Inquiry learning… what is *relevant* evidence ?

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Rationale

- "Educational gains" everywhere
  - Strict statistical significance but…
    all interventions have an effect (Hattie 2008)
  - Good evidence bur re-use limited
- **Poor** scientific understanding of students (PISA, Rocard, 2006)
- **Inquiry** advocated Europe-wide
- -> Better **descriptions** of learning designs *Teufel steckt im detail*
- -> Relevant **measure** of student scientific knowledge
  - inform design and learning supervision.

Description of learning design

- Relevance
  - Capture the dimensions that influence learning gains
- Socio-cognitive view of learning
  - Learning triggered by perturbation of cognitive environment that cannot be ignored
    - => Milieu (Brousseau, 1998)
- Effects of activities ?
  - Describe expected cognitive and motivational states, not activities (Altet, 1993)

How to describe « milieu » ?

- Milieu often not described (activities)
- Design Rules
  - Describe and analyze traces of (socio) cognitive states
  - Suggests actions to guide towards cognitive desired states
  - Linked to educational (cognitive, motivational, …) effects that can be expected
- Analyse design dynamics
  - Abstract design (conceptual structure)

Epistemic complexity

- Epistemic complexity (Hakkarainen, K. 2003, Zhang, J., Scardamalia, M. 2007)
- Current biology paradigm
  - Explanations of underlying mechanisms (Morange, P. 2003)
  - ≠ descriptions (facts)
  - -> elaborated explanations
- Higher level cognitive skills (Bloom, 1956)

Research Design

- Part of a larger (PhD) research
- Develop IBL design (~10 years)
- Validate design :
  - School : adequate curricular / results /
  - Relevant to biology paradigm
    - In-depth scientific *understanding*
- Analyze design : DBR
  - Analyze iterations of design / holistic approach
  - Conceptualization
    - -> Relevant variables
  - Validated Design Rules

Inquiry Based Learning

- How does the teacher ensure students address the « good » questions while students keep ownership of Q°
  - Under press in JBE
- What scaffolding / resources access / social structure guides towards in-depth scientific knowledge ?
- Findings mostly not discussed here
  - 34 Design rules
  - Synthetic abstract model of IBL.

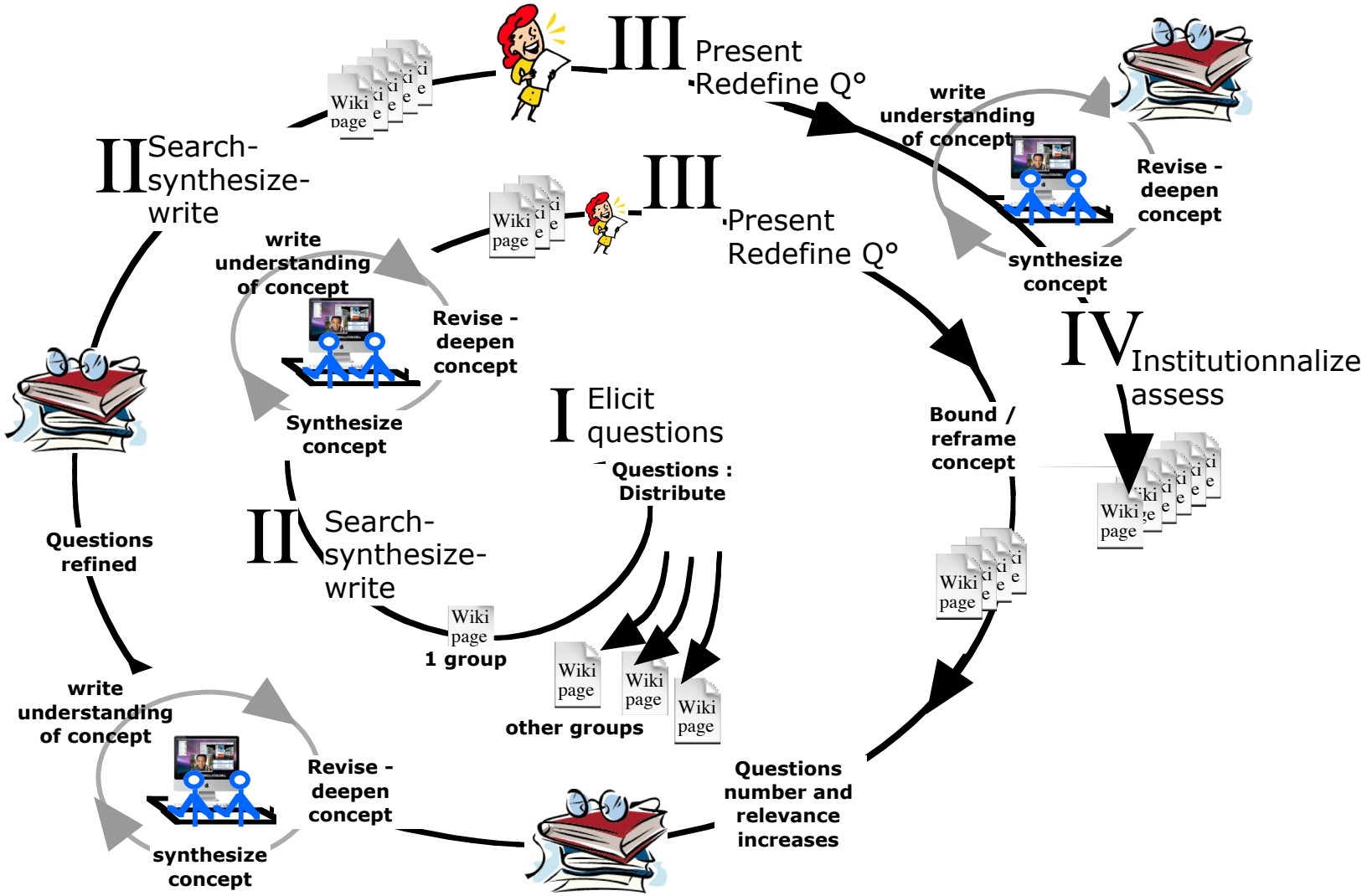
« In other courses, you wait a few moments and the teacher gives the answer, so you write it down and don't do the effort of thinking, and finally you must redo all the work of understanding at home. "

Student. Evaluation questionnaire end-of-year 2006

Research Q°

- What is relevant evidence ?
- What dimensions are relevant to describe designs
- What measure of student understanding Relevant / Content independent ?
  - Cf EARLI 2013 “Can epistemic complexity be used as a measure of inquiry progress in science education ?”

The design we analyzed



Sample

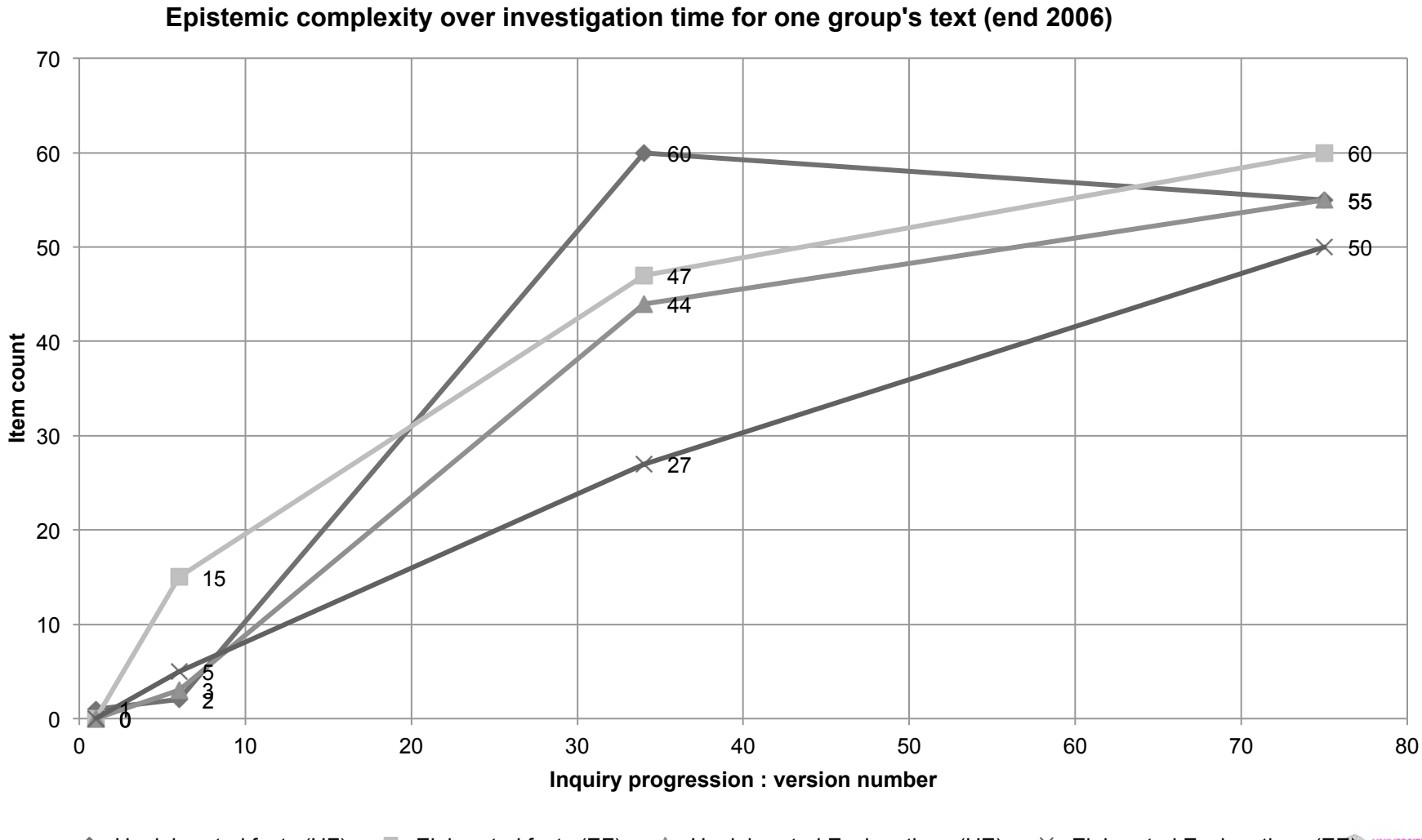
- 19 year old final higher secondary school students N = 61
- Wiki records 10^6 words
  - Questionnaires
    - End of year
    - 1 year later at university
- 4 years 2006-2010
- Full year inquiry
- 12-16 students / 4 groups
- Normal time, curriculum, exams

T=R !

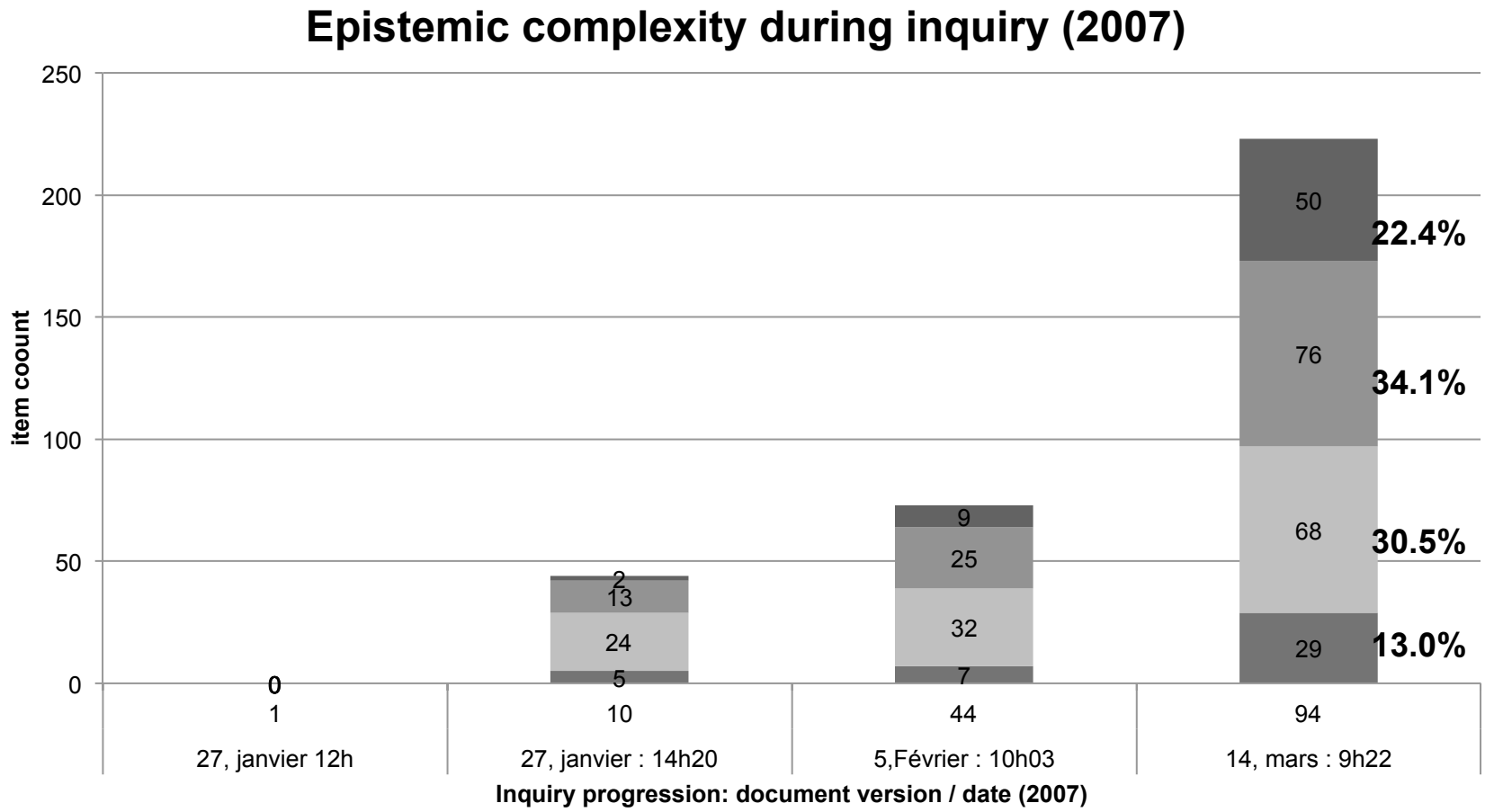
Epistemic Compexity Coding method

- Students write their understanding in a shared wiki space.
  - Documents critical for student exams
- One final Wiki document typically 200 EC items
  - 3-4 weeks, 3000 words 3-4 students
- Coding of all units of meaning within student text into 4 categories of EC
- 1 Unelaborated Facts
- 2 Elaborated Facts
- 3 Unelaborated explanations
- 4 Elaborated explanations

Investigation progress



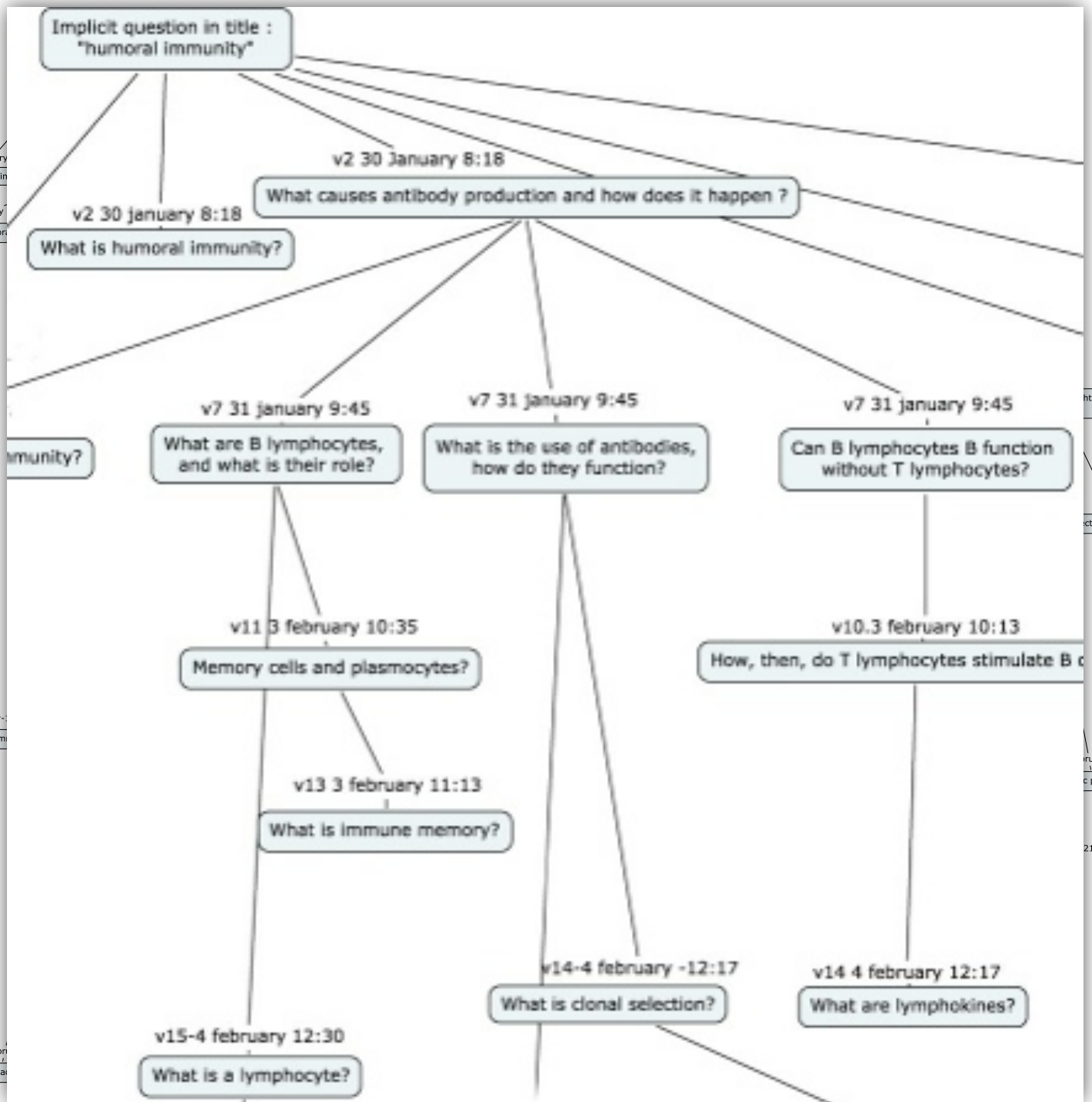
Inquiry progression / Duration needed



Design rules for ”milieu”

Example

- RD10: Responses should address the concept defined by the question: conceptual coherence of questions and corresponding answers
  - > prevent overwhelming by easy-to-find answers
  - > maintains guidance by teacher
  - > conceptual refinement


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
What is a lymphocyte?

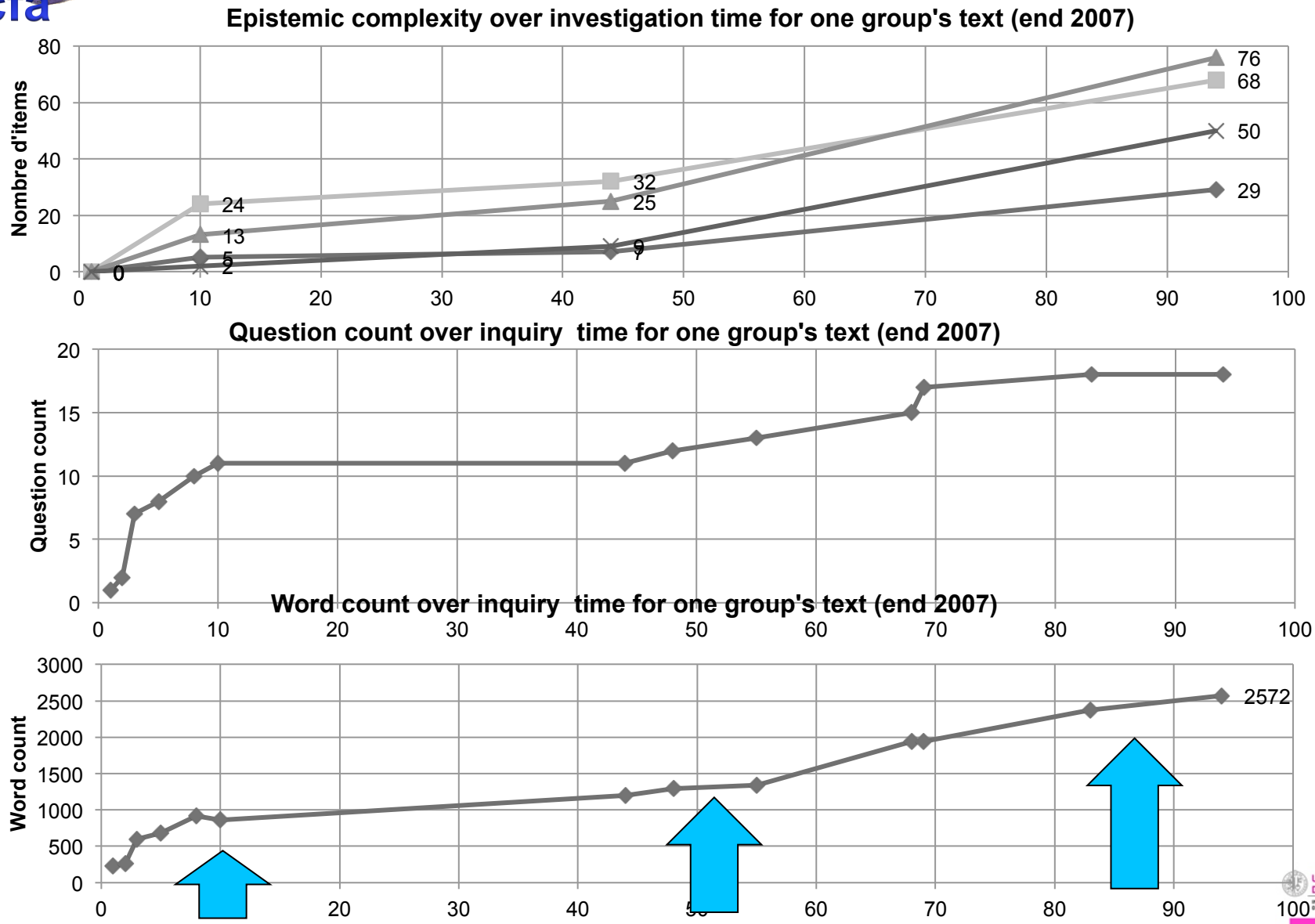
Question converge to paradigm questions if sudents encounter authentic resources

- RD6: Let the "good questions" emerge from confrontations with **authentic resources** in the **paradigm**; create this confrontation if necessary.
  - Authenticity Cf. ERIDOB 2010 Yarden, Lombard, etc.

- RD15: The **conceptual centripetal effect** can ensure that vague questions develop towards "good" questions within the paradigm

- RD14: Teacher insures **at least one question colonizes** each major area of the conceptual field to avoid ignored areas

EC to discuss phases



Student involvement

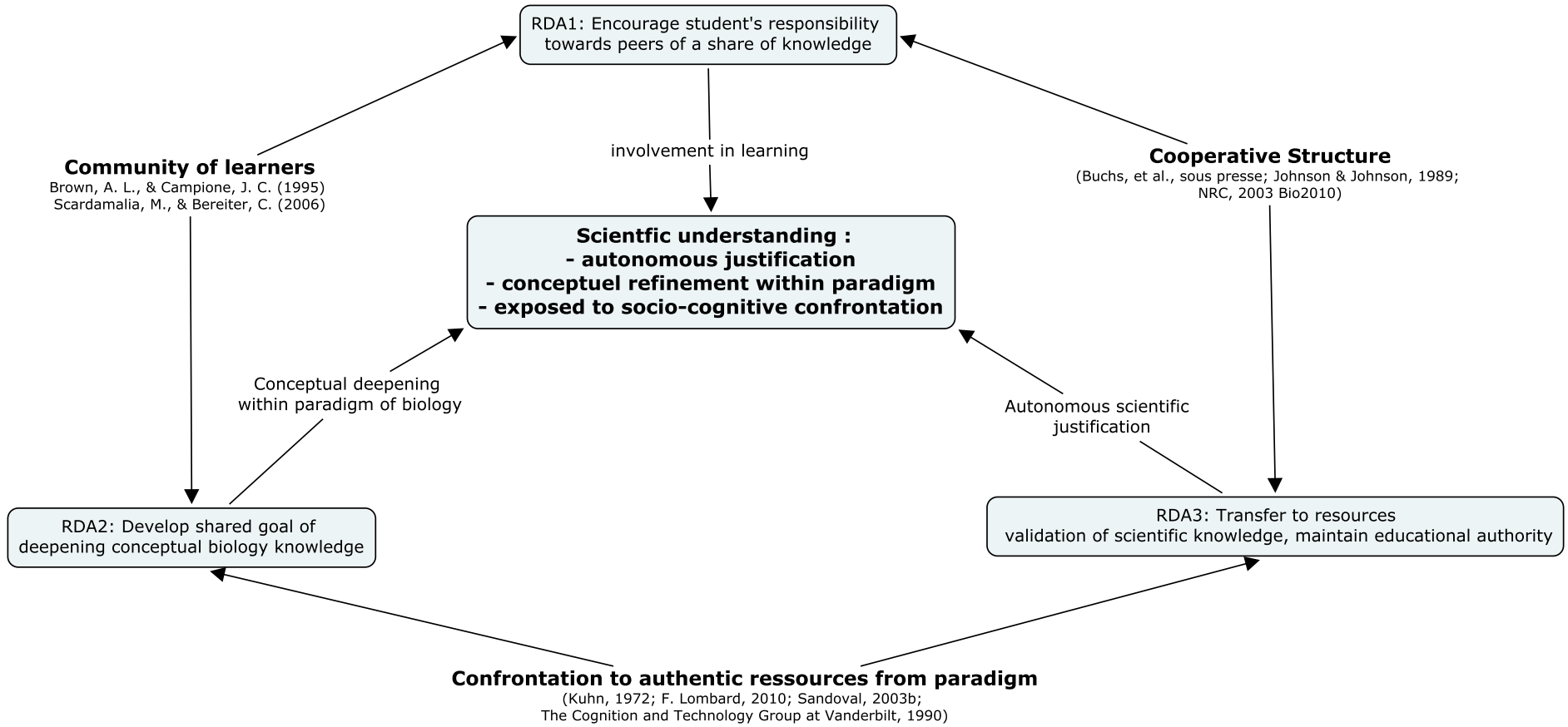
- RDA1: Encourage student's responsibility towards peers of a share of knowledge
  - RD20: Students are responsible for the written report of a sub-theme in a document vital for the group

Teacher intervention ?

- RDA3: Defer justification of scientific knowledge (**authority**) to resources, but firmly maintain **educational authority** with the teacher
  - RD23: Teacher feedback encourages cognitive conflicts by highlighting inconsistencies or differences in explanations intra-text, inter-texts and with external resources
  - RD27: Educational authority is embedded in the structure of the design but reaffirms the freedom of students and frees the teacher for conceptual control and relationship management.

Design conceptualization

Abstract design



Potentials and limits

- Epistemic Complexity
  - Relevant to biology, Coherent with scientific paradigm
  - Process variable : informs progression
  - Subject-independant : allows comparisons
  - Teacher training : discuss learning effects
- “Milieu” description of Rules for Design
  - Expresses socio-cognitive view of learning
  - Describes and analyses traces of (socio) cognitive states and actions to guide towards

Generalizability ?

- Routine class use
  - simpler version ?
- Acceptance in research
  - not validated
- Acceptance in schools
  - not aligned with frequent assessment.

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Tecfa

Thankyou for
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