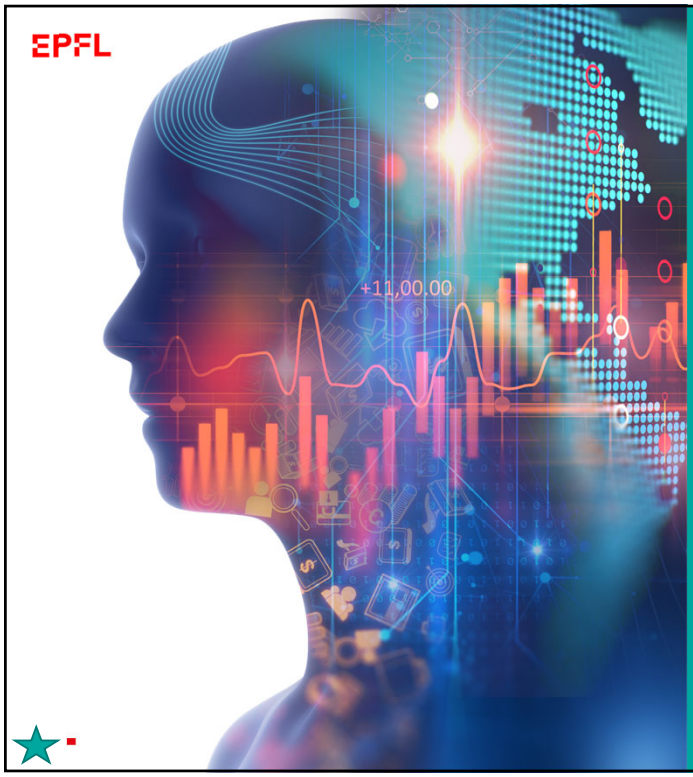

Presenting and Lecturing in Engineering

Day 3

Siara Isaac, Ph.D
Joelyn de Lima Ph.D.

Teaching Support Centre
cape.epfl.ch
March 2023

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Schedule Day 3 2024

MORNING

9:00	Introduction, Reasoning + representing
10:30	break
10:45	High impact lesson plans
12:00	Reflective activity
12:15	lunch break

AFTERNOON

13.15	Group warm up Mini lessons, 2 cycles
14:30	break
14:45	Mini lessons, 1 cycle
15:15	Conclusion, prep for Day 4
16.00	END

2

EPFL

Objectives

- Describe differences between expert and novice ways of thinking in your discipline
- Analyse problems using Polya's problem solving method and demonstrate it during in your teaching
- Identify patterns / systems of thinking that are typical to your field
- Create a lesson plan to improve representational competence

EPFL

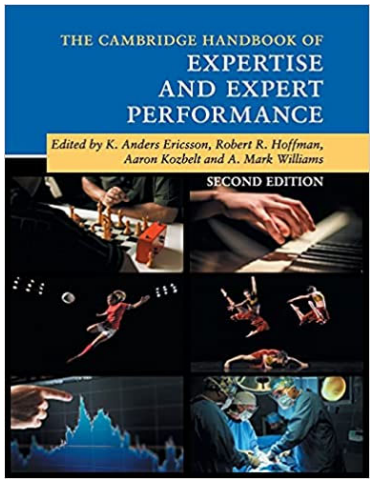
Novice - Expert

What differentiates a novice from an expert in your field?

- *Write down three characteristics*
- *Pair up and compare with your neighbour*
- *Share*

EPFL

What is expertise?



Superior reproducible performance on *representative tasks*

Ericsson, K. A. (2018).

EPFL

Experts **behave** differently

Novice → Expert

What do they know?

How do they think?

EPFL

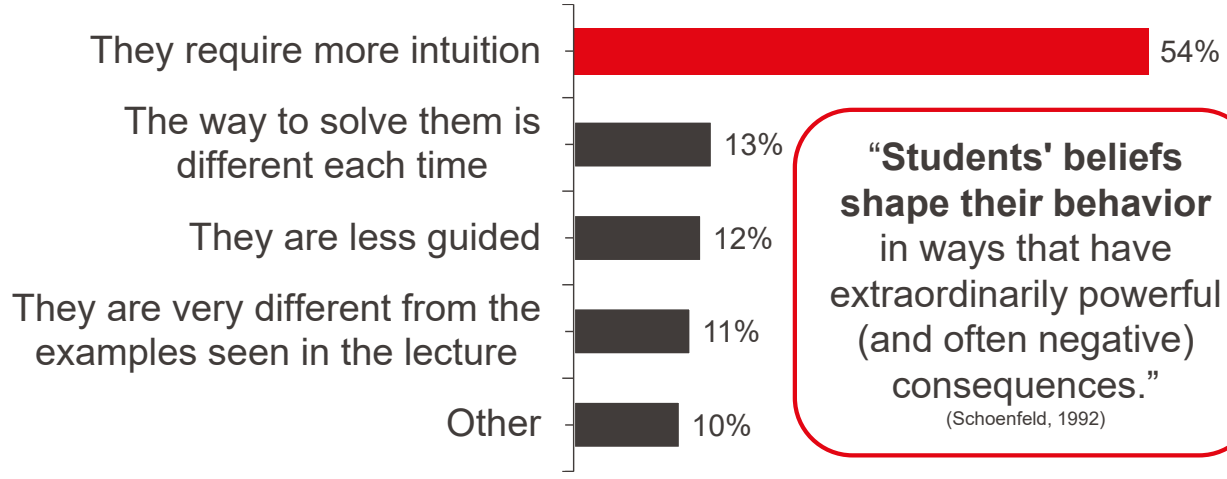
Experts behave differently

- Reasoning (thinking)
  - Problem solving

EPFL

How do students see problem solving?

How are exercises in EPFL different from exercises in high school?



"**Students' beliefs shape their behavior** in ways that have extraordinarily powerful (and often negative) consequences."
(Schoenfeld, 1992)

EPFL « Apprendre à étudier » session, April 2017, 223 participants

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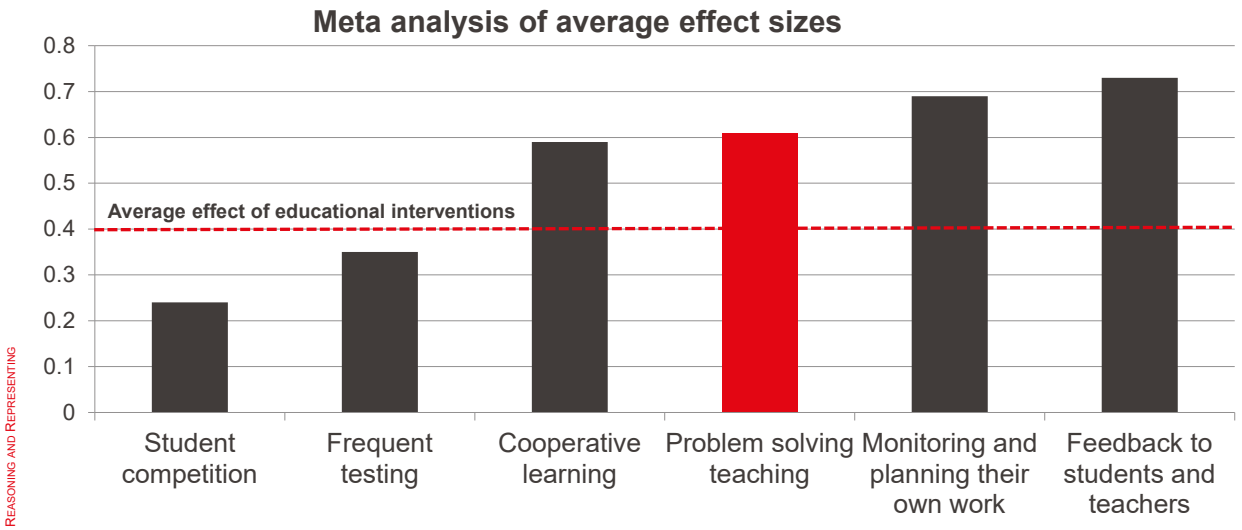
Evidence about teaching



REASONING AND REPRESENTING

Hattie, Visible Learning, 2009

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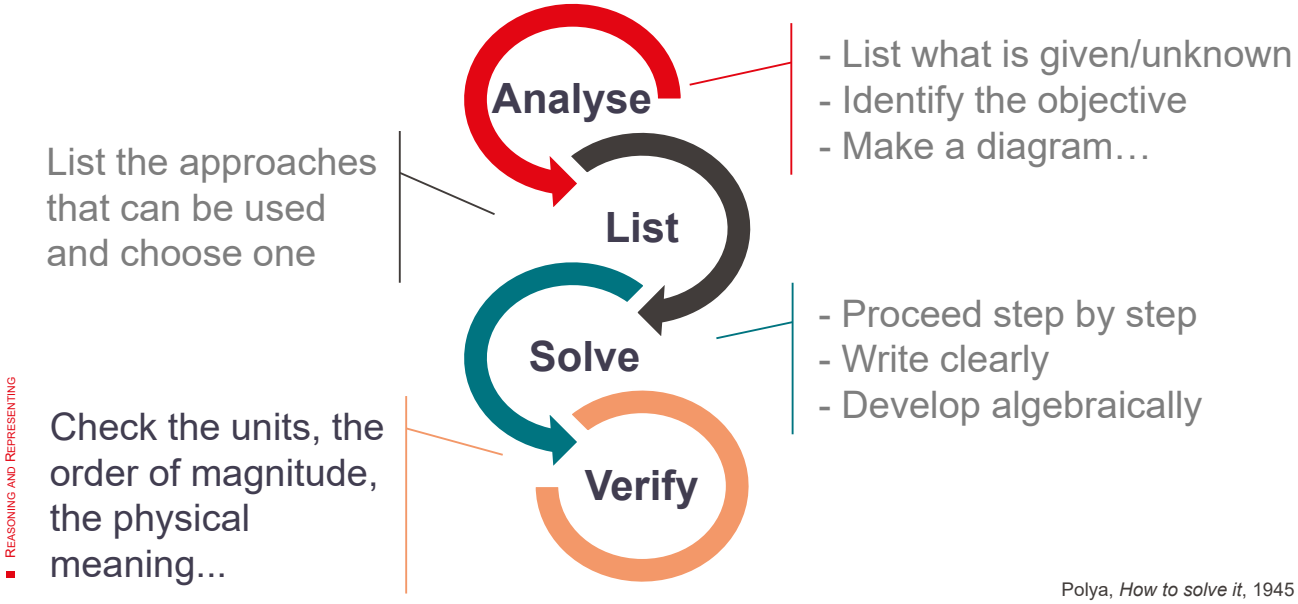
EPFL

Teaching problem solving heuristics



REASONING AND REPRESENTING

Polya, *How to solve it*, 1945

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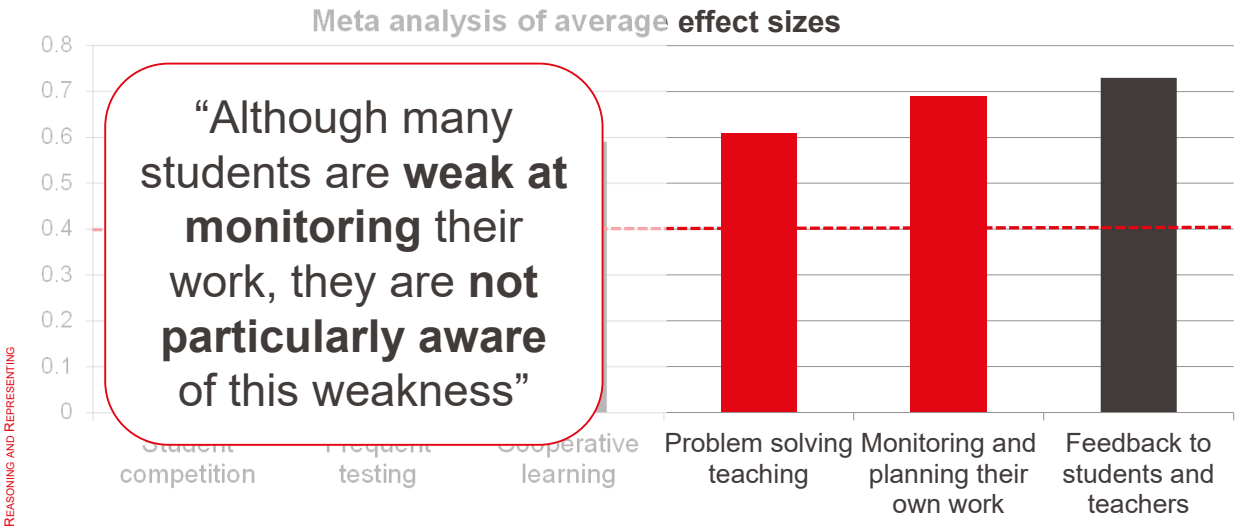
EPFL

Evidence about teaching



"Although many students are **weak at monitoring** their work, they are **not particularly aware** of this weakness"

Colussi, M., et.al., 2014; Hattie, Visible Learning, 2009

REASONING AND REPRESENTING

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EPFL

Teaching problem solving heuristics

Look back at your mini-lesson from Day 2 (exercise / problem solving activity):

- Are the problem solving heuristics from your field explicit?
- How did you encourage your students to monitor their work?

REASONING AND REPRESENTING

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EPFL

Experts behave differently

- Reasoning (thinking)
  - Problem solving
  - Identifying patterns

EPFL

Experts identify patterns

Type of comment	Expert	Advanced beginner	Novice
Description	24	37	45
Evaluation	29	16	9

Sabers, D. S., Cushing, K. S., & Berliner, D. C. (1991)

EPFL

Experts identify patterns

Group	n	Elements	Relationships	Function
Experts	10	13	15	18
Preservice teachers	26	12	8	8
Middle school students	20	12	7	8

Hmelo-Silver, C. E., Marathe, S., & Liu, L. (2007). Fish swim, rocks sit, and lungs breathe: Expert-novice understanding of complex systems.

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Systems thinking

- Thinking of the whole complex system as a unit
- More than the sum of the parts

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Missing the forest for the trees

- What are some patterns in your field that novices might miss because they are focussing on the minutia?

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EPFL

Experts behave differently

- Reasoning (thinking)
  - Problem solving
  - Identifying patterns
- Representing

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EPFL

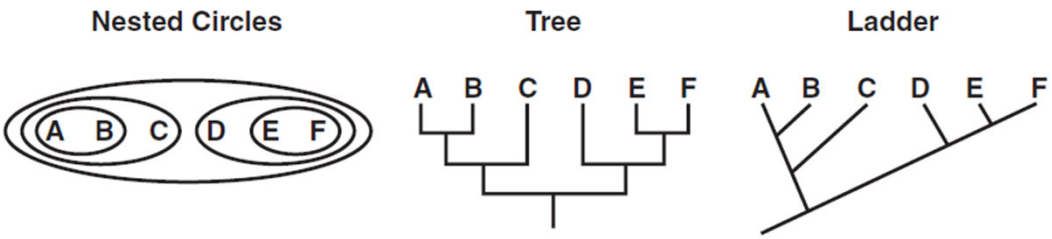
Common representations - 1

IGF1 v IGF1

- Look similar
- But represent two very different concepts

EPFL

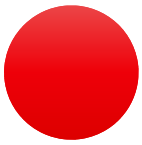
Common representations - 2



- Look different
- But represent the same concept

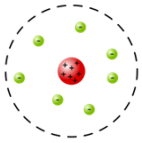
EPFL

Common representations - 3

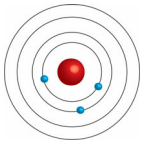


Marble model
Dalton 1803

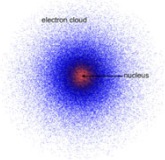
Plum pudding model
Thomson 1904



Nuclear model
Rutherford 1911



Planetary model
Bohr 1913



Quantum model
Schrödinger 1926

- Historical models
- Increasing accuracy

REASONING AND REPRESENTING

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Representational competence

- Make the conventions explicit
- Use multiple types of representations – explain contexts when one might be better than the other
- Explain difference between historical representations and current multiple representations
- Give students opportunity to interpret and construct

REASONING AND REPRESENTING

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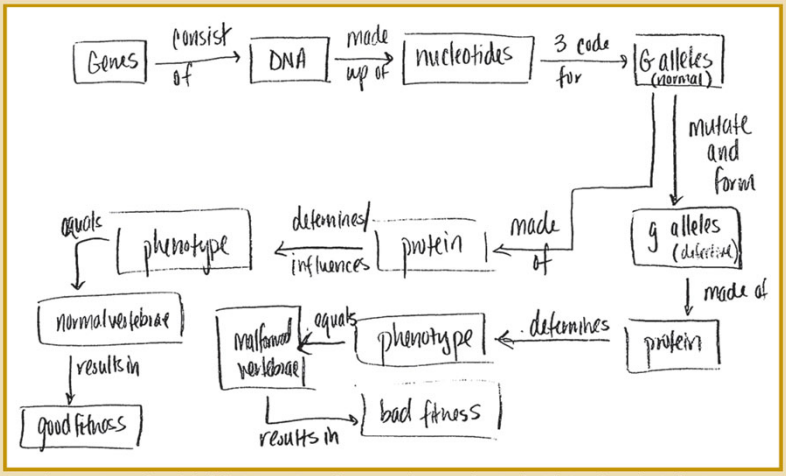
EPFL

Representational competence

- What are some of the common representations in your field?
- What barriers could a novice face when using (interpreting and constructing) such representations?

EPFL

SBF model - biology



A student-constructed model of the interactions of moose and gray wolves in the Isle Royale ecological system.

EPFL

Experts identify patterns

Group	n	Elements	Relationships	Function
Experts	10	13	15	18
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Middle school students	20	12	7	8

Hmelo-Silver, C. E., Marathe, S., & Liu, L. (2007). Fish swim, rocks sit, and lungs breathe: Expert-novice understanding of complex systems.

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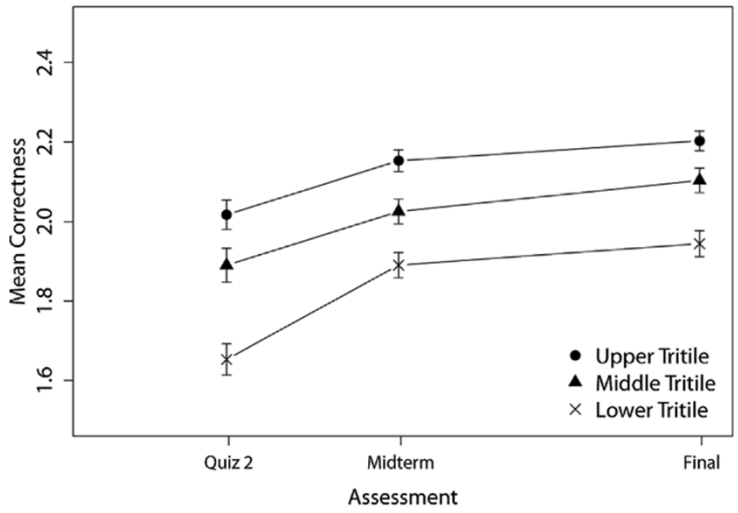
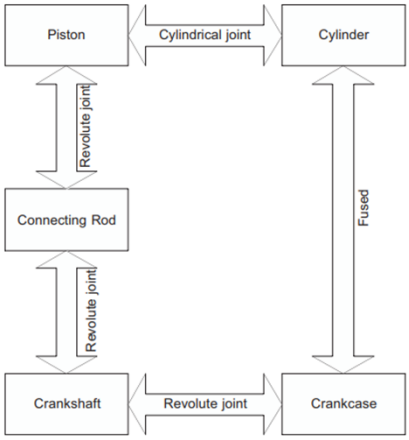
Decrease in gap between low and high achievers



Dauer, J. T., Momsen, J. L., Speth, E. B., Makohon-Moore, S. C., & Long, T. M. (2013).

EPFL

SBF model - engineering



Yaner & Goel (2006)

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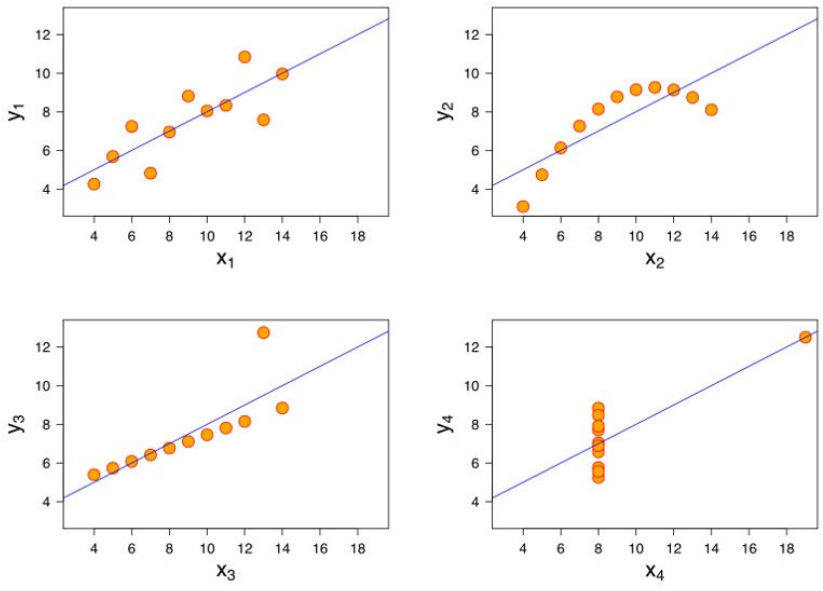
EPFL

Visualising data

These 4 plots have the same:

- mean(x)
- mean(y)
- variance(x)
- variance(y)
- x-y correlation
- Regression intercept
- Regression slope
- p-values
- R^2



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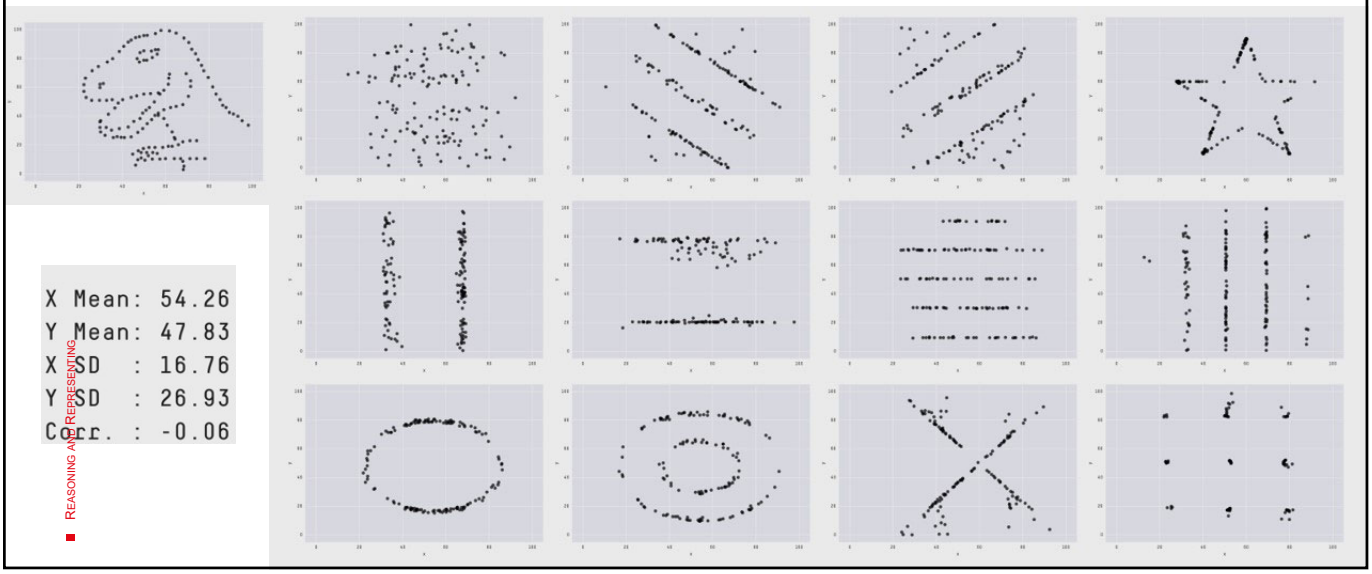
Representations (visualisations) are important!



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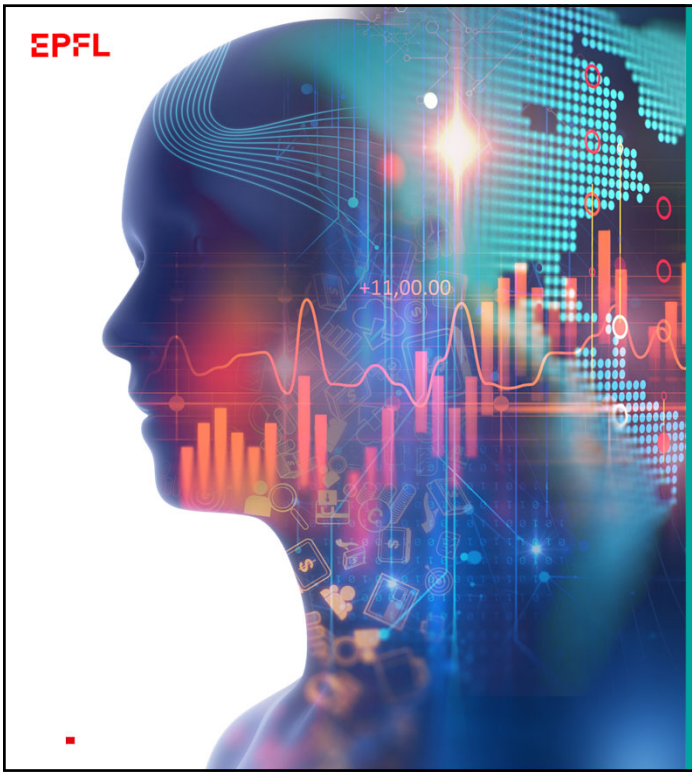

High impact lesson plans

Siara Isaac Ph.D.

Teaching Support Centre
cape.epfl.ch

March 2023

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EPFL

7 ways to increase the focus on student learning

1. Connecting to students' existing knowledge
2. Involving students as active participants
3. Promoting and harnessing student-student interactions
4. Enabling the structuring of knowledge
5. Integrating assessment in learning tasks
6. Supporting knowledge transfer and application
7. Developing students' reflective practice

Degree of focus on learning

Level 1	2	3
teacher performs and demonstrates the thinking	teacher encourages students to think, with clear guidelines	teacher creates context where students interact, decide and think

St-Pierre, Bédard, Lefebvre, Université de Sherbrooke, mars 2011

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7 ways to increase the focus on student learning

Which aspects were least/most present in the sample lesson plan?

Which of the 7 ways were easiest to reinforce? The hardest?

-> Which of the 7 ways are missing from your mini lessons?

St-Pierre, Bédard, Lefebvre, Université de Sherbrooke, mars 2011

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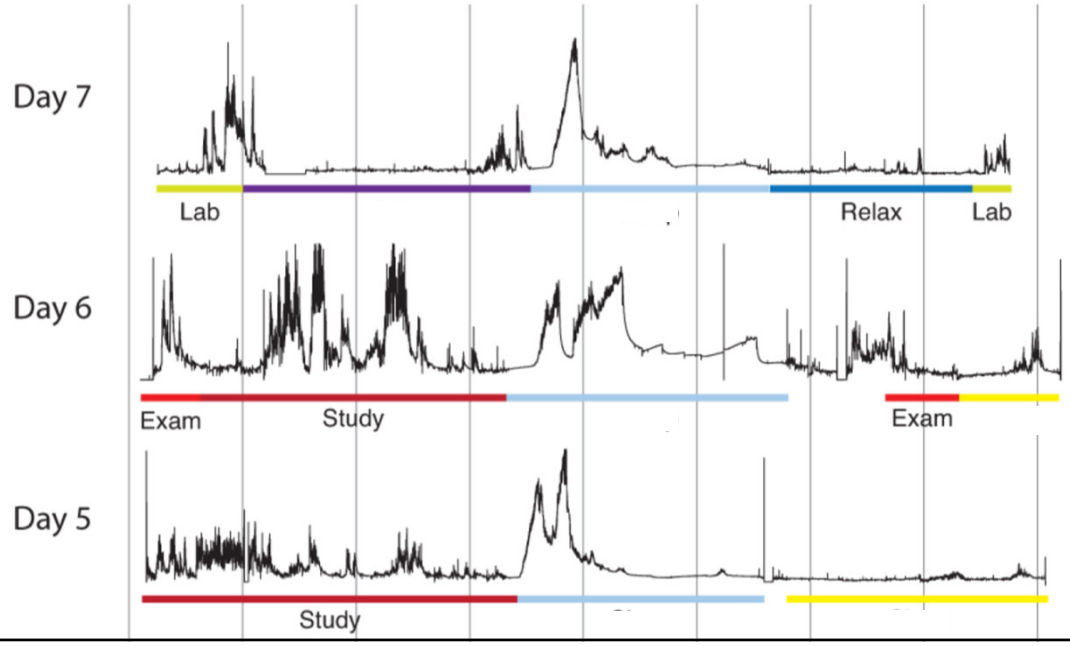
"Changes in skin conductance reflect activity & provide a sensitive measure of emotion, cognition, and attention"



Swenson + Picard "A Wearable Sensor for Unobtrusive, Long-Term Assessment of Electrodermal Activity." Biomedical Engineering, IEEE Transactions 2010: 1243-1252.

EPFL

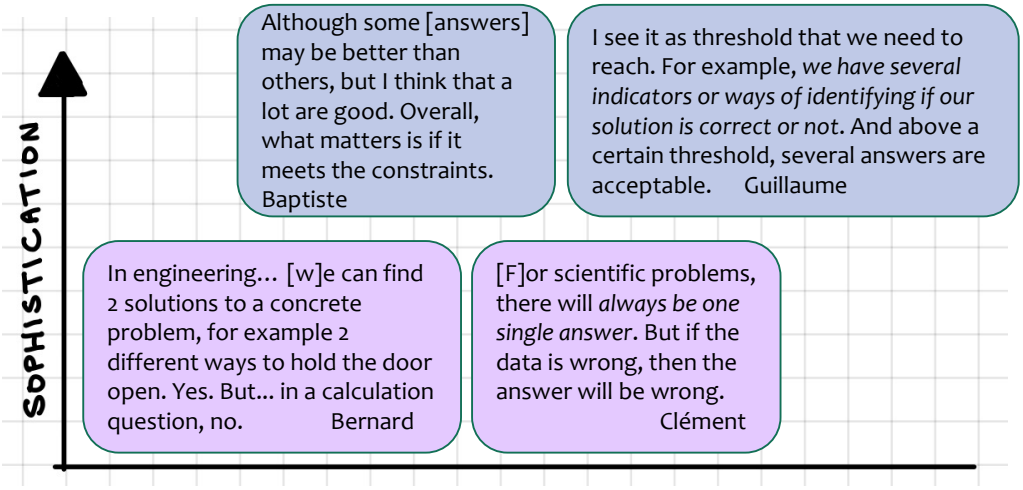
Epistemic beliefs describe how we perceive the nature of knowledge and how it is acquired, proven and transferred.

– Where does *knowledge come from?*

– *How do we know something is true?*

EPFL

Epistemic beliefs are important for engineers.



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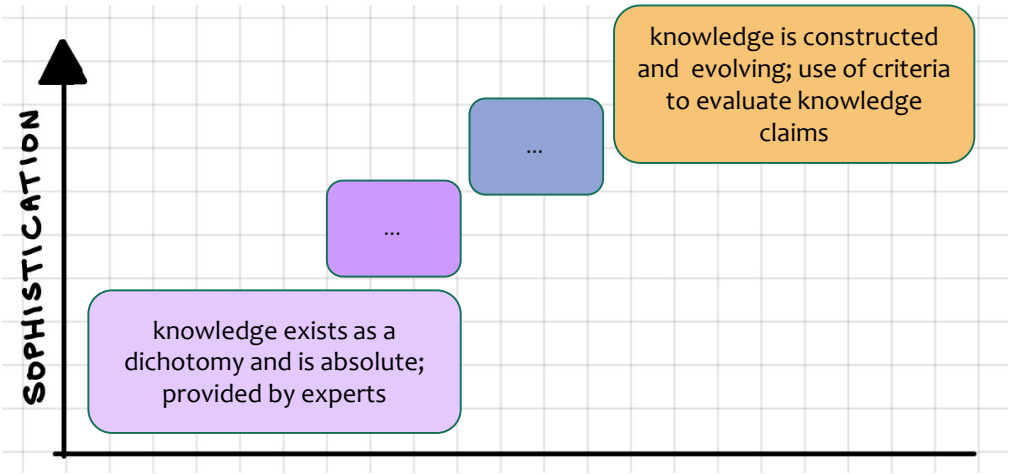
Epistemic beliefs are often characterised by stage- based models



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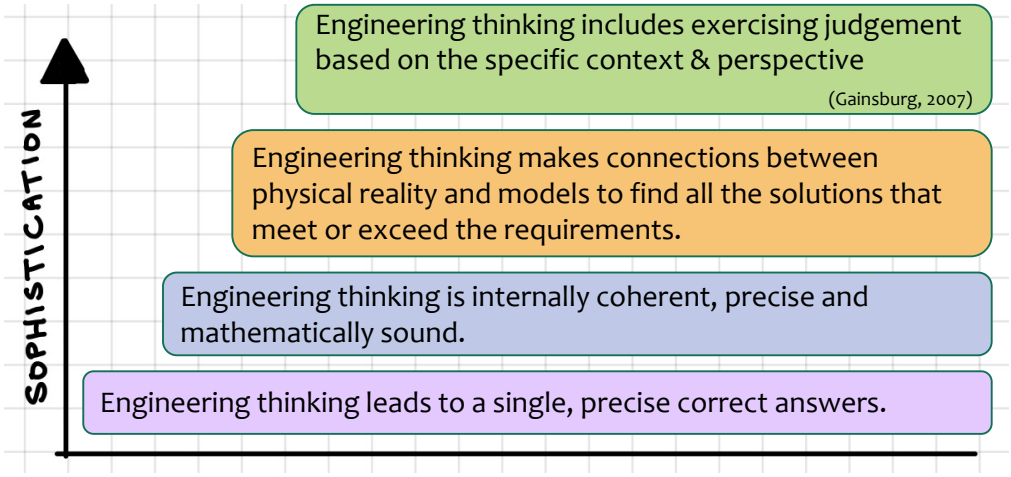

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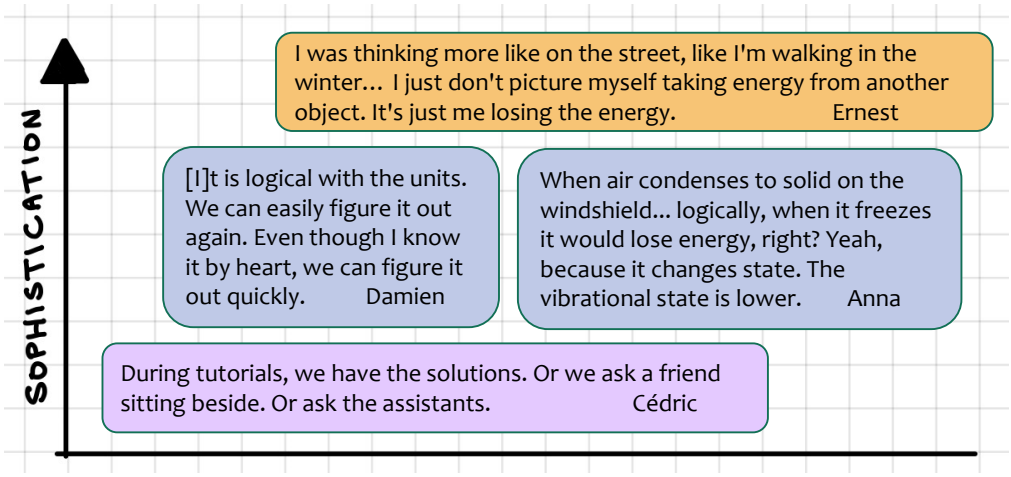

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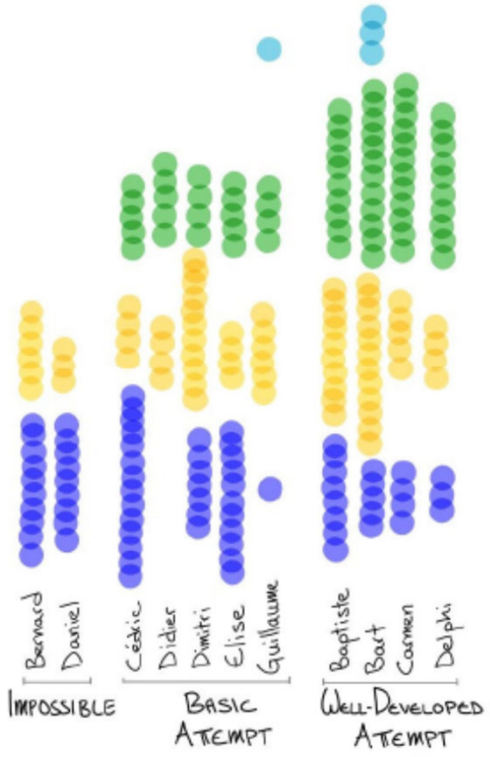
Students' Epistemic Practices Frequency Profiles by Progress on an Ill-Structured Task



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Homework

1. Preparation Assignment on Moodle
2. Prepare your mini lesson for Day 4
   - Choose some quantitative data and present it for GENERAL public audience.
   - Use visualization(s) and / or diagrams
   - Use the full LOAFS structure, per Day 4 lesson planning matrix
   - 10 minutes
   - Include active learning