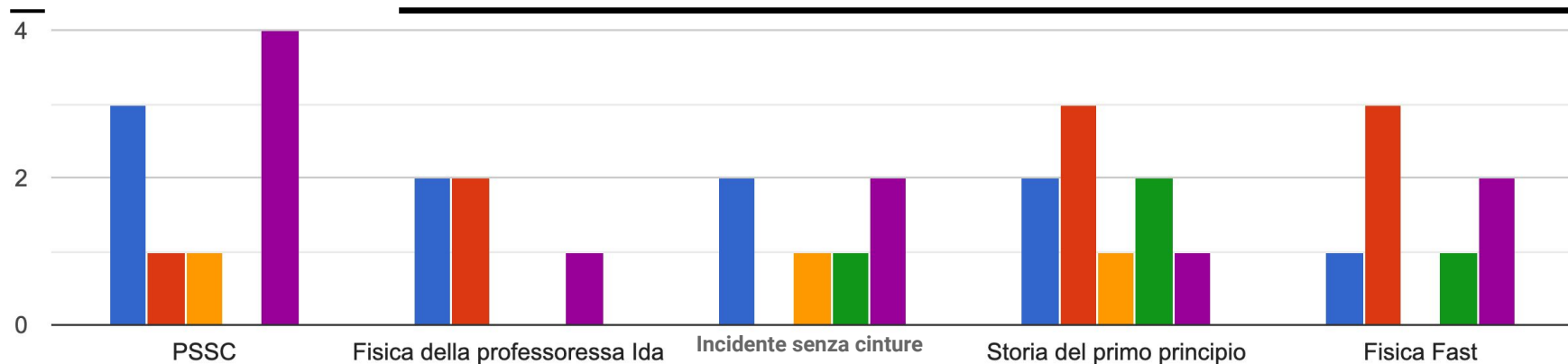
PCK FOR SCIENCE TEACHING (Magnusson et al., 1999)

2

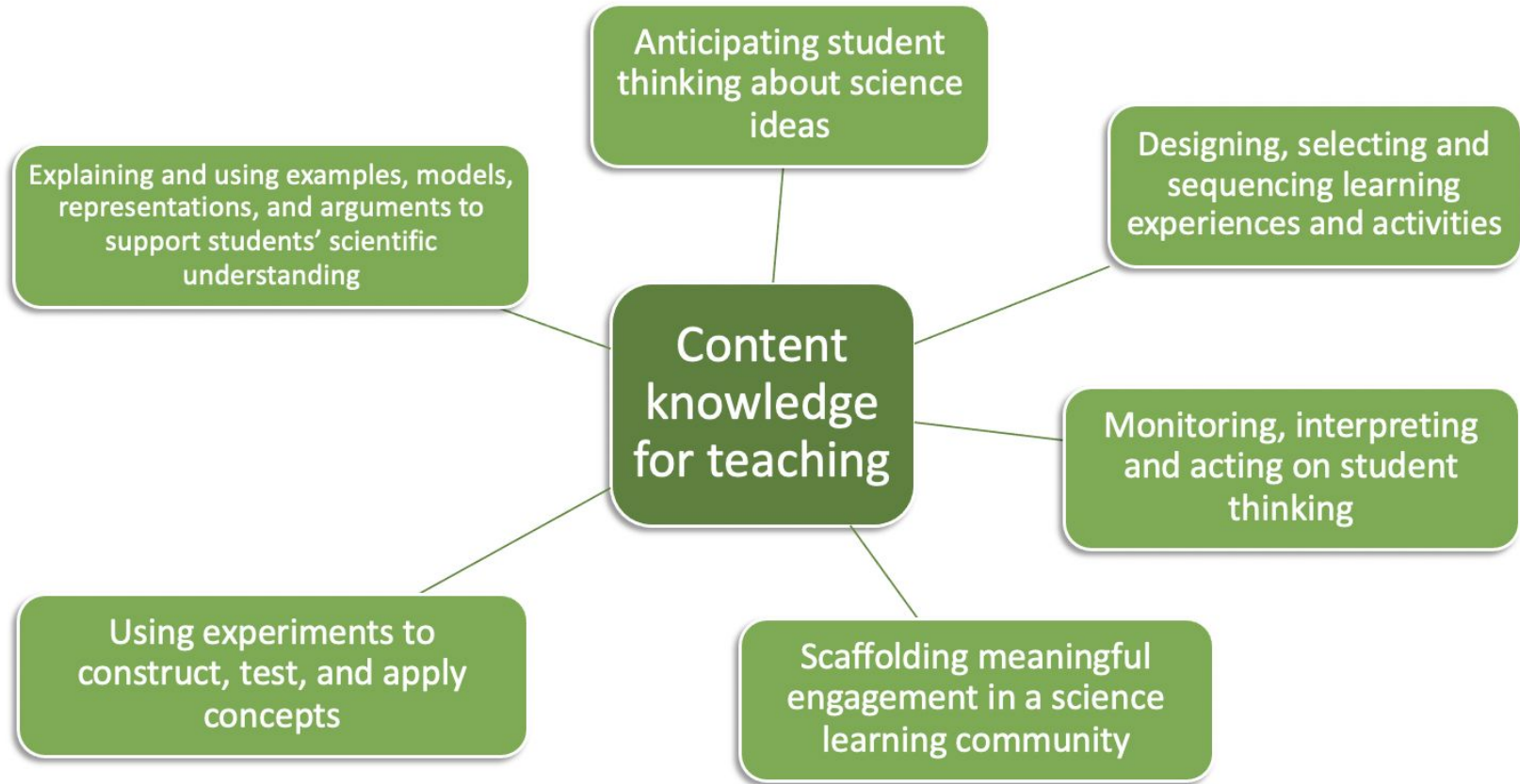
PCK FOR PHYSICS TEACHING (Etkina, 2010)
CONTENT KNOWLEDGE FOR PHYSICS TEACHING
(Etkina, 2018)

3

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



- Orientation towards 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



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

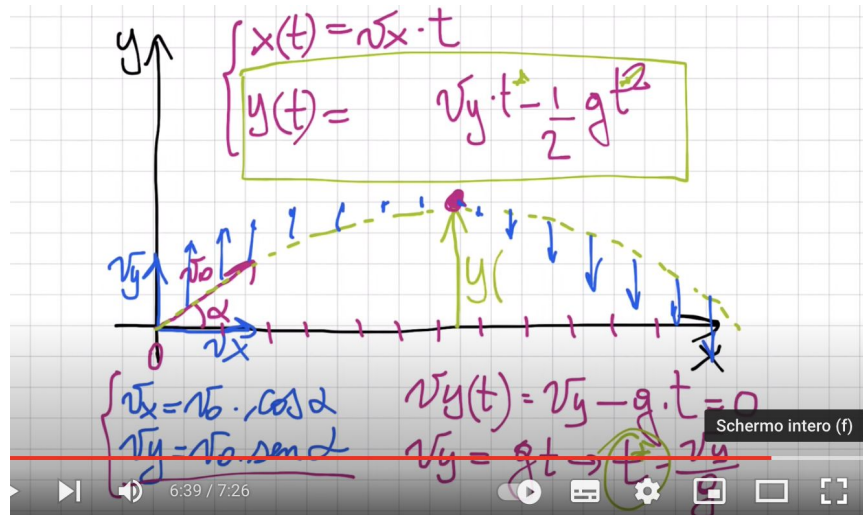
Application

Employing already known laws and mathematical representations in problem solving

Developing new patterns for integrating Math/Phys Interplay

- 1) Which are the tasks that the teacher has in mind while teaching in the CKT frameworks?
- 2) Which are student specific target?
- 3) How to develop the other patterns? Make at least THREE examples!

<https://www.youtube.com/watch?v=xZ0WN8z3cD0> Moto di un proiettile



- 1) Uso di esempi, modelli, matematica
Ha cercato di fornire una struttura ordinata da seguire
- 2) Risolvere un tipo specifico di esercizi
- ③ [Application: già sviluppato]

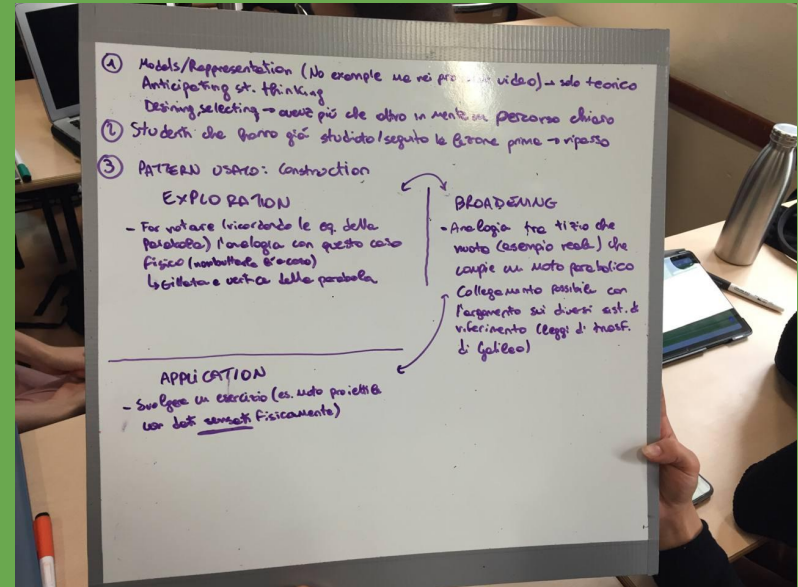
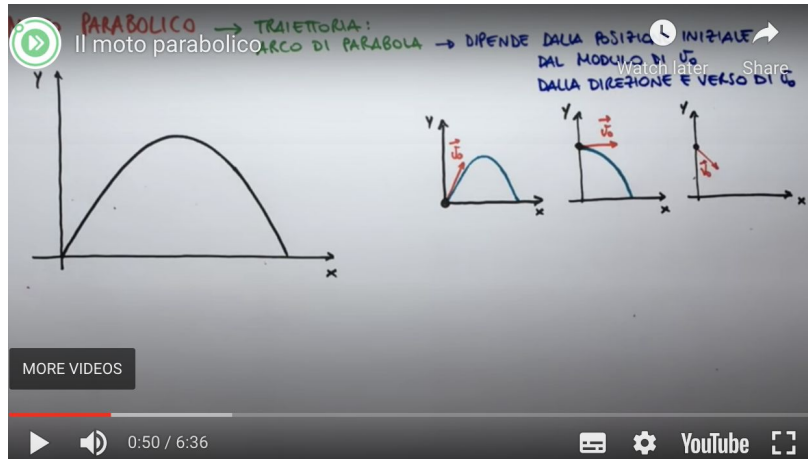
Exploration: immaginare di trovarsi in un altro pianeta con gravità diversa

- Vedere cosa succede andando indietro nel tempo
- cosa succede variando l'angolo iniziale fino a casi limite ($\alpha = 90^\circ$)
- Aggiunta di una quota iniziale s_0

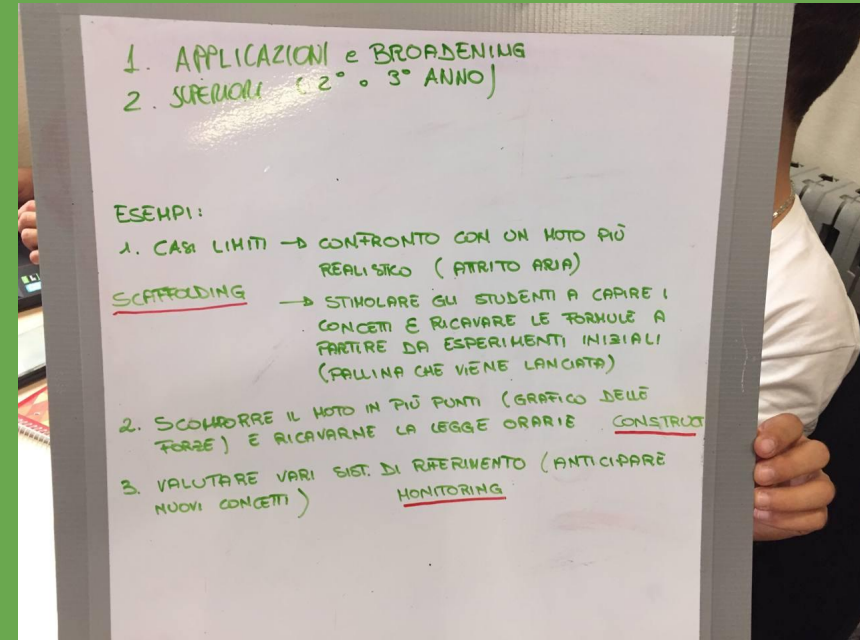
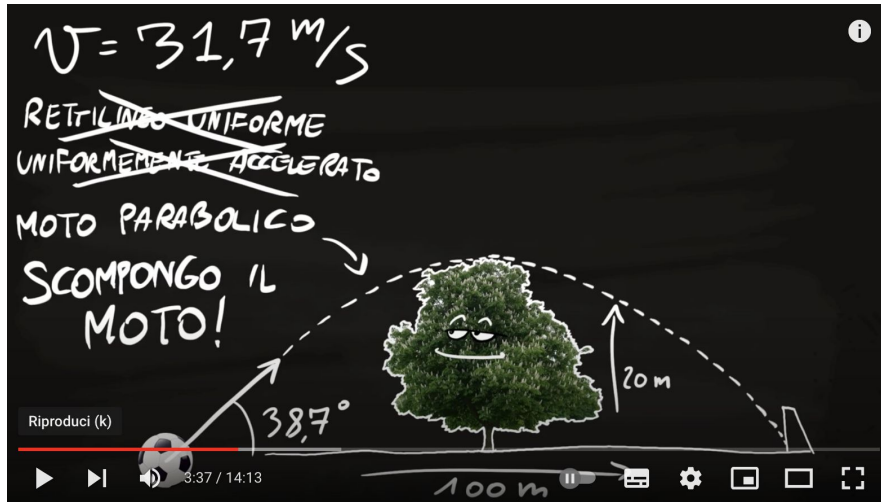
Construction - studio delle proprietà della parabola

Broadening - valutare lo stesso problema dal punto di vista della conservazione dell'energia

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

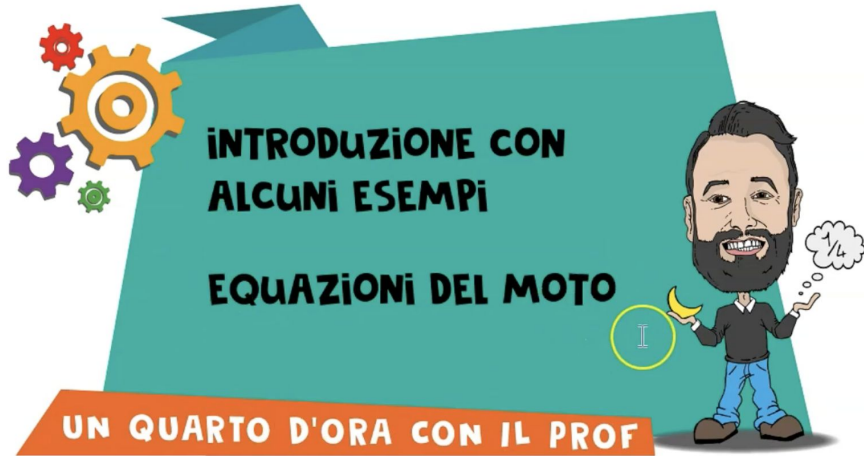


<https://www.youtube.com/watch?v=qK3tlupN Xw> Step by step



<https://www.youtube.com/watch?v=fEvBuROI8as>

Un quarto d'ora con il prof



4

APPLICATION ✓

EXPLORATION ✗

- PARTIRE DA MOTO ACCELERATO VERTICALE E AGGIUNGERE VELOCITÀ ORIZZONTALE

CONSTRUCTION ✗

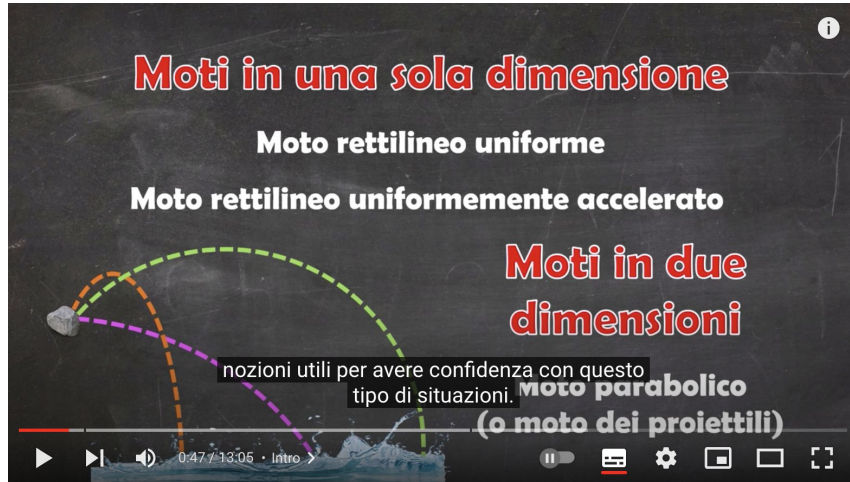
- TRACCIARE TRAIETTORIA DA VIDEO DI UNA PALLA
- TROVARE STATO INIZIALE PER COSTRUIRE PARABOLA SPECIFICA

BROADENING ✗

TASKS: mathematical models
TARGET: descrizione matematica del fenomeno

<https://www.youtube.com/watch?v=Wf9zZyPKTL0>

The BlackBoard Physics



Moti in una sola dimensione

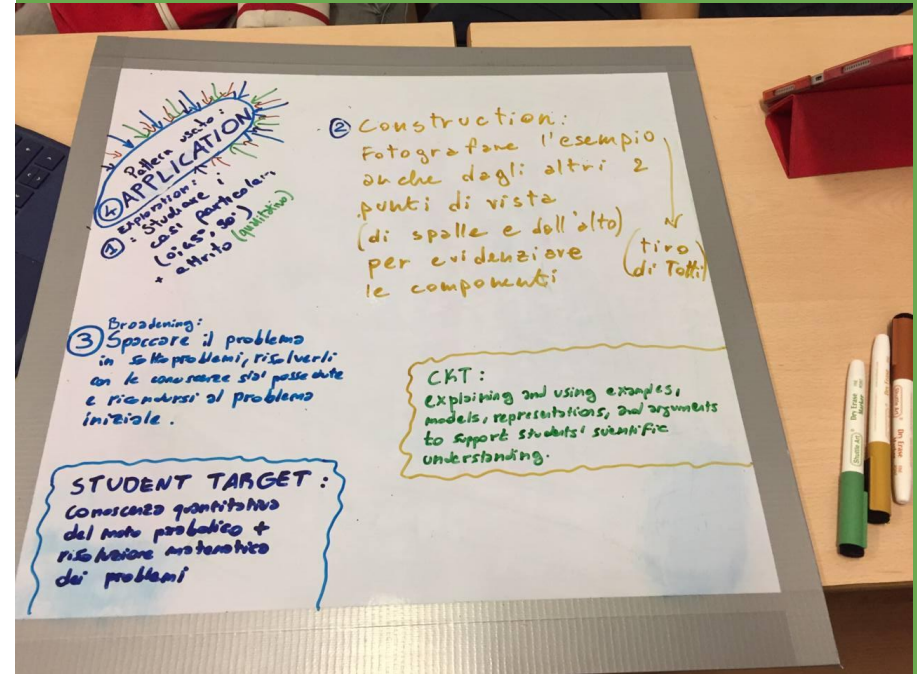
Moto rettilineo uniforme

Moto rettilineo uniformemente accelerato

Moti in due dimensioni

nozioni utili per avere confidenza con questo tipo di situazioni. **Moto parabolico**
(o moto dei proiettili)

0:47 / 13:05 • Intro



APPLICATION

Potenza usata:

④ - Esperienze: casi particolari (locci, 50') + attrito (qualitativo)

③ Broadening: Spezzare il problema in 5-6 problemi, risolverli con le conoscenze già possedute e ricorrere al problema iniziale.

② Construction: Fotografare l'esempio anche dagli altri 2 punti di vista (di spalle e dall'alto) per evidenziare le componenti (tiro di Totti)

CKT: Explaining and using examples, models, representations, and arguments to support students' scientific understanding.

STUDENT TARGET:
Conoscenza quantitativa del moto parabolico + risoluzione analitica dei problemi

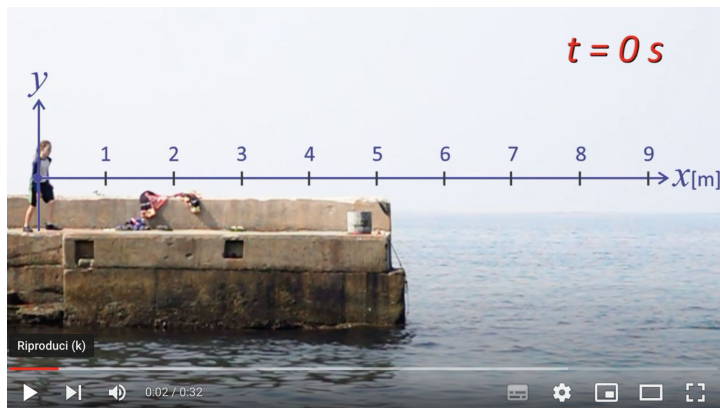
SAME TOPIC,
DIFFERENT PERSPECTIVES!

MATHS PERSPECTIVES
VS
PHYSICS PERSPECTIVES

EXERCISE FOR REASONING

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

Horizontal Jump



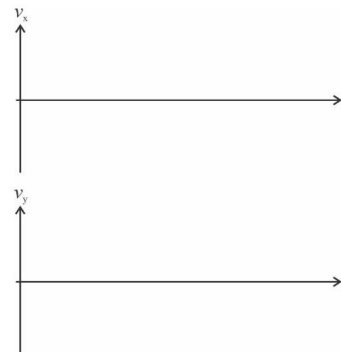
Gorazd Planinsic, University of Ljubljana, Slovenia
and Eugenia Etkina, Rutgers University, USA

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/155Znh2lwHAfodD4CGaAQse3P3jIVBhoh/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>

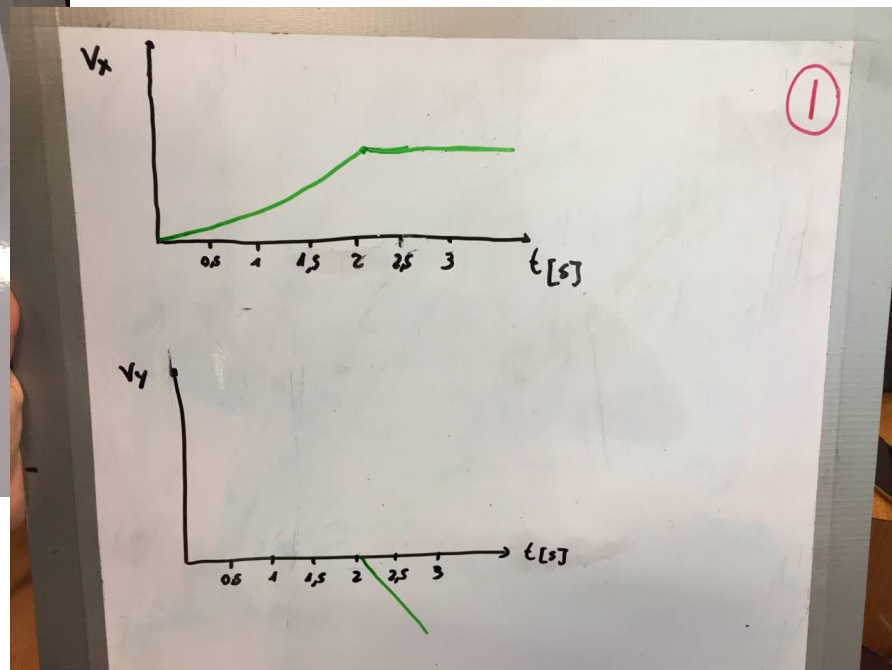
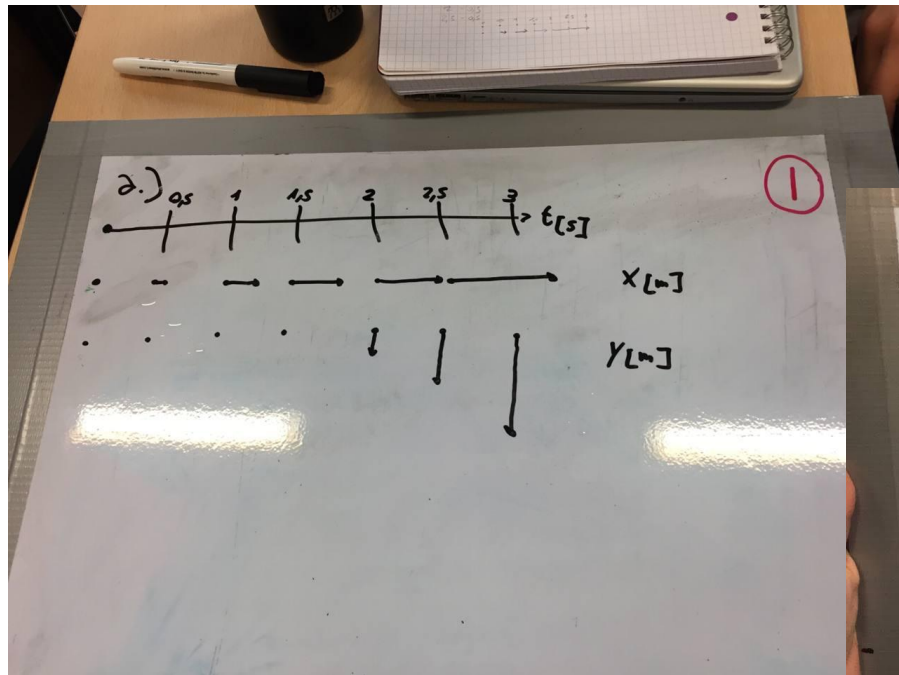
Developing new patterns for integrating Math/Phys Interplay

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?

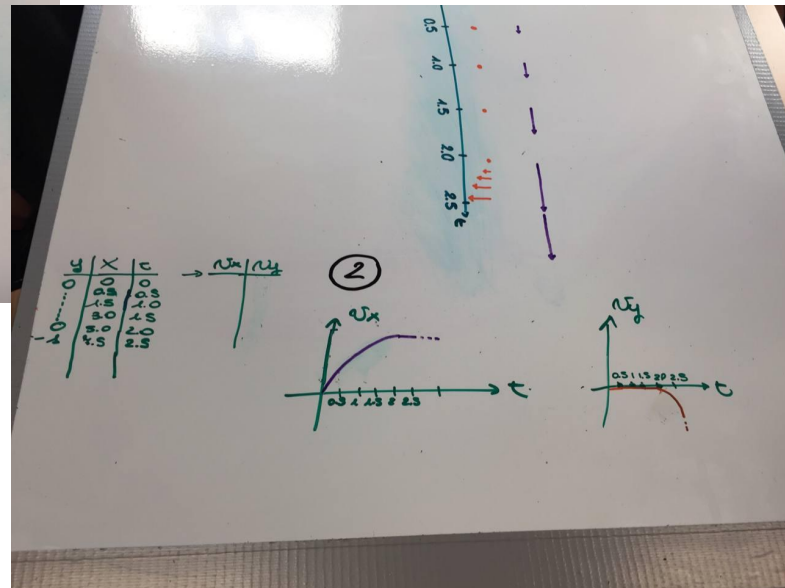
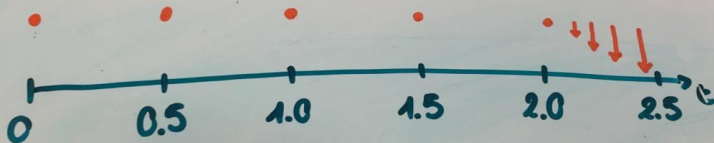


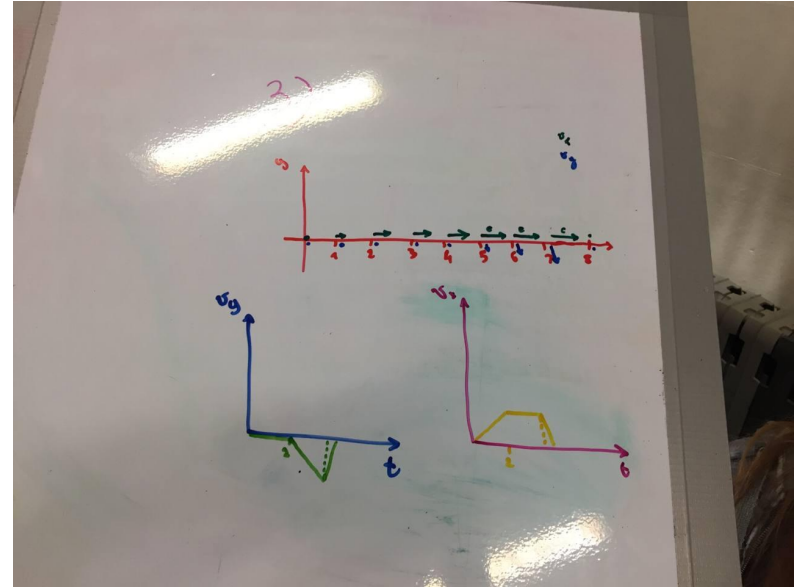
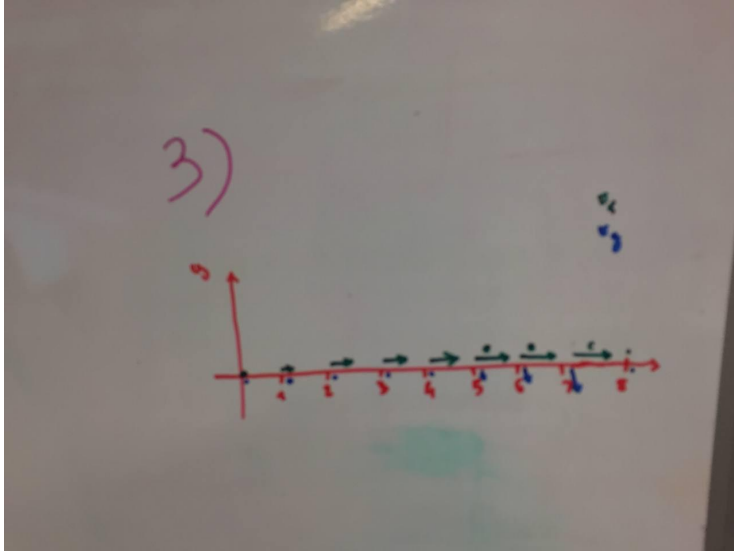
②

$u_x :$

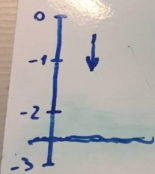
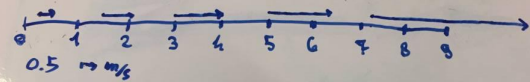


$u_y :$





4



4

