Physics Education Laboratory Lecture 04

Pedagogical Content Knowledge: Math/Phys interplay

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1. PCK FOR SCIENCE TEACHING (Magnusson et al., 1999)
2. PCK FOR PHYSICS TEACHING (Etkina, 2010)
3. DECLINING PCK FOCUSED ON MATH/PHYS INTERPLAY (Lehavi et al., 2014, 2017)

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...

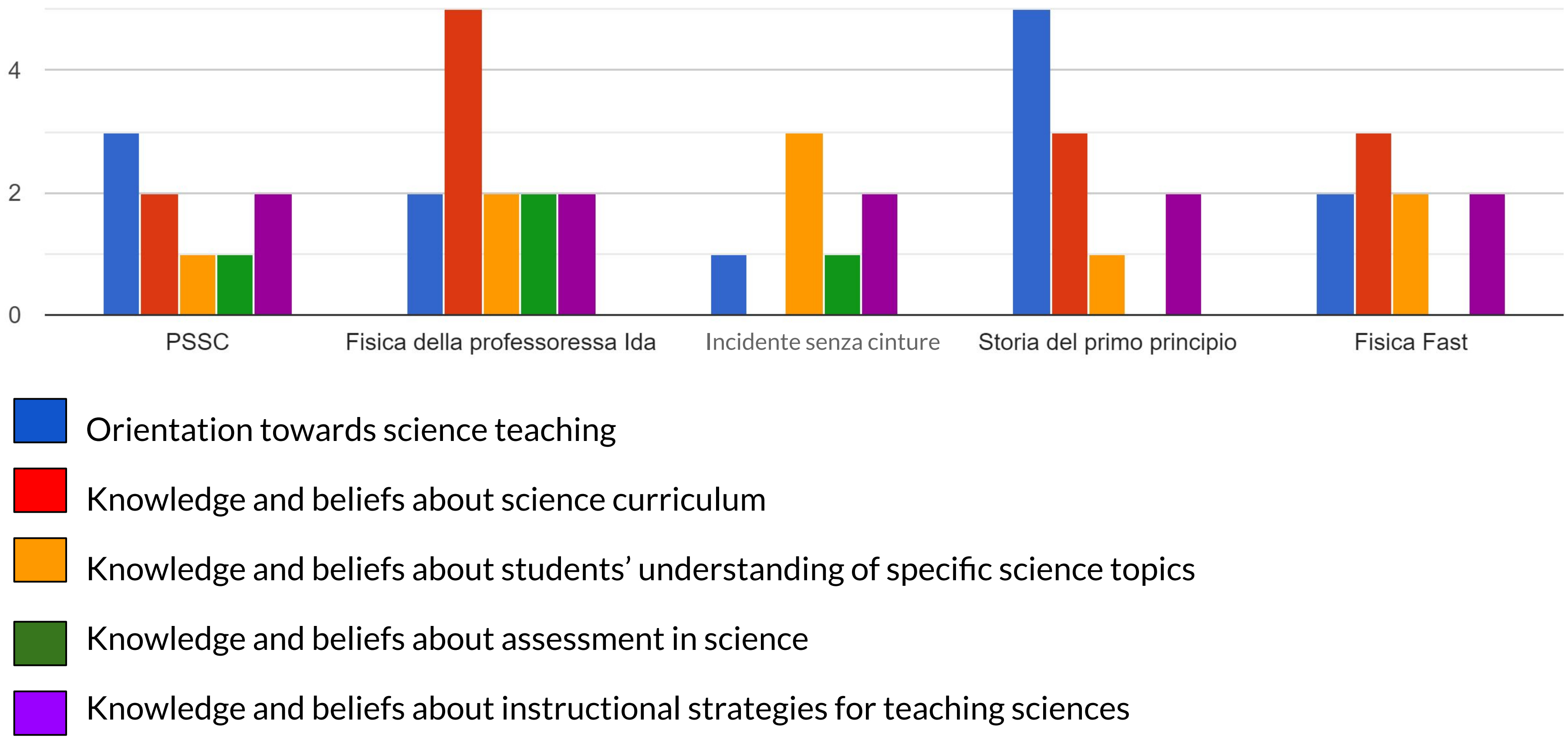
Knowledge of instructional strategies to scaffold students' learning of key concepts and practices in science.

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.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PSSC
Fisica della professoressa Ida
Incidente senza cinture
Storia del primo principio
Fisica Fast
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

Declining PCK for Math-Phys interplay

(Lehavi et al., 2014; 2017)

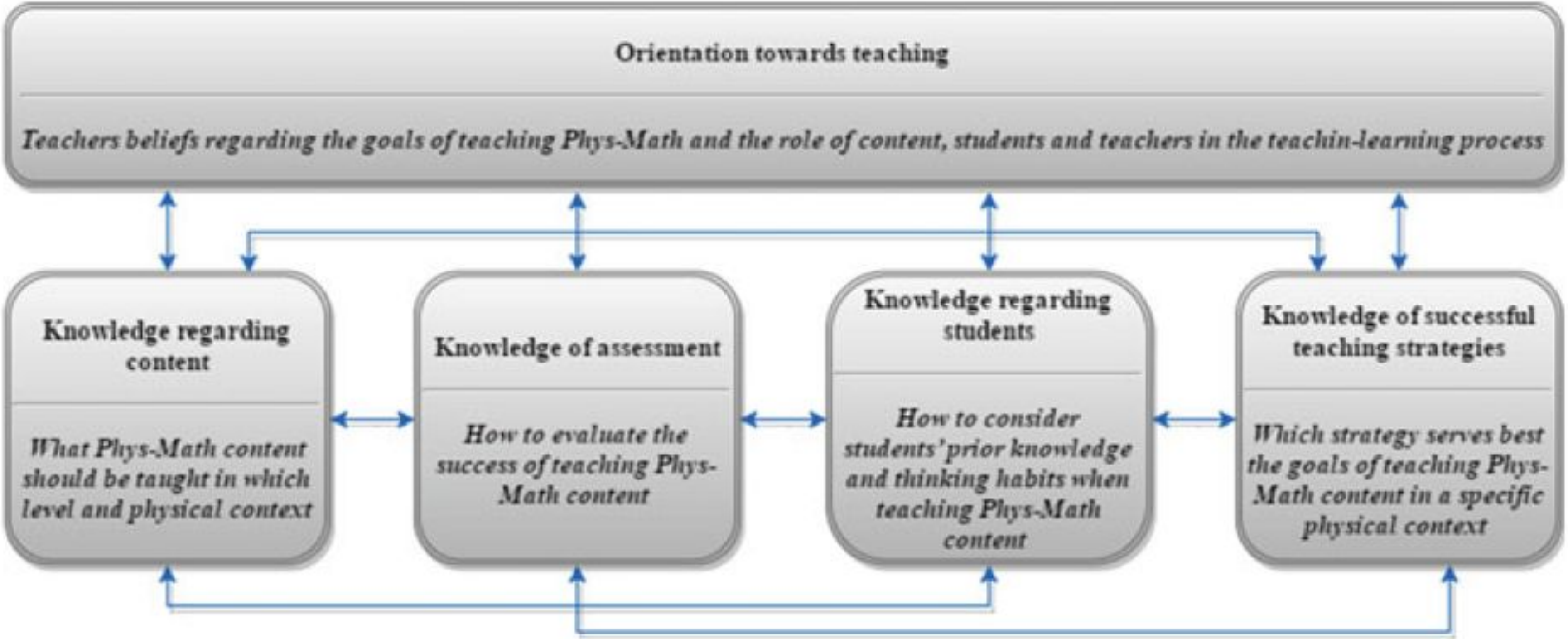


Table 1 Phys-Math patterns, teaching goals and teaching practices (note close relations to goals a-f in the Magnusson PCK model)

Pattern	The teaching goal	The teaching practices
A. Exploration	To demonstrate how phys-math is used to explore the behavior of physical systems	Exploring within math ramifications for the physical system: borders (of validity, of approximation), extreme cases, etc.
B. Construction	To demonstrate how phys-math is used in constructing a model for physical systems	Constructing and developing (from experiments or from first principles) mathematical tools to describe and analyse physical phenomena
C. Broadening	To demonstrate how phys-math can be used in broadening the scope of a physical context	Adopting a bird's-eye view and employing general laws of physics, symmetries, similarities and analogies
D. Application	To demonstrate how phys-math provides aid in problem solving	Employing already known laws and mathematical representations in problem solving

The practice of employing different patterns of the Phys-Math interplay can distinguish master teachers from other expert teachers.

Keep in mind

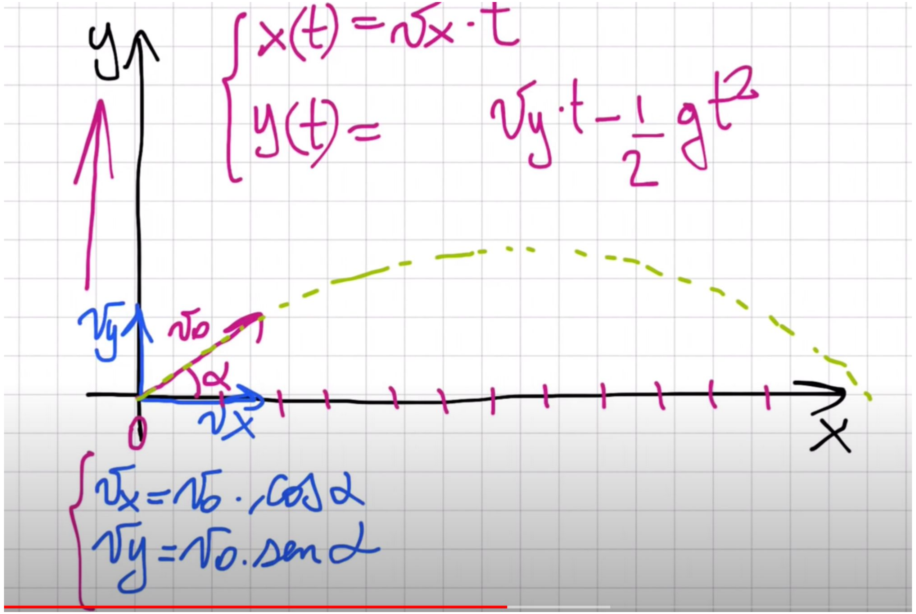
1. **Exploration** — Exploring within math ramifications for the physical system: borders (of validity, of approximation), extreme cases, etc.

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

Which pattern is prevalent?



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

Which pattern is prevalent?

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

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=xxFWe1JI6b8

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