
Physics Education

Laboratory

Lecture 04

Pedagogical Content Knowledge, Math/Phys interplay vs CKT

Francesco Longo 20/10/2022

1

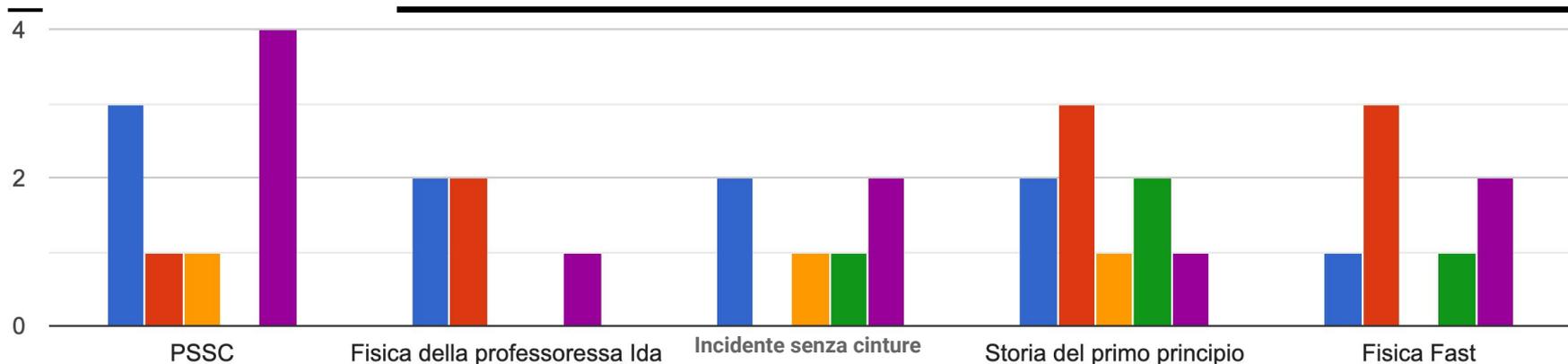
PCK FOR SCIENCE TEACHING (Magnusson et al., 1999)

2

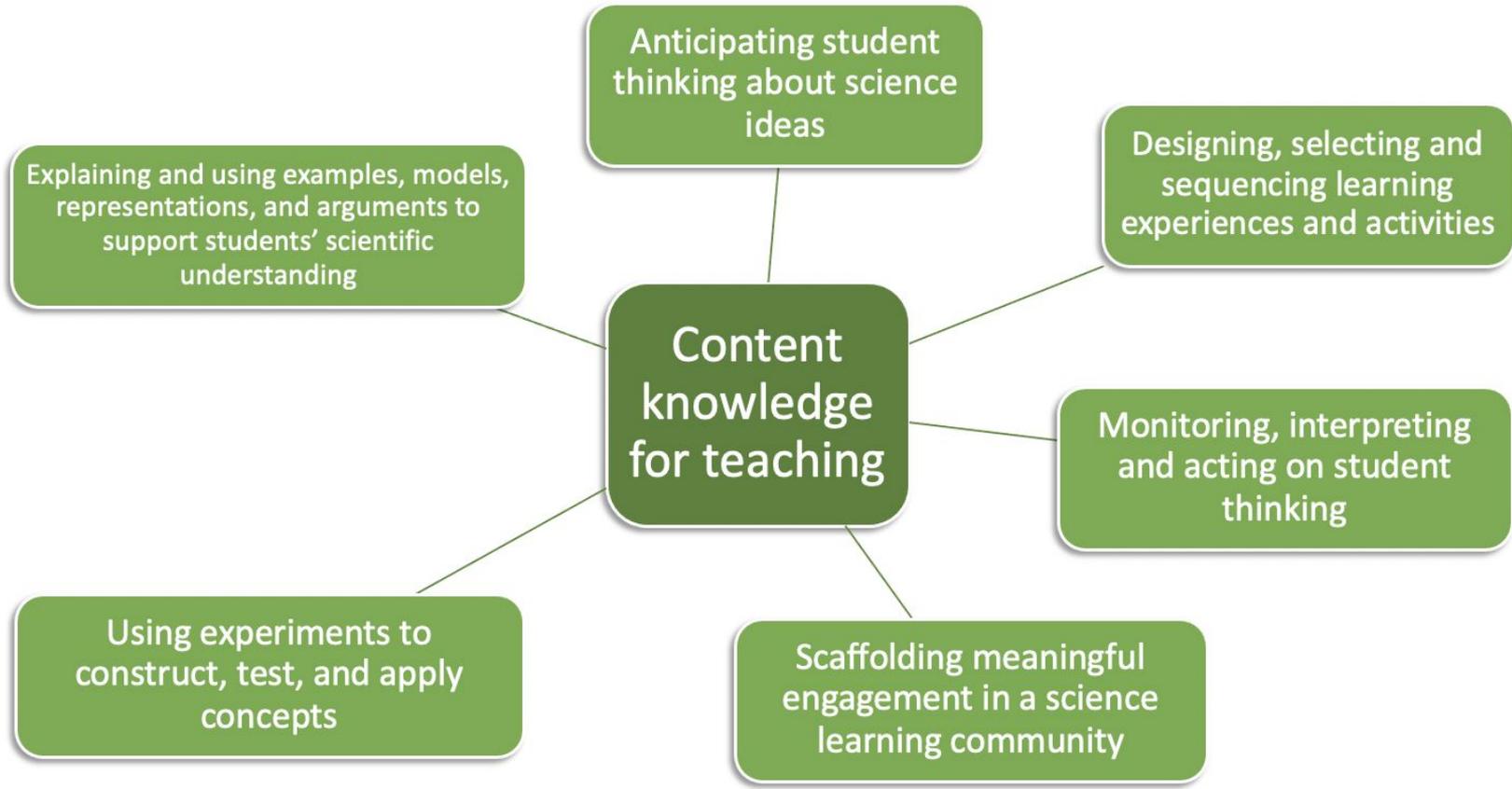
**PCK FOR PHYSICS TEACHING (Etkina, 2010)
CONTENT KNOWLEDGE FOR PHYSICS TEACHING
(Etkina, 2018)**

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

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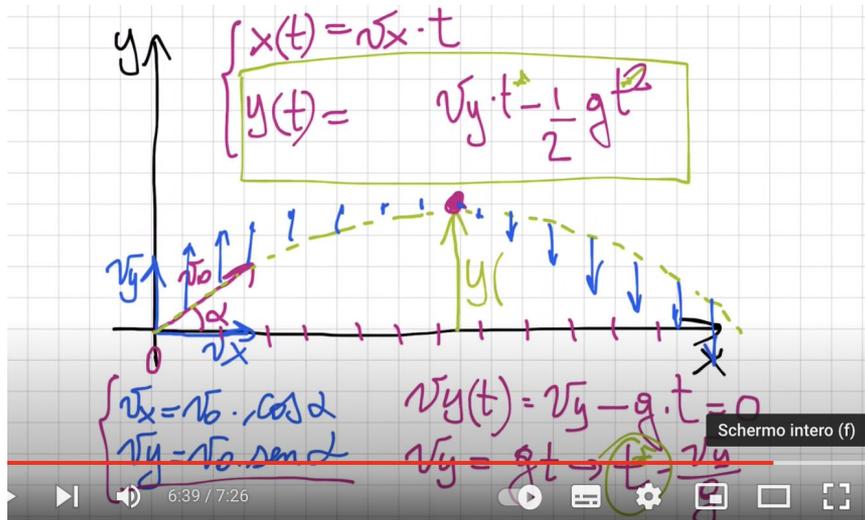
Application

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]

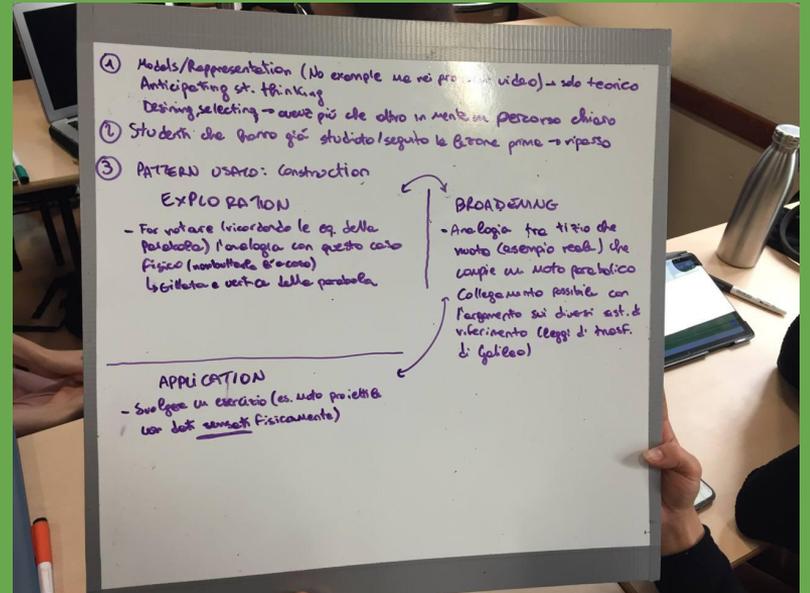
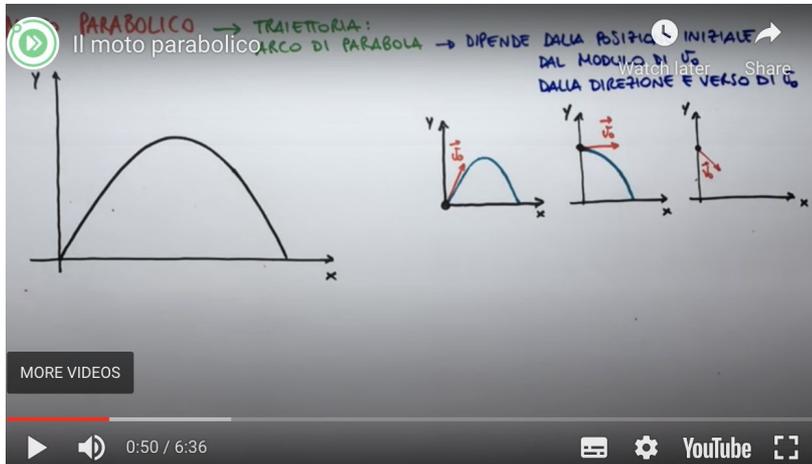
Exploration: immaginare di trovarsi in un altro pianeta con gravità diversa

- 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

K3tlupN_Xw Step by step

$v = 31,7 \text{ m/s}$

~~RETILINEO UNIFORME~~
~~UNIFORMEMENTE ACCELERATO~~

MOTO PARABOLICO
SCOMPONGO IL MOTO!

38,7°

20 m

100 m

Riproduci (k) 3:37 / 14:13

The video player shows a physics diagram of projectile motion. A ball is launched from the ground at an angle of 38.7 degrees. The initial velocity is given as v = 31.7 m/s. The trajectory is a dashed parabolic arc that reaches a maximum height of 20 meters and lands 100 meters away. A tree is drawn in the middle of the path. The text 'MOTO PARABOLICO' and 'SCOMPONGO IL MOTO!' are written in large letters. The previous text 'RETILINEO UNIFORME' and 'UNIFORMEMENTE ACCELERATO' is crossed out with diagonal lines. The video player interface at the bottom shows a play button, a progress bar at 3:37 / 14:13, and various control icons.

1. APPLICAZIONI e BROADENING
2. SUPERIORI (2° o 3° ANNO)

ESEMPI:

1. CASI LIMITI → CONFRONTO CON UN MOTO PIÙ REALISTICO (ATTRITO ARIA)

SCAFFOLDING → STIMOLARE GLI STUDENTI A CARIARE I CONCETTI E RICAVARE LE FORMULE A PARTIRE DA ESPERIMENTI INIZIALI (PALLINA CHE VIENE LANCIATA)

2. SCORRERE IL MOTO IN PIÙ PUNTI (GRAFICO DELLE FORSE) E RICAVARNE LA LEGGE ORARIA CONSTRUCT

3. VALUTARE VARI SIST. DI RIFERIMENTO (ANTICIPARE NUOVI CONCETTI) MONITORING

The image shows a whiteboard with handwritten notes in green ink. The notes are organized into a list of points and examples. The first point is '1. APPLICAZIONI e BROADENING' and the second is '2. SUPERIORI (2° o 3° ANNO)'. Below these are 'ESEMPI:' followed by three numbered items. The first example is '1. CASI LIMITI → CONFRONTO CON UN MOTO PIÙ REALISTICO (ATTRITO ARIA)'. The second is '2. SCORRERE IL MOTO IN PIÙ PUNTI (GRAFICO DELLE FORSE) E RICAVARNE LA LEGGE ORARIA' with 'CONSTRUCT' underlined. The third is '3. VALUTARE VARI SIST. DI RIFERIMENTO (ANTICIPARE NUOVI CONCETTI)' with 'MONITORING' underlined. The word 'Scaffolding' is underlined in the second example. The whiteboard is held by a person whose arm is visible on the right side.

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

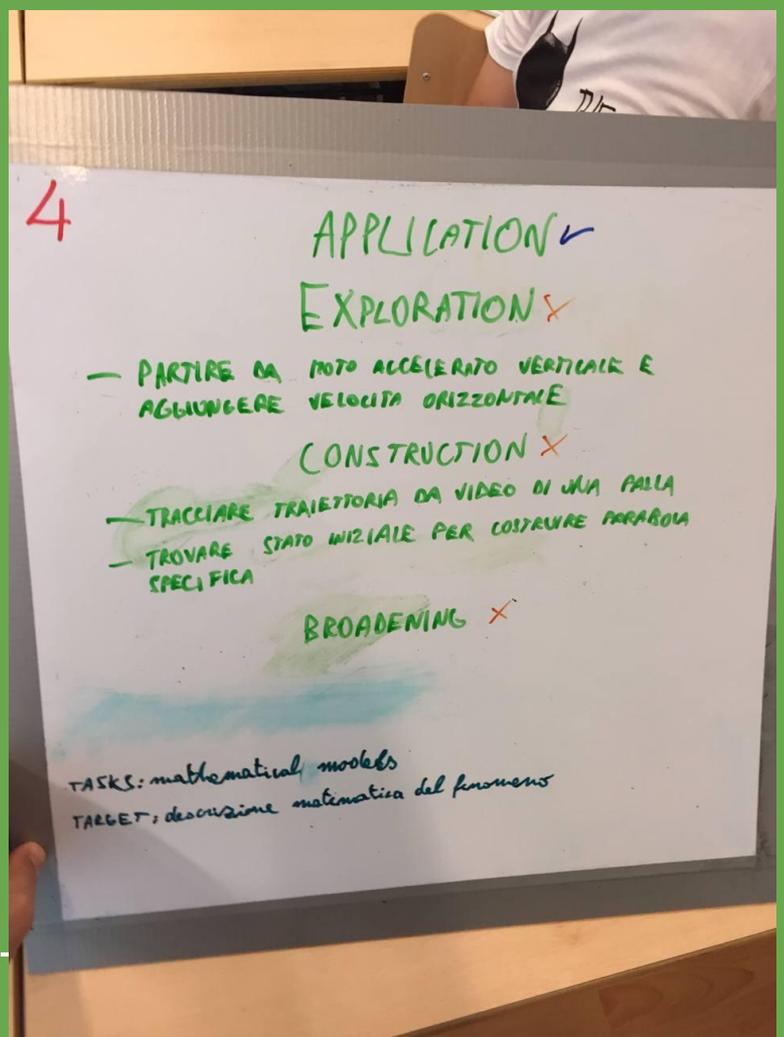
Un quarto d'ora con il prof



**INTRODUZIONE CON
ALCUNI ESEMPI**

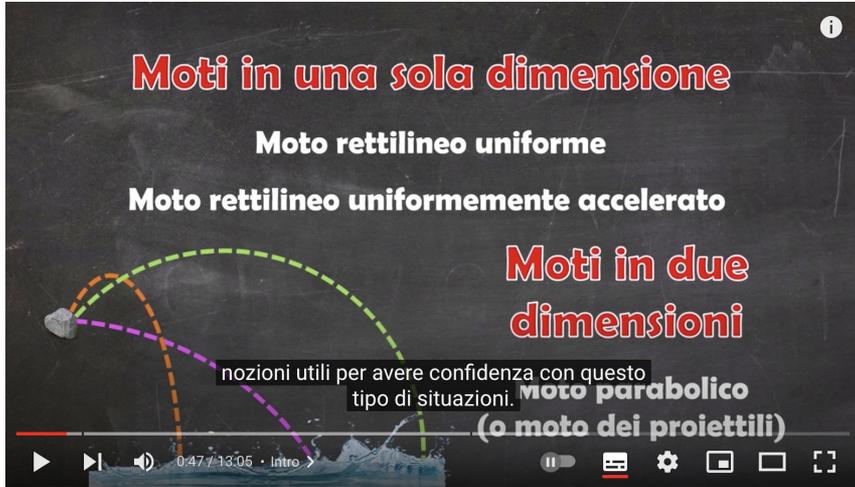
EQUAZIONI DEL MOTO

UN QUARTO D'ORA CON IL PROF



<https://www.youtube.com/watch?v=Wf9zZyPKTLO>

The BlackBoard Physics



Moti in una sola dimensione

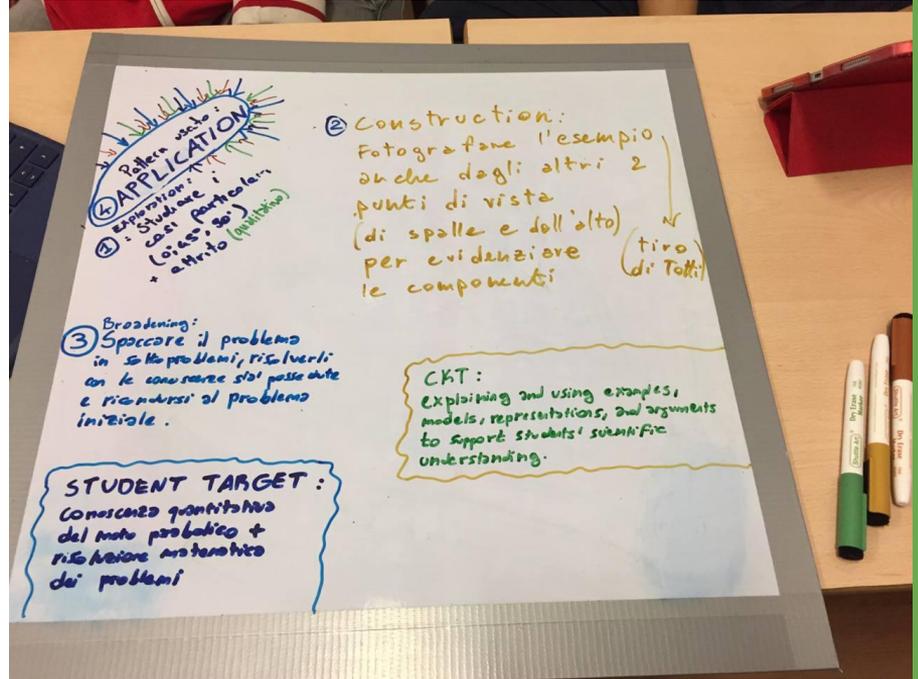
Moto rettilineo uniforme

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

Polter usato:

① - Esperienze (casi particolari) + attività (qualitative)

② - Studio

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

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

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

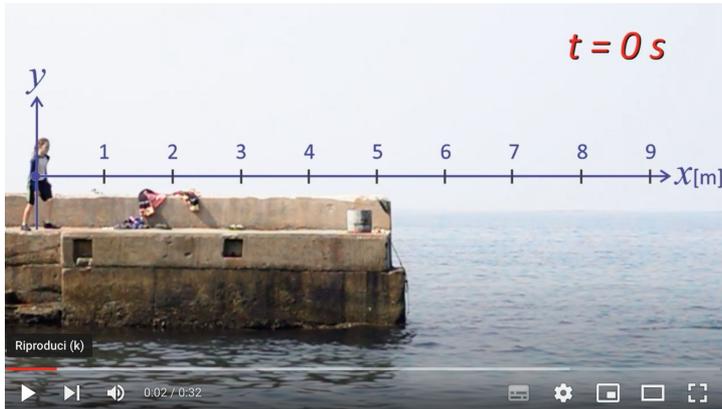
VS

PHYSICS PERSPECTIVES

EXERCISE FOR REASONING

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

Horizontal Jump



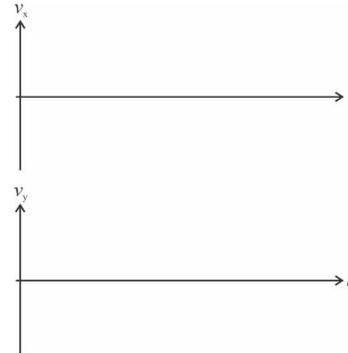
Gorazd Planinsic, University of Ljubljana, Slovenia
and Eugenia Etkina, Rutgers University, USA

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/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>

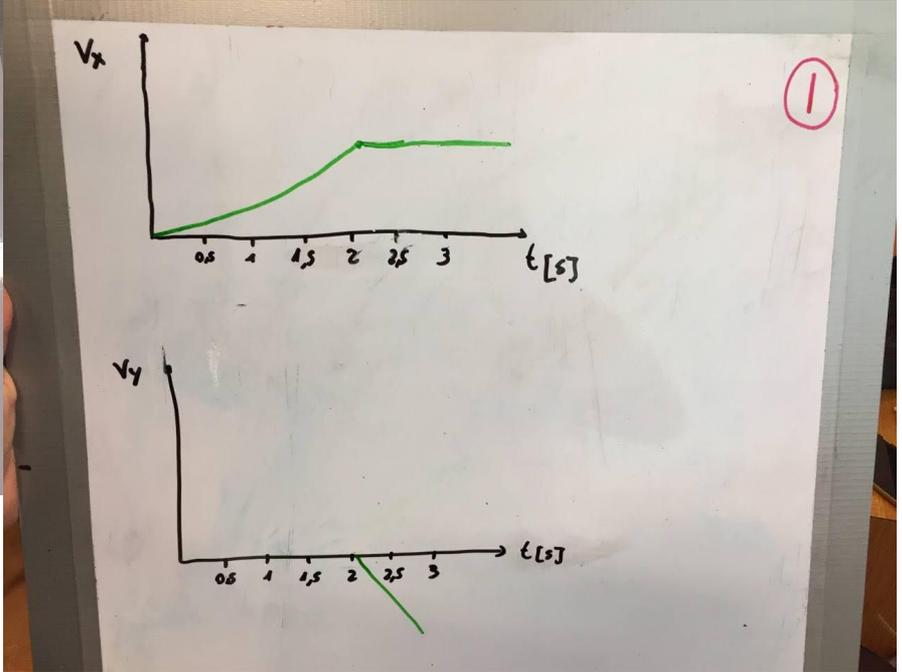
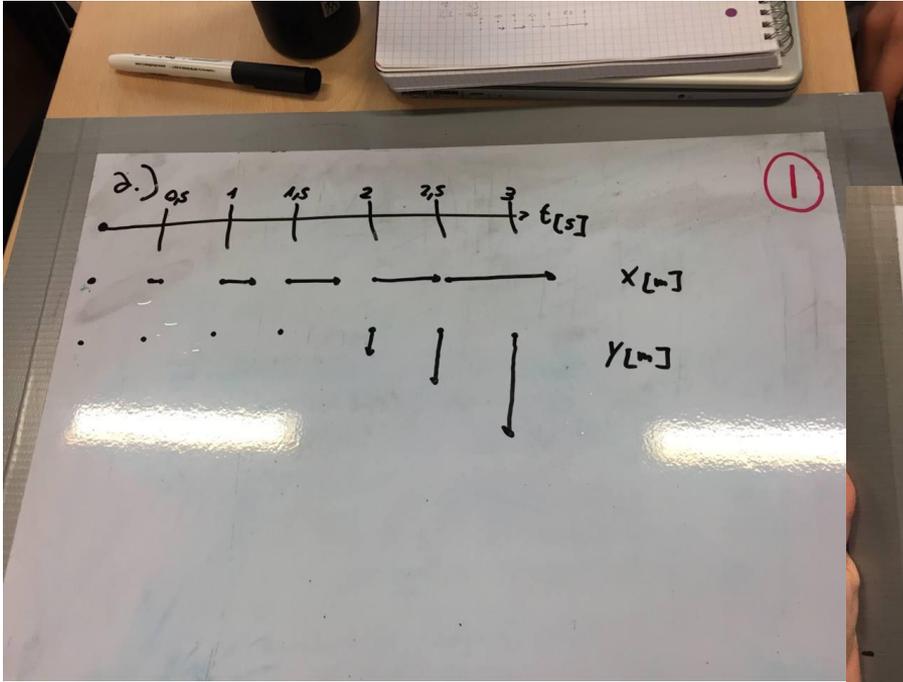
Developing new patterns for integrating Math/Phys Interplay

REFLECT on the EXERCISE FOR REASONING!

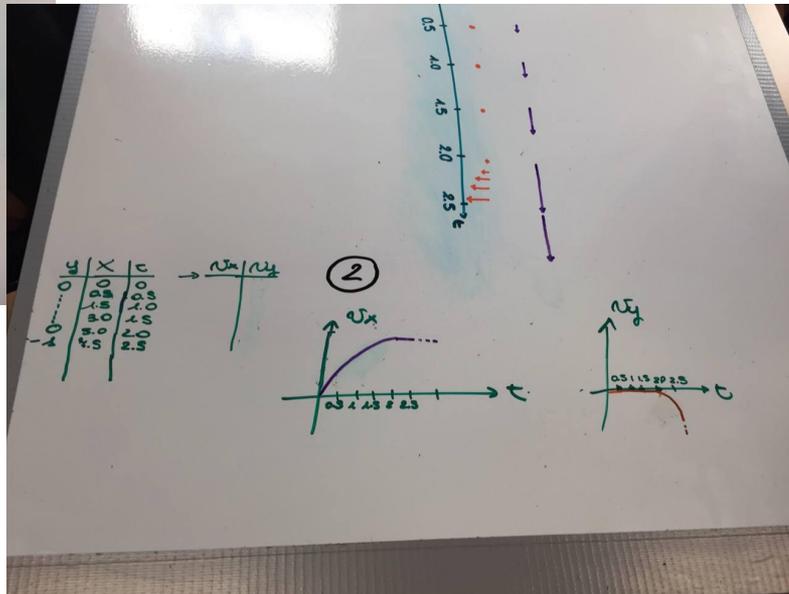
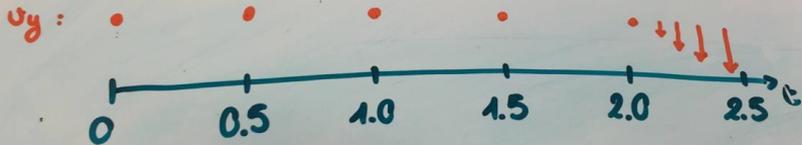
WHICH PATTERN IS PREVALENT?

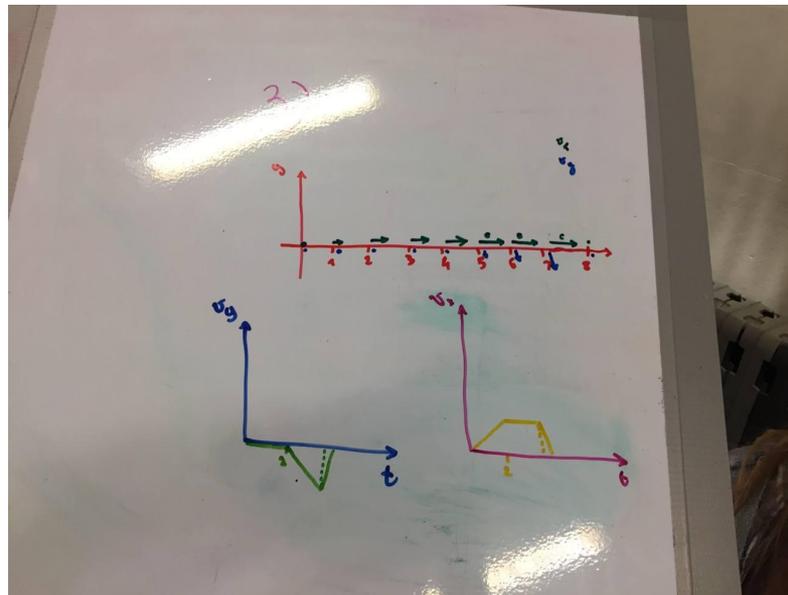
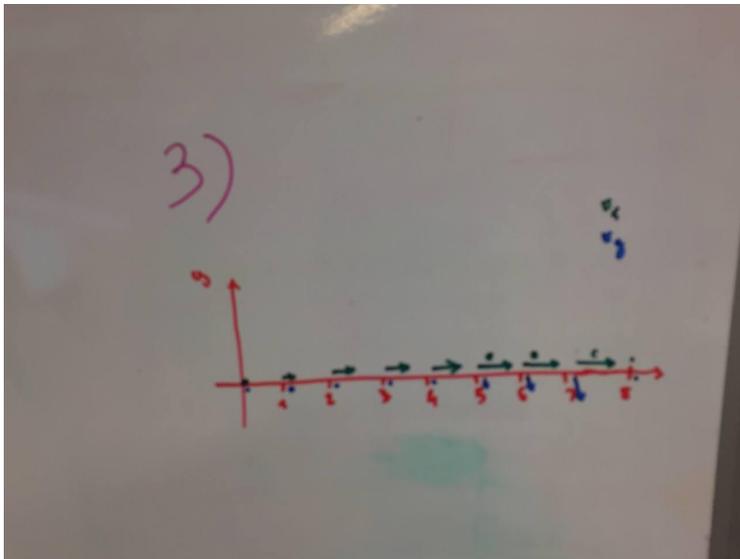
Which are student specific target?

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

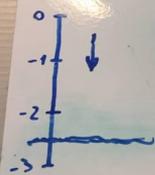
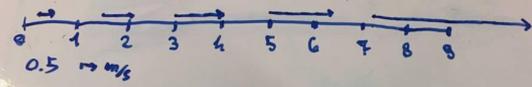


②





4



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