Tecfa

Sustainable IBL

inquiry-based science learning

Optimizing the
student learning/
teacher fatigue
ratio.

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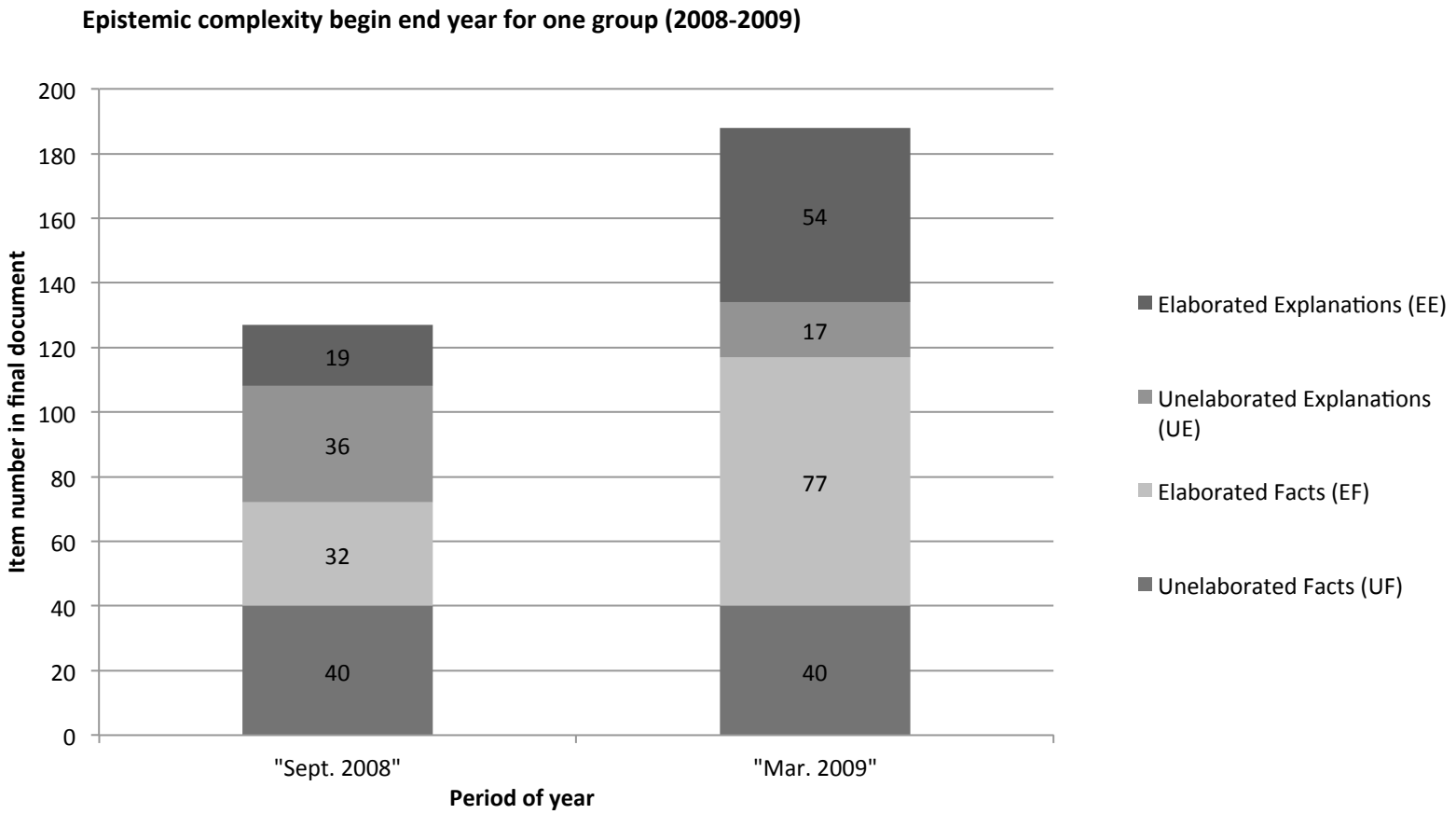
Rationale


Epistemic complexity begin end year for one group (2008-2009)
Item number in final document
200
180
160
140
120
100
80
60
40
20
0
19
36
32
40
54
17
77
40
"Sept. 2008"
"Mar. 2009"
Period of year
Elaborated Explanations (EE)
Unelaborated Explanations (UE)
Elaborated Facts (EF)
Unelaborated Facts (UF)

Scientific knowledge ?

GÉNÉTIQUE

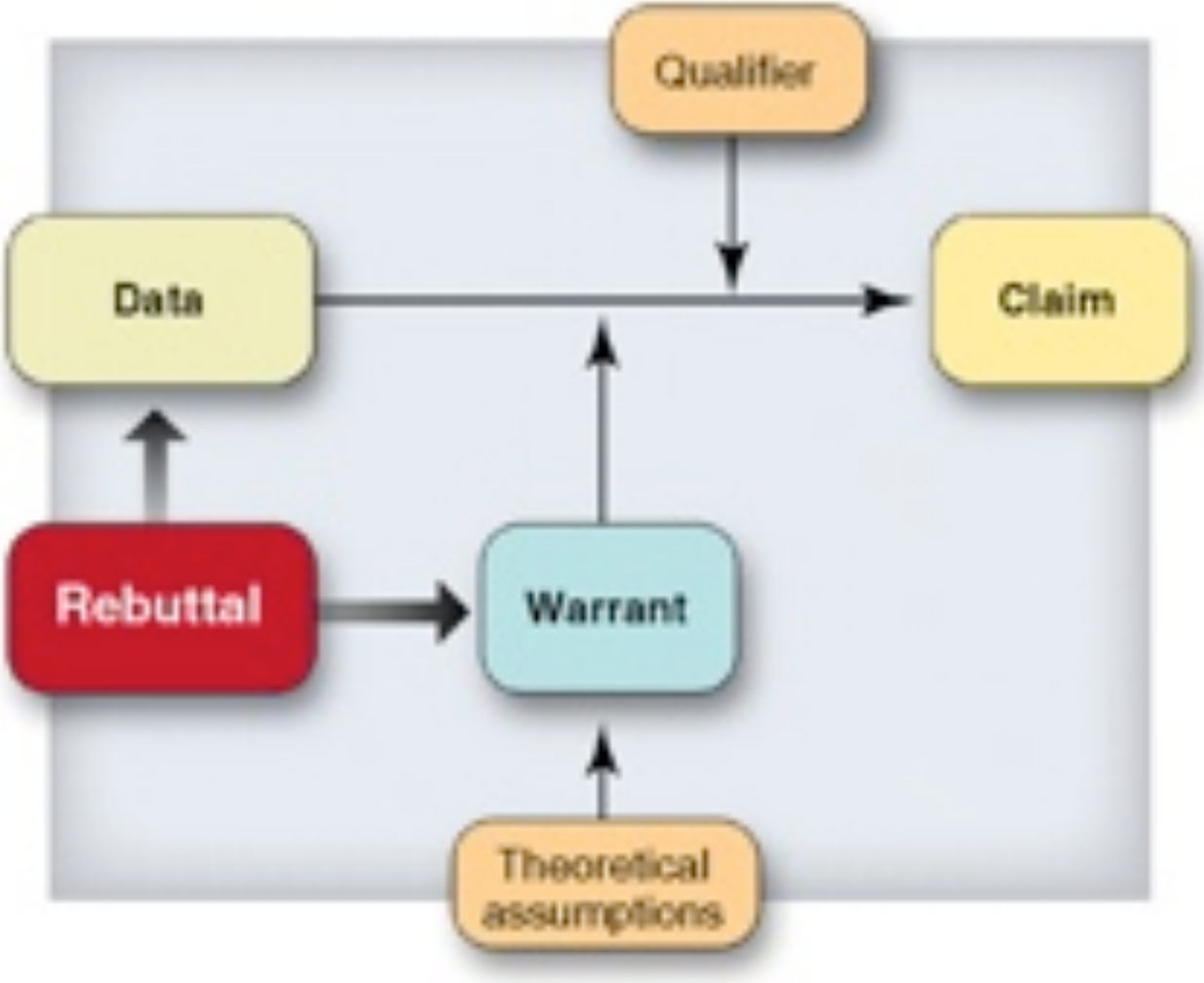
D'un individu à l'autre, les gènes diffèrent de 12 %

Nous serions plus différents qu'on ne le croyait jusqu'à présent : 3 000 de nos gènes, soit près de 12 % d'entre eux, ont subi des modifications au cours de l'évolution, et nous différencient aujourd'hui les uns des autres au sein de l'espèce humaine. En cause : des duplications, délétions et insertions de segments d'ADN, qui peuvent influencer l'activité des gènes. Une équipe de chercheurs a inspecté et dénombré, *via* une nouvelle technologie de scanner, ces variations dans le génome de 270 volontaires provenant d'Europe, d'Afrique et d'Asie. Verdict : 1 447 variations, dont certaines sont déjà connues pour être liées aux maladies d'Alzheimer et de Parkinson, tandis que d'autres influenceraient la sensibilité au virus HIV-1 ou seraient impliquées dans certaines formes de daltonisme. Une découverte qui expliquerait les différences de sensibilité à l'environnement, aux médicaments et aux maladies. V.B.

> 3 000 de nos gènes nous différencient au sein de notre espèce.

Scientific *understanding*

- Justified (Toulmi
  - Based on exper
  - Aware of metho
  - Debated with c
    - Subjected to
- "Thickness" of s
- Understanding i
  - To *understand* s
    ≠ to know abou
- Autonomous *jus*



Justification in science and in school

- **Experiment** – publication - discussion (social confrontation)
- Science – Nature -> proxy for experiment
- Textbook : proxy for proxy for experiment**...**
- Teacher handout : proxy for proxy for proxy for experiment ...

Didactical transposition (Chevallard, 1991) Loss of methods, uncertainty, limits, discussion, -> definitive visually striking testable conclusion

-> Confront students to **authentic** resources

IBL : focus on *learning*

« In other lectures, you wait a few moments and the teacher gives the answer, so you write it down and don't do the effort of thinking, and finally you must redo all the work of understanding at home. "

Student in questionnaire end of year 2006

Inquiry …a sharing of responsibility towards knowledge between the teacher and the students leaving important parts of responsibility to the students Bueno-Ravel, L. et al. (2010) *Mind the Gap*.

Teac

- Don’t teach,
  - because science is r
  - because it doesn’t v
- Manage interaction
  resources
-
-

Most critical design elements

- 1 ° Authority separation
  - Scientific authority from experiment or authentic resources
    - Wean students from T authority in justification
  - Firm but encouraging pedagogical authority : T
  - Guide by negotiating questions

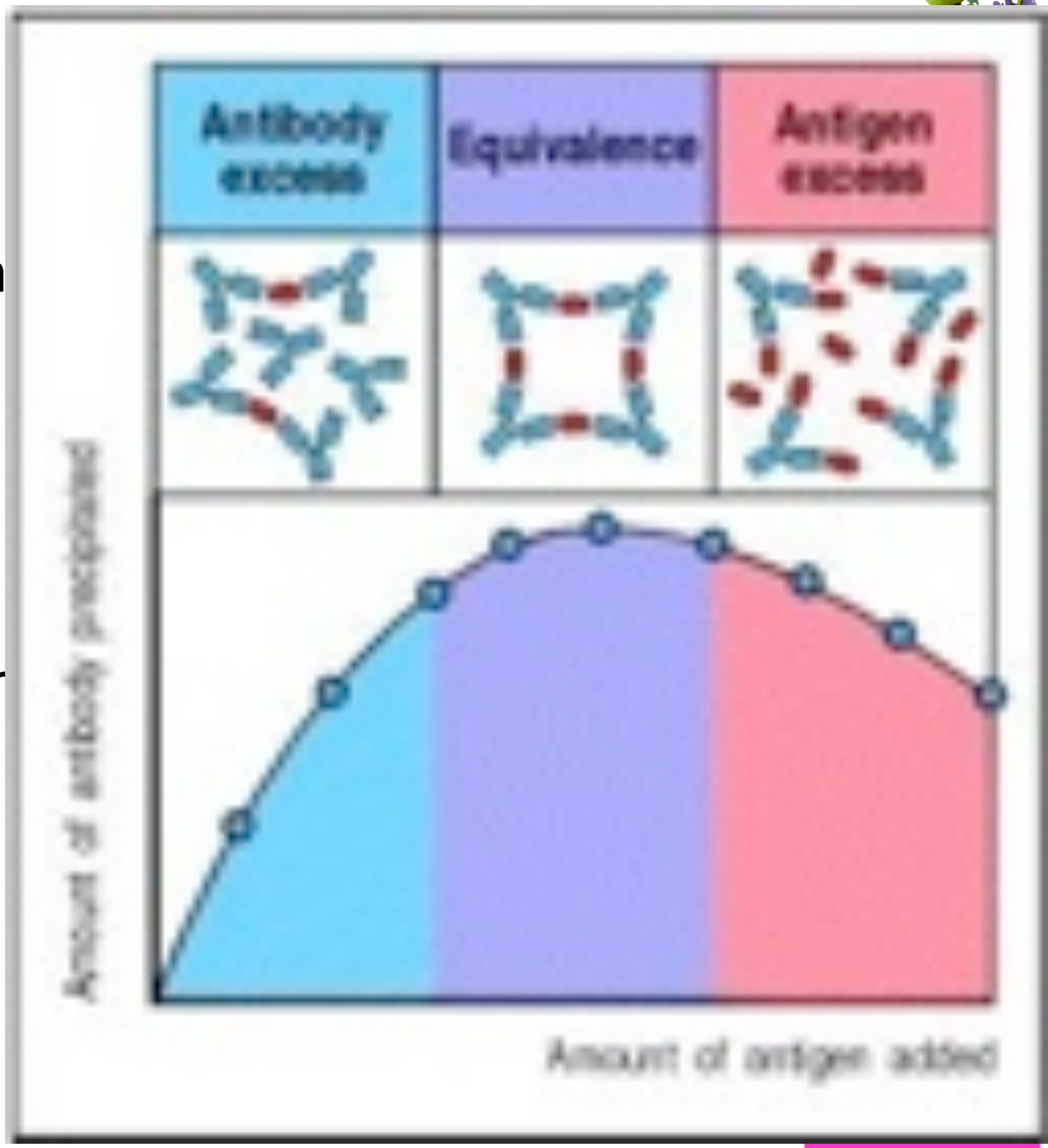
Which Q° is

- Discuss with n

- 1) What is the group ?

- 2) Why is mixir giving udp and

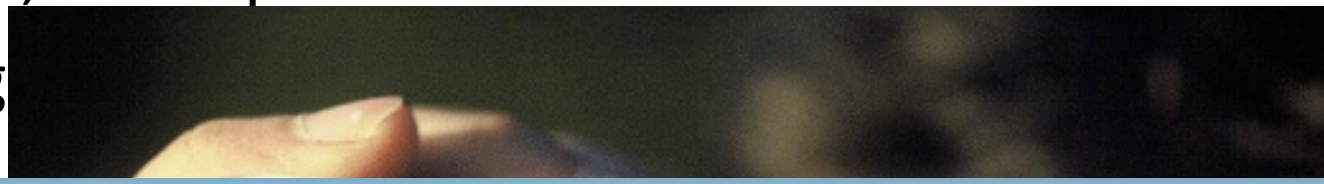
- Vote 1 or 2

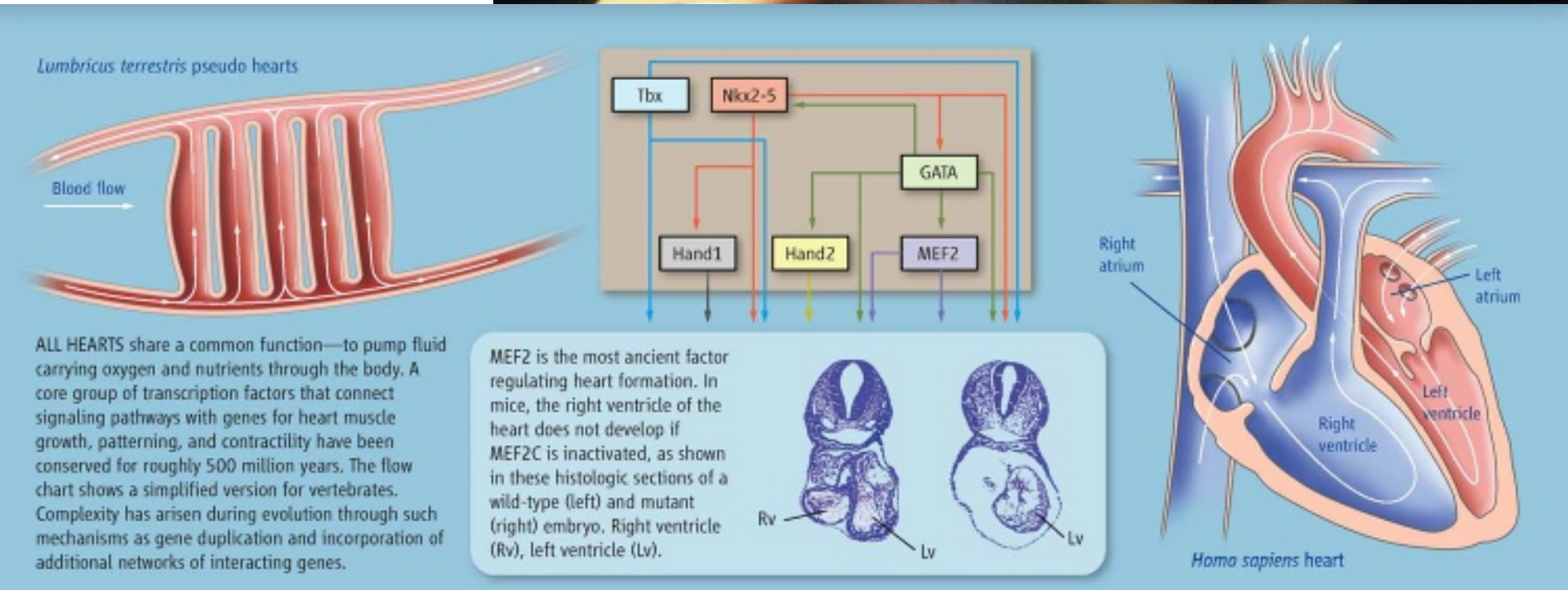


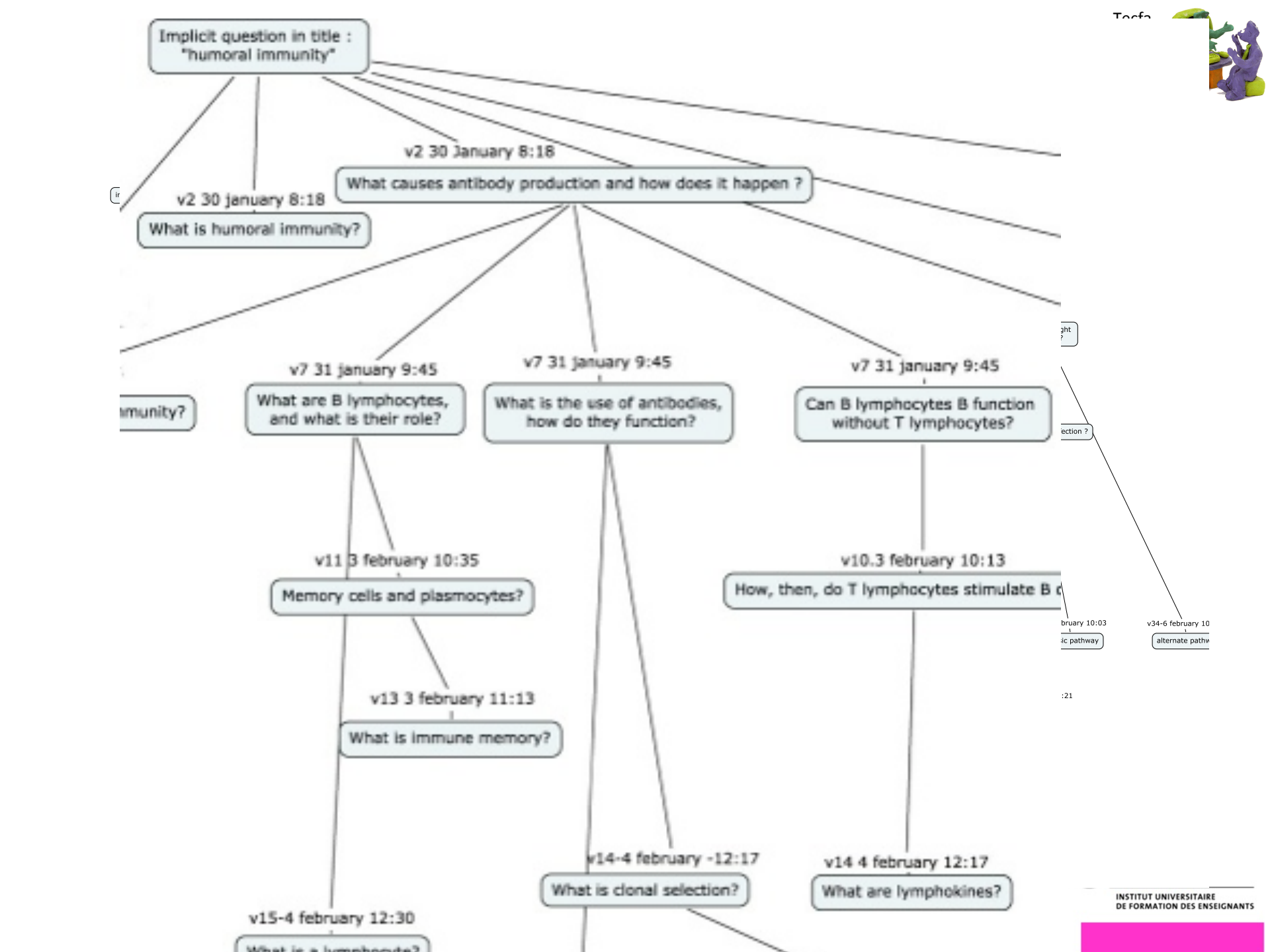
Janeway, fig A9

Good scientific question?

- Biology main question
  - Ontological, Descriptive -> 1950
  - Underlying






Implicit question in title : "humoral immunity"
v2 30 January 8:18
What causes antibody production and how does it happen ?
v2 30 january 8:18
What is humoral immunity?
v7 31 january 9:45
What are B lymphocytes, and what is their role?
v7 31 january 9:45
What is the use of antibodies, how do they function?
v7 31 january 9:45
Can B lymphocytes B function without T lymphocytes?
v11 3 february 10:35
Memory cells and plasmocytes?
v10.3 february 10:13
v13 3 february 11:13
What is immune memory?
v14-4 february -12:17
What is clonal selection?
v14 4 february 12:17
What are lymphokines?
v15-4 february 12:30
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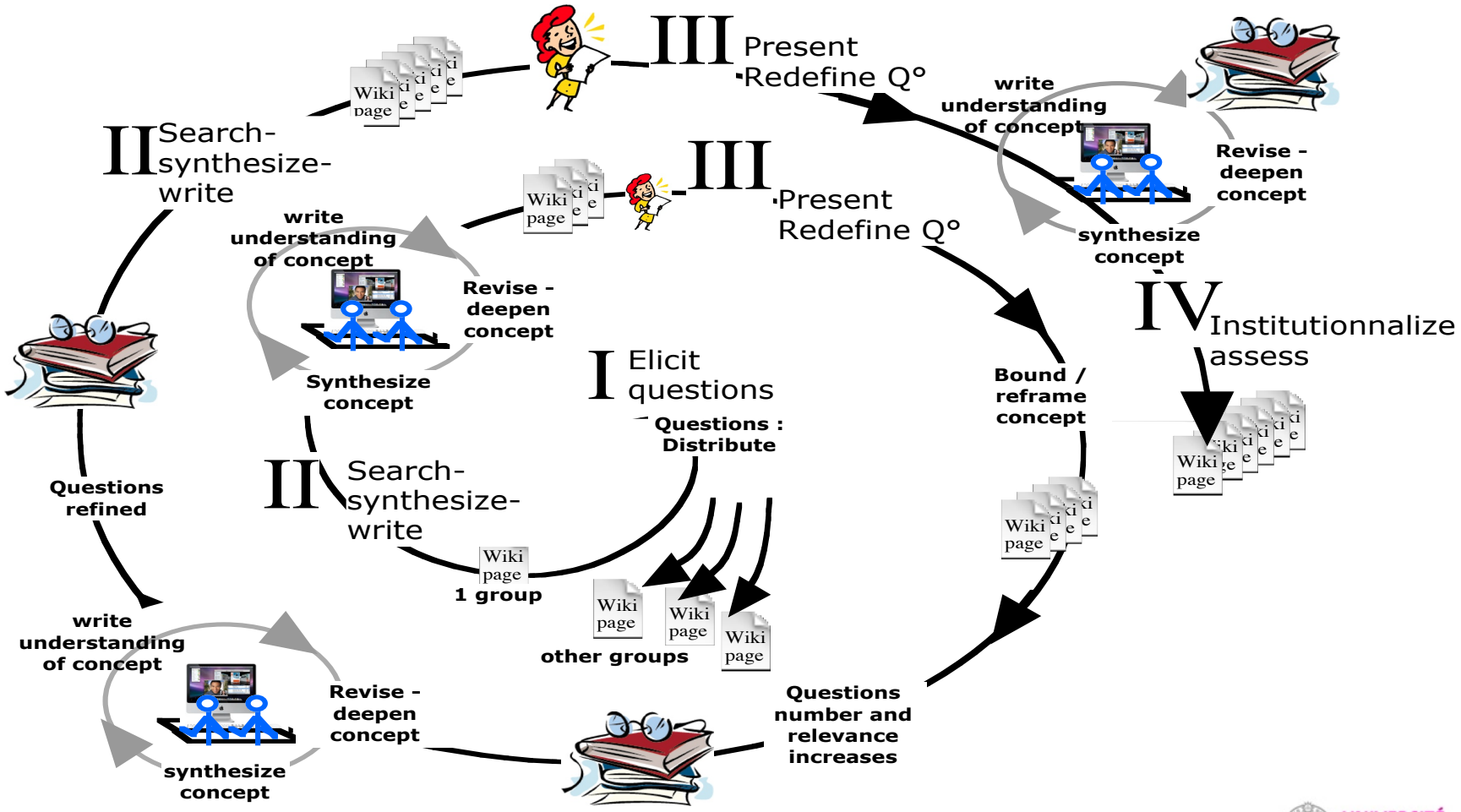
Most critical design elements

- 2° Student *responsibility* (towards peers) of developing a share of knowledge
- Learners « own » Q° (want to / understand)
- Chapter divided into groups
- Co-writing of critical document for peers to prepare exams
- Peer presentations – early
- Commitment to knowledge improvement

The design we analyzed



Question-centered and Q°-driven

- RD8: Questions negotiated in reference to the objectives drive investigation
  - Supervise Q° ~ as conceptual attractors
  - Question refinement : vague Q° -> good Q°
- RD10: Responses should address the concept defined by the question: conceptual coherence of questions and corresponding answers
  - Allows guidance
  - Prevents “Google - drowning “

Critical variable for guiding

- Good scientific answer ?
- Epistemic complexity (K. Hakkarainen, 2003, Zhang, J., Scardamalia, 2007)
  - Facts simple elaborated explanations simple elaborated
- Quality of answer
  - Content independent
  - Relevant (Morange 2003)

Lombard, F. E., & Schneider, D. K. (2013)**. Good student questions in inquiry learning**. *Journal of Biological Education, 47*(3), 166-174. doi: 10.1080/00219266.2013.821749

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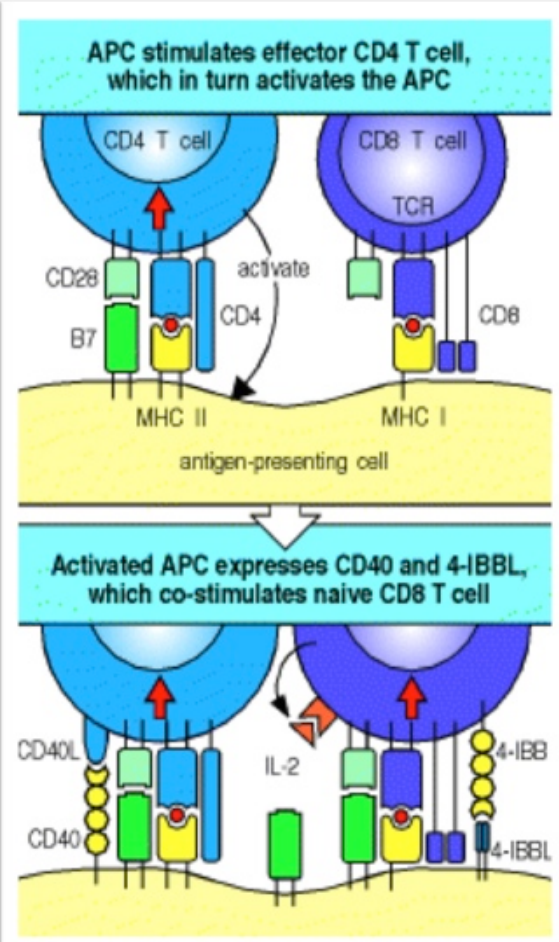
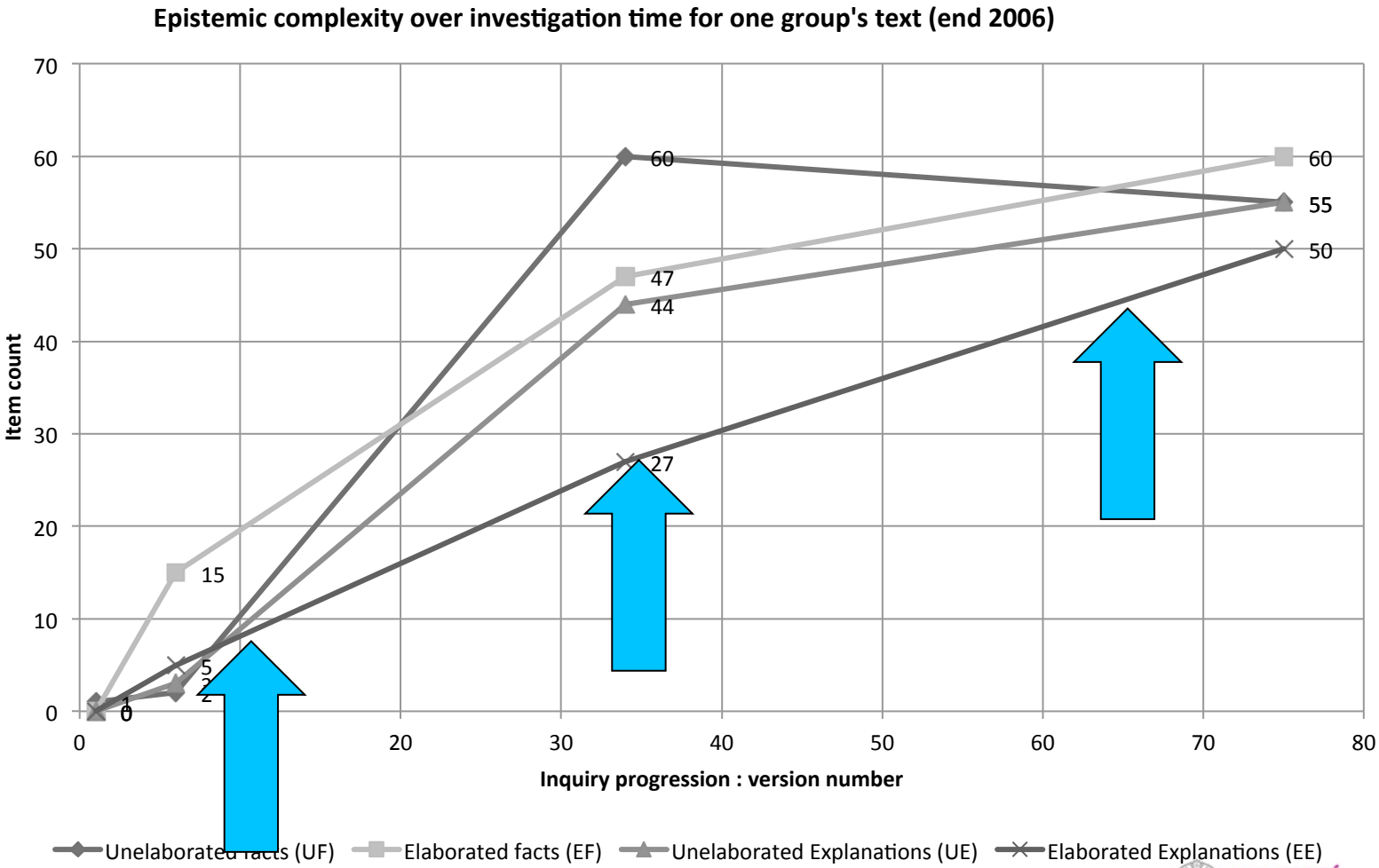
Simple facts… to … Elaborated **explanations**

- Reasons, relationships, or mechanisms elaborated.

How are the antigen-specific type of lymphocytes activated by cytokines, i.e. what is double activation?
Double activation. Certain T8 responses require T4 : T8 recognizing antigens on weakly co-stimulatory cells can only be activated in presence of T4 linked to the same APC. This happens mainly by way of a T4 recognizing an antigen on an activated APC inducing high levels of co-stimulatory activity on the APC, which in turn activates T8 to produce it's own IL-2. *(Translated from french by author*) »



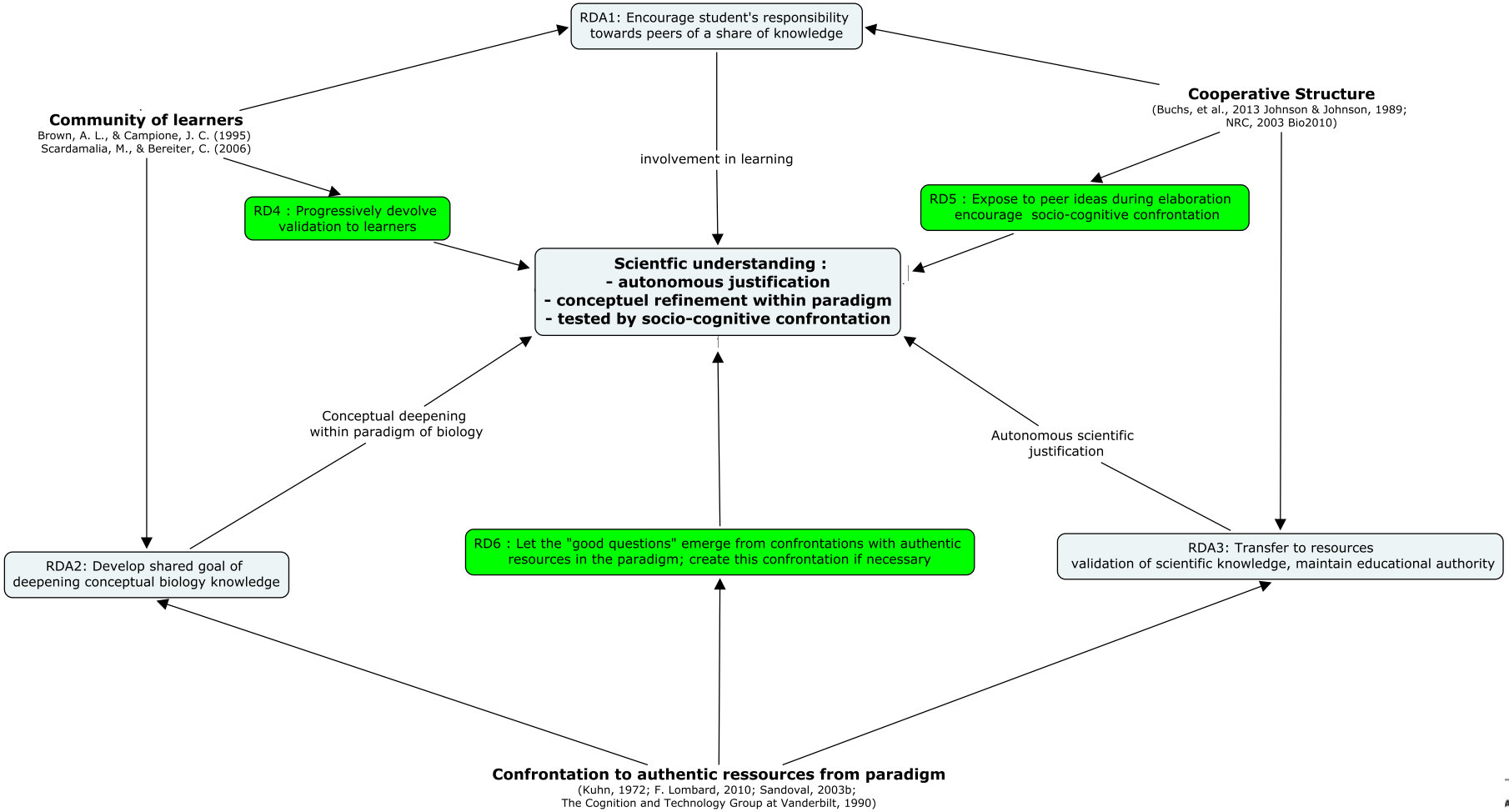
Teacher intervention ->phase change



Question negotiation

- Questions mainly arise from resources and activities
- Questions are revised during presentations
- Questions are supervised by T
- Q° framed by Objectives, guided by paradigm - resources

Teacher centered view



Student- Teacher share common goal of conceptual knowledge deepening

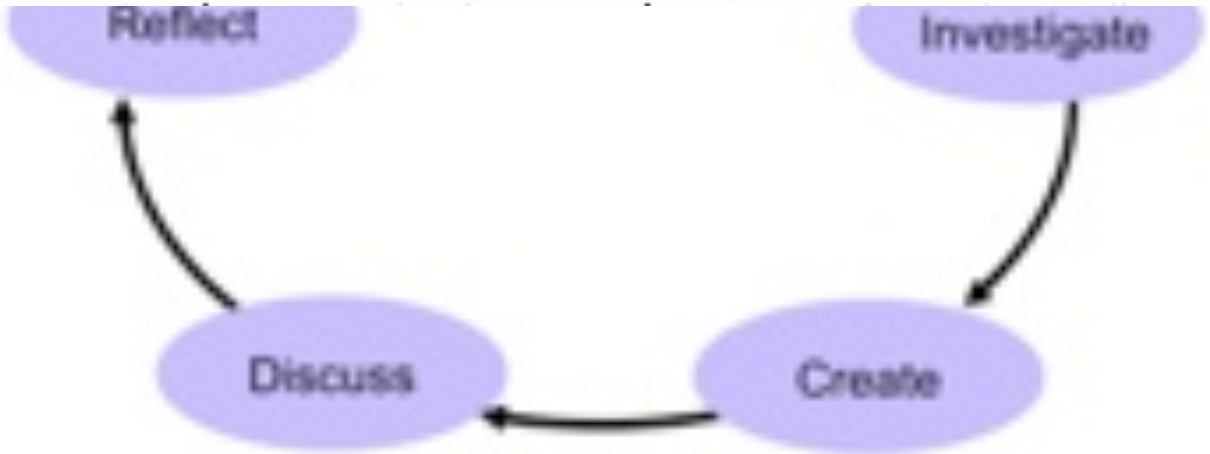
- Assessment, feedback focused on improvement :
  - RD23: Teacher feedback encourages cognitive conflicts by

Comment un gène peut-il être régulé ?

La régulation des gènes ce passe sur l'ADN. *plus haut vous dites que cela peut se passer ailleurs... précisez que vous étudiez ce cas bien documenté* En effet, il y a tout d'abord une lutte entre activateurs et répresseur pour savoir *je ne pense pas que ces molécules savent quoi que ce soit... on préfère un langage objectif en science.* si le gène sera inhibé ou activé. Certains répresseurs empêche l'activation de l'ADN polymérise et d'autres empêche la liaisons des activateurs à l'ADN ce qui inhibe le processus de la transcription. Si le régulateur de protéine ne vient pas se lier avec l'ADN *ici il manque un bout de phrase ...* polymérise alors la protéine ne se fera pas au final. Dans

constru

- Cooperat
  - Studen
  - RD5: E
    encour



Focus on student knowledge *improvement*

- Tolerate imperfection, but progressively develop quality of explanation

- Assess for progress not moral values
  - Allow revision

What guidance ?

- Firm, encouraging pedagogical authority allows student autonomy
  - RD27: Educational authority is largely embedded in the structure of the design thus confirming the freedom of students within that framework and frees the teacher for conceptual control and relationship management

Vous êtes-vous sentis autonomes mais suffisamment encadré-e (à la fin) ?

Je me suis senti désorienté-e =1 -> L'autonomie me convenait bien =4

Average 4 years = 3.41 out of 4 sd.= 0.69 N = 22

field and the emergence of epistemic complexity


We Love Biologie!

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- With the support of Département de l'Instruction Publique Genève, DGPO
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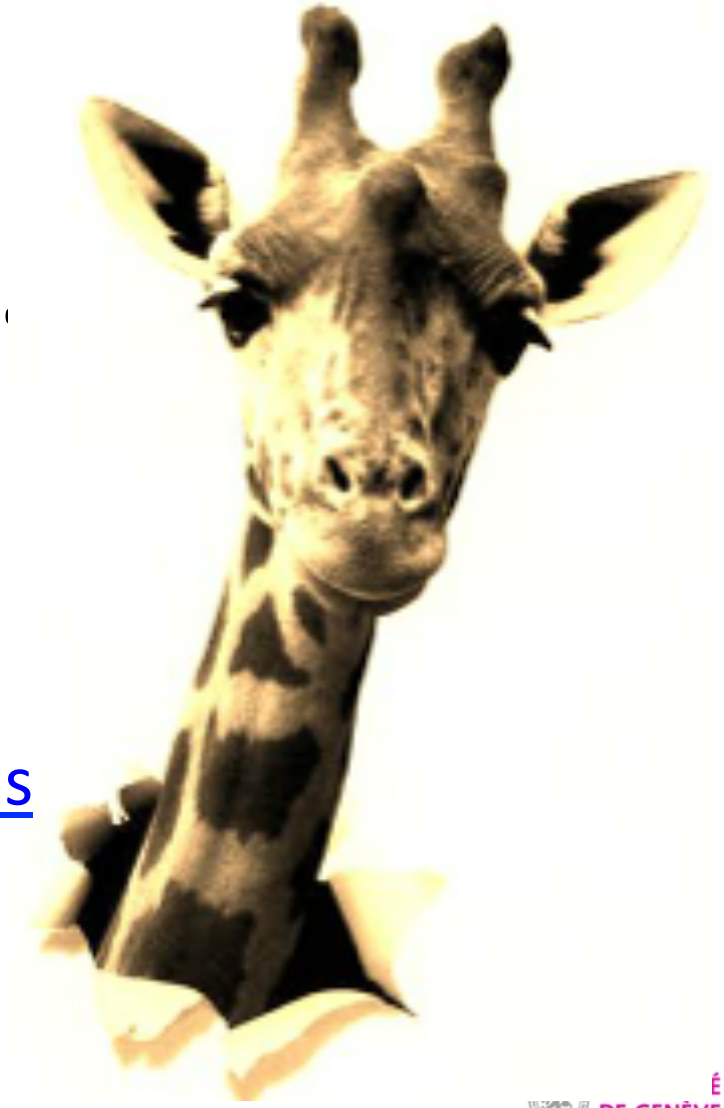
  - Collège Calvin

Thankyou for
For your attention



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Sample

- 19 year old final higher secondary school students N ~ 98
- Wiki records 10^6 words
  - Questionnaires
    - End of year
    - 1 year later at university
- 2002-2014
- Full year inquiry
- 12-16 students / 4 groups
- Normal time, curriculum, exams

T=R !

Truth in science ?

- Science is models
  - Hypothetical
  - Modifiable
  - Appropriate for certain problems
  - Limited scope (Martinand, 1996)
- Models are accepted for their capacity to explain data ≠ truth

Didactical transposition

Confront students to authentic resources

■ **récepteurs au salé**: pointe de la langue, bord latéral

Chandrashekar, J., Hoon, M. A., Ryba, N. J. P., & Zuker, C. S. (2006). The receptors and cells for mammalian taste. *Nature, 444*(7117), 288-294.

Salé

(a)

Figure 12.6 Répartition des récepteurs sur la langue pour les quatre qualités du goût.

l'amer, l'acide (1 g de sucre est perceptible dans 1 litre d'eau, 1 g de sel l'est dans 10 litres).