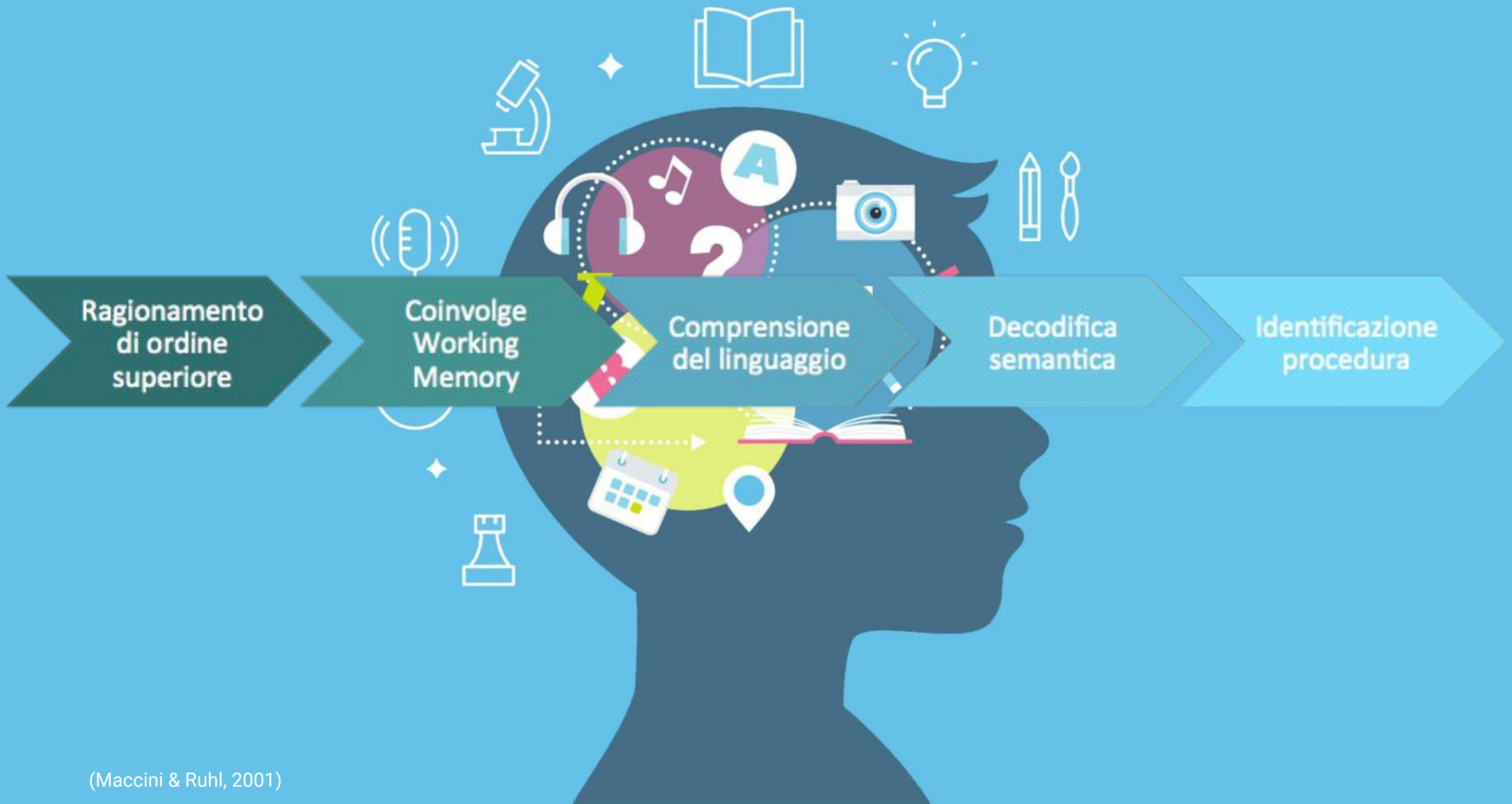
Physics Education Laboratory
Lecture 12
Content Knowledge for Electricity

Francesco Longo - 13/11/23

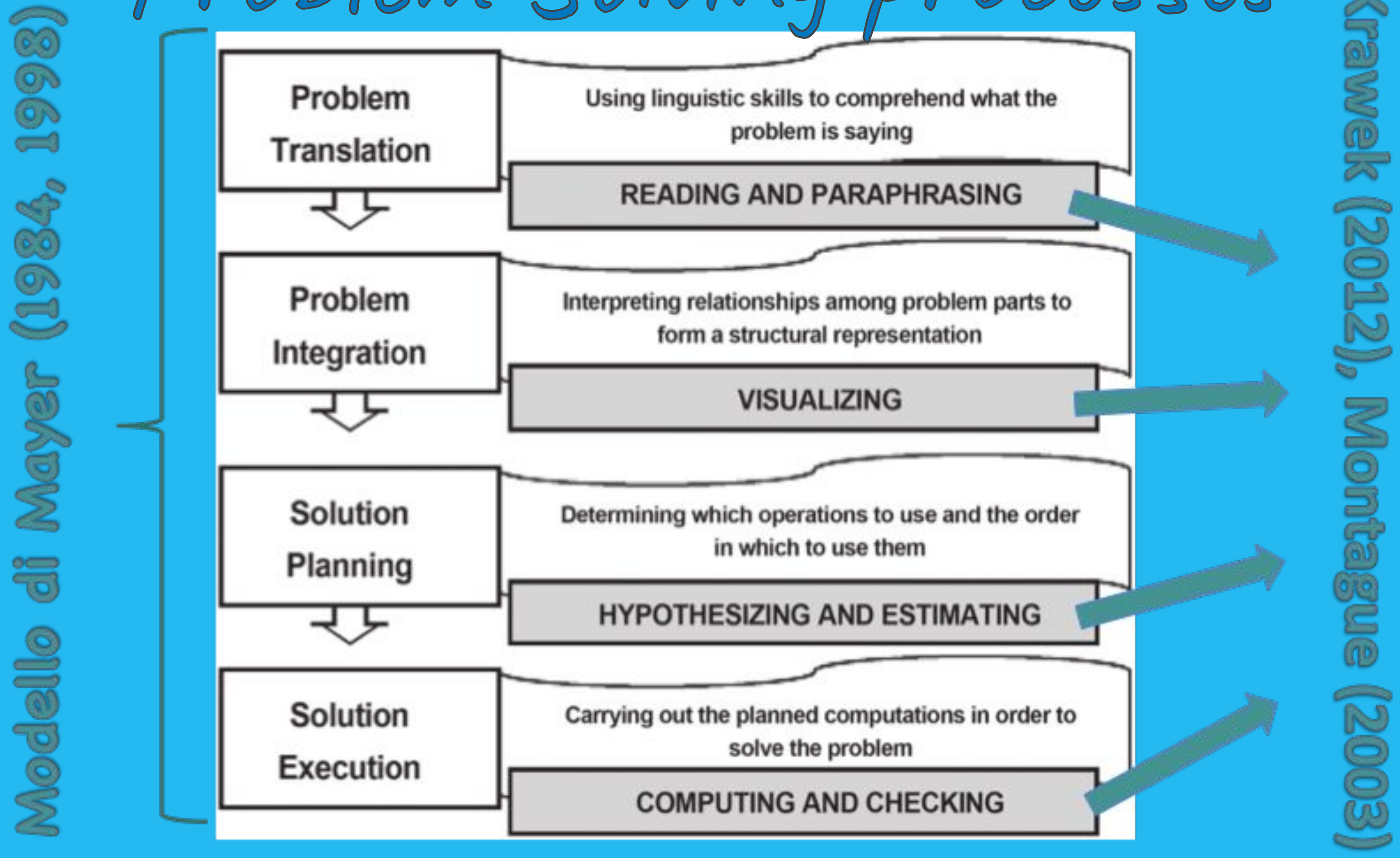
Inside **learning cognitive approach** for problem-solving

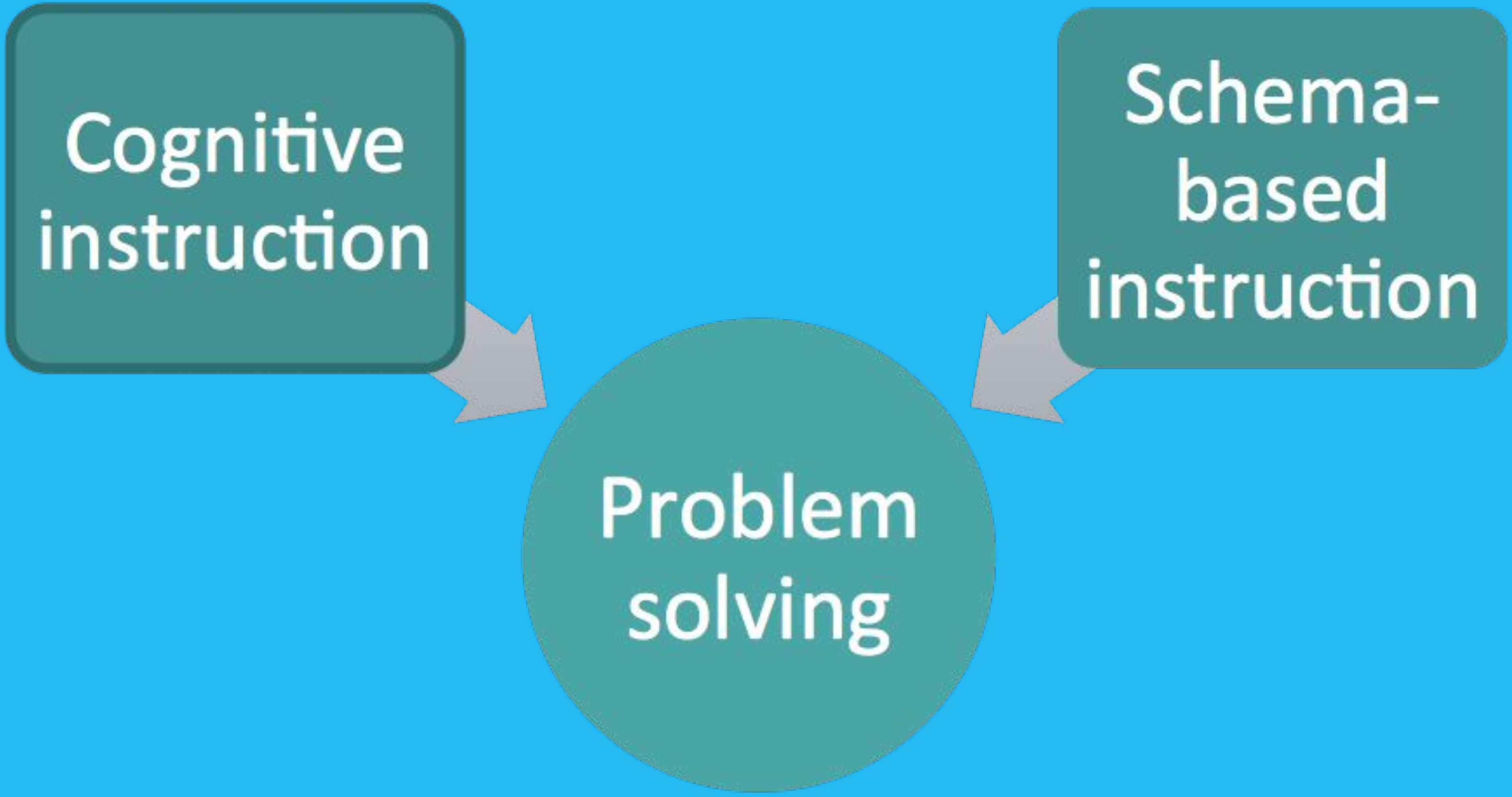
(Montague, Warger e Morgan, 2000)

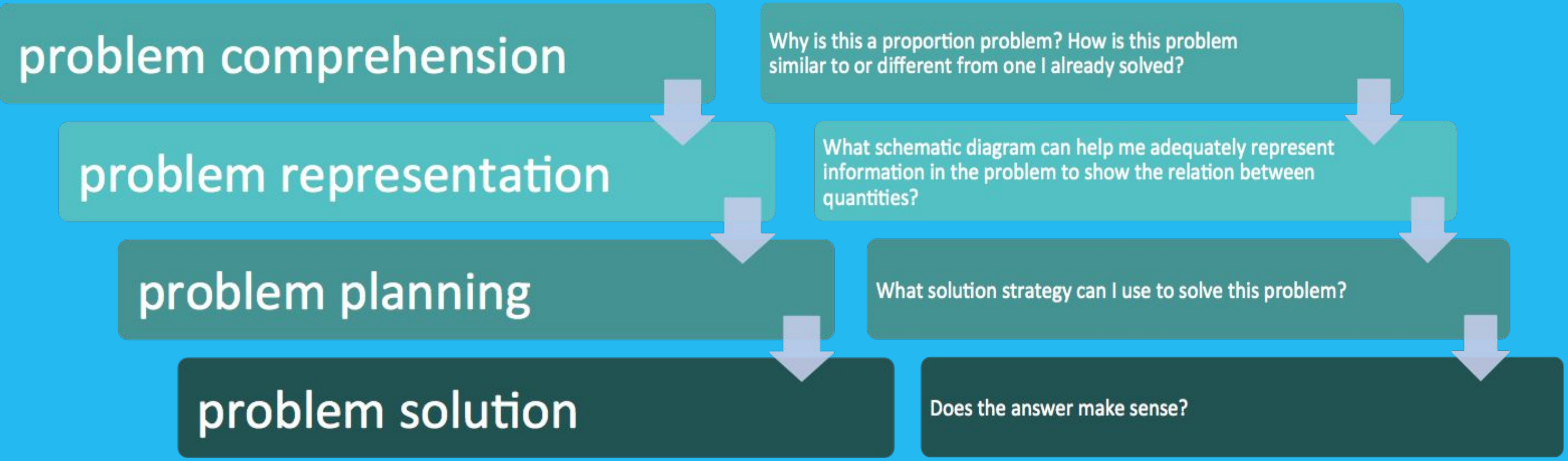


(Maccini & Ruhl, 2001)

Problem Solving processes

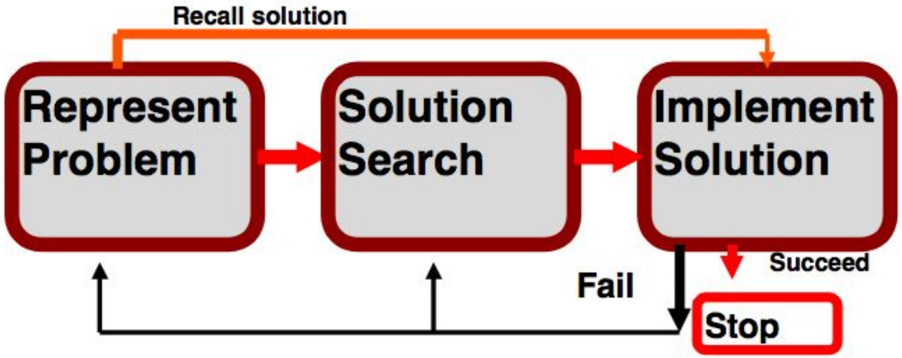



Cognitive instruction
Schema-based instruction
Problem solving



Jitendra, K.A, Star, J.R., Rodriguez, M., Lindell, M., & Someki, F. (2011).

PROBLEM SOLVING MODEL
FOR LEARNING PHYSICS

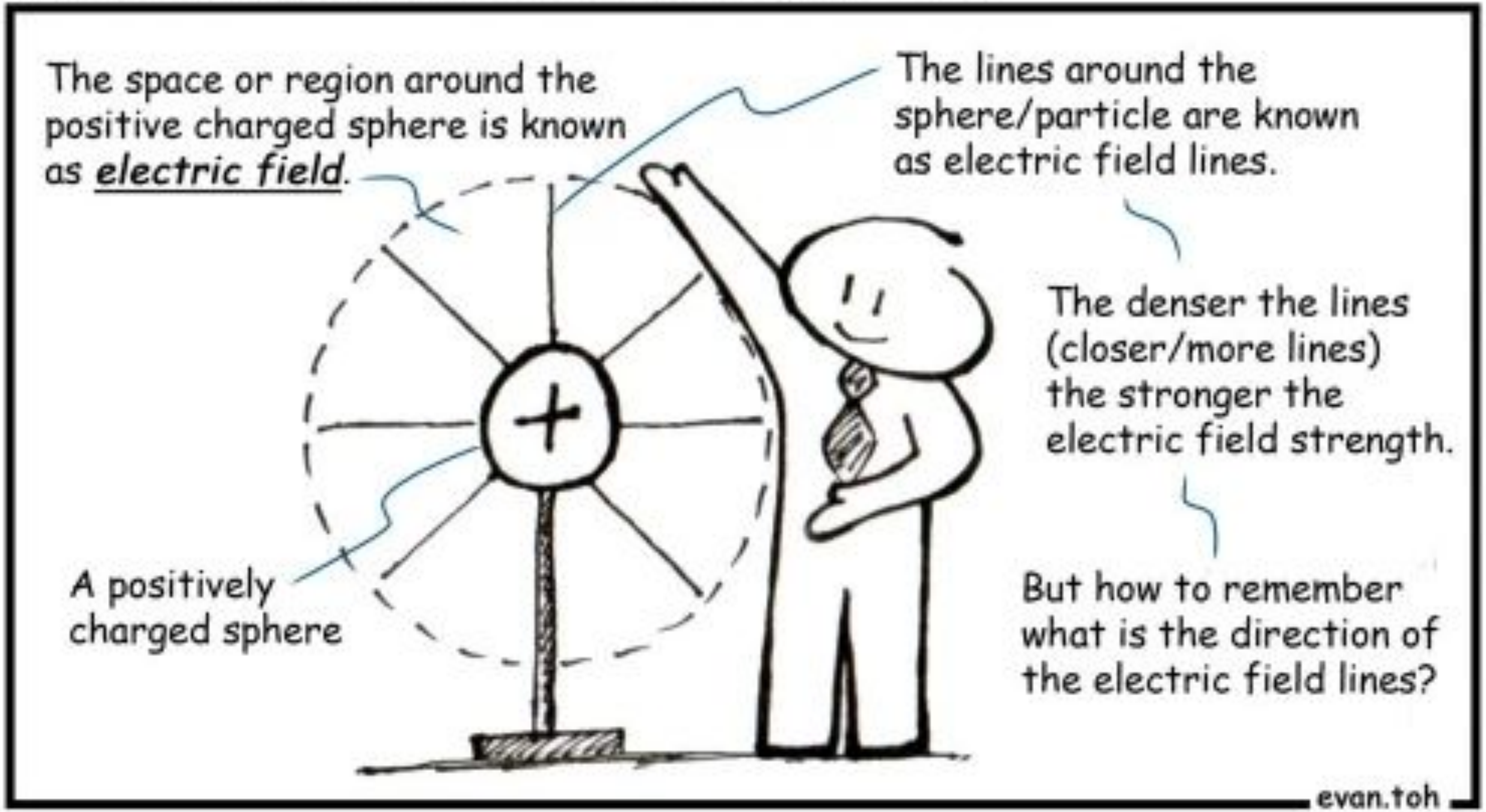


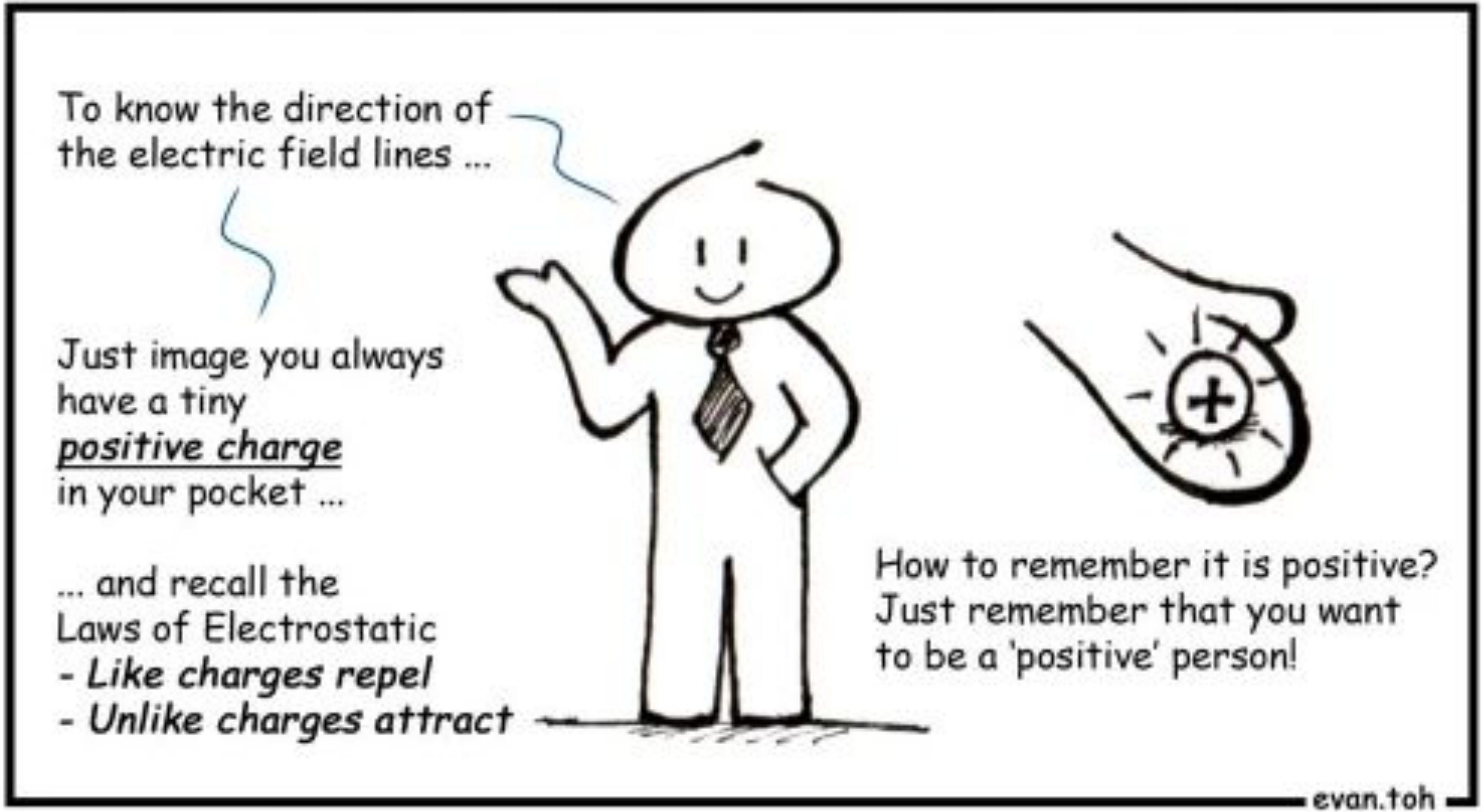
This model identifies a basic sequence of three cognitive activities in problem solving:

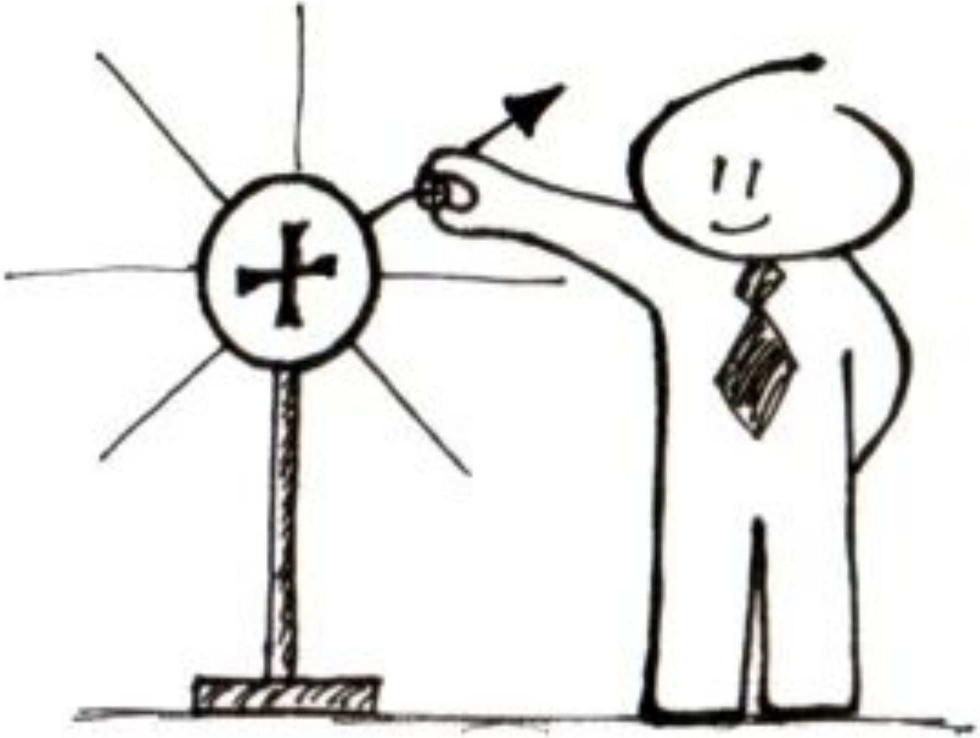
- *Representing the problem* includes calling up the appropriate context knowledge, and identifying the goal and the relevant starting conditions for the problem.
- *Solution search* includes refining the goal and developing a plan of action to reach the goal.
- *Implementing the Solution* includes executing the plan of action and evaluating the results.

(Foshay, 1998)

Electric Field, Electric Field Lines and Direction




To know the direction of the electric field lines ...
Just image you always have a tiny positive charge in your pocket ...
... and recall the Laws of Electrostatic
- Like charges repel
- Unlike charges attract
How to remember it is positive? Just remember that you want to be a 'positive' person!
evan.toh



Using the positive test charge, place it in the electric field of the positive sphere in this case.

As like charges repel, the positive charge will be repelled by the positive sphere. Hence it will move outwards.

The direction of the force experiences by the positive charge indicates the direction of the field lines.

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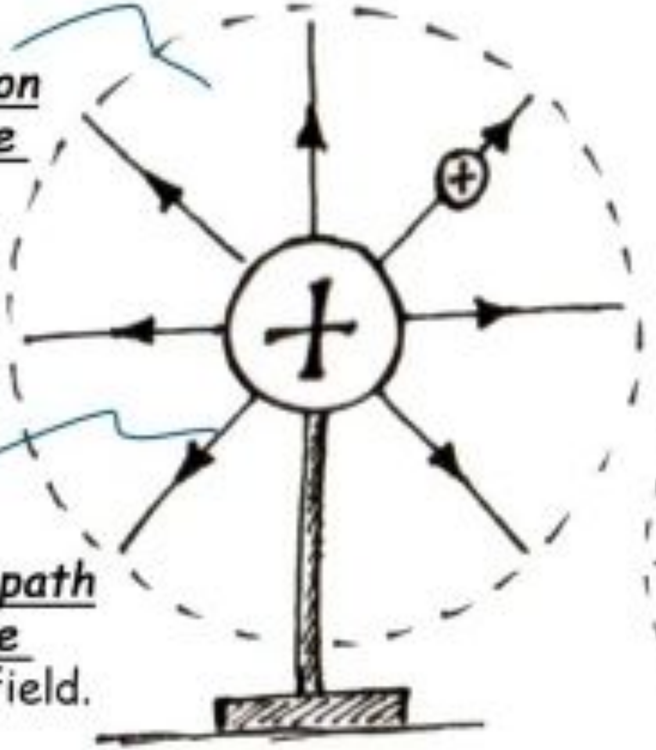
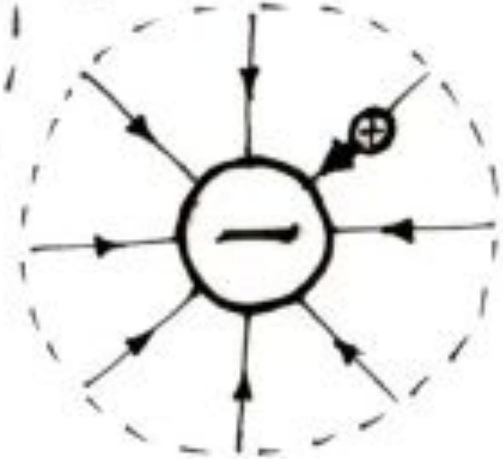
Definition of the terms...

Electric field is the ***region*** in which an ***electic charge experiences a force*** (attraction or repulsion).



Concepts apply for electric field around a negatively charged sphere.



Electric field line is the ***path*** in which ***a positive charge*** would take in an electric field.

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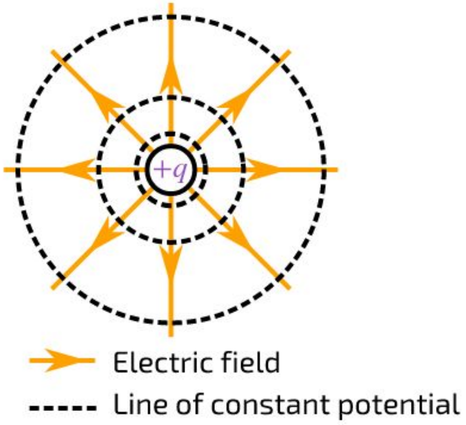
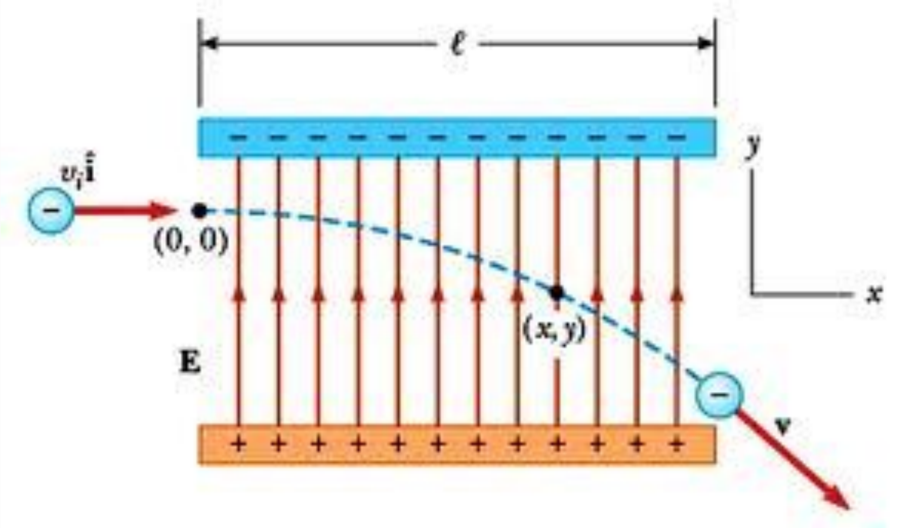
Key concepts in Electrostatics

- The electric charge (with opposite signs)
- The Coulomb law
- The Electric field
- The Electric potential



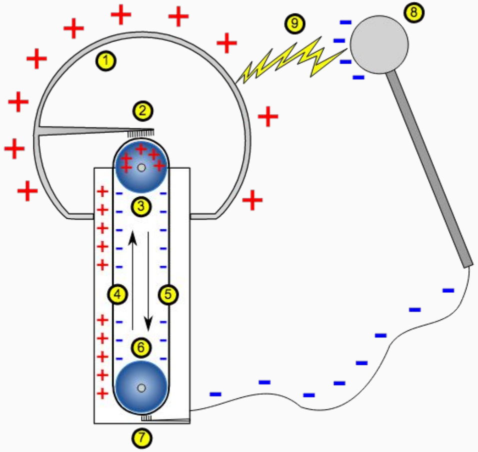
Key concepts in Electrostatics

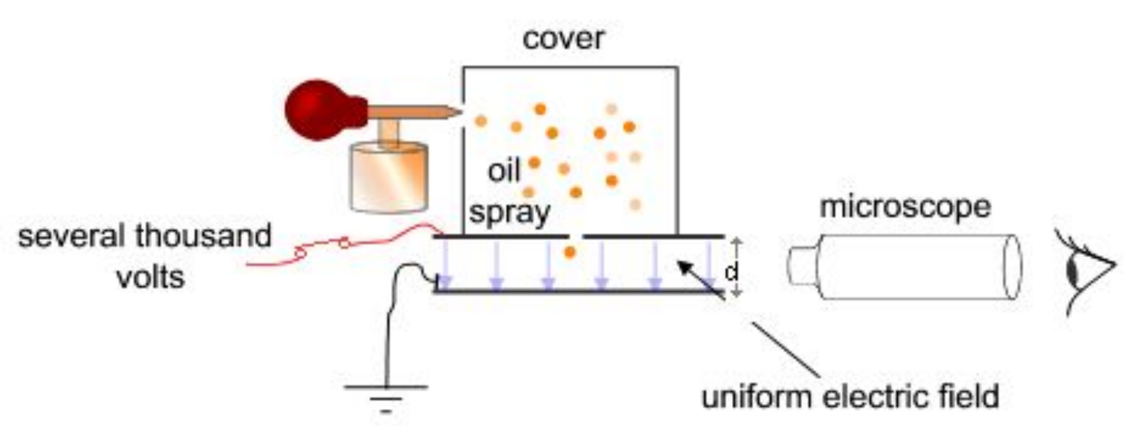
- Motion of particles in Electric field



Key concepts in Electrostatics

- The electric charge



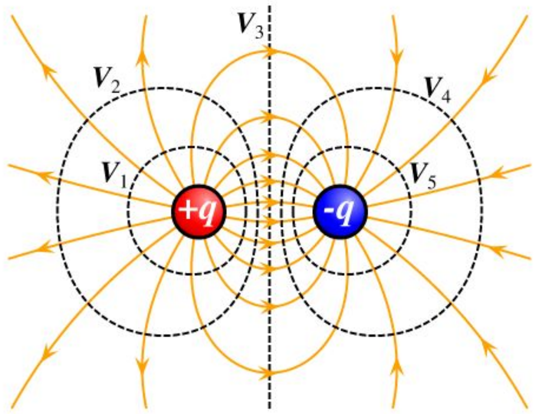


Key concepts in Electrostatics

- The electric charge

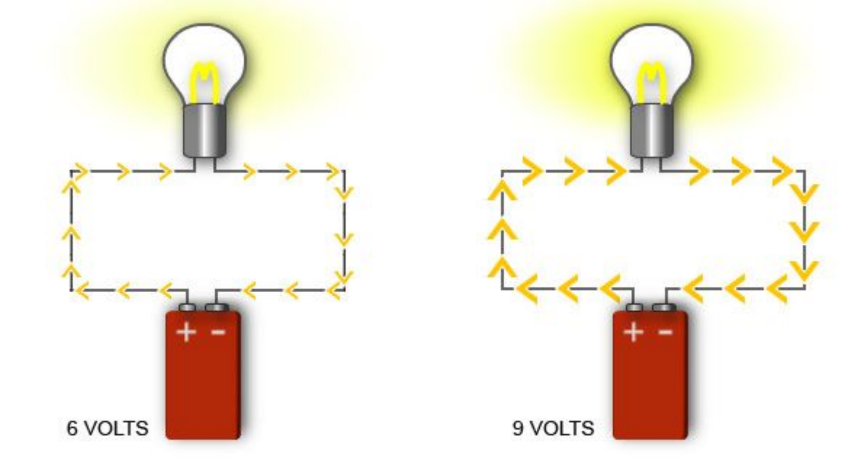
Key concepts in Electrostatics

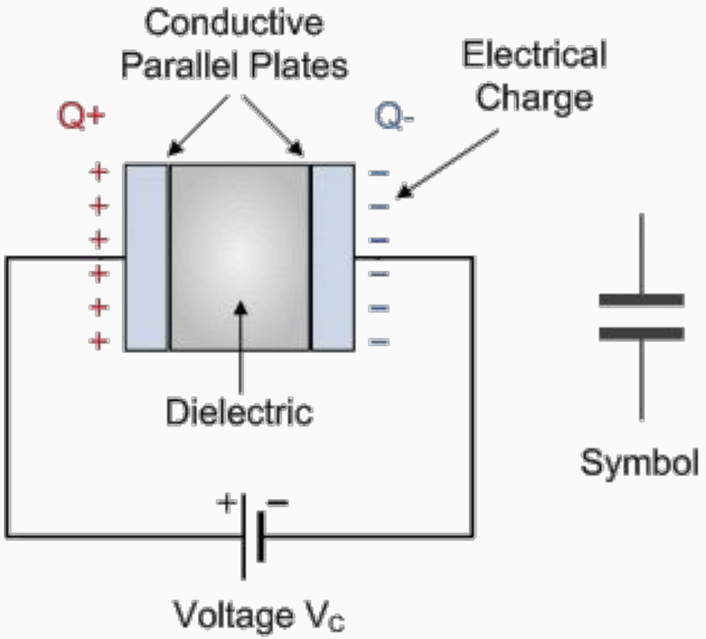
- The Electric field as a vector
- The Potential as a scalar field
- How to “see” them?



Key concepts in Electrostatics

- Concept of "Voltage"
- Voltage and currents
- Voltage and capacitors



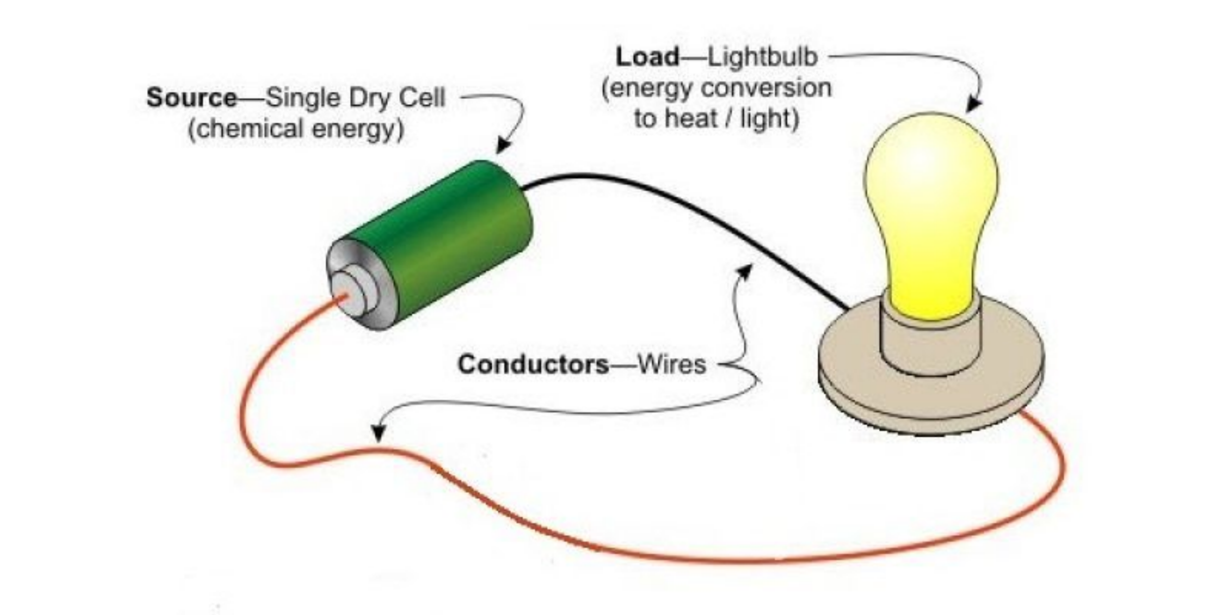


Key concepts in Electrostatics

- Voltage and capacitors

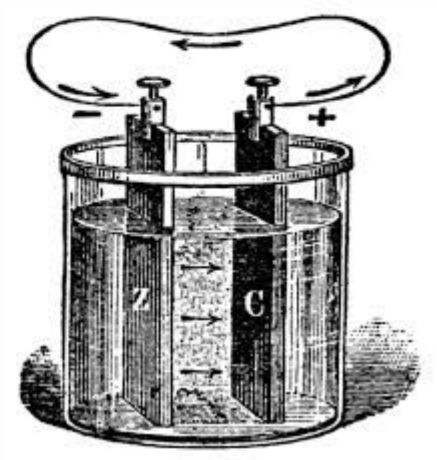
Key concepts in Electrostatics

- The electric current
- Electric resistance
- Circuits in CC
- Ohm’s law
- Batteries



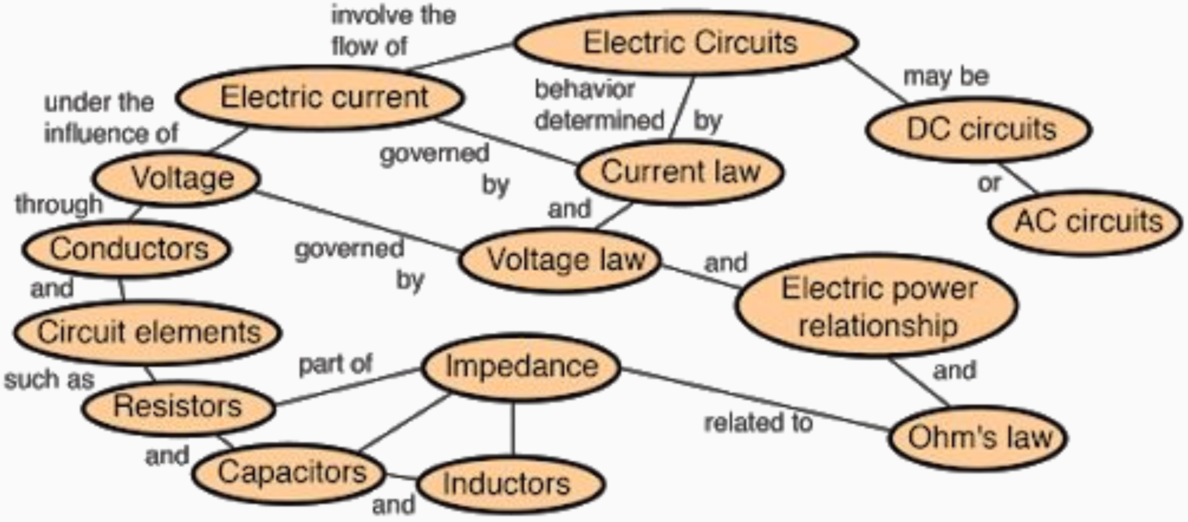
Key concepts in Electrostatics

- Batteries



Key concepts in Electrostatics

- Electric circuits



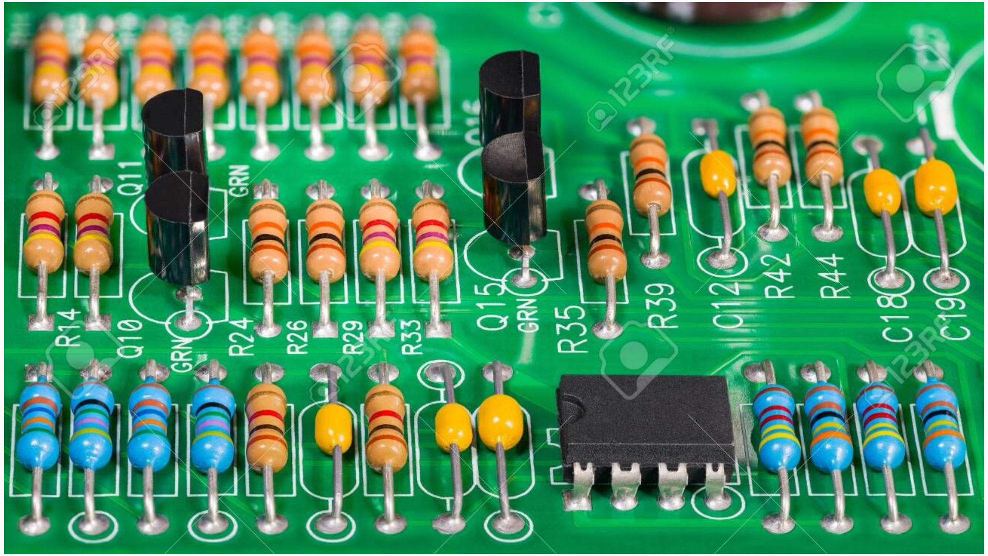
Key concepts in Electrostatics

- The Ohm's law

Ohm's law formulas www.ohmlaw.com	To Calculate			
Given parameters	Voltage (V)	Current (I)	Resistance (R)	Power (P)
Current & Resistance	$V = IR$	---	---	$P = I^2R$
Current & Power	$V = \frac{P}{I}$	---	$R = \frac{P}{I^2}$	---
Voltage & Current	---	---	$R = \frac{V}{I}$	$P = VI$
Voltage & Resistance	---	$I = \frac{V}{R}$	---	$P = \frac{V^2}{R}$
Voltage & Power	---	$I = \frac{P}{V}$	$R = \frac{V^2}{P}$	---
Power & Resistance	$V = \sqrt{P.R}$	$I = \sqrt{P/R}$	---	---

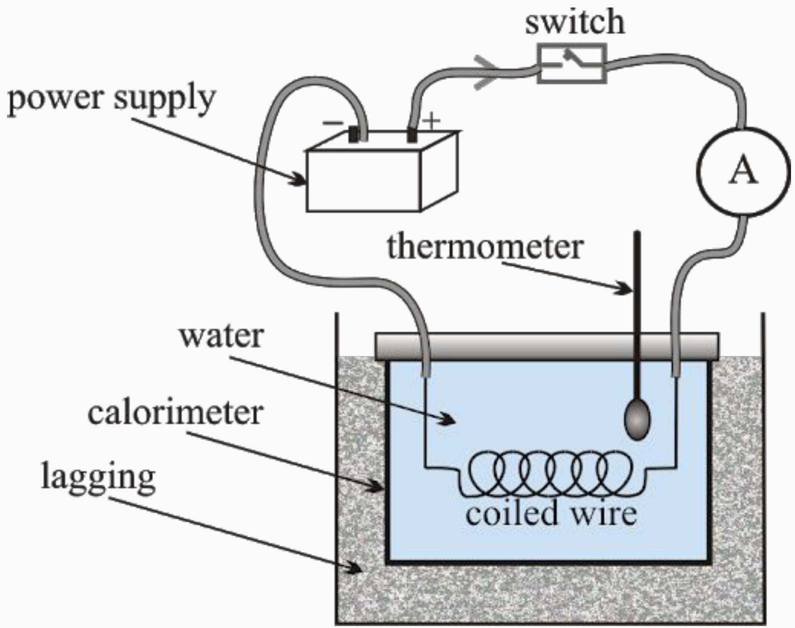
Key concepts in Electrostatics

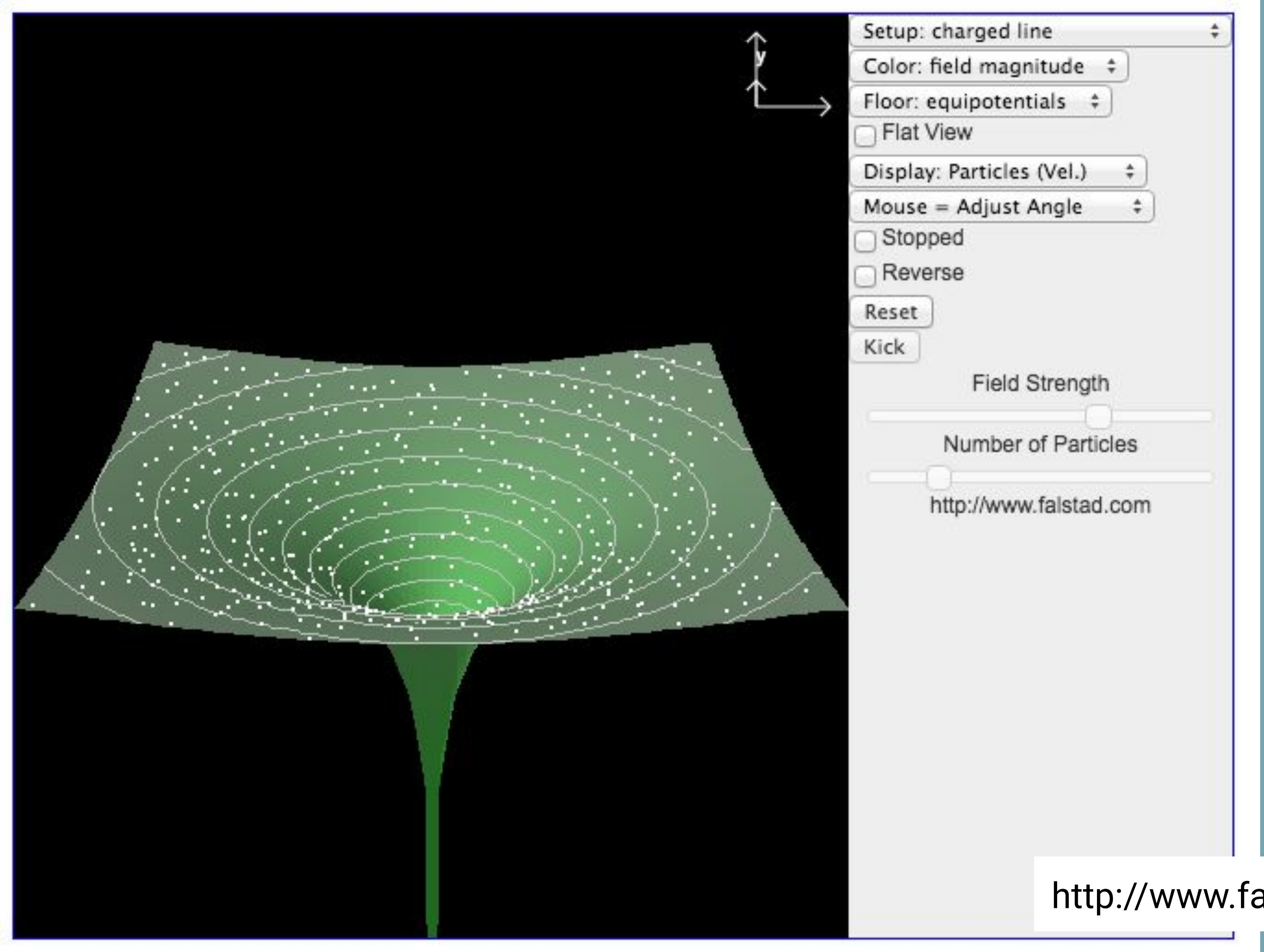
- The resistors



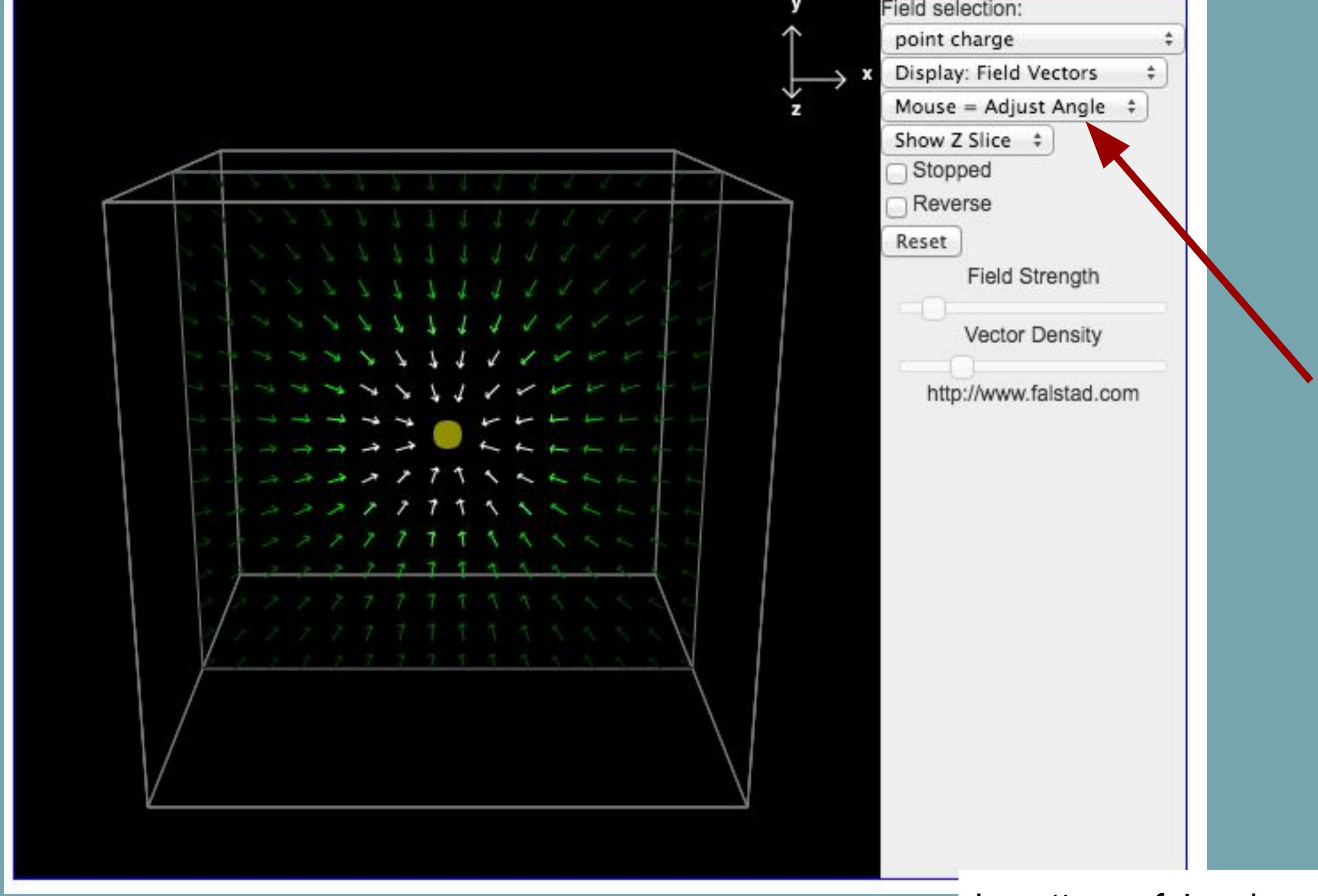
Key concepts in Electrostatics

- The power in Electric fields





http://www.falstad.com/vector2de/



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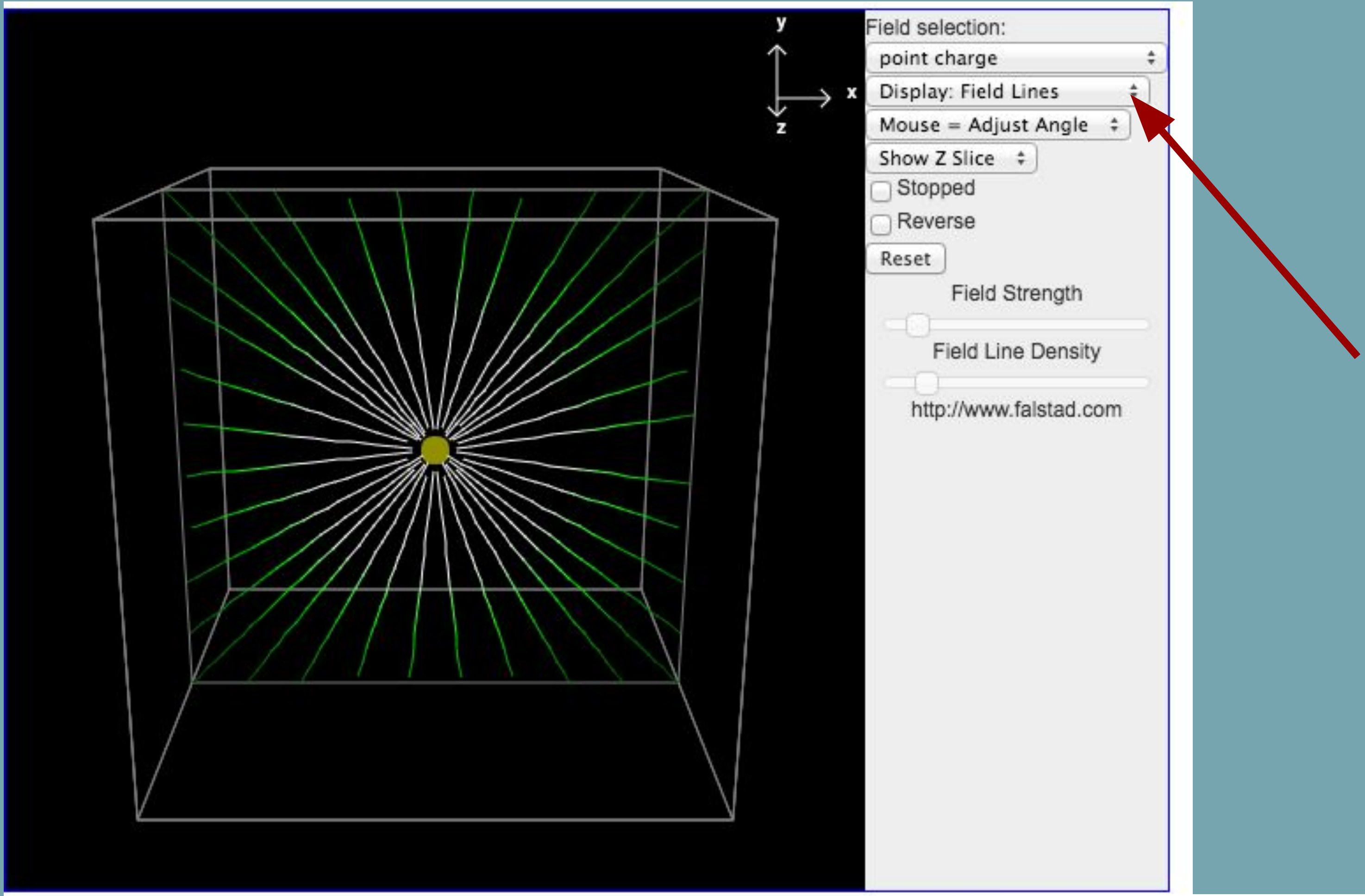

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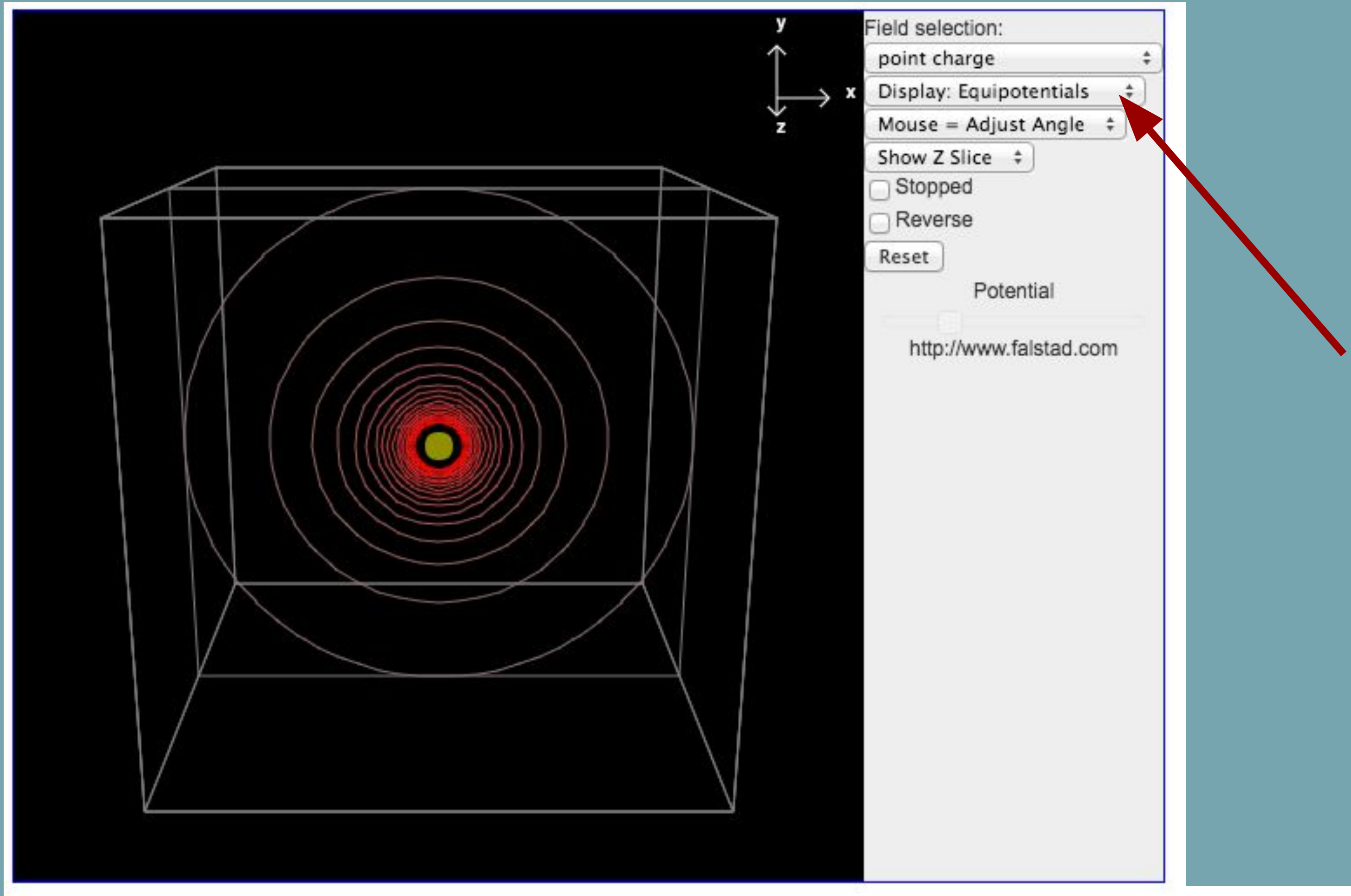


http://www.falstad.com/vector3de/

Misconceptions in Electrostatics

- Current flows in one direction and charges move in the other one
- Electric field is a scalar field
- Potential field is a vector field -- which relation to electric field ?
- The elementary charge
- Neutrality of matter and electricity …
- Potential and Potential energy
- Capacitors treatment - Voltage and charge relationships
- Potential - Voltage
- Ohm law inversion

Inquiry Based Science Education (IBSE approach)

Inquiry is a multifaceted activity that involves: making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.

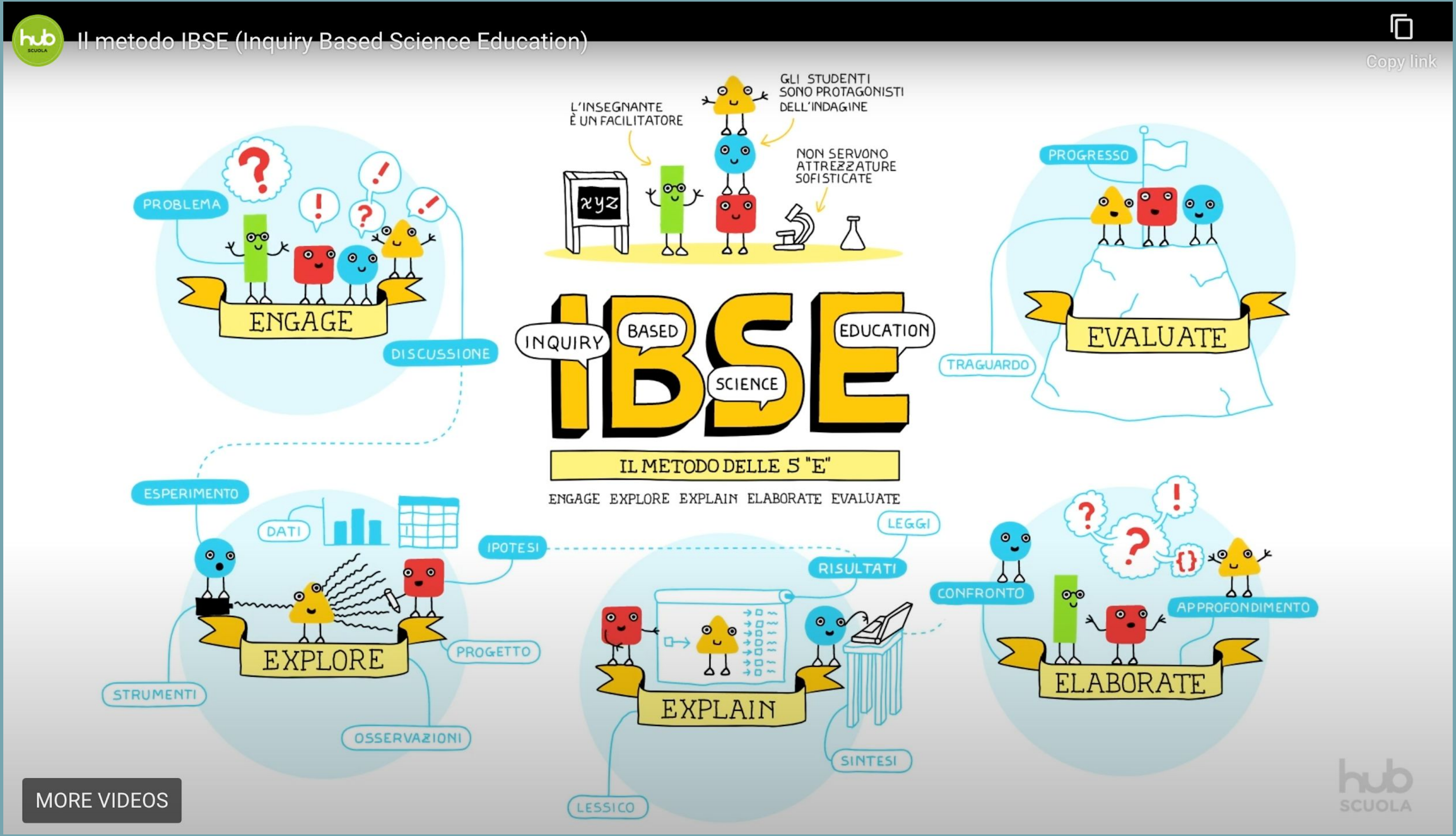
(National Research Council, 1996)

What is Inquiry-Based Learning?

https://www.youtube.com/watch?v=QlwkerwaV2E&list=RDCMUCRmWJULBr4CIP5xUucVg0vw&index=1

https://www.youtube.com/watch?v=kYap39FNFv8

IBSE DESCRIPTION


Il metodo IBSE (Inquiry Based Science Education)
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L'INSEGNANTE
È UN FACILITATORE
GLI STUDENTI
SONO PROTAGONISTI
DELL'INDAGINE
NON SERVONO
ATTREZZATURE
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IBSE
IL METODO DELLE 5 "E"
ENGAGE EXPLORE EXPLAIN ELABORATE EVALUATE
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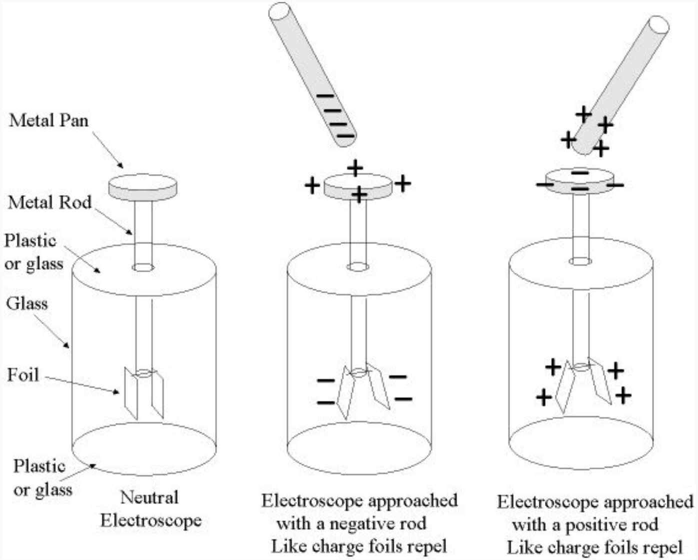
IBSE example for Electrostatics

- ENGAGE students in Electrostatics : find few examples …



IBSE example for Electrostatics

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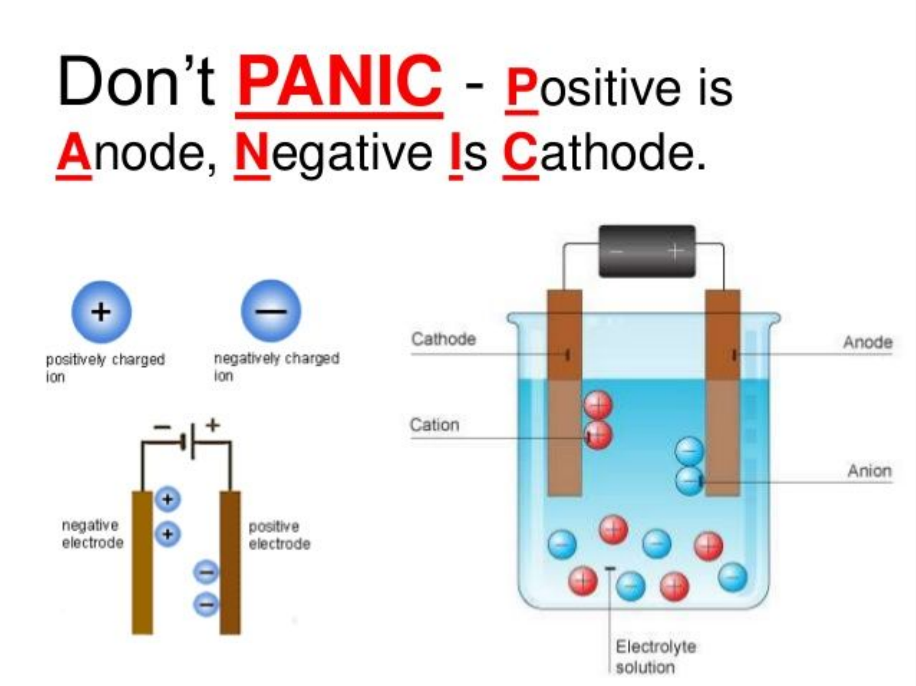
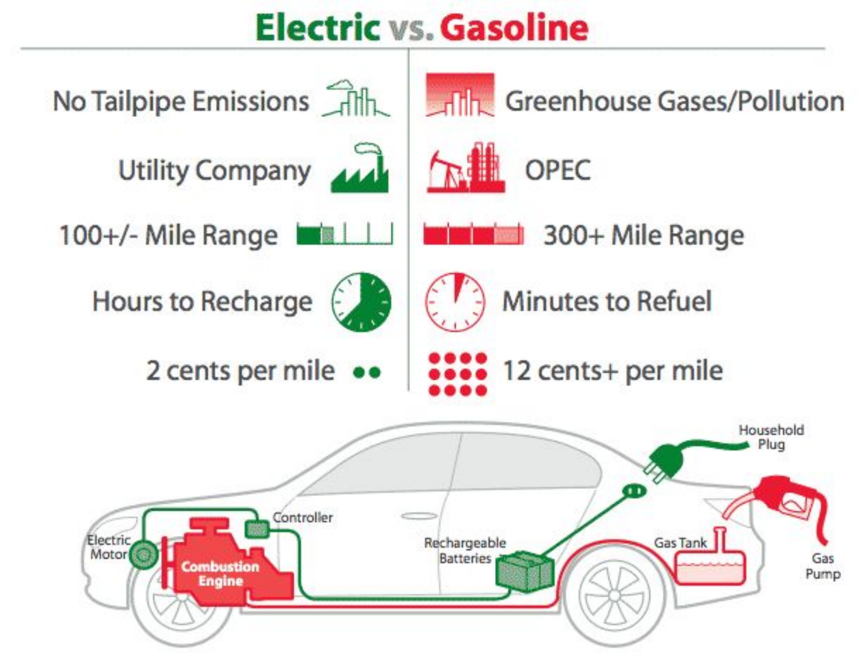


IBSE example for Electrostatics

- ENGAGE students in Electrostatics : find few examples …



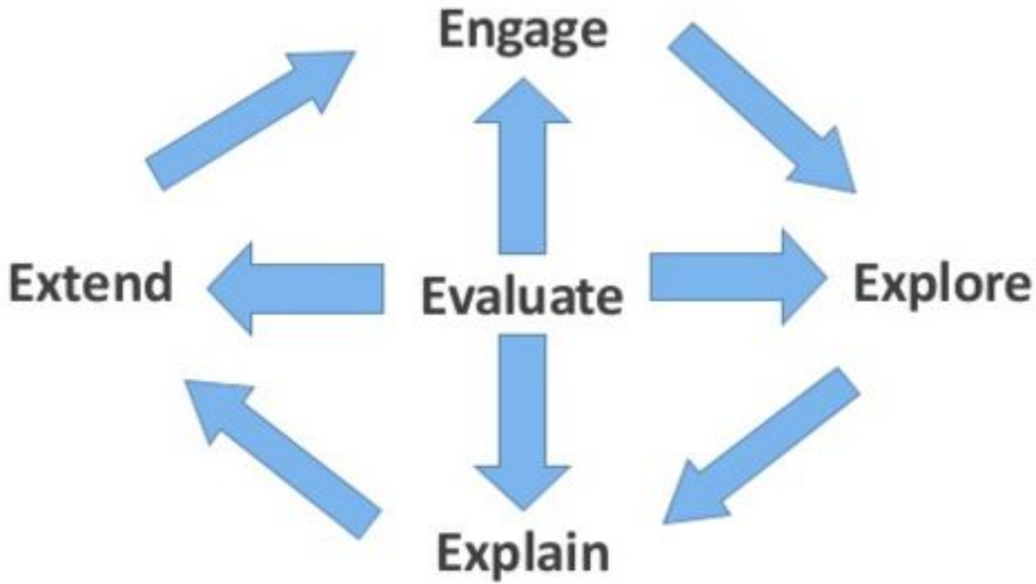
Engage examples

- Carica cellulare - Wifi - Piastra induzione
- Fulmine in Auto
- Scossa in giornate secche
- La scossa
- Display pixel
- Carica e scarica batteria

Engage more examples

- Palloncino con capelli - van der Graaf example
- Più carichi meno dura la batteria
- Alta tensione e uccellini
- Penna che attira la carta
- Stare sotto un albero durante un temporale
- Perche’ prendo la scossa e non quando attacco il cellulare
-

Learning Cycle



Inquiry Levels

Open Inquiry	No predetermined question:Students propose and pursue their own questions.
Guided Inquiry	No predetermined method: students must determine how to investigate the problem.
Structured Inquiry	No predeterminted answer: conclusions based solely on student investigation.
Limited Inquiry	"Traditional" labs: students follow the directions and make sure their results match those given in the text.

Confirmation inquiry

It is based on confirmation or verification of laws and theories. Confirmatory inquiry is appropriate at the beginning of IBSE implementation, when the teacher aims to develop observational, experimental and analytical skills of the students. When conducting experiments, students follow teacher's detailed instructions under his/her guidance.

Structured inquiry

The teacher significantly influences the inquiry at this level and helps students by asking questions and providing guidance. Students look for solutions (answers) through their inquiry and provide an explanation based on the evidence they have collected. A detailed procedure of experiments is defined by the teacher, but the results are not known in advance. Students show their creativity in discovering laws. However, they are conducted by teacher’s instructions in the research. This level of inquiry is very important for developing students' abilities to perform high-level inquiry.

Guided inquiry

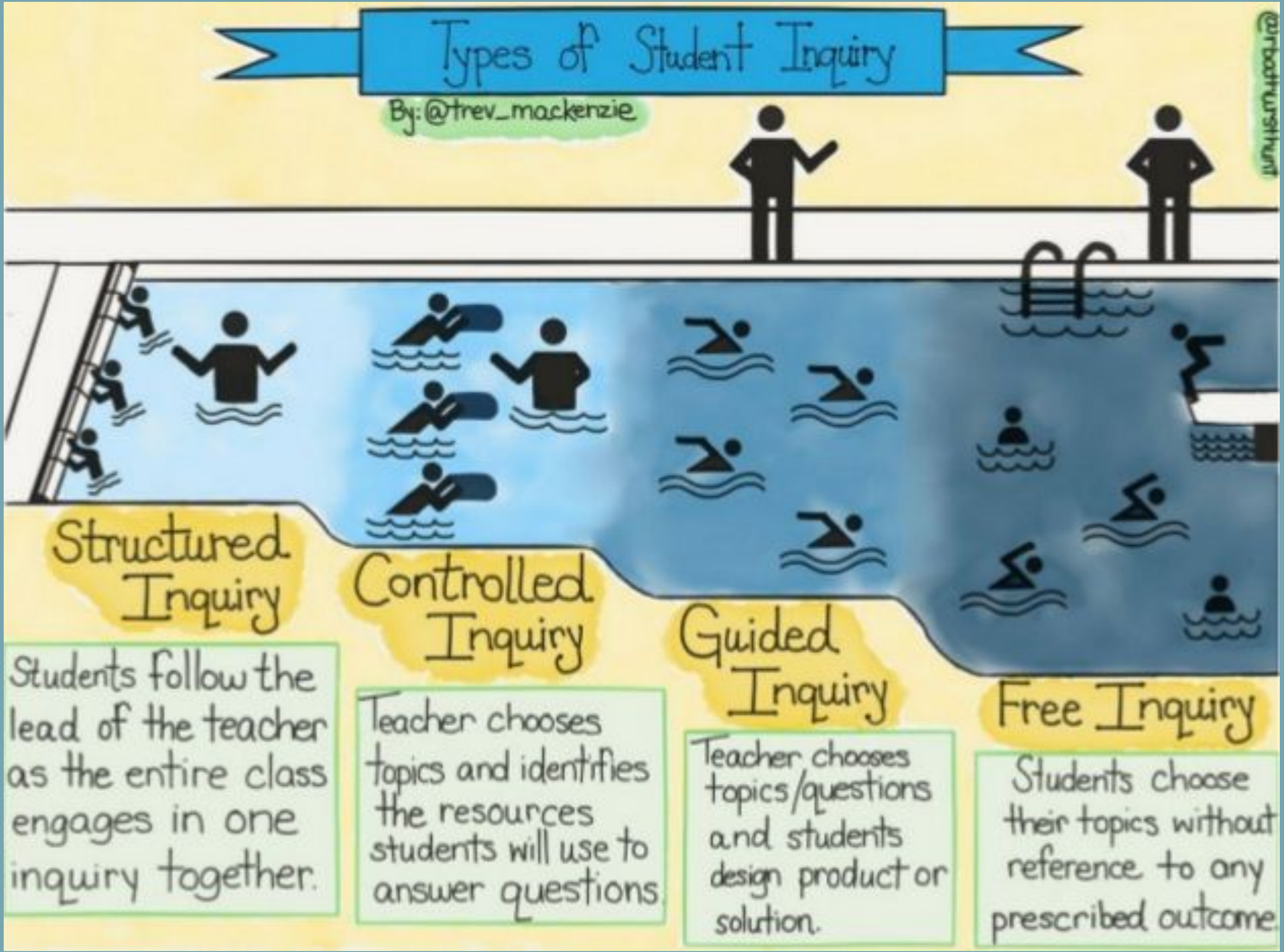
The third level of IBSE changes the role of the teacher dramatically. The teacher becomes a students´ guide. He/she cooperates with students in defining research questions (problems) and gives advice on procedures and implementation. Students themselves suggest procedures to verify the inquiry questions and their subsequent solutions. Students are encouraged by the teacher much less than in the previous two levels, which radically increases their level of independence. Students should have previous experience of lower levels to be able to work independently.

Open inquiry

This highest level of IBSE builds on previous three inquiry levels and it resembles a real scientific research. Students should be able to set up their inquiry questions, methods and procedures of research, record and analyze data and draw conclusions from evidence. This requires a high level of scientific thinking and places high cognitive demands on students, so it is applicable for the oldest and/or gifted students.

Inquiry Levels

	Traditional Hands-on	Structured Inquiry	Guided Inquiry	Student Directed Inquiry	Student Research Inquiry
Topic	Teacher	Teacher	Teacher	Teacher	Teacher/Student
Question	Teacher	Teacher	Teacher	Teacher/Student	Student
Materials	Teacher	Teacher	Teacher	Student	Student
Procedures/ Design	Teacher	Teacher	Teacher/Student	Student	Student
Results/ Analysis	Teacher	Teacher/Student	Student	Student	Student
Conclusions	Teacher	Student	Student	Student	Student



Types of Student Inquiry
By: @trev_mackenzie
@rbathursthunt
Structured Inquiry
Students follow the lead of the teacher as the entire class engages in one inquiry together.
Controlled Inquiry
Teacher chooses topics and identifies the resources students will use to answer questions.
Guided Inquiry
Teacher chooses topics/questions and students design product or solution.
Free Inquiry
Students choose their topics without reference to any prescribed outcome.

http://www.establish-fp7.eu/resources/units/direct-current-electricity.html