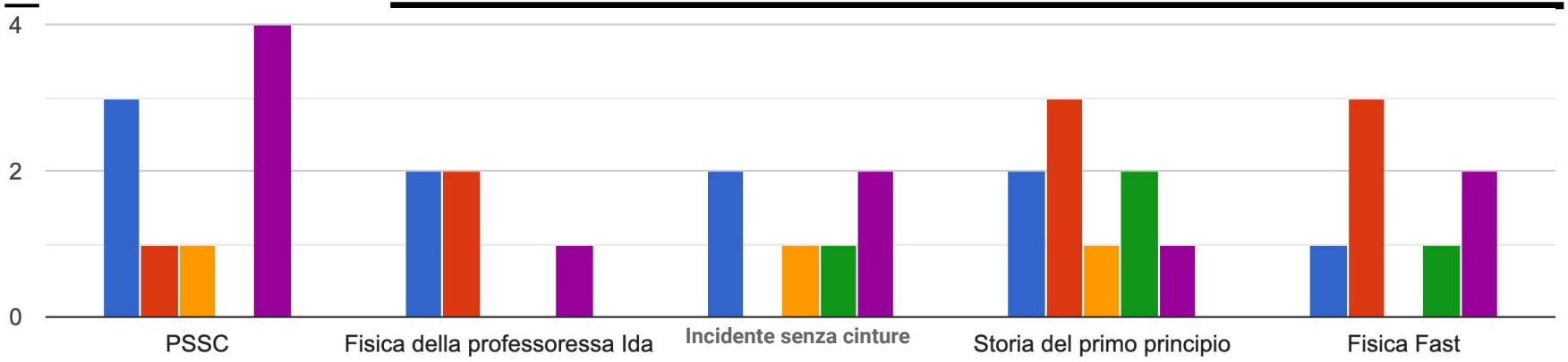
Physics Education Laboratory Lecture 04

Pedagogical Content Knowledge, Math/Phys interplay vs CKT

Francesco Longo 12/10/2021

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

https://www.youtube.com/watch?v=282D-YkMxyI - storia del primo principio

Orientation to science teaching

- Beliefs regarding the role of students' prior knowledge in their learning;
- the purpose of problem solving;
- the role of experiments in the classrooms;
- what motivates students in the classroom

When students solve more textbook problems, students learn to apply physics principles and connect physics and math.

Students learn to reason like scientists; they need to learn to represent problem situations in multiple ways. Thus students should learn to represent a particular situation in multiple ways without solving for anything.

AND WHAT ELSE?

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.

One needs to understand the ideas of impulse and momentum in order to construct a microscopic model of gas pressure.

Students learn the laws of the dynamics after kinematics.

MAKE ANOTHER EXAMPLE.

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

Productive ideas: Conservation and transfer of money can be related to such conserved quantities as mass, momentum, and energy.

Language: Heat in everyday language is treated as a noun–a quantity of stuff–whereas in physics, heating is an active process involving the transfer of thermal energy. Also, force is often treated as an entity .. an object has a weight of 50 N as opposed to an interaction between two objects… OR..

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.

Physics "Jeopardy" problems in which a student has to describe a situation that matches a given equation are an effective way to assess whether students understand the meanings of the symbols in mathematical equations that they use to describe physical processes and to solve problems.

FOR EXAMPLE...

_____

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

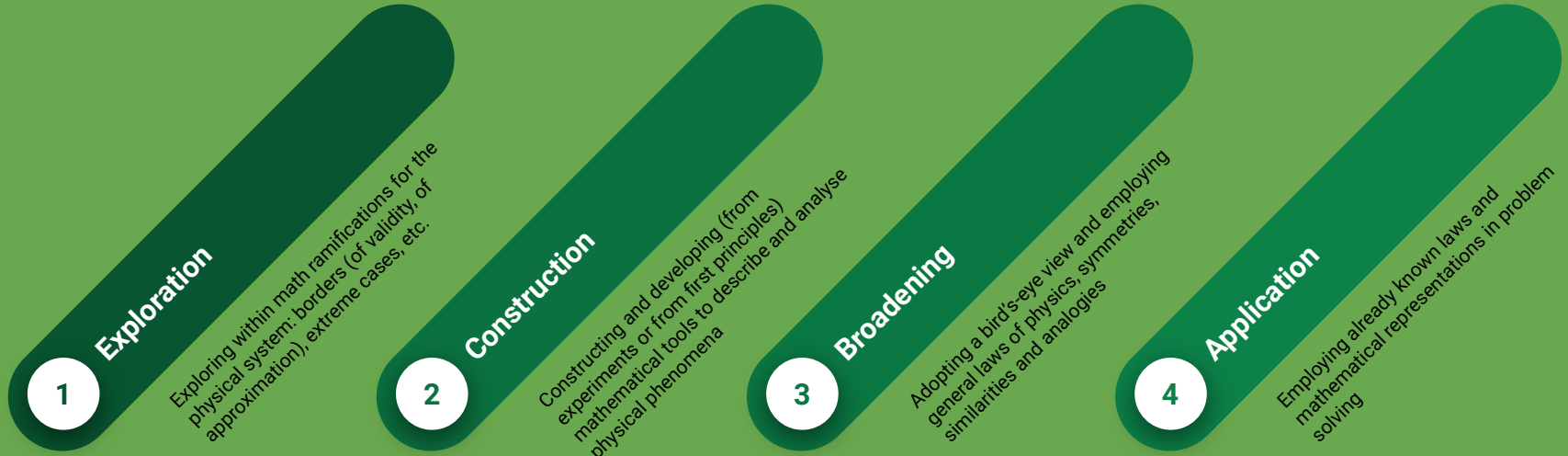
Knowledge of multiple methods or specific activity sequences that make student learning more successful and an ability to choose the most productive strategy or modify a strategy for a particular group of students or an individual.

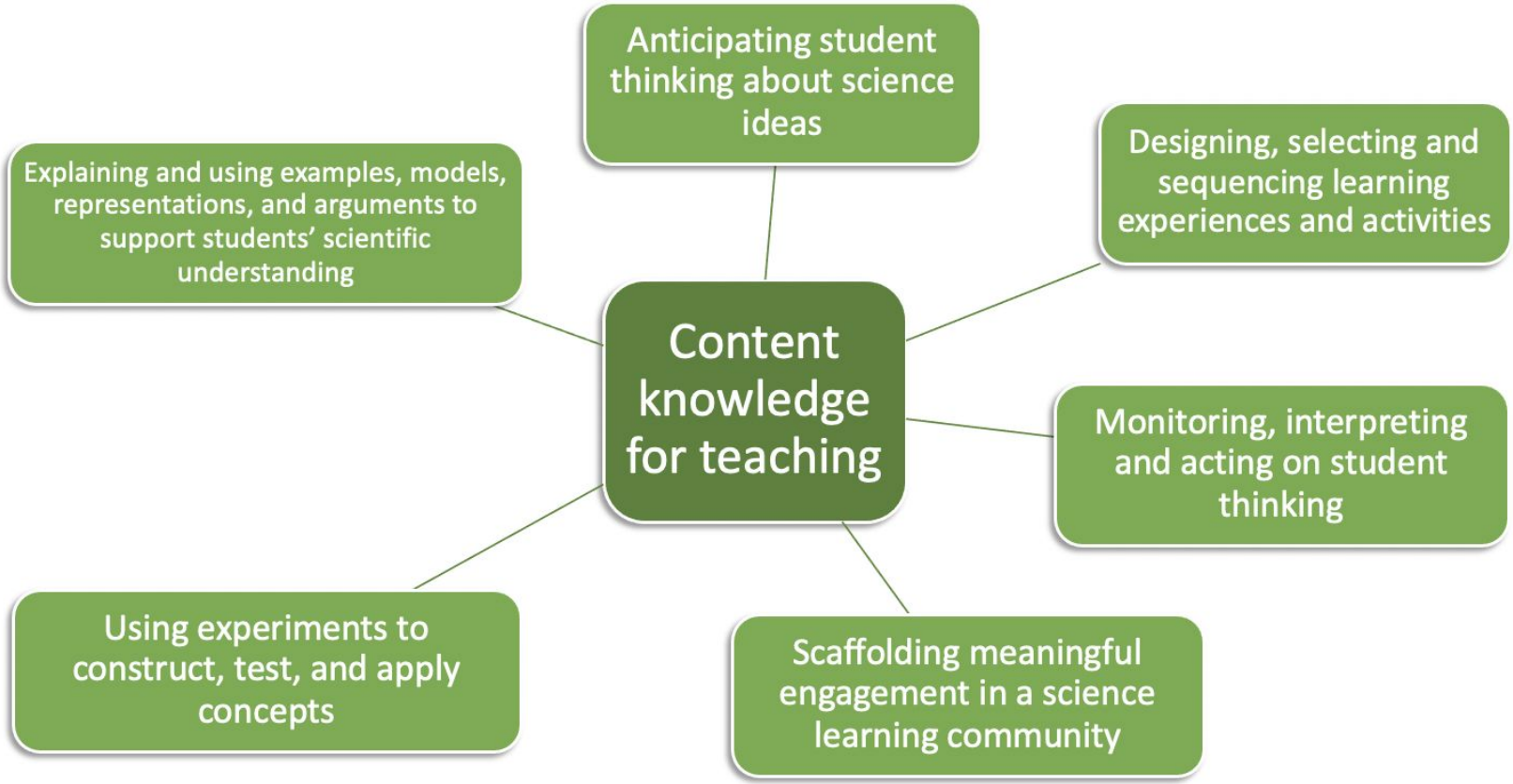
For example, when students learn Newton's laws, it is helpful to label any force with two subscripts indicating two interacting objects.

when students learn about electric current and potential difference, it is useful to know that an analogy between a battery and a water pump might not be clear for the students as many do not understand how pumps work.

MAKE ANOTHER EXAMPLE.

Keep in mind

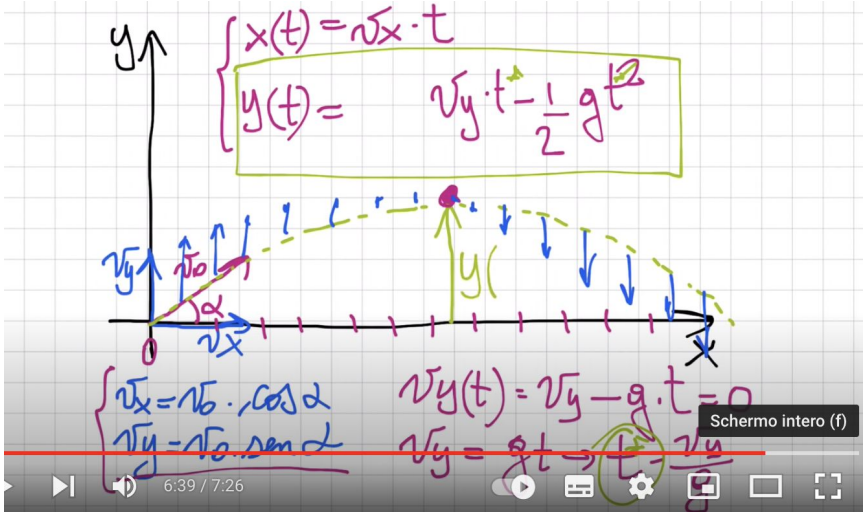

1
Exploration
Exploring within math ramifications for the physical system: borders (of validity, of approximation), extreme cases, etc.
2
Construction
Constructing and developing (from experiments or from first principles) mathematical tools to describe and analyse physical phenomena
3
Broadening
Adopting 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


Anticipating student thinking about science ideas
Explaining and using examples, models, representations, and arguments to support students' scientific understanding
Designing, selecting and sequencing learning experiences and activities
Content knowledge for teaching
Monitoring, interpreting and acting on student thinking
Using experiments to construct, test, and apply concepts
Scaffolding meaningful engagement in a science learning community

Etkina, 2018

Which pattern is prevalent?

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



How to develop the other patterns?

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

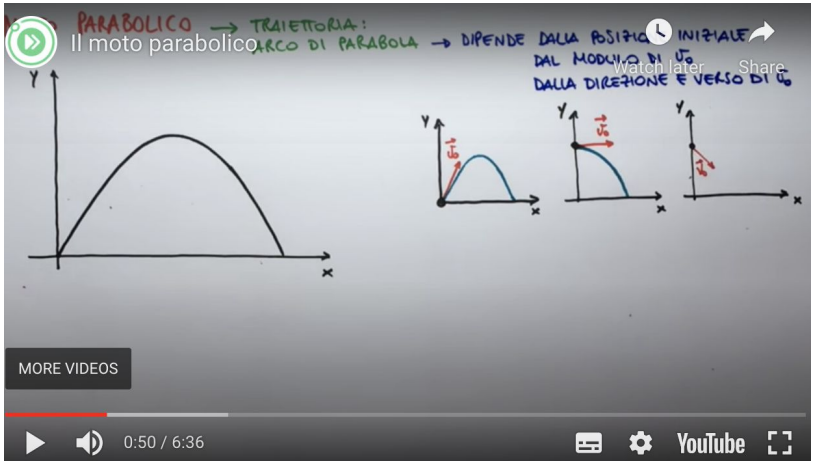
Which are student specific target which are lacking in this lesson?

shorturl.at/eoBYZ

Developing new patterns for integrating Math/Phys Interplay

Which pattern is prevalent?

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



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https://www.youtube.com/watch?v=wEQ69qW8Q6I Fisica Fast moto parabolico

https://www.youtube.com/watch?v=qK3tIupN_Xw Step by step

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

https://www.youtube.com/watch?v=xxFWe1JI6b8

La Fisica Che Ci Piace - Lezioni di Fisica Live! Caduta Libera

Orientation to science teaching:

- fare l'esempio concreto (rischio concetti slegati)
- catturare l'attenzione con un esempio concreto diverso dalla percezione degli studenti
- chiarire dove si vuole arrivare
- formula costruita insieme agli studenti
- introduzione con molti esempi

Knowledge of curricula:

- concept of vector product before explaining Lorenz's force.
- per poter parlare delle forze di attrito gli studenti devono conoscere le leggi della dinamica
- per iniziare a parlare di relatività ristretta bisogna conoscere meglio la relatività galileiana
- moto parabolico senza aver capito bene l'accelerazione e la forza peso
- Di Sessa Ohm's primitives

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

- flusso as a vector field in fluidodinamica e in elettrodinamica flusso è uno scalare, così il concetto di flusso è stato usato in due modi diversi
- concetto esteso e non specifico di campo
- pre-concetto analogia con teorema di Gauss flusso del campo elettrico e di un fluido
- massa e peso
- oggetto sul tavolo che non subisce nessuna forza…
- misconception sulle forze a contatto e a distanza
- lavoro ed energia, concetto di energia che poi non ritrovano
- analogia generatore di tensione come una pompa di fluido
-

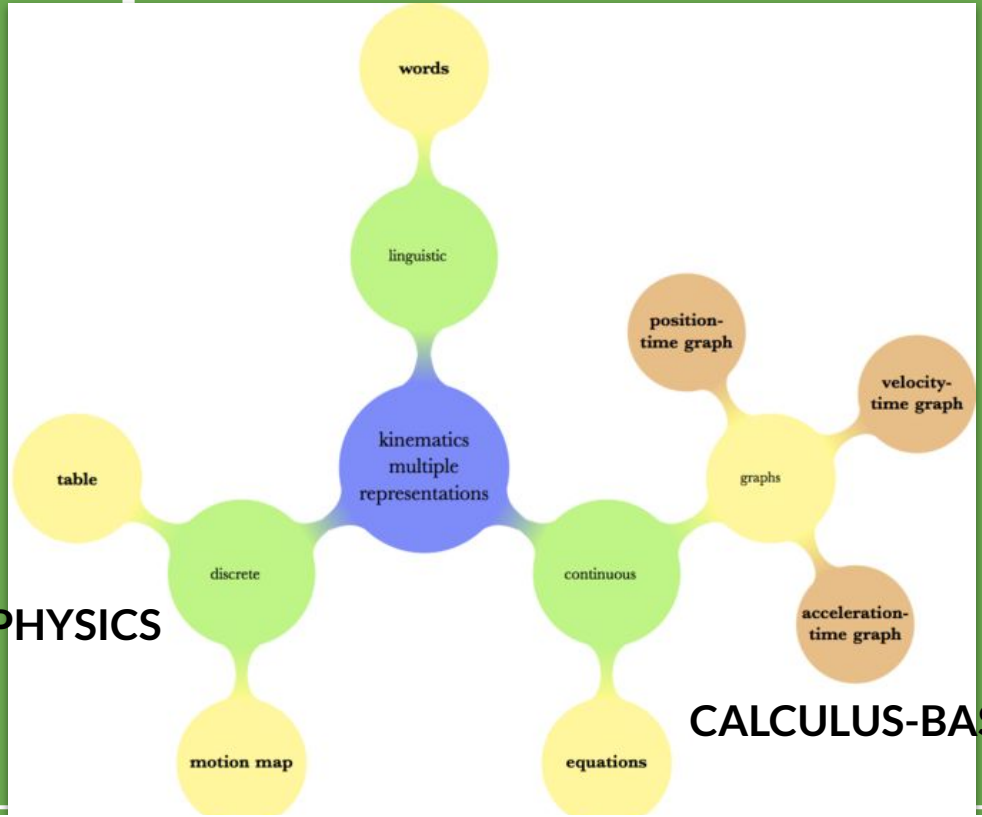
Knowledge of what to assess and specific strategies to assess students' understandings of key concepts and practices.

- Dal grafico al fenomeno: leggere un grafico con dati, ricostruire la tabella
- Non dare tutti i particolari, per esempio se vuoi integrare la densità di massa devi fare dove c'è la massa.
- riconoscono gli studenti la forma di energia che è in gioco in quel momento
- proporre un problema/esercizio senza fornire quantità numeriche ma chiedere di risolvere solo verbalmente, descrivendo i concetti o le idee che si vorrebbero mettere in pratica
- tirare fuori gli esempi dell'argomento disCusso

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

- uso concordato delle lettere che esplicano una certa grandezza
- notazione chiara della caratteristica vettoriale/scalare
- coerenza simboli matematici che si usano anche da un libro ad un altro e da un insegnante all'altro
- usi diversi non aiutano a collegare le informazioni tra loro
- grandezze fisiche sono FUNZIONE di altre grandezze

Multiple representations in kinematics



ALGEBRA-BASED PHYSICS

CALCULUS-BASED PHYSICS

https://fockphysics.wordpress.com/2013/06/15/sbg-and-multiple-representations-in-kinematics/