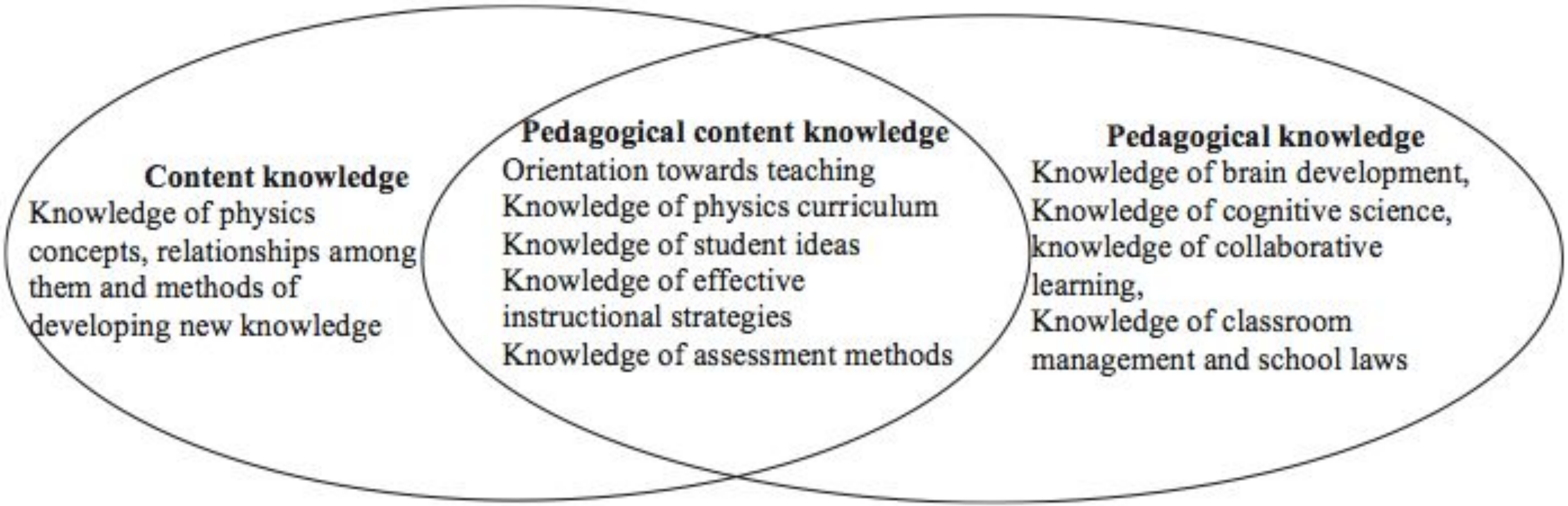
Laboratorio Didattico di Fisica - Modulo A Lezione 03

Francesco Longo • 17/10/2024

La struttura della “Teacher Knowledge”
(Fazio, 2010)



What's next?

Riflessioni su:

VETTORI + CINEMATICA + DINAMICA

TEOREMA GAUSS – USO DI MODALITA' INNOVATIVA o TRADIZIONALE?

CALORIMETRIA e TERMODINAMICA

Argomenti

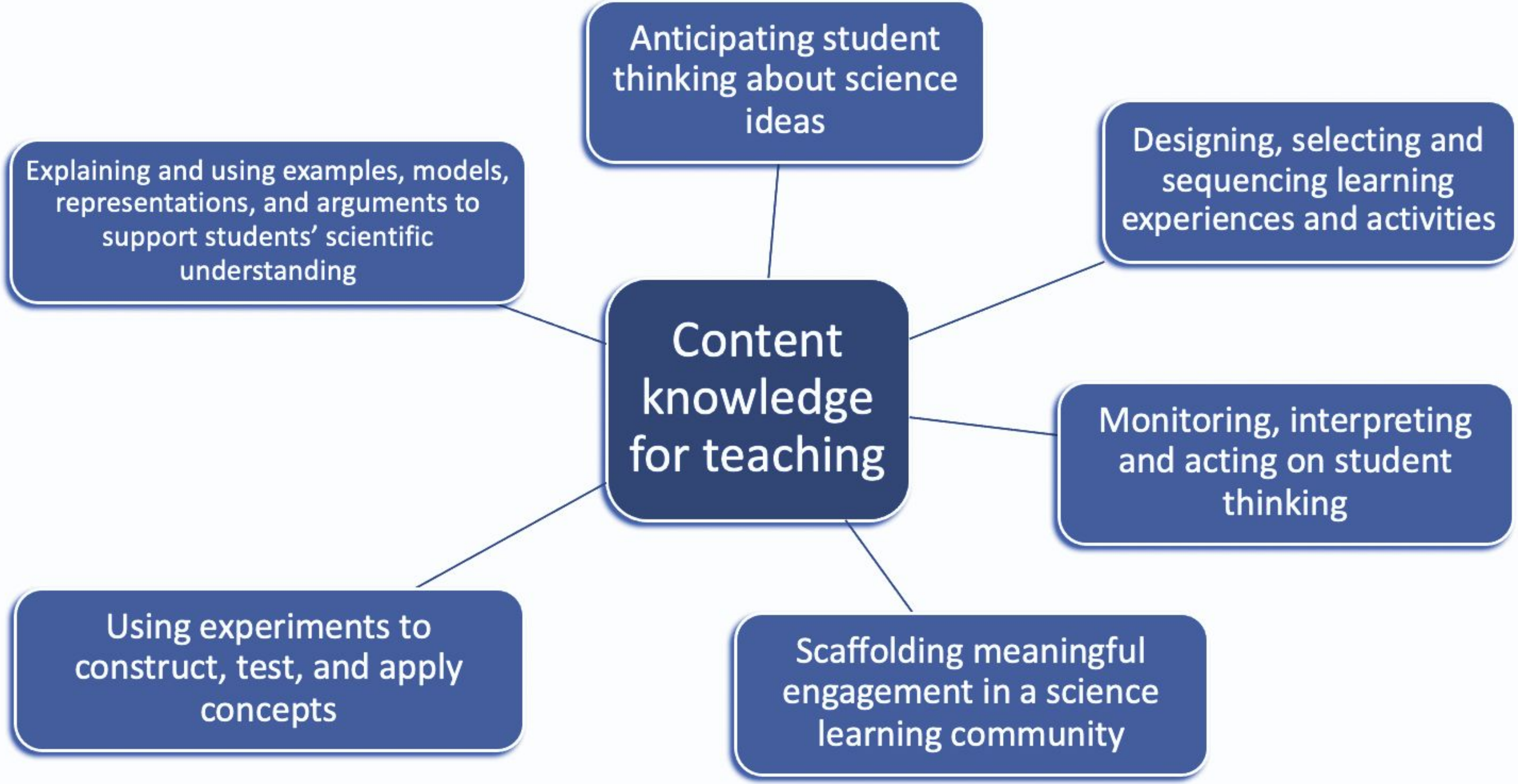
Cinematica
Dinamica
Energia
Fluidodinamica
Calorimetria/termodinamica
Ottica
Elettrostatica
Magnetismo
Elettromagnetismo
Meccanica quantistica
Relatività speciale e generale

Tools per l’Insegnamento della Fisica

Early Physics
Multiple Representations in Physics
Historical approaches
Problem-solving; Jeopardy problems
Physics of everyday Thinking
Project Based Education
Modelling instruction
Simulation for Educational Physics
ISLE - Investigative Science Learning Environment
IBSE - Inquiry Based Science Education
Bayesian updating method
On line educational tool-kit

Teachers' content knowledge for teaching

E.Etkina et al. (2018)
PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH 14, 010127


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

Tasks of Teaching

APPENDIX A: TASKS OF TEACHING

This section provides a list of the tasks of teaching.

Task of teaching	Description	Specific tasks
I. Anticipating student thinking around science ideas	*While planning and implementing instruction teachers are able to anticipate particular patterns in student thinking. They understand and recognize challenges students are likely to confront in developing an understanding of key science concepts and mathematical models. Teachers are also familiar with student interests and background knowledge and enact instruction accordingly.*	*Teachers:* I. a) anticipate specific student challenges related to constructing scientific concepts, conceptual and quantitative reasoning, experimentation, and the application of science processes I. b) anticipate likely partial conceptions and alternate conceptions, including partial quantitative understanding about particular science content and processes I. c) recognize student interest and motivation around particular science content and practices I. d) understand how students' background knowledge both in physics and mathematics can interact with new science content

Tasks of Teaching

II. Designing, selecting, and sequencing learning experiences and activities	*Classroom learning experiences and activities are designed around learning goals and involve key science ideas, key experiments, and mathematical models relevant to the development of ideas and practices. Learning experiences reflect an awareness of student learning trajectories and support both individual and collective knowledge generation on the part of students.*	*Teachers:* II. a) design or select and sequence learning experiences that focus on sense-making around important science concepts and practices, including productive representations, mathematical models, and experiments in science that are connected to students' initial and developing ideas II. b) include key practices of science including experimentation, reasoning based on collected evidence, experimental testing of hypotheses, mathematical modeling, representational consistency, and argumentation II. c) address projected learning trajectories that include both long-term and short-term goals and are based on evidence of actual student learning trajectories II. d) address learners' actual learning trajectories by building on productive elements and addressing problematic ones II. e) provide students with evidence to support their understanding of short- and long-term learning goals II. f) integrate, synthesize, and use multiple strategies and involve students in making decisions II. g) prompt students to collectively generate and validate knowledge with others II. h) help students draw on multiple types of knowledge, including declarative, procedural, schematic, and strategic II. i) elicit student understanding and help them express their thinking via multiple modes of representation II. j) help students consider multiple alternative approaches or solutions, including those that could be considered to be incorrect

Tasks of Teaching

III. Monitoring, interpreting, and acting on student thinking	*Teachers understand and recognize challenges and difficulties students experience in developing an understanding of key science concepts; understanding and applying mathematical models and manipulating equations; designing and conducting experiments, etc. This is evident in classroom work, talk, actions, and interactions throughout the course of instruction so that specific learning needs or patterns are revealed. Teachers also recognize productive developing ideas and problem solutions and know how to leverage these to advance learning.* *Teachers engage in an ongoing and multifaceted process of assessment, using a variety of tools and methods. Teachers draw on their understanding of learners and learning trajectories to accurately interpret and productively respond to their students' developing understanding.*	*Teachers:* III. a) employ multiple strategies and tools to make student thinking visible III. b) interpret productive and problematic aspects of student thinking and mathematical reasoning III. c) identify specific cognitive and experiential needs or patterns of needs and build upon them through instruction III. d) use interpretations of student thinking to support instructional choices both in lesson design and during the course of classroom instruction III. e) provide students with descriptive feedback III. f) engage students in metacognition and epistemic cognition III. g) devise assessment activities that match their goals of instruction

Tasks of Teaching

IV. Scaffolding meaningful engagement in a science learning community	*Productive classroom learning environments are community-centered. Teachers engage all students as full and active classroom participants. Knowledge is constructed both individually and collectively, with an emphasis on coming to know through the practices of science. The values of the classroom community include evidence-based reasoning, the pursuit of multiple or alternative approaches or solutions, and the respectful challenging of ideas.*	*Teachers:* IV. a) engage all students to express their thinking about key science ideas and encourage students to take responsibility for building their understanding, including knowing how they know IV. b) develop a climate of respect for scientific inquiry and encourage students' productive deep questions and rich student discourse IV. c) establish and maintain a "culture of physics learning" that scaffolds productive and supportive interactions between and among learners IV. d) encourage broad participation to ensure that no individual students or groups are marginalized in the classroom IV. e) promote negotiation of shared understanding of forms, concepts, mathematical models, experiments, etc., within the class IV. f) model and scaffold goal behaviors, values, and practices aligned with those of scientific communities IV. g) make explicit distinctions between science practices and those of everyday informal reasoning as well as between scientific expression and everyday language and terms IV. h) help students make connections between their collective thinking and that of scientists and science communities IV. i) scaffold learner flexibility and the development of independence IV. j) create opportunities for students to use science ideas and practices to engage real-world problems in their own contexts

Tasks of Teaching

V. Explaining and using examples, models, representations, and arguments to support students' scientific understanding	*Teachers explain and use representations, examples, and models to help students develop their own scientific understanding. Teachers also support and scaffold students' ability to use models, examples, and representations to develop explanations and arguments. Mathematical models are included as a key aspect of physics understanding and are assumed whenever the term* model *is used.*	*Teachers:* V. a) explain concepts clearly, using accurate and appropriate technical language, consistent multiple representations, and mathematical representations when necessary V. b) use representations, examples, and models that are consistent with each other and with the theoretical approach to the concept that they want students to learn V. c) help students understand the purpose of a particular representation, example, or model and how to integrate new representations, examples, or models with those they already know V. d) encourage students to invent and develop examples, models, and representations that support relevant learning goals V. e) encourage students to explain features of representations and models (their own and others') and to identify/evaluate both strengths and limitations V. f) encourage students to create, critique, and shift between representations and models with the goal of seeking consistency between and among different representations and models V. g) model scientific approaches to explanation, argument, and mathematical derivation and explain how they know what they know. They choose models and analogs that accurately depict and do not distort the true meaning of the physical law and use language that does not confound technical and everyday terms (e.g., heat and energy). V. h) provide examples that allow students to analyze situations from different frameworks such as energy, forces, momentum, and fields

Tasks of Teaching

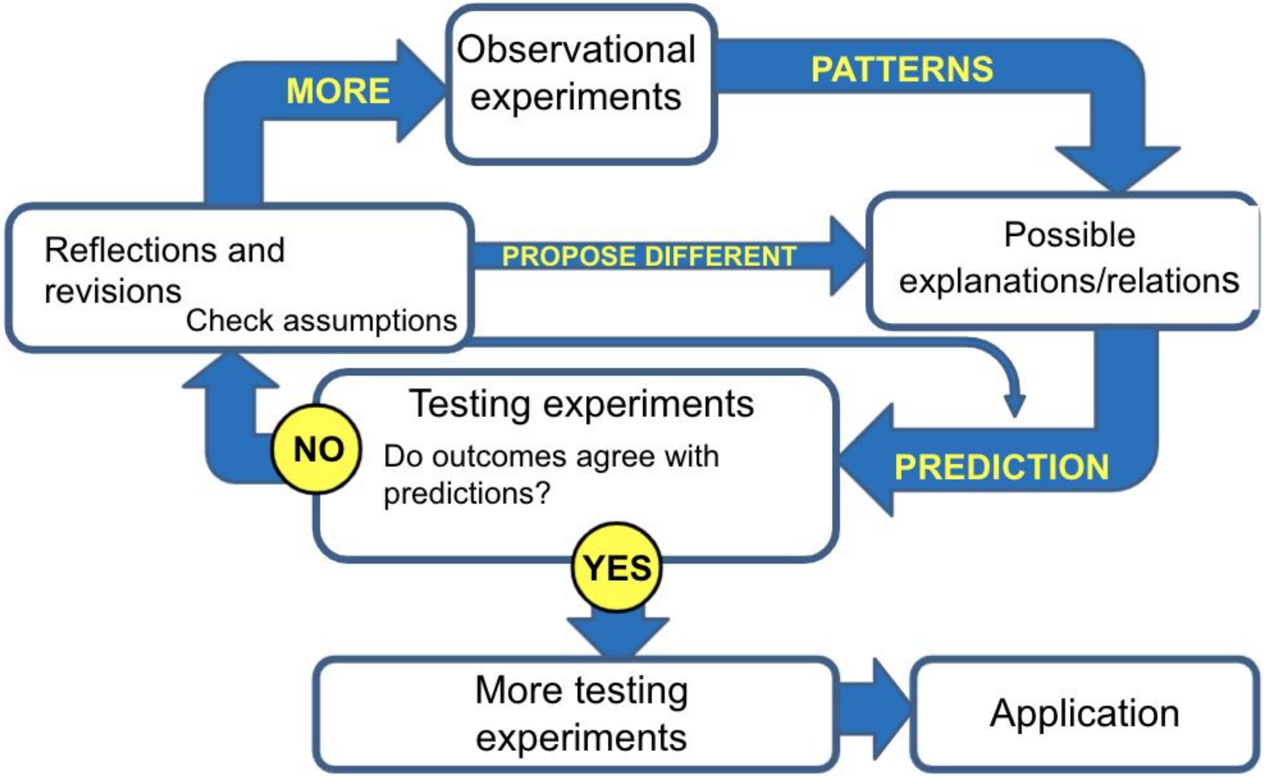
VI. Using experiments to construct, test, and apply concepts	*Teachers provide timely and meaningful opportunities throughout instruction for students to design and analyze experiments to help students develop, test, and apply particular concepts. Experiments are an integral part of student construction of physics concepts and are used as part of scientific inquiry in contrast with simple verification.*	*Teachers:* VI. a) provide opportunities for students to analyze quantitative and qualitative experimental data to identify patterns and construct concepts VI. b) provide opportunities for students to design and analyze experiments using particular frameworks such as energy, forces, momentum, field, etc. VI. c) provide opportunities for students to test experimentally or apply particular ideas in multiple contexts VI. d) provide opportunities for students to pose their own questions and investigate them experimentally VI. e) use questioning, discussion, and other methods to draw student attention during experiments to key aspects needed for subsequent learning, including the limitations of the models used to explain a particular experiment VI. f) help students draw connections between classroom experiments, their own ideas, and key science ideas VI. g) encourage students to draw on experiments as evidence to support explanations and claims and to test explanations and claims by designing experiments to rule them out

Investigative Science Learning Environment

(ISLE approach)

OBSERVATIONAL EXPERIMENT

Investigative Science Learning Environment - ISLE cycle



Etkina, 2015

Observational Experiment Table 2.1

Using dots to represent motion

Observational experiment	Analysis
Experiment 1. You push a bowling ball (the object of interest) and let it roll on a smooth linoleum floor. Each second, you place a beanbag beside the bowling ball. The beanbags are evenly spaced.	The dots in this diagram represent the positions of the beanbags you placed each second as the bowling ball slowly rolled on the floor. • • • •
Experiment 2. You repeat Experiment 1, but you push the ball harder before you let it roll. The beanbags are farther apart but are still evenly spaced.	The dots in this diagram represent the positions of the beanbags, which are still evenly spaced but separated by a greater distance than the bags in Experiment 1. • • •
Experiment 3. You push the bowling ball and let it roll on a carpeted floor instead of a linoleum floor. The distance between the beanbags decreases as the ball rolls.	The dots in this diagram represent the decreasing distance between the beanbags as the ball rolls on the carpet. • • • •
Experiment 4. You roll the ball on the linoleum floor and gently and continually push on it with a board. The distance between the beanbags increases as the pushed ball rolls.	The dots in this diagram represent the increasing distance between beanbags as the ball is continually pushed across the linoleum floor. • • • •

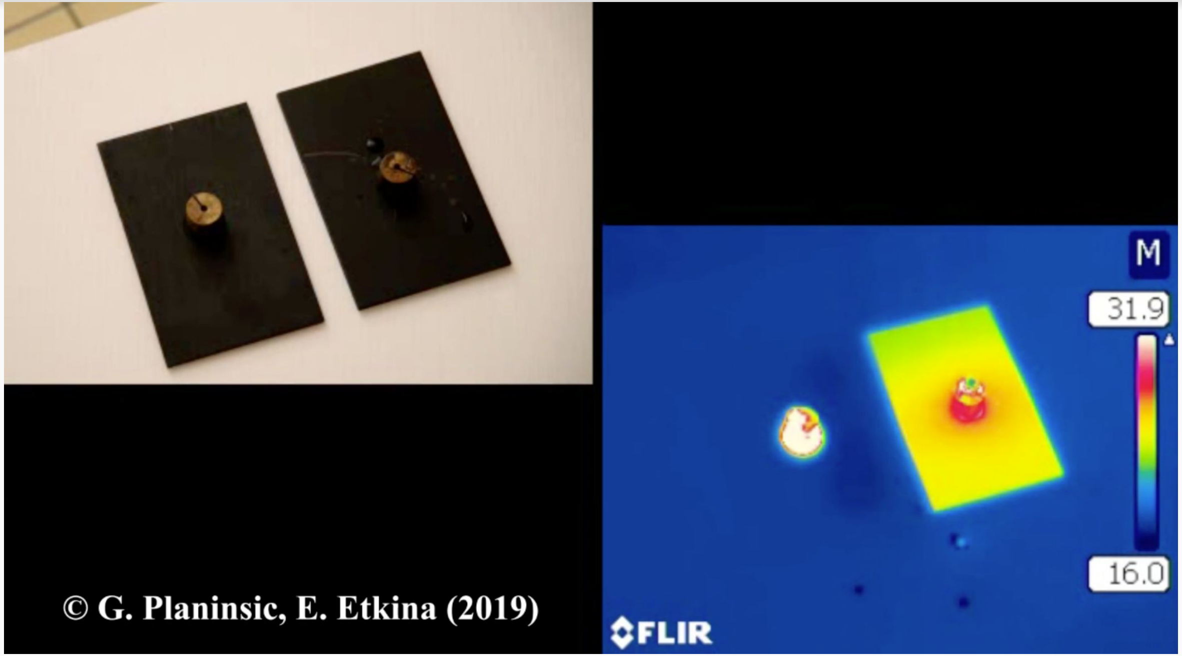
Pattern

- The spacing of the dots allows us to visualize the motion of the object of interest.
- When the object travels without speeding up or slowing down, the dots are evenly spaced.
- When the object slows down, the dots get closer together.
- When the object moves faster and faster, the dots get farther apart.

a. What patterns did you notice in the placement of the dots?

b. How can you use the distances between the dots to describe the motion of the bowling ball?

Example of Observation Experiment



In the experiment, two identical metal objects (made of brass) are taken from the same hot water bath and placed on two identically-shaped (same height, length, and width) plates. The plates are made of wood and aluminum (colored with the same black paint to reduce the reflective properties of aluminum) and have been sitting on the table for a long time.

a. Describe what you observe.

b. Devise one or more explanations for your observation.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-7-2

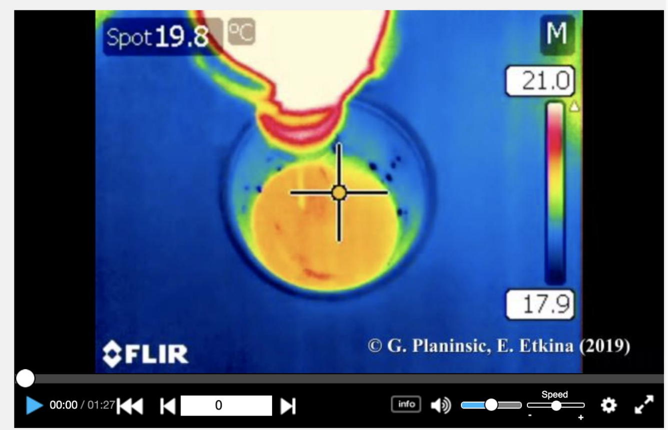
Example of Testing Experiment

a. Use the explanations you made in Observational Experiment to predict what you will observe.

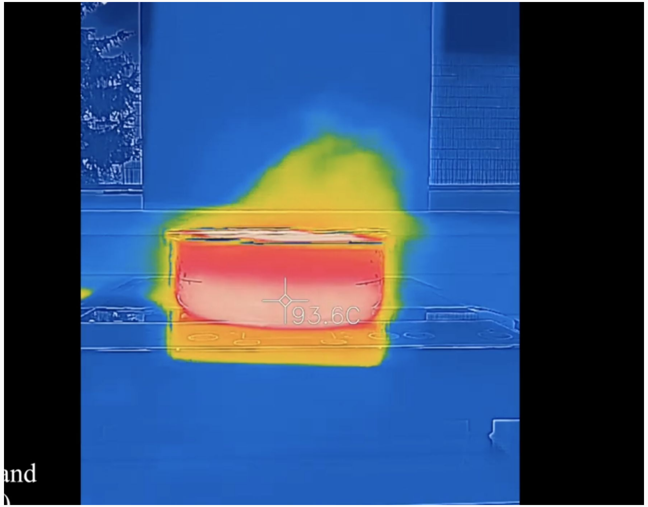
b. View the video [https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-7-3] and compare the outcome to your predictions. Do you need to revise your explanation?

Example of Application Experiment

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-5-7



https://youtu.be/hLcYCzMgSzc

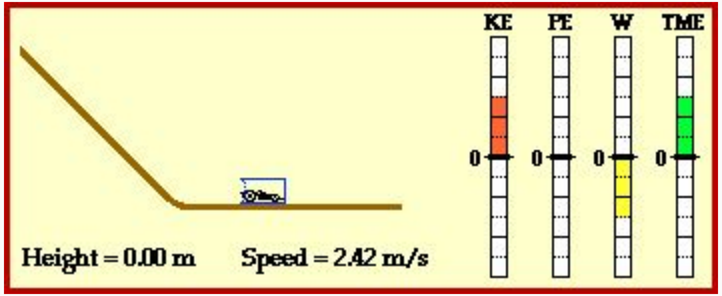


Tools usati

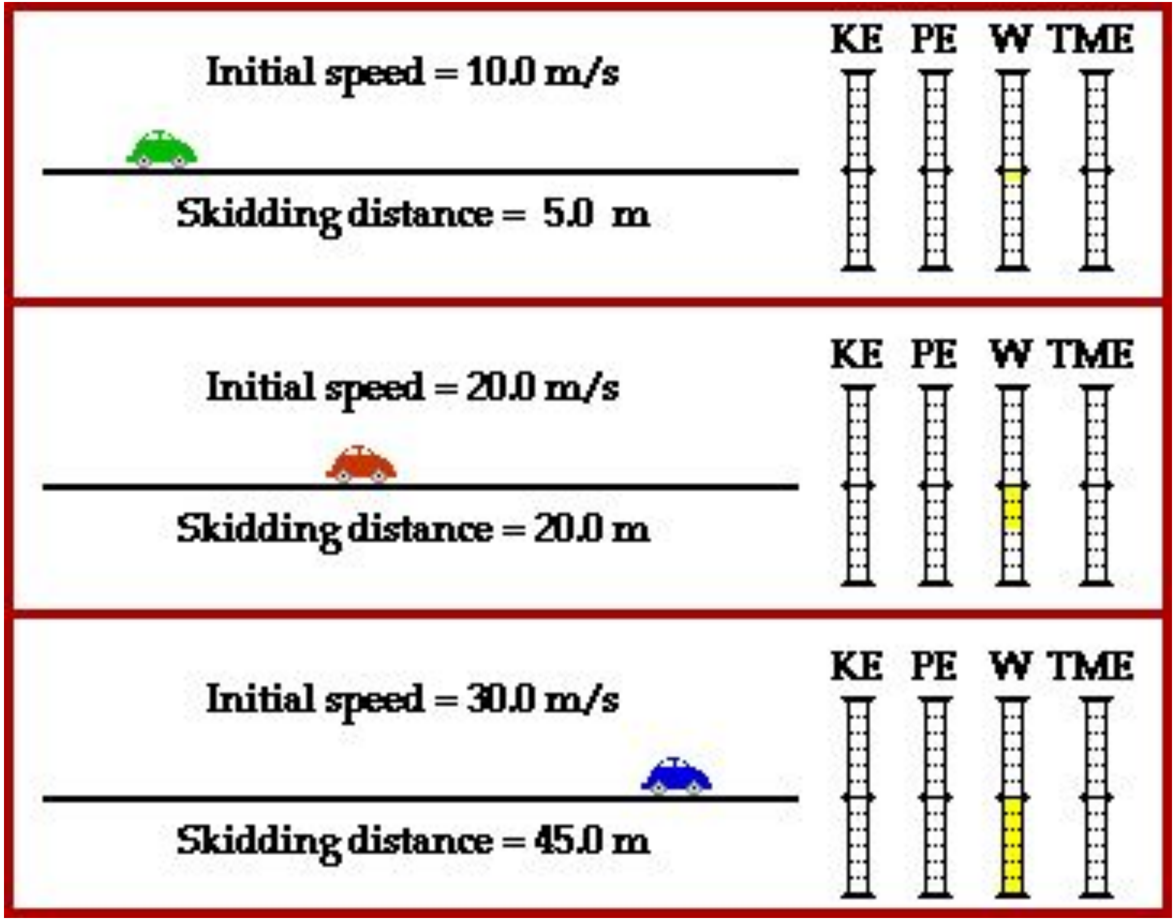
- Motion Diagram
- Force Diagram
- Energy bar chart

Qualitative work – energy bar charts that serve the same role for analyzing work – energy processes as motion diagrams and force diagrams serve when analyzing kinematics and dynamics problems.

The use of these bar charts helps students think more about the physics of a work – energy process rather than relying on formula-centered techniques that lack qualitative understanding.



View animation: https://www.physicsclassroom.com/mmedia/energy/hw.cfm



View animation: https://www.physicsclassroom.com/mmedia/energy/cs.cfm https://www.physicsclassroom.com/Physics-Interactives/Work-and-Energy/Work-Energy-Bar-Charts/Work-Energy-Bar-Charts-Interactive

TEST YOURSELF!

—

The different systems are chosen for the same physical process.

(a) The cart, the spring, and Earth are in the system.
(b) The cart and the spring are in the system, but not Earth.
(c) The system includes only the cart.
For each chosen system there is one work–energy bar chart and the corresponding generalized work–energy equation.

In practice, it would be easy for students to use a system that includes Earth and the spring, although the choice of the system does not affect the physical results.