Introduction to IBSE Activity

HST2012@ CERN

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PH-EDU

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Overview

1. Aims of HST Programme
2. Mindset Change
3. The ‘What’, ‘Why’ and ‘How’ of Inquiry-based Learning
4. Reflecting on Inquiry-based Learning & Teaching

Inspire my students & answer their questions

Share my enthusiasm & knowledge with my colleagues & students

Upgrade my enthusiasm & knowledge of Particle Physics

Make science more attractive to my students

I love physics

Why am I here?

Prepare citizens to make decisions about science

Learn a method for teaching physics to my students that is not boring

Science is not dead

HST Aims

→ Experience the atmosphere of frontier research in physics

→ Interact with scientists and understand “how science works”

→ Share knowledge and experience with each other

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→ Develop useful ideas and skills on how to bring out the best in:

- You
- Students
- Future teachers and colleagues

Change of Mindsets & Mindsets of Change

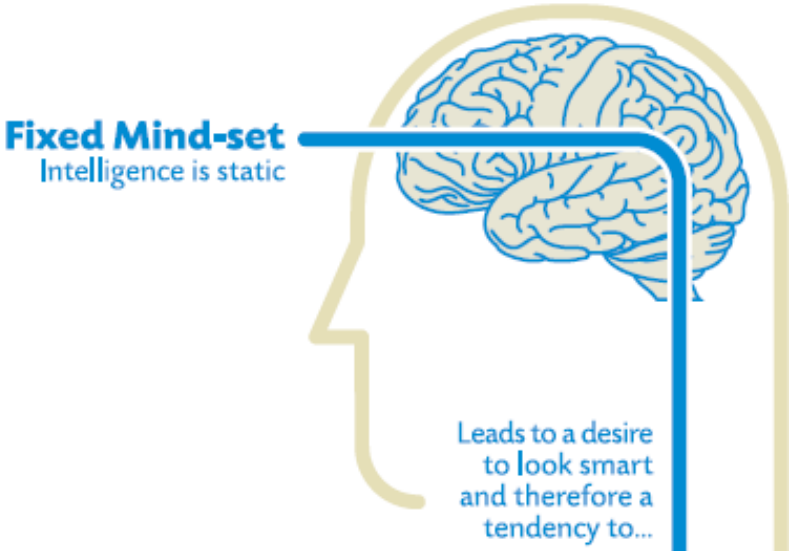
"Smart people don't learn...because they have too much invested in proving what they know and avoiding being seen as not knowing"

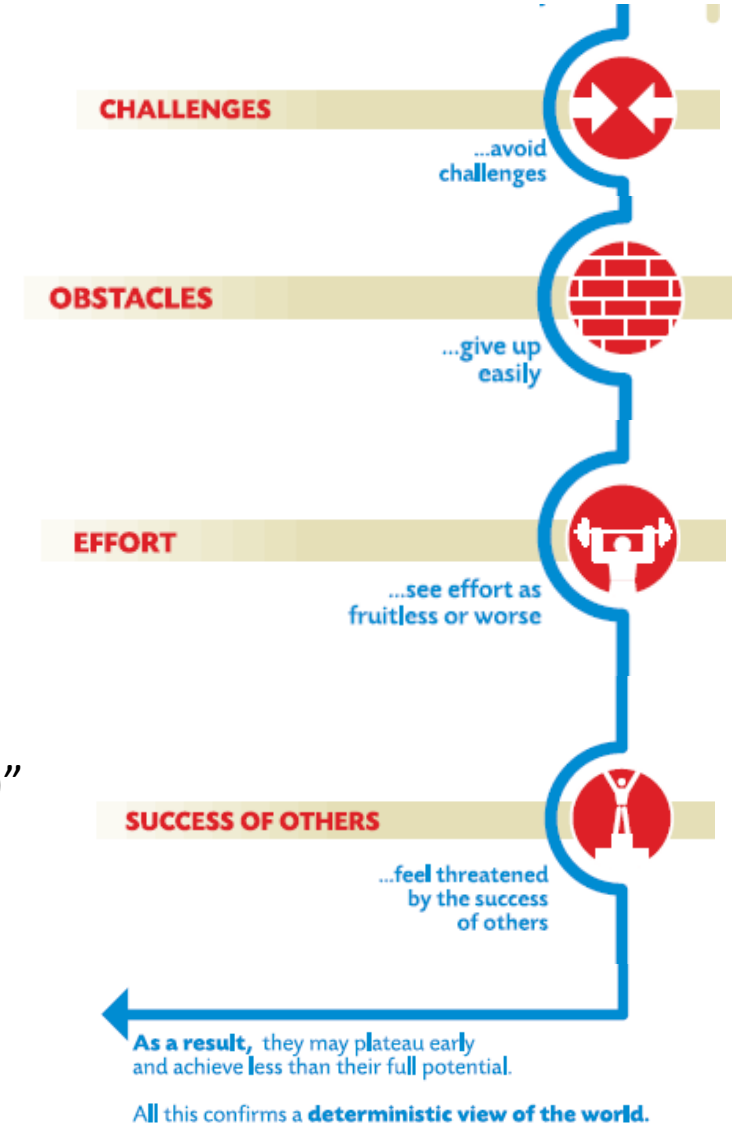
Chris Argyris
[Business theorist]

"I didn't really want to be the coach who wins but the coach who educates. I want to keep preparing them for the future"

Vincente del Bosque
[Spain's football team coach]

The “Fixed” Mindset (Dweck, 2008)

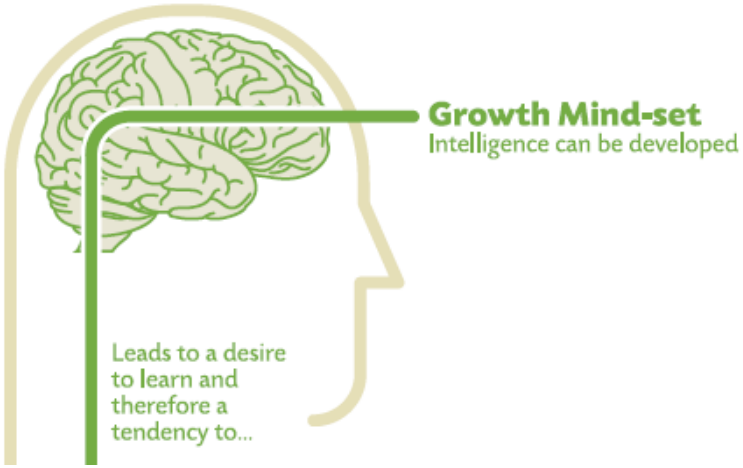


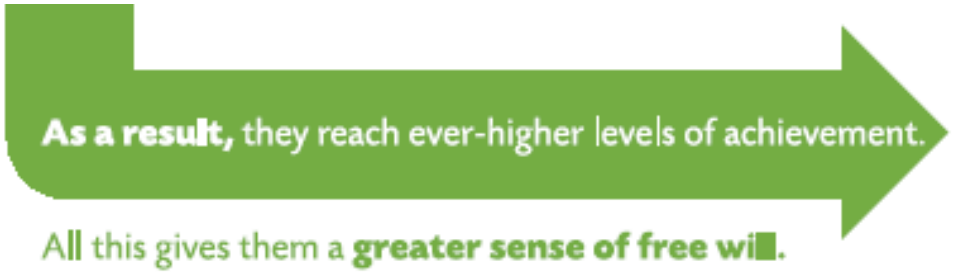


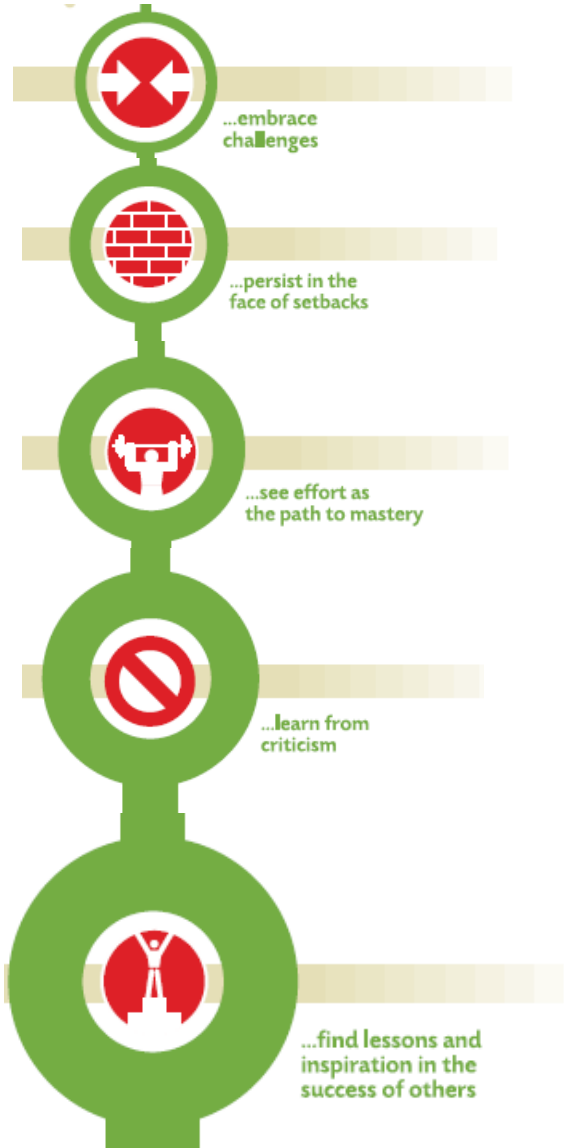
A Fixed Mindset saying:
“I don’t do physics (or maths or…science)”

Holmes, N. (n.d) Mindset graphic http://www.stanfordalumni.org/news/magazine/2007/marapr/images/features/dweck/dweck_mindset.pdf
Richard, M. G. (n.d.) “Fixed mindset vs. growth mindset: which one are you?” http://michaelgr.com/2007/04/15/fixed-mindset-vs-growth-mindset-which-one-are-you/

The “Growth” Mindset (Dweck, 2008)







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Learning Objectives of Science Education

→ Students need to:

- learn the principles and concepts of science
- acquire the reasoning and procedural skills of scientists
- understand the nature of science as a particular form of human effort

Inquiry-based Science Education (IBSE)

→ The learning activities in which students develop:

- knowledge and skills (i.e. abilities) to do scientific inquiry
- an understanding of how scientists study the natural world

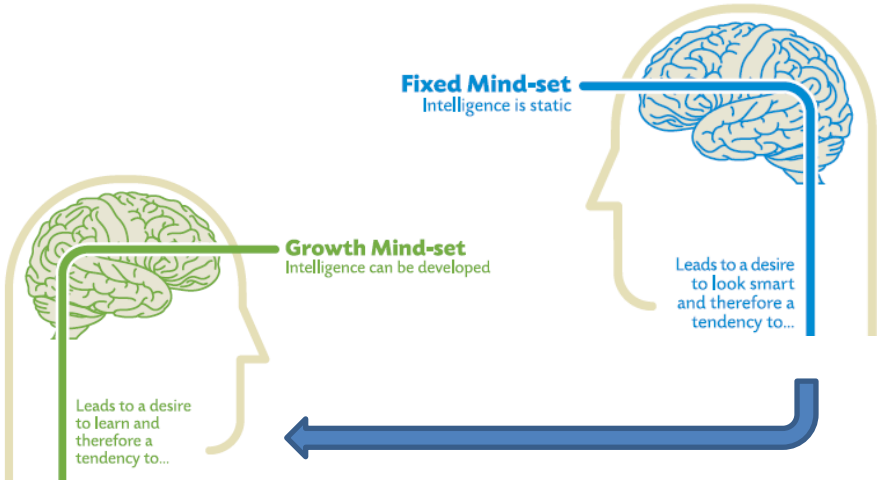
Inquiry can be defined as *"the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments"*

(Linn, Davis & Bell, 2004: 4)

Why Inquiry-based Learning?

→ Engagement
- Students work together
- Students choose which areas to explore and which questions to answer
- Students are active in the learning process

→ Focus
- Towards the student
- Towards the subject
- Towards the learning process



→ But
- Requires preparation
- Requires confidence to allow students to explore

Five Features of Inquiry Learning & Teaching

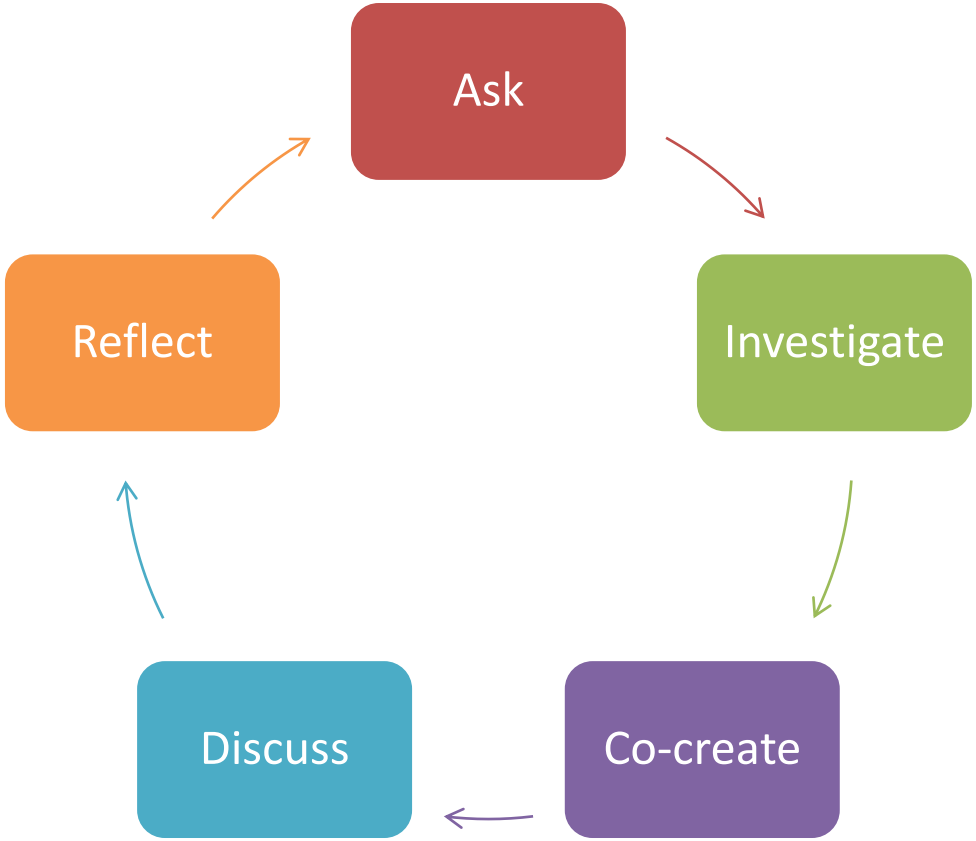
i. Students engage with a scientific question, event or phenomenon.

ii. Students explore ideas through hands-on observations and create explanations of what they observe.

iii. Students gather evidence from observations and clarify concepts and explanations.

iv. Students extend their understanding and identify applications of their findings to other situations.

v. Students reflect on what they have learned and how they have learned it.



Common Myths

1. All science subject matter should be taught through inquiry

2. True inquiry occurs only when students generate and pursue their own questions

3. Student engagement in hands-on activities guarantees that inquiry teaching and learning are occurring

4. Inquiry can be taught with no attention to subject matter nor the age of the students

References

Dweck, C. (2008) “Mindset: The New Psychology for Success”, Ballantine Books, Random House, New York.

Holmes, N. (n.d.) Mindset graphic http://www.stanfordalumni.org/news/magazine/2007/marapr/images/features/dweck/dweck_mindset.pdf

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Back up Slides

1. Variations of inquiry essential features

2. Examples of teaching and assessment that support inquiry-oriented outcomes

Variations of Inquiry Essential Features

Essential Feature	Variations			
1. Learner engages in scientifically oriented questions	Learner poses a question	Learner selects among questions, poses new questions	Learner sharpens or clarifies question provided by teacher, materials, or other source	Learner engages in question provided by teacher, materials, or other source
2. Learner gives priority to evidence in responding to questions	Learner determines what constitutes evidence and collects it	Learner directed to collect certain data	Learner given data and asked to analyse	Learner given data and told how to analyze
3. Learner formulate explanations from evidence	Learner formulates explanation after summarizing evidence	Learner guided in process of formulating explanations from evidence	Learner given possible ways to use evidence to formulate explanation	Learner provided with evidence and how to use evidence to formulate explanation
4. Learner connects explanations to scientific knowledge	Learner independently examines other resources and forms the links to explanations	Learner directed toward areas and sources of scientific knowledge	Learner given possible connections	
5. Learner communicates and justifies explanations	Learner forms reasonable and logical argument to communicate explanations	Learner coached in development of communication	Learner provided broad guidelines to use sharpen communication	Learner given steps and procedures for communication

More ——— Amount of Learner Self-Direction ——— Less
Less ——— Amount of Direction from Teacher or Material ——— More

Examples of teaching and assessment that support inquiry-oriented outcomes

Standards-Based Educational Outcomes What should students learn?	**Teaching Strategies** What are the techniques that will provide opportunities for students to learn?	**Assessment Strategies** What assessments align with the educational outcomes and teaching strategies?
Understanding Subject Matter (e.g., Motions and Forces; Matter, Energy, and Organization in Living Systems; Energy in the Earth System)	Students engage in a series of guided or structured laboratory activities that include developing some abilities to do scientific inquiry but emphasize subject matter (e.g., laws of motion, F = ma, etc.).	Students are given measures that assess their understanding of subject matter. These may include performance assessment in the form of a laboratory investigation, open response questions, interviews, and traditional multiple choice.
Developing Competencies Necessary to Do Scientific Inquiry (e.g., students formulate and revise scientific explanations and models using logic and evidence)	Students engage in guided or structured laboratory activities and form an explanation based on data. They present and defend their explanations using (1) scientific knowledge and (2) logic and evidence. The teacher emphasizes some inquiry abilities in the laboratory activities used for subject-matter outcomes.	Students perform a task in which they gather data and use that data as the basis for an explanation.
Developing Competencies Necessary to Do Scientific Inquiry (e.g., students have opportunities to develop all the fundamental abilities of the standard)	Students carry out a full inquiry that originates with their questions about the natural world and culminates with a scientific explanation based on evidence. The teacher assists, guides, and coaches students.	Students do an inquiry about a question of personal interest without direction or coaching. The assessment rubric includes the complete list of fundamental abilities.
Developing Understandings about Scientific Inquiry (e.g., scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide the rules of evidence; it must be open to question and possible modification; and it must be based on historical and current scientific knowledge)	The teacher could direct students to reflect on activities from several laboratory activities. Students also could read historical case studies of scientific inquiry (e.g., Darwin, Copernicus, Galileo, Lavoisier, Einstein). Discussion groups pursue questions about logic, evidence, skepticism, modification, and communication.	Students are given a brief account of a scientific discovery and asked to describe the place of logic, evidence, criticism, and modification.