

CS-411 : Digital Education & Learning Analytics

Chapter 3: The Edges Library

Edge Label

Why is a_i a condition for a_j ?

$E = \{ e_{ij} \mid e_{ij}: (a_i, a_j, \{\text{operators}\}, \{\text{controls}\}, \text{label}, \text{weight}, \text{elasticity})$

How much is a_i a condition for a_j ?

Edge Weight

Library of Edge Labels

Why is a_i a condition for a_j ?

The **preparation** edges connect two activities when the learner has a higher probability of succeeding at a_j if he carried out a_i before a_j .

The **set** edges connect two activities when the **skills or contents addressed in a_i and a_j are in relationship with each other**; for example, subset/superset, whole/part, and siblings. (UP / DOWN)

The **translation** edges connect two activities in which the same content is addressed under different formats, representations, notations, or viewpoints. Learners therefore have **to translate the representation used in a_i into the representation used in a_j** .

The **generalization** edges introduce variations of the content or skills across the **space of generalization**, namely introducing the student to more general, less general, or analogical contexts from a_i to a_j . (UP / DOWN)

Library of Edge Labels

Why is a_i a condition for a_j ?

Preparation	Set	Translation	Generalization
(P) Prerequisite	(S+) Aggregation	(T) Proceduralization	(G+) Induction
(P) ZPD	(S+) Expansion	(T) Elicitation	(G+) Deduction
(P) Adv. organizer	(S-) Decomposition	(T) Alternate	(G+) Extraction
(P) Motivation	(S-) Selection	(T) Reframe	(G+) Synthesis
(P) Anticipation	(S=) Juxtaposition	(T) Reverse	(G=) Analogy
(P) Logistics	(S=) Contrast	(T) Repair	(G=) Transfer
(P) Data collection	(S=) Identity	(T) Teach	(G-) Restriction

Edge Library

Preparation Edges

- Prerequisite
- ZPD
- Adv. Organizer
- Motivation
- Anticipation
- Logistics
- Data collection



Pre-requisites are common sense: You need to be able to do $5+7$ (a_i), before trying $25+37$ (a_j).

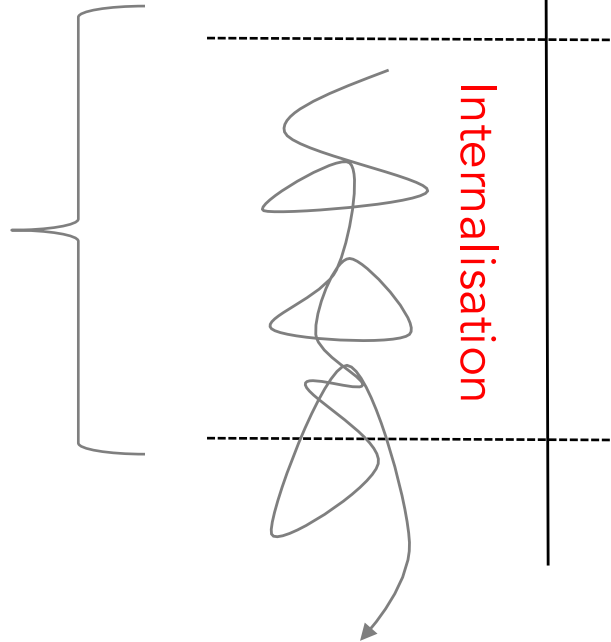
Nonetheless, a high portion of failure is explained the accumulation of small gaps in pre-requisites.

Mastery learning focused especially on this sequencing

Edge Library

Preparation Edges

- Prerequisite
- Zone of Proximal Development
- Adv. Organizer
- Motivation
- Anticipation
- Logistics
- Data collection



What I do (a_i)
in interaction with a more
knowledgeable peer

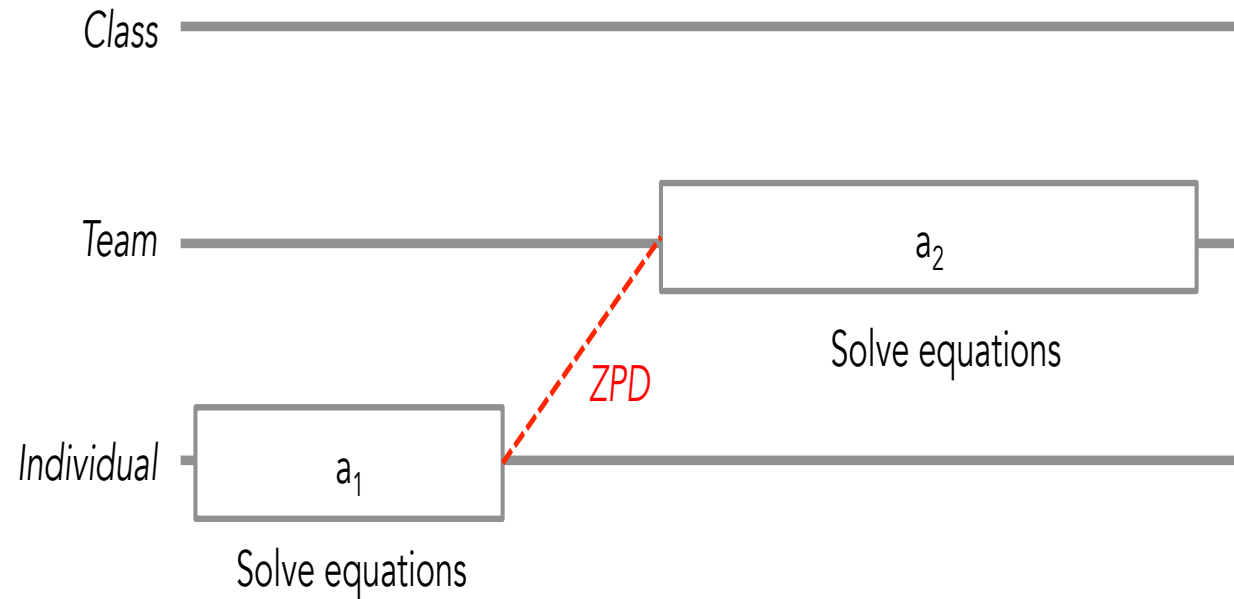
What I can do alone (a_j)

CHAPTER 6

Edge Library

Preparation Edges

- Prerequisite
- Zone of Proximal Development
- Adv. Organizer
- Motivation
- Anticipation
- Logistics
- Data collection



In the first activity, students solve equations individually. The teacher analyzes their work and identifies those who concentrate on algebraic manipulations compared to those able to think in terms of problem-solving strategy. In the second activity, a student from the first category is asked to work with a student from the second category. The latter is expected to convey his strategies by arguing about the choice of equation manipulations proposed by the former.

Edge Library

Preparation Edges

- Prerequisite
- ZPD
- Adv. Organizer 
- Motivation
- Anticipation
- Logistics
- Data collection

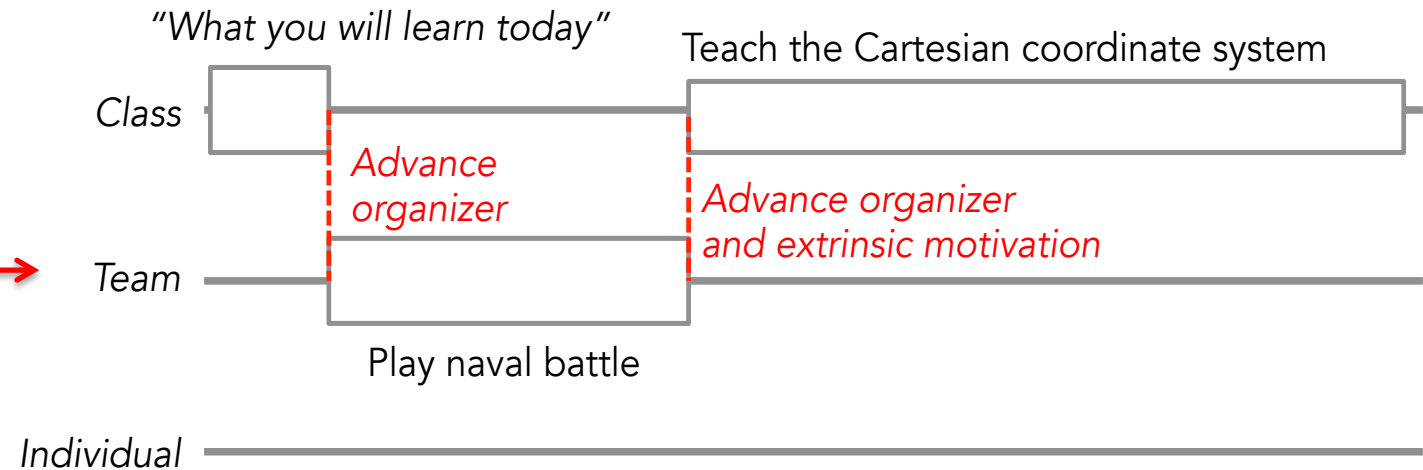
An advance organizer is information presented by an instructor that helps the student organize new incoming information (D. Ausubel):

- Reactivate previous knowledge
- Preactivate knowledge structures

Edge Library

Preparation Edges

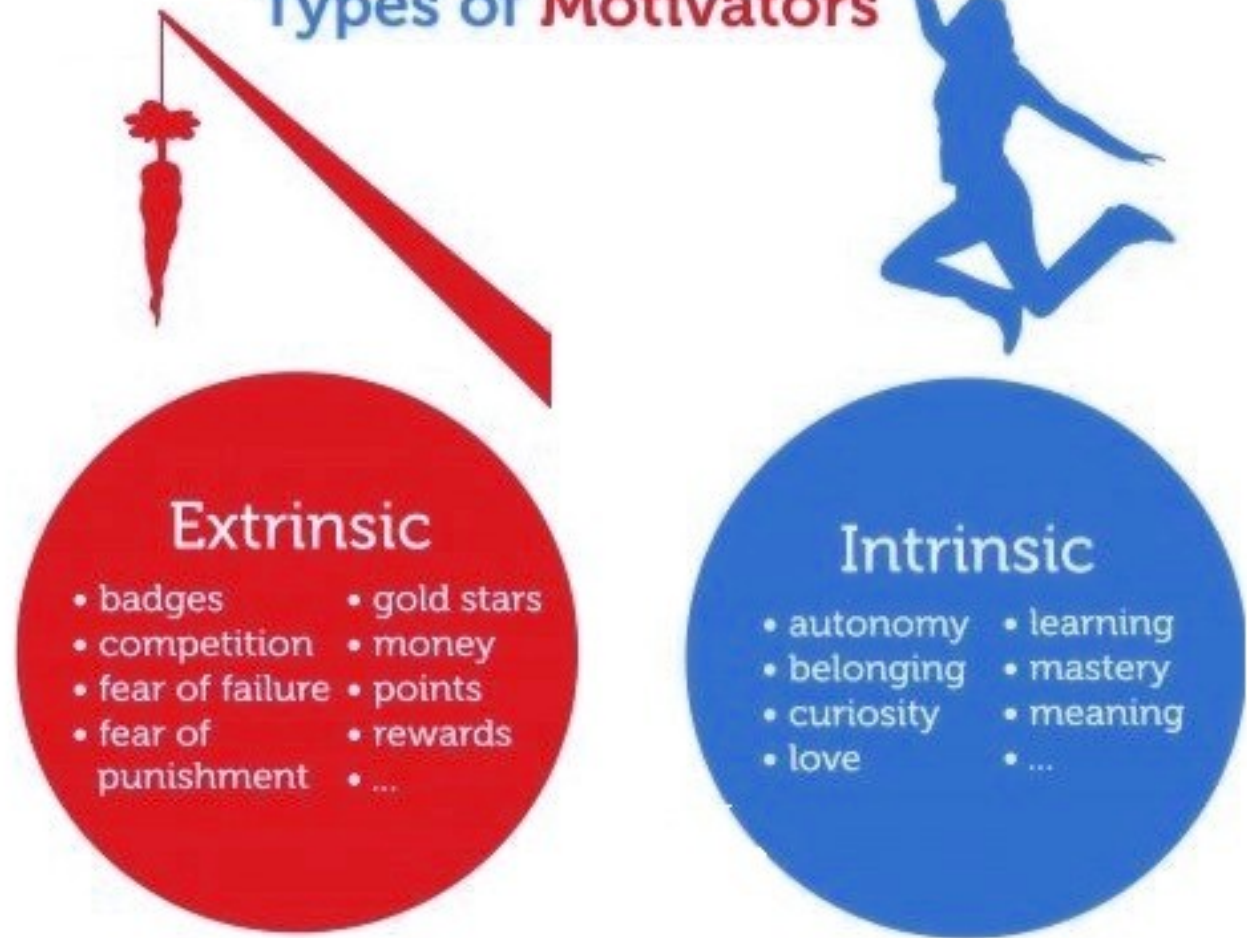
- Prerequisite
- ZPD
- Adv. Organizer →
- Motivation
- Anticipation
- Logistics
- Data collection



Preparation Edges

- Prerequisite
- ZPD
- Adv. Organizer
- Motivation →
- Anticipation
- Logistics
- Data collection

Types of Motivators



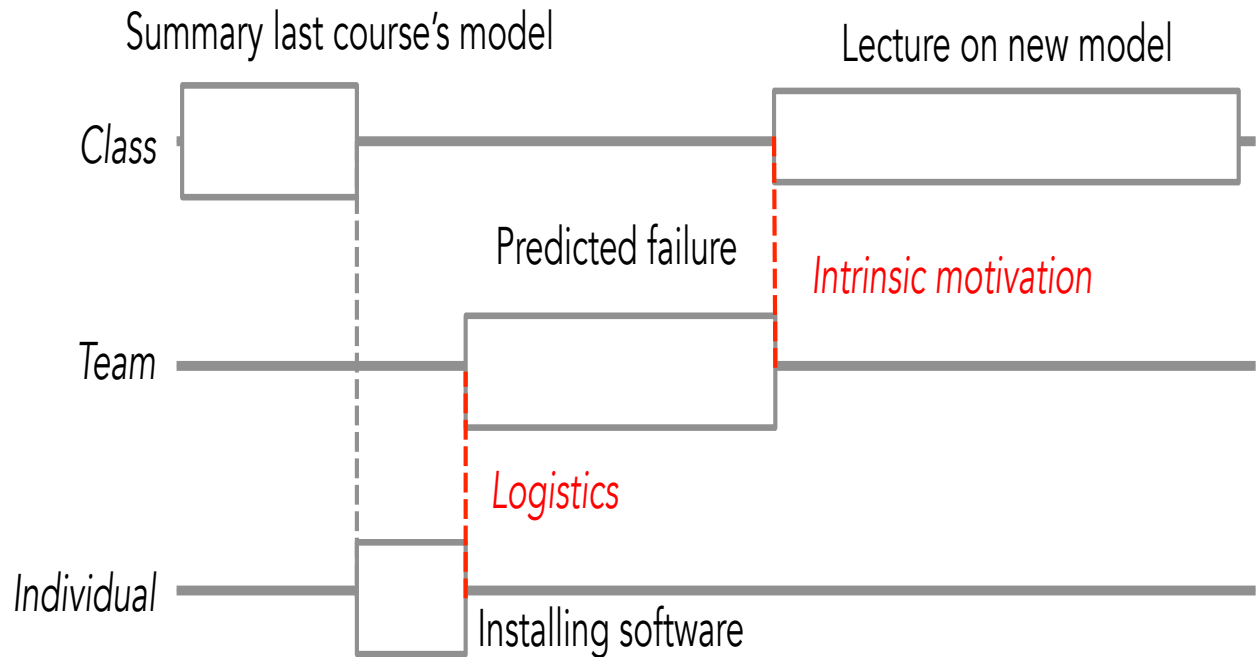
Students may try to get the reward without learning anything

It is sometimes hard to demonstrate why some skills are useful.

Edge Library

Preparation Edges

- Prerequisite
- ZPD
- Adv. Organizer
- Motivation →
- Anticipation
- Logistics →
- Data collection

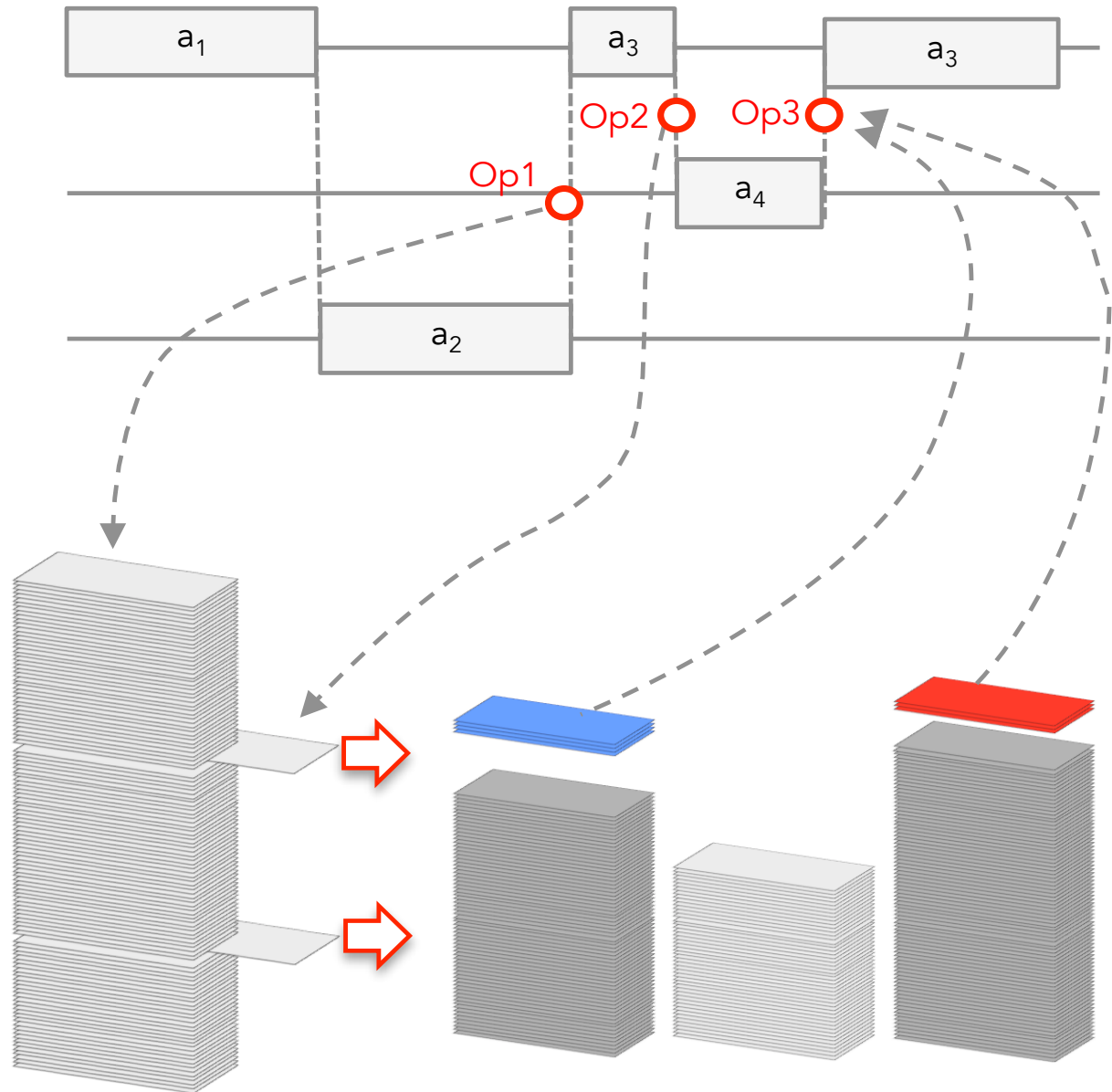


The teacher reminds students of the model taught the previous week and asks students to install a new simulation tool (logistics edge). He gives them a phenomenon for which the previous model produces incorrect results, which will justify a revision of the previous model.

Edge Library

Preparation Edges

- Prerequisite
- ZPD
- Adv. Organizer
- Motivation
- Anticipation
- Logistics
- Data collection



Edge Library

Set Edges

(S+) Aggregation

(S+) Expansion

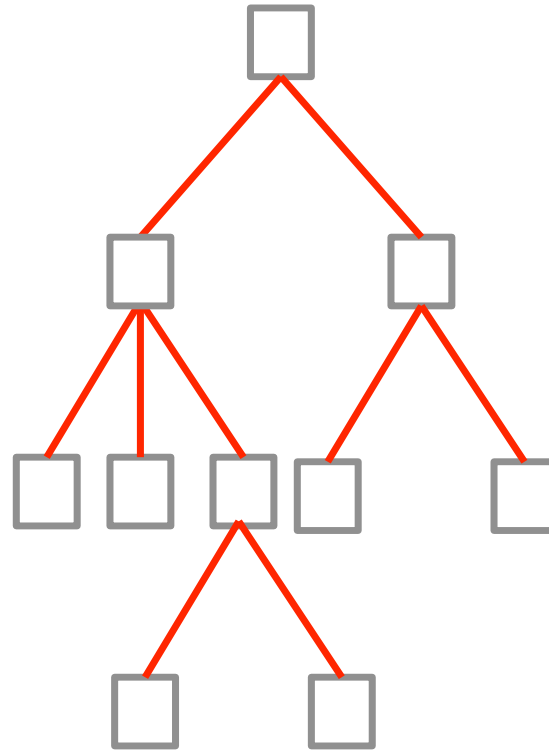
(S-) Decomposition

(S-) Selection

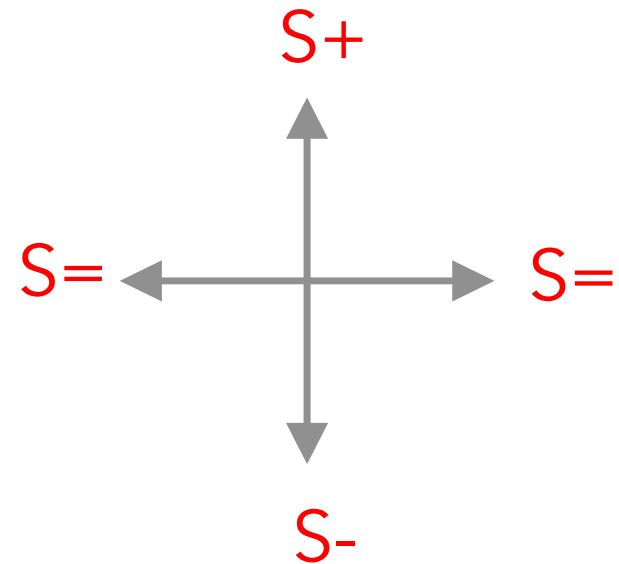
(S=) Juxtaposition

(S=) Contrast

(S=) Identity



Knowledge space or « Class-Structure » of the domain to be taught.



Bringing the learner up/down and left/right in this knowledge space

Edge Library

Set Edges

(S+) Aggregation

(S+) Expansion

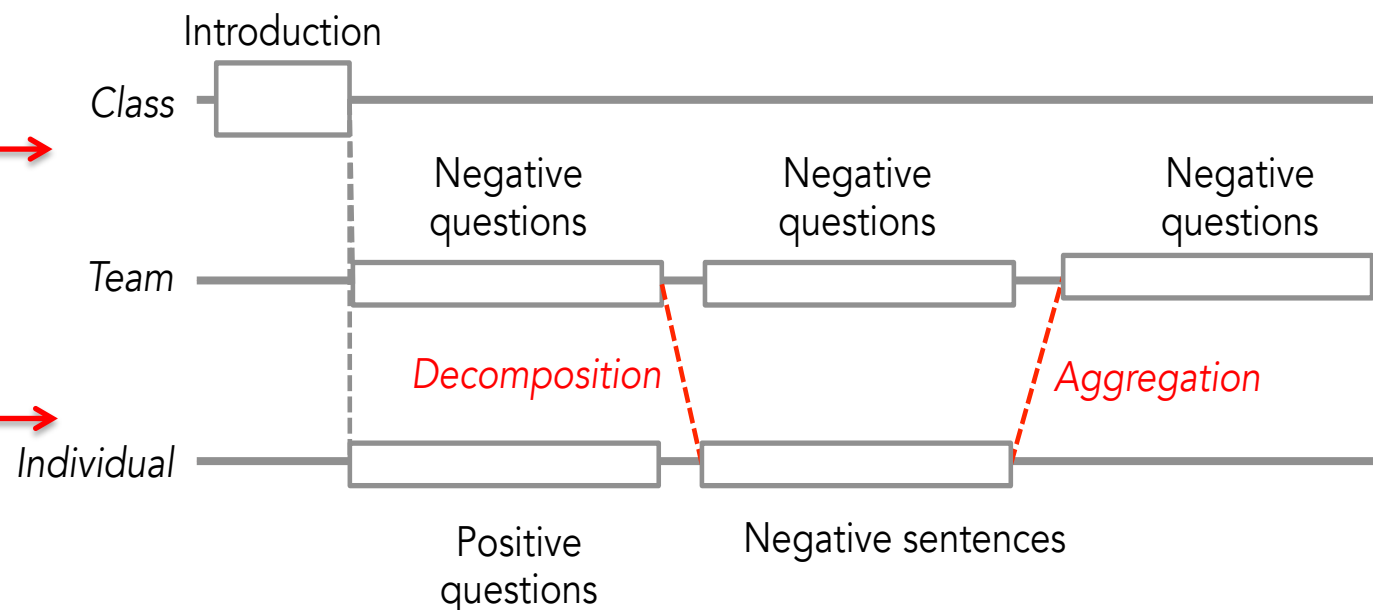
(S-) Decomposition

(S-) Selection

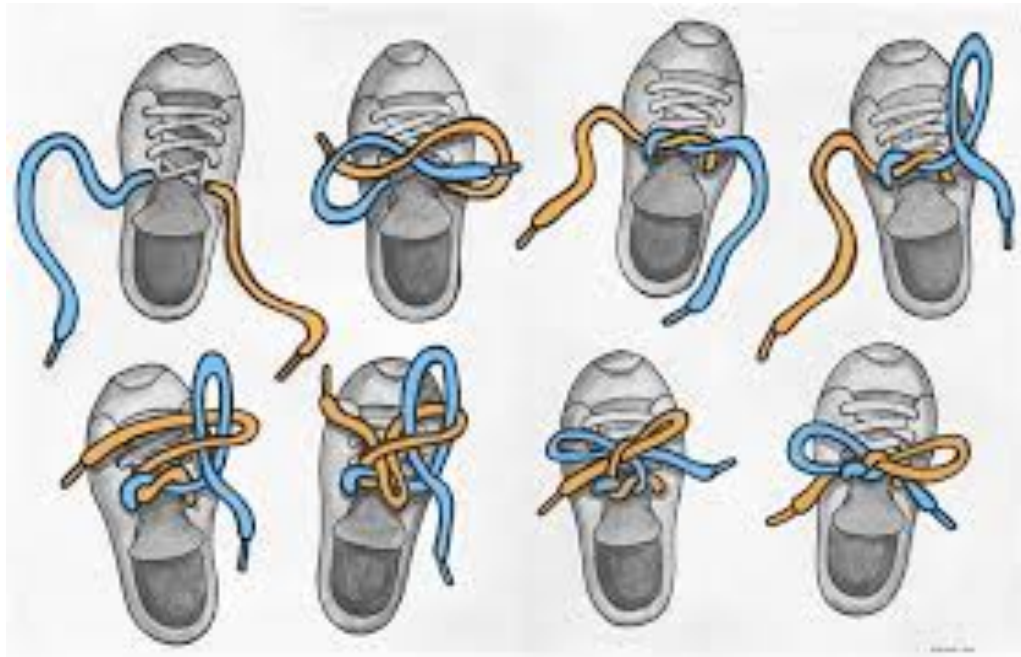
(S=) Juxtaposition

(S=) Contrast

(S=) Identity



After an introduction, the teacher splits the class into two subclasses, those who have already studied how to form questions and negative sentences in English, and those who have not. The novices do individual exercises on each skill (first questions and then negative sentences), and finally these two skills are aggregated during pair dialogue exercises that include negative questions. The more experienced subclass starts directly with the pair dialogue exercises, but the students who encounter difficulties are then redirected towards individual exercises on each skill.

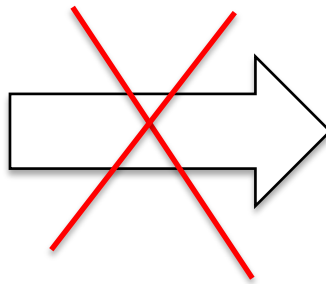


How do you lace your shoes ?

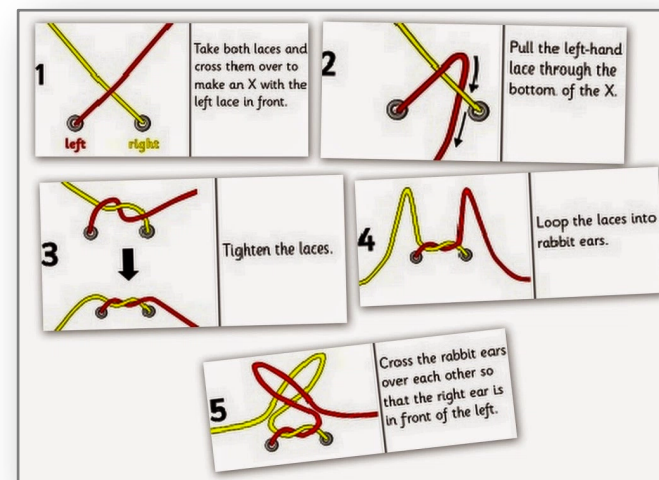
Programme a shoe lacing robot !

« I know how to lace my shoes »

« I am able to lace shoes »



« I can explain how to lace shoes »

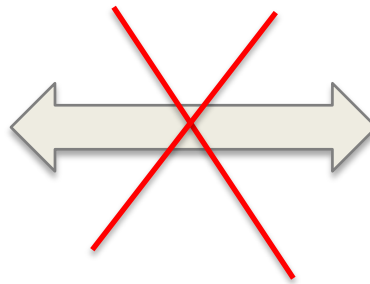


« I know how to lace my shoes »

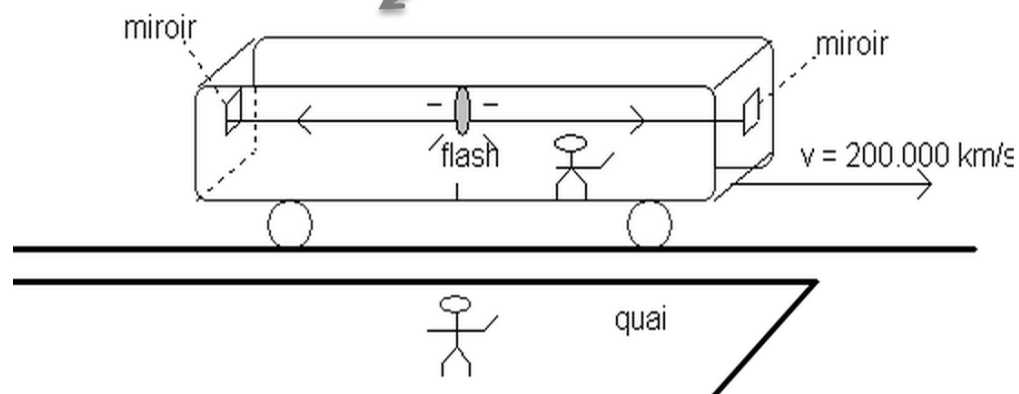
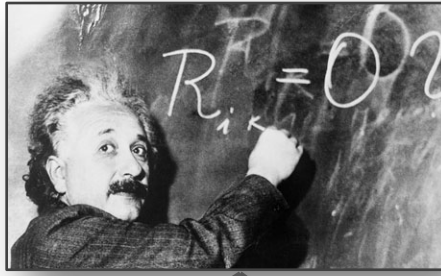
« I am able to
lace shoes »

« I can explain how
to lace shoes »

Procedural
knowledge

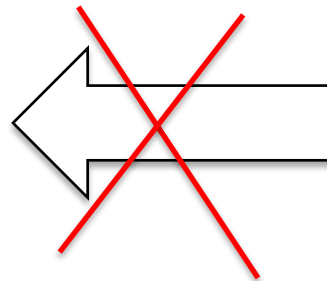


Declarative
knowledge



« If speed of light cannot be compressed, then time is elastic »

Procedural
knowledge

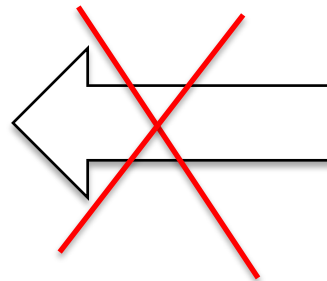


Declarative
knowledge



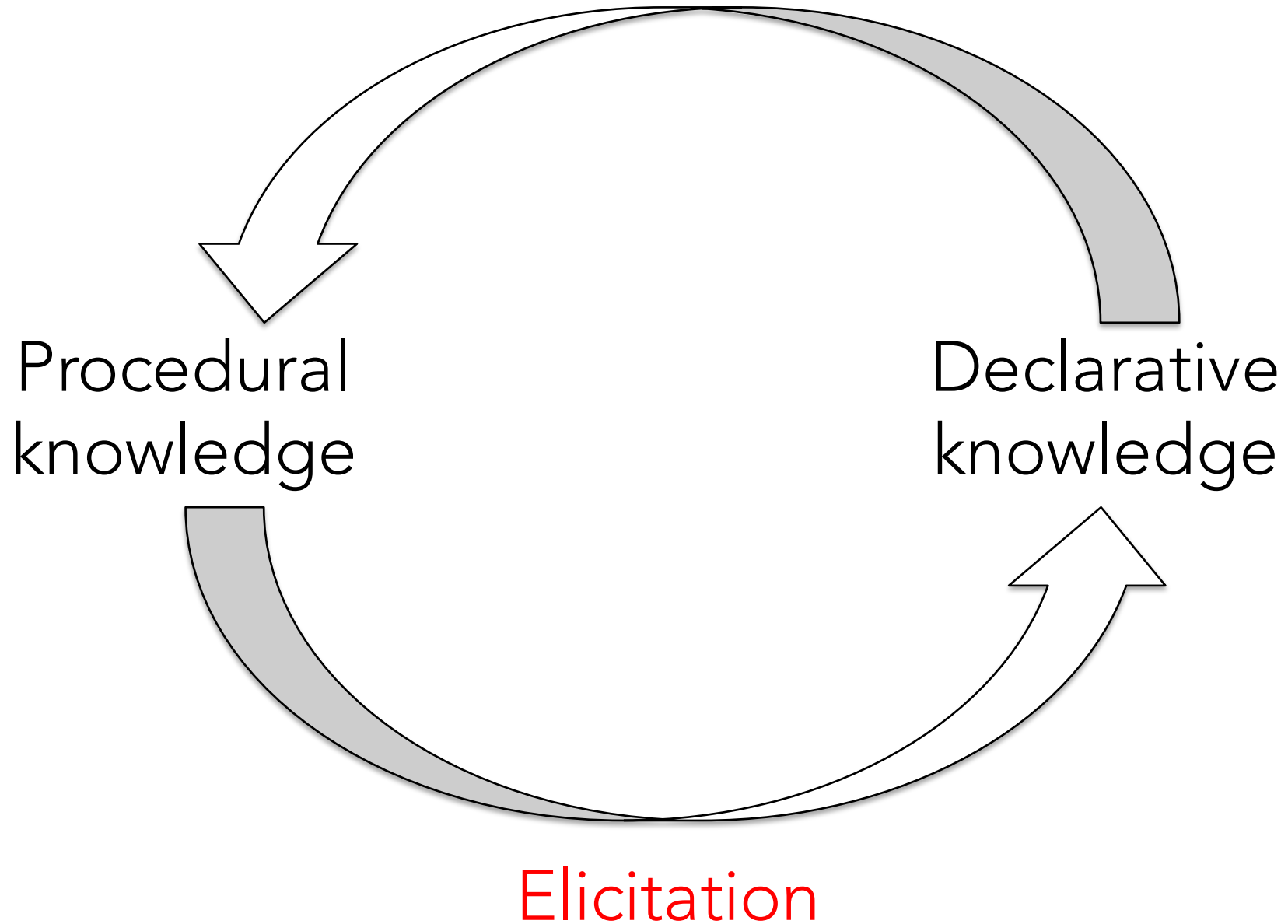
Procedural
knowledge

Mets ton centre de
gravité sur le ski aval !



Declarative
knowledge

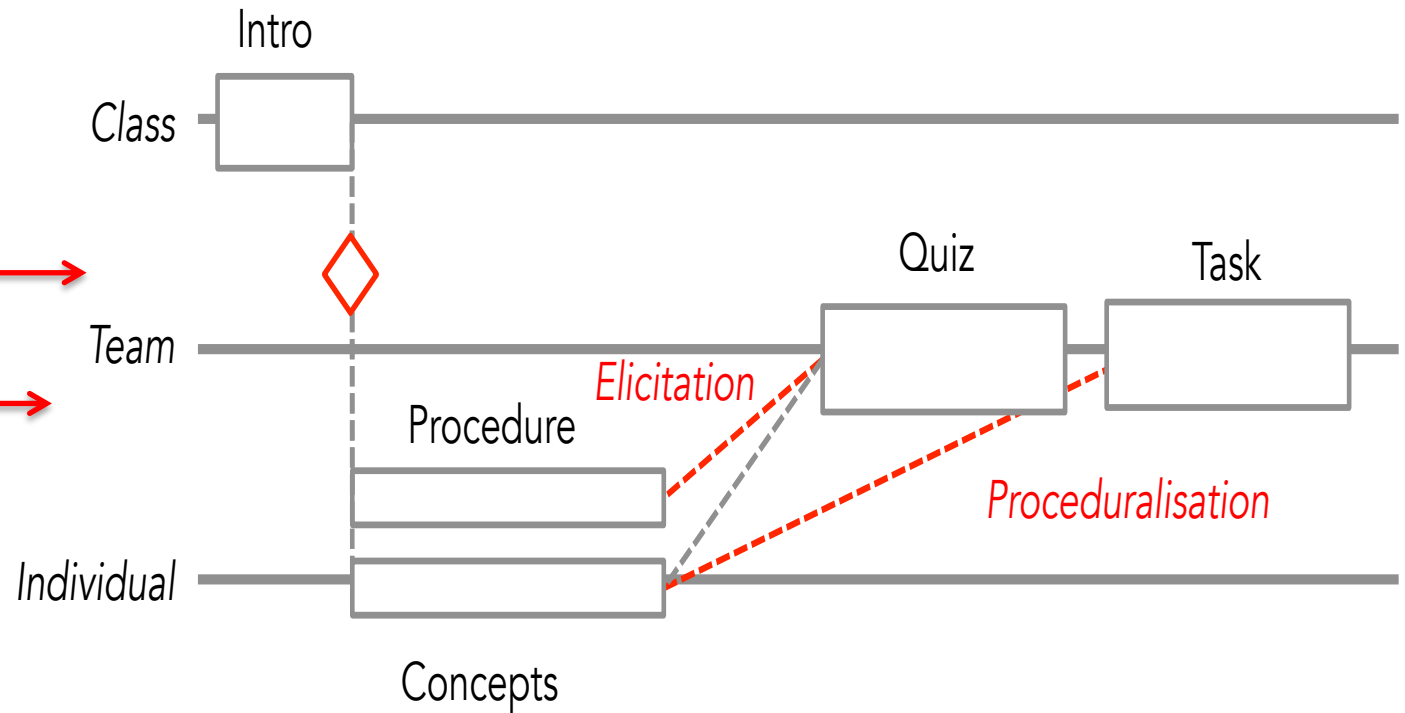
Proceduralisation



Edge Library

Translation Edges

- Proceduralization →
- Elicitation →
- Alternate
- Reframe
- Reverse
- Repair
- Teach



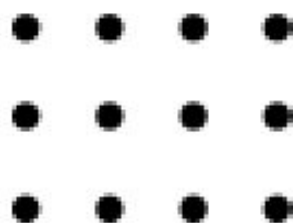
After an introductory video, the participants in this MOOC, "*Introduction to statistics*," are split into 2 subclasses for individual activities. In the first subclass, students acquire procedural knowledge—how to manually calculate the standard deviation for a set of 20 data points. In the second subclass, students acquire declarative knowledge—the concepts of dispersion, heterogeneity and variance, and illustrated graphical representations. Then, each student from a subclass is paired with a student from the other subclass, and collaboratively they first have to do a quiz that measures declarative knowledge and then a task that requires procedural knowledge. To be able to collaborate with their peer, those who acquired declarative knowledge individually have to proceduralize it with the help of their peer, and those who acquired procedural knowledge individually have to elicit it (next edge label).

REPRESENTING Multiplication

Grouping Model



Array

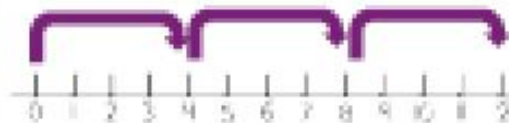


$$3 \times 4 =$$

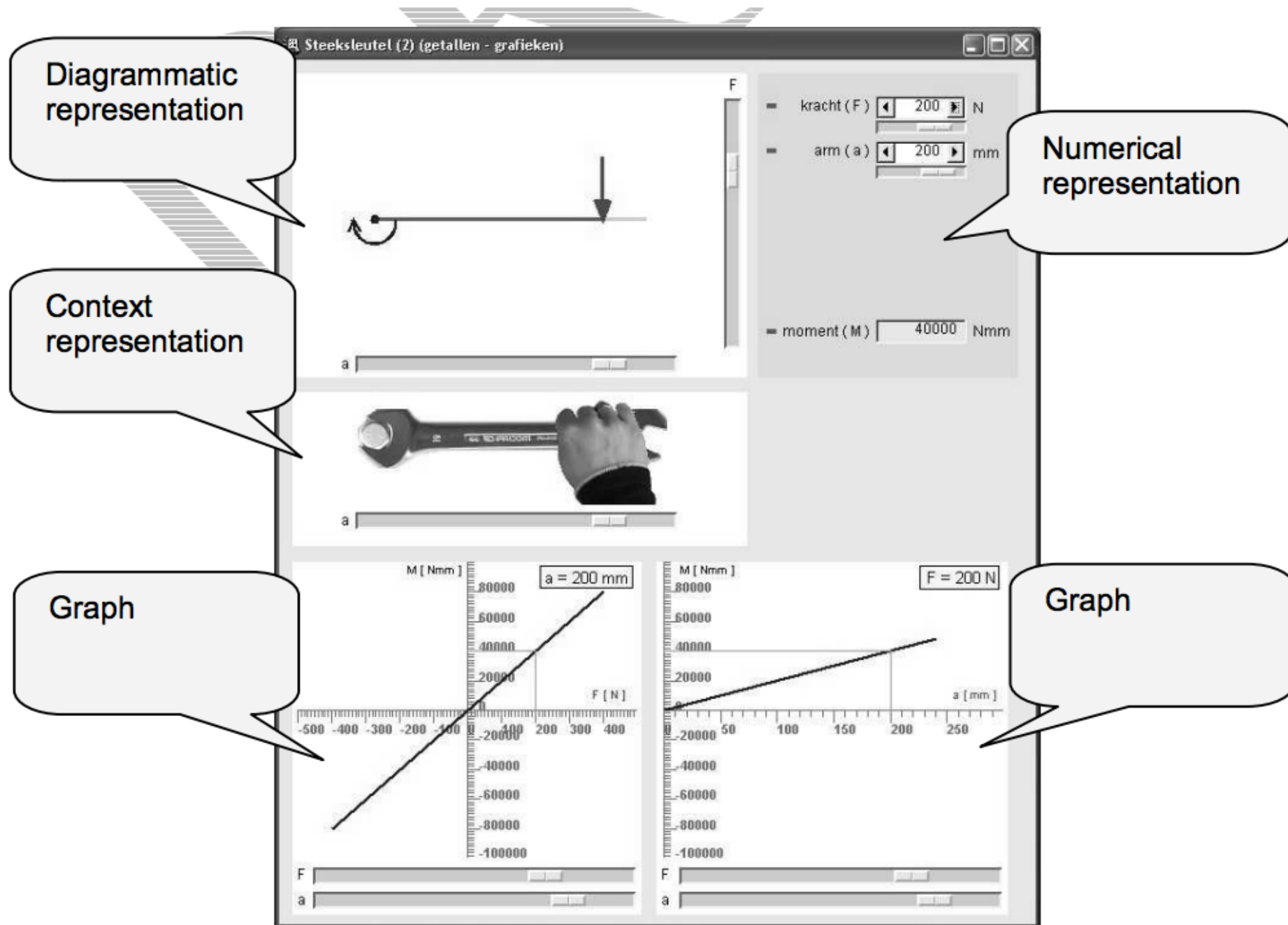
Repeated
Addition

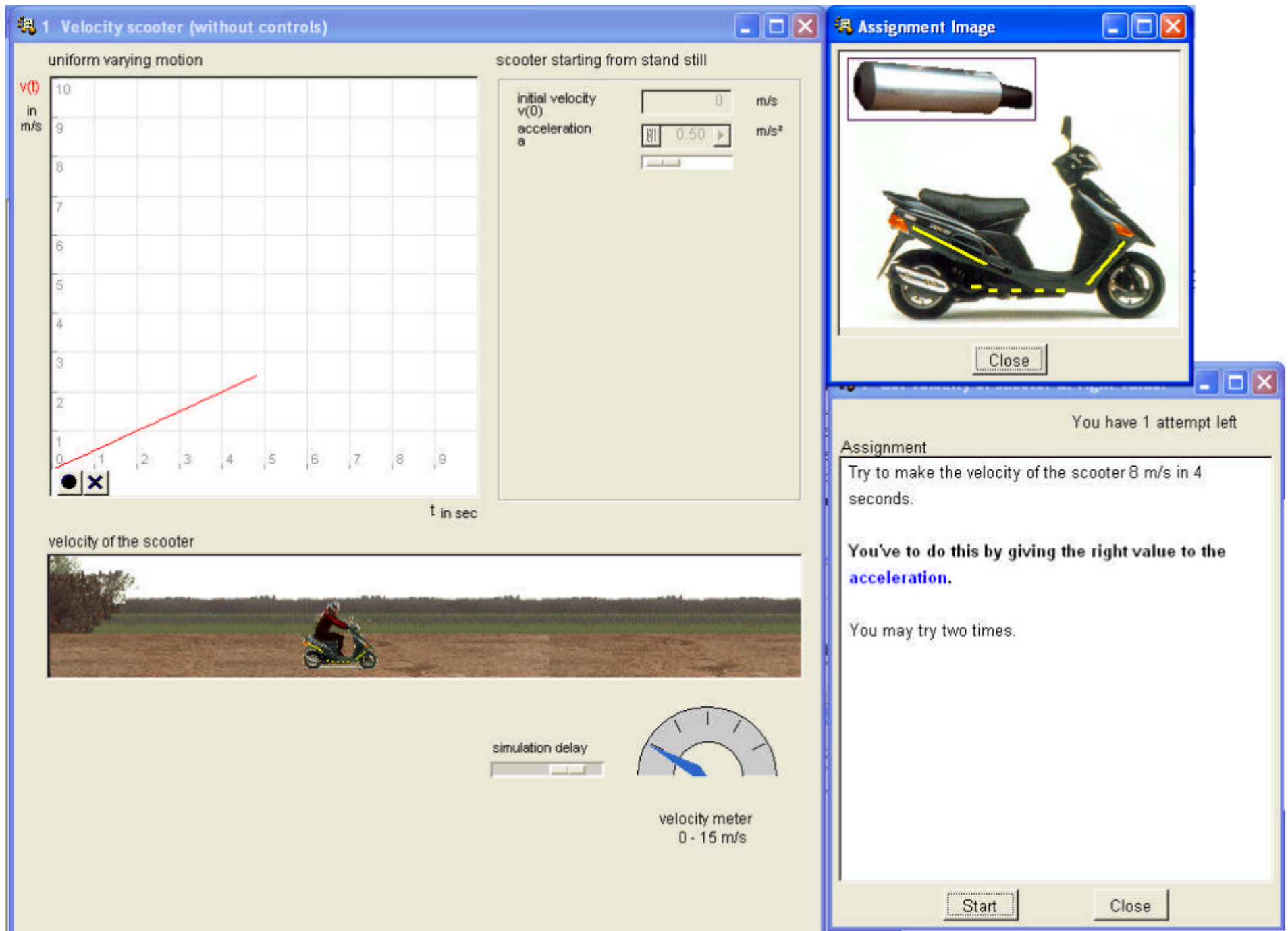
$$4 + 4 + 4 = 12$$

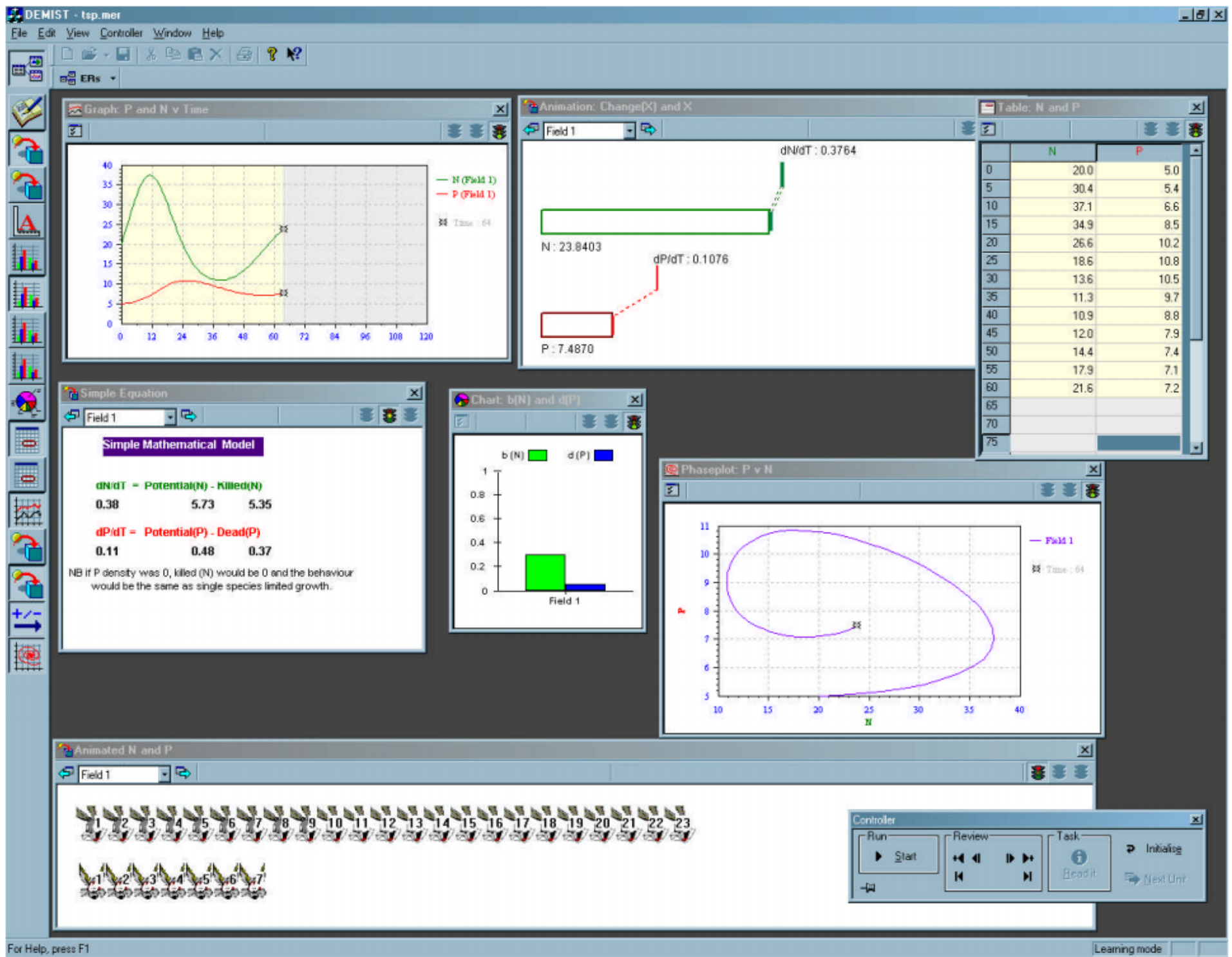
Number
Line



There is a large body of empirical studies that show that is beneficial for learners to switch between multiple representations.



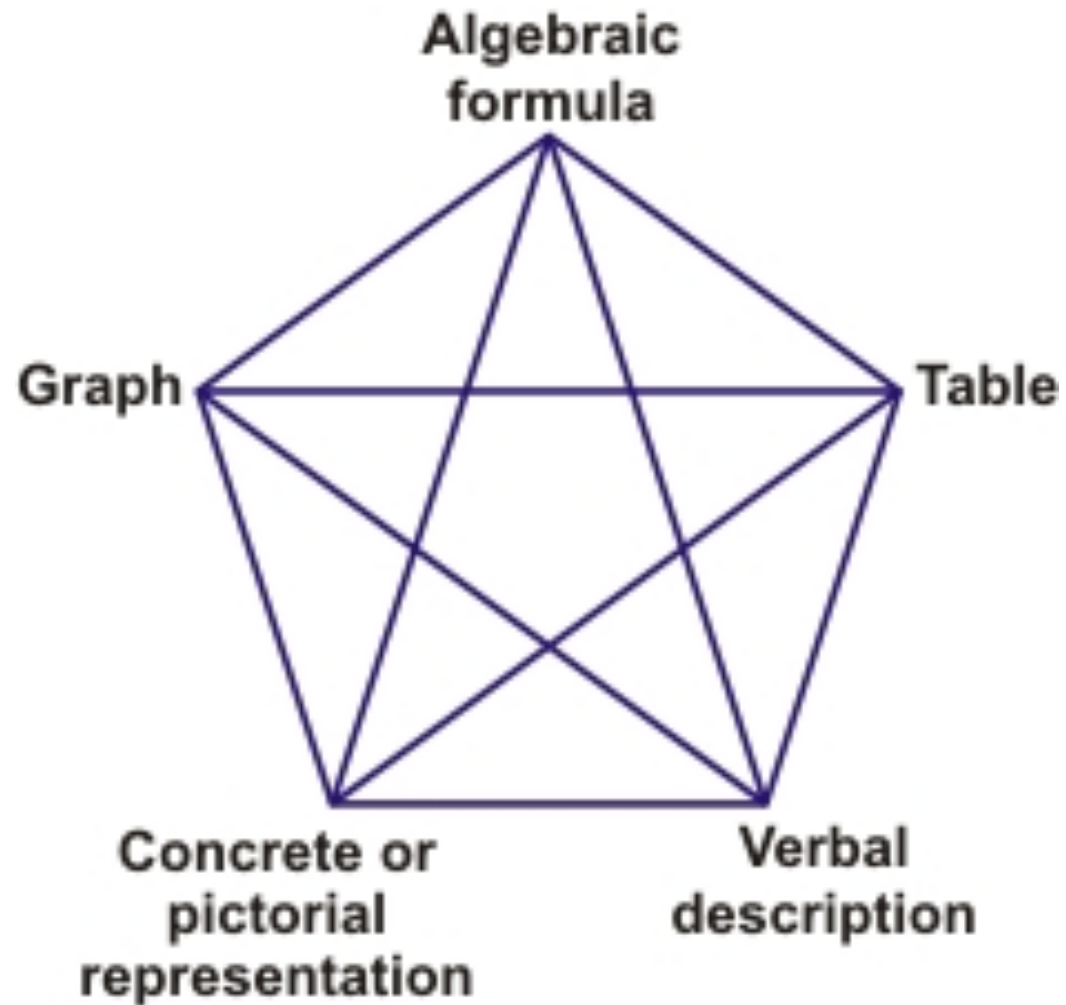




Edge Library

Translation Edges

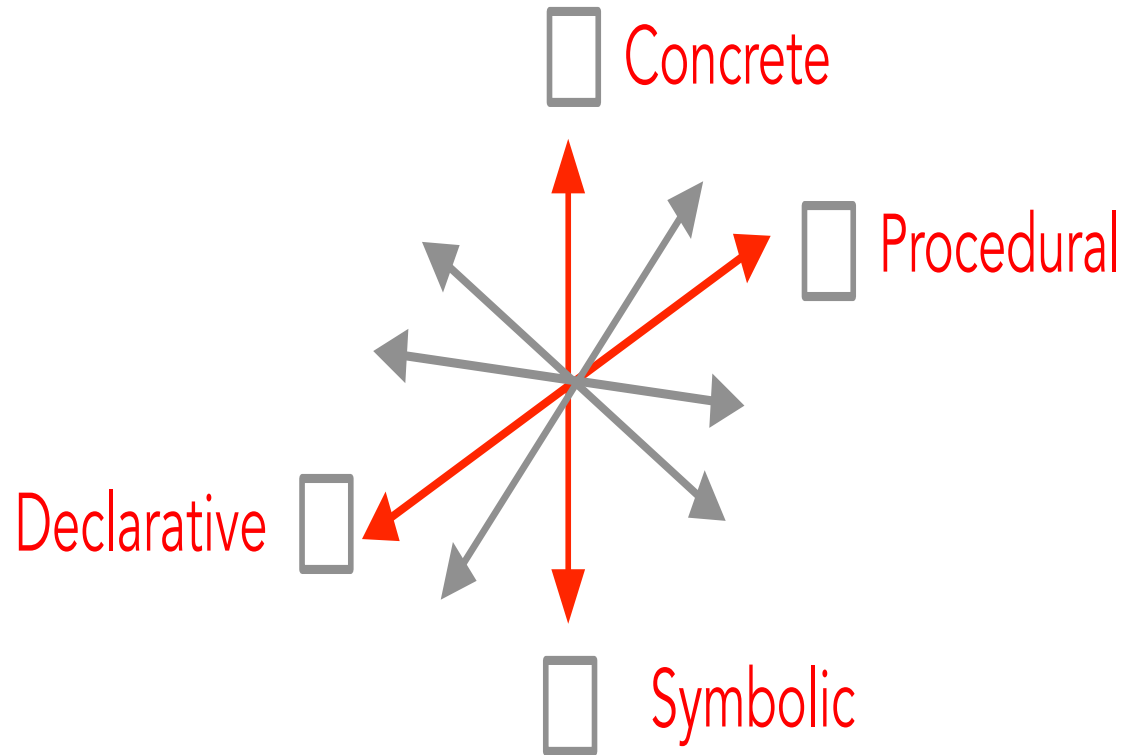
- Proceduralization
- Elicitation
- Alternate
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- Teach



Edge Library

Translation Edges

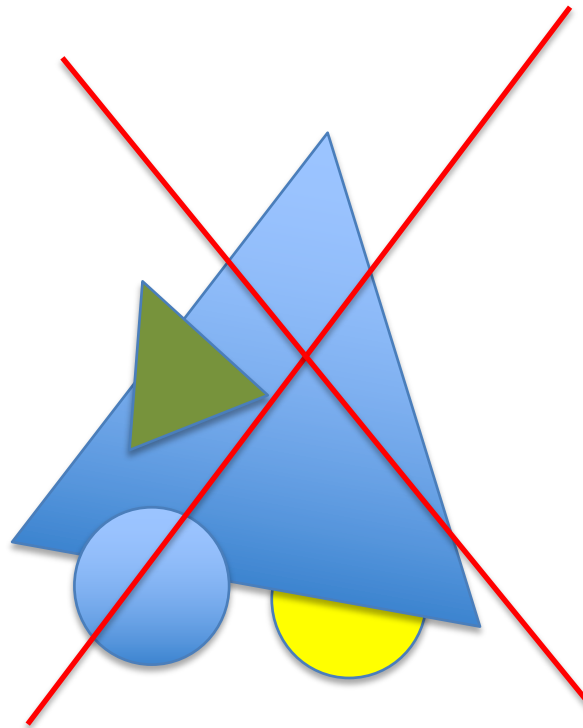
- Proceduralization
- Elicitation
- Alternate
- Reframe
- Reverse
- Repair
- Teach



- Multiple types (procedural, declarative)
- Multiple levels of abstraction (concret, abstract)
- Multiple representations
- Multiple viewpoints
- Multiple scales
- Multiple methods
-

A_1

A **splountz** is a triangle with 3 smaller shapes placed on different sides, one in the same color as the triangle and the two others in a different color.



A_2

A **splountz** is a triangle with 3 smaller shapes placed on different sides, one in the same color as the triangle and the two others in a different color.



Is this a Splountz ?

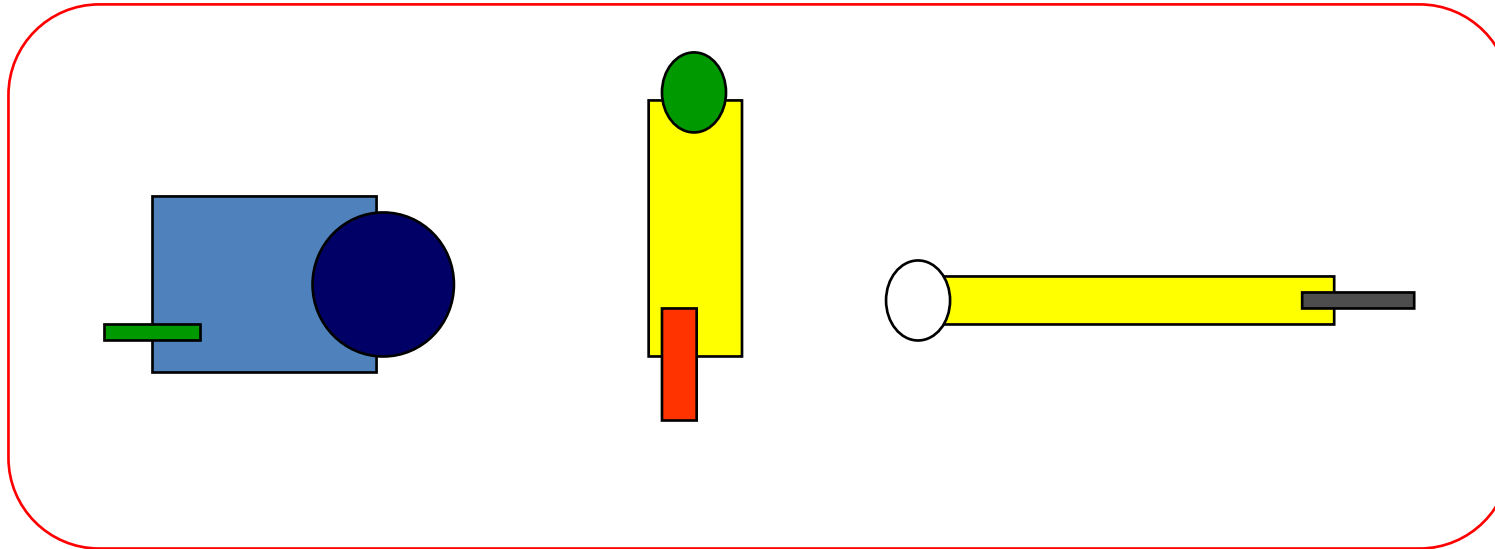
- ☐ Yes
- ☒ No

Label $(A_1, A_2) =$ deduction

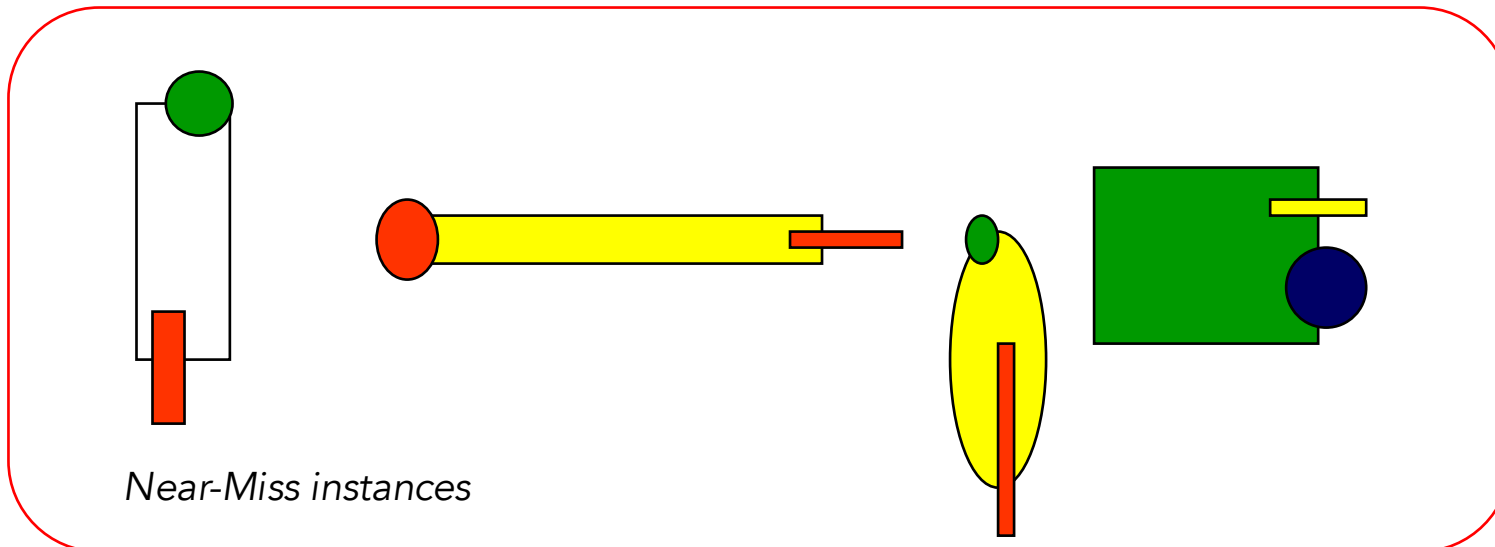
From the general to the particular

A_1

$SPUC_s$



Positive
instances



Near-Miss instances

Negative
instances

A_2

What is a SPUC ?

Label (A_1, A_2) = induction

From the particular to the general

Edge Library

Generalisation Edges

(G+) Induction

(G+) Deduction

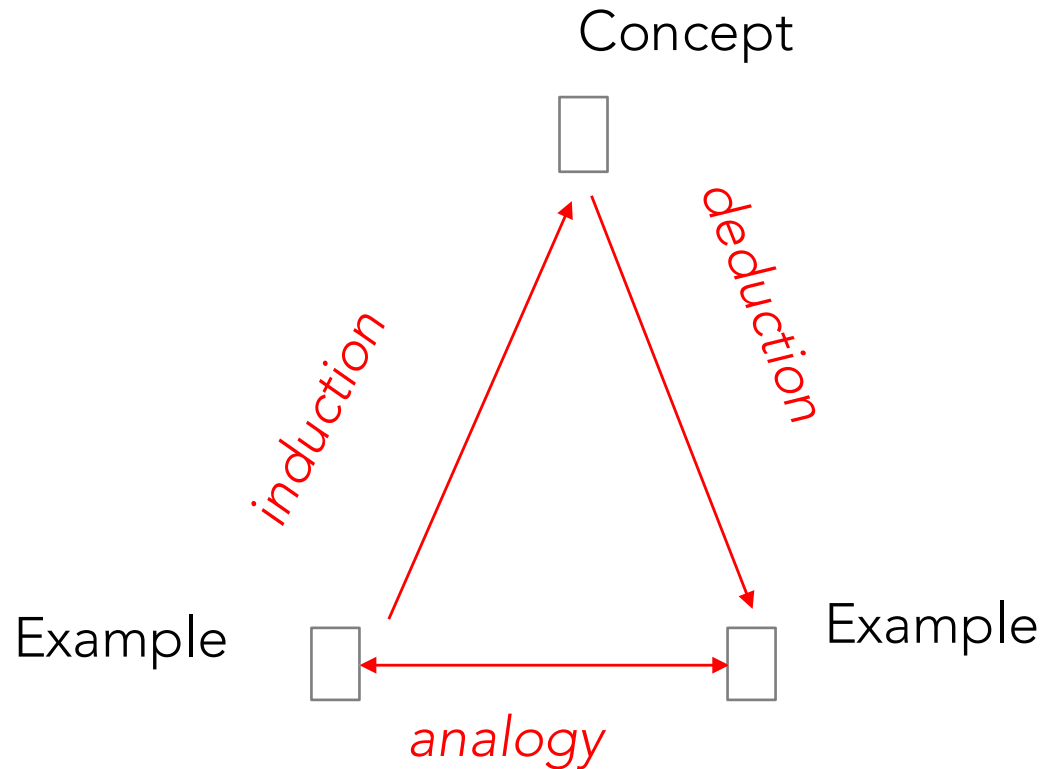
(G+) Extraction

(G+) Synthesis

(G=) Analogy

(G=) Transfer

(G-) Restriction



The problem of transfer

"If 1 bottle of milk costs 5 francs, how many can I buy for 35 francs"

Near transfer

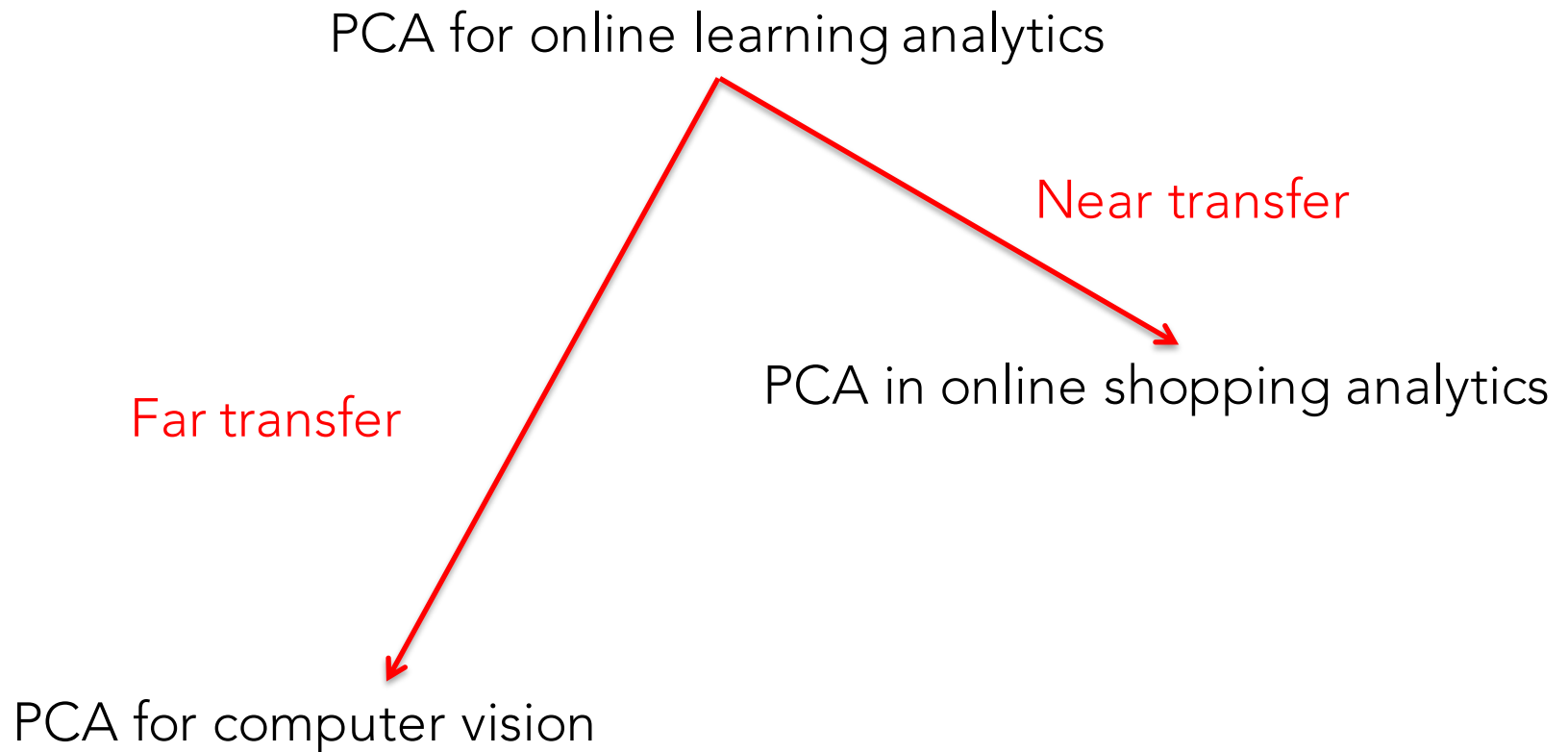
"If 2 books 10 francs, how many can I buy for 50 francs"

Far transfer

"If a car travels a distance of one kilometer in 5 minutes, how many kilometers will the car travel if it continues at the same speed for 35 minutes."

Humans are not very good at transfer because knowledge structures are very much anchored into a specific context.

The problem of transfer



Edge Library

Generalisation Edges

(G+) Induction

(G+) Deduction

(G+) Extraction

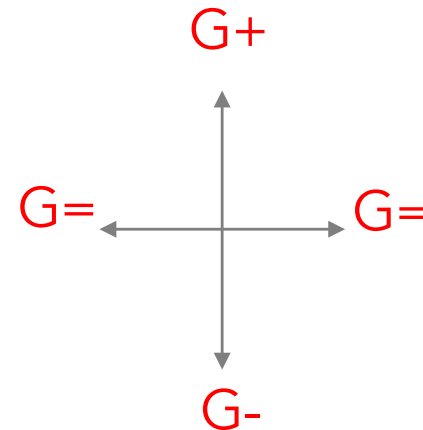
(G+) Synthesis

(G=) Analogy

(G=) Transfer

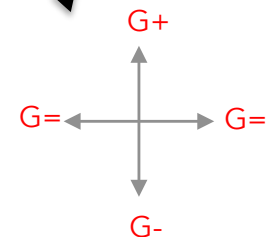
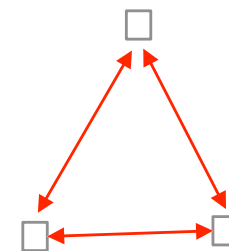
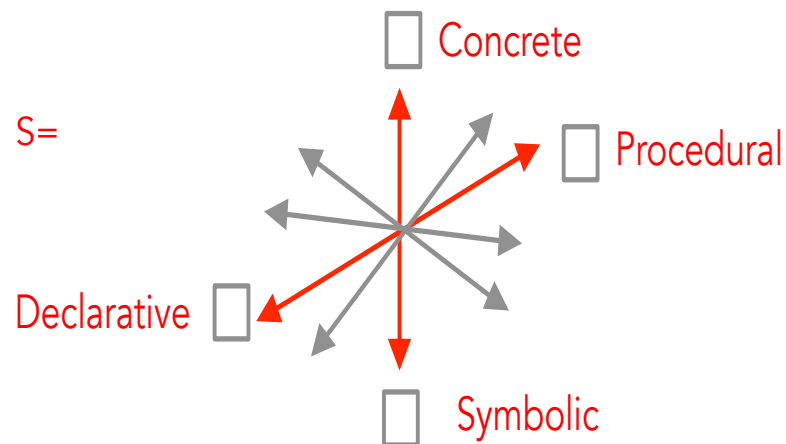
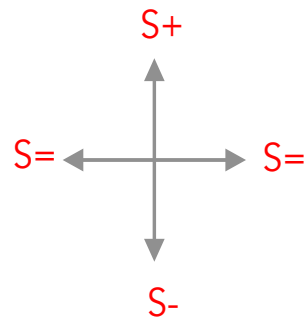
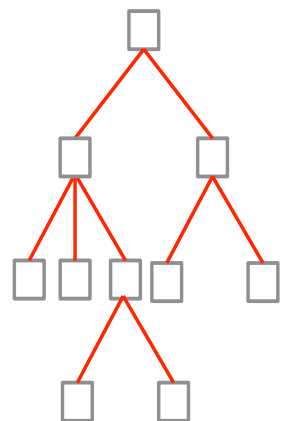
(G-) Restriction

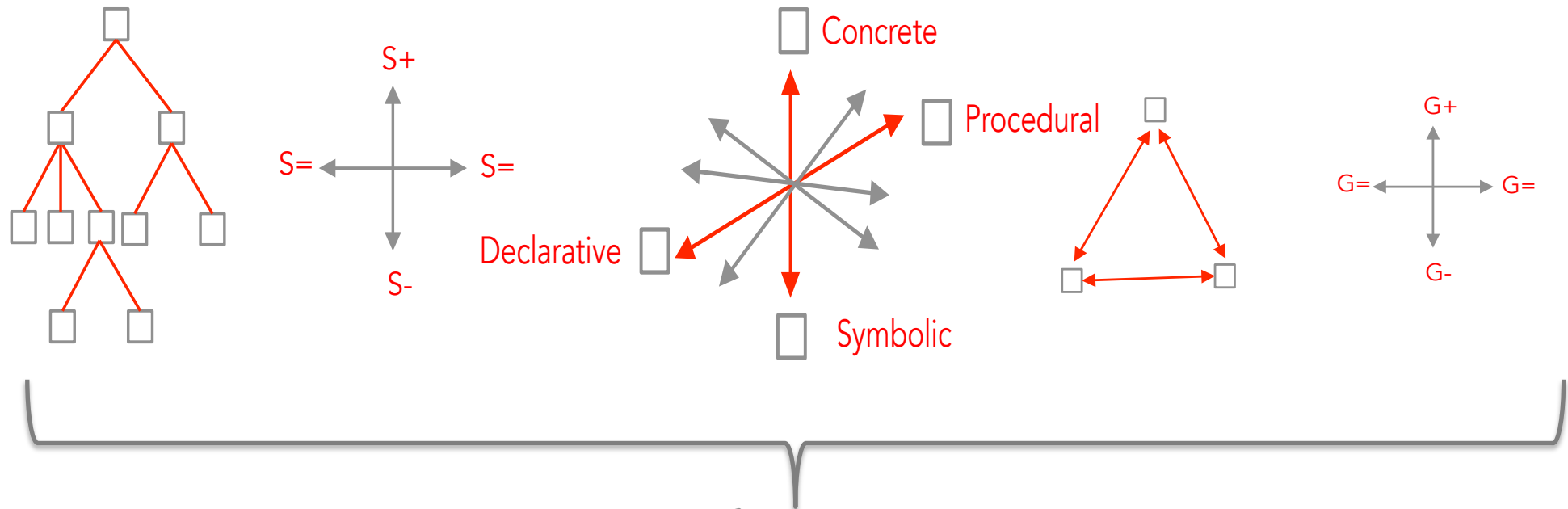
The learners become better in transfer if ,
during the learning scenario,
the teacher paid attention
to vary systematically the context
of the examples/exercises presented.



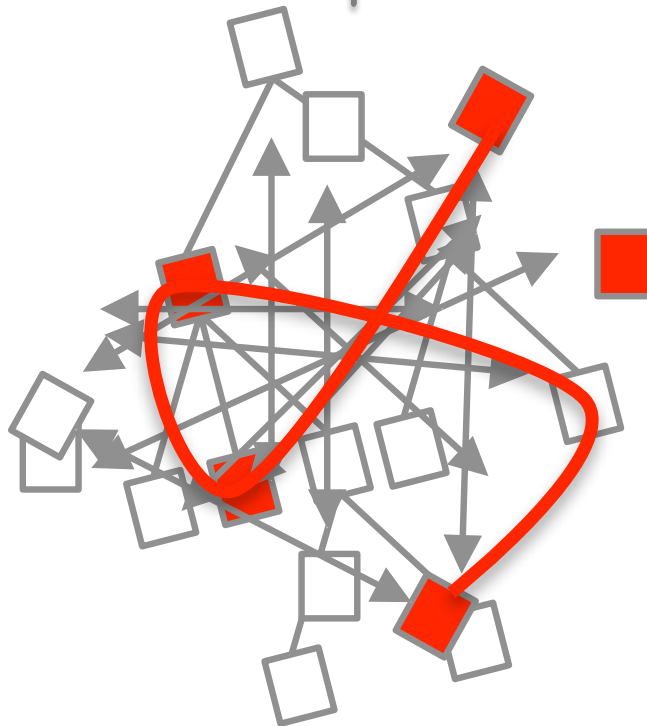
Library of Edge Labels

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(P) Data Collection	(S=) Identity	(T) Teach	(G-) Restriction



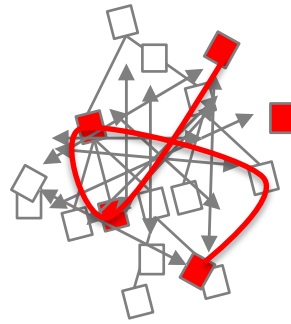


A learning scenario must explore the **knowledge mesh** in multiple ways, creating multiple pathways between various formats of knowledge.

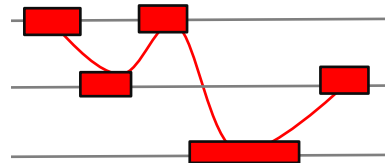
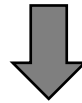


You don't know a forest if you walk around it or across it but only if you have crossed it in many ways, many directions, etc.

The orchestration graph translates this multidimensional exploration into a linear path, because time is linear.



Knowledge Mesh



Orchestration Graph