# The Four Pillars of Educational ICT Research

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## Credits

- Presenting here a collective & collaborative work with (alpha order): Mihai Dascalu, Benoît Lemaire, Sonia Mandin, Stefan Trausan-Matu, Angélique Vernier, Emmanuelle Villiot-Leclercq, Virginie Zampa
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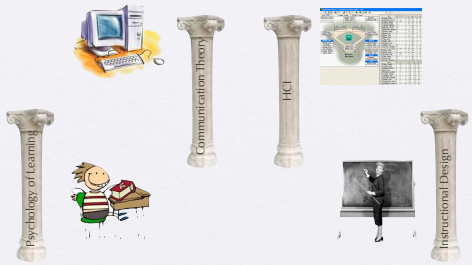
## Goals of the Talk

- To provide instances of the way theoretical foundations have impact on the design/use of ICT in educational settings
- Focus on
  - ILEs, Life-long Learning, writing activity, experimentations in real-world settings
- Emphasis on (instructional & learning) design
- Give some research directions to be discussed





## The 4 Pillars of Educ. ICT Res. [after Spector 08]








## Pillars as Fundations

[Spector '08]

- *Psychology of learning*: Understand the nature of thought to devise appropriate means/methods to train it (Dewey, Piaget, Bruner, etc.)
- *Instructional design*: Devise human strategies/methods to implement effective teaching (Gagné, Reigeluth, van Merriënboer, etc.)
- *Communication theory*: The use of language in learning (Vygotsky). The use of cognitive tools that communicate
- HCI: Because of the use of computer, refine the way to exchange information between humans/computer (Merrill, Rosson & Carroll, etc.)





## Links between Writing & Learning

- "Essays are one of the most useful tool to assess learning outcomes" [Valenti et al. '03]
- Both activities – Emerge from symbolic cognitive processes, – are fostered and allowed by self-provided feedback, – use/provide connections between concepts – are successful if engaged, active and self-rythmed [Emig '77]

# Writing & Feedback

- Focus on writing:
  - 25% teacher's time spent on grading written assignments [Vigilante '99]
  - Students spend a lot of time waiting assessment or advice
  - Interactions at a distance increase this time waste
- Need of computer-based feedback





# Presence vs Distance Situations [Villiot-Leclercq & Dessus '09]

| Presence | Distance |
|---|---|
| • On-line learning activity. *T* gets on-the-fly information on *S* | • Partly on-line learning activity. *T* relies on preselected tracks |
| • Intensive & explicit *S*'s shared attention & social relations | • Difficult to track *S*'s shared attention & social relations |
| • *S*'s questions as part of the interaction | • *S*'s questions often considered as intrusive |
| • Explicit/negotiated instructional scenario | • Instructional scenario partly depends on the system |

*S*: Students
*T*: Teacher



# Likely Solution

- Devise systems (interactive learning environments) that
  - embed instructional & learning activities in the ILE
  - model high-level cognitive processes like summarizing, understanding, dialog acts, etc.
  - help students build knowledge instead of simply learn/repeat text







# Main Thesis & Outline of the Talk

- If we intent to design efficient educational ICT, theories from these 4 pillars have to be *jointly* taken into account. Test efficiency experimentally
- Outline

I. The Four Pillars

II. Research Projects








# Bad news: Teachers use Pencil/ paper-based Cognitive Tools

Easy of use
Very robust and cheap
Portable
Standard







# Computer-based Cognitive Tools

- As previous non-computer-based tools
  - Help & foster action (teaching, learning)
  - Easy to use
  - Decreases cognitive load
  - Represent what (remains) to do

# I. The Four Pillars

# I.1 Psychology of Learning & Instructional Design

*First Two Pillars*



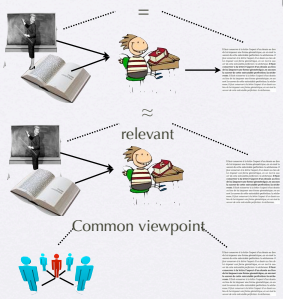
## Psychology of Learning & Instructional Design [after Spector 08]






## Views of Learning [Sfard 98]

- Learning as copying/repeating
- Learning as understanding
- Learning as participating





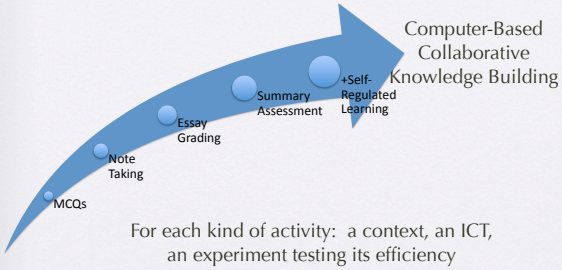



## Psychological Models of Learning

- Evolved from associationism-behaviorism (rote learning) to constructivism (freely interact with an environment)
- Foster three kinds of students' abilities [Chi '09]
  - active: doing an engaging activity physically
  - constructive: product output that go beyond presented information
  - interactive: dialoguing with peers & taking their viewpoint into account



## Research Genealogy




For each kind of activity: a context, an ICT, an experiment testing its efficiency

# 1. Multiple Choice Questionnaires 1/2



- Context
  - Teacher provides valid content and Student tries to distinguish it from fake
- Easy to design
- Assess factual knowledge
- For Teacher: difficult to find likely answers yet wrong for avoiding Student guess
- Tons of MCQ software: *Hot Potatoes*, *eXe*





# 1. Multiple Choice Questionnaires 2/2 [Dessus '00]



- MCQ in epistemology:
  - Les principes de la causalité naturelle sont…
    - A. Des principes causaux qui existent réellement dans la nature
    - B. Des principes que tous les scientifiques utilisent.
    - C. Des principes des scientifiques modernes.
    - D. Des principes qui ont fait leur preuve mais qu'on n'utilise plus beaucoup.
    - E. Des principes inexacts qu'on a naturellement tendance à appliquer.



# 2. Note Taking 1/2



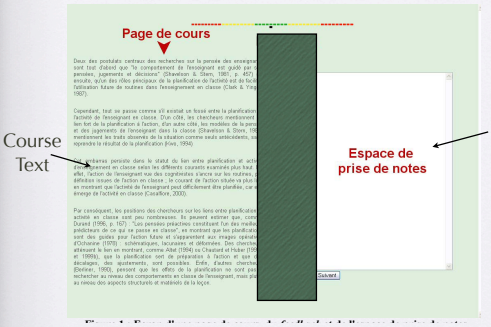
- Context
  - A student jots down text when attending a course
  - Not just a summary
- Keeps track of content, thoughts, understanding
- Fosters two main processes
  - encode/link new information (within text, external: with prior knowledge)
  - external storage





# 2. Note Taking 2/2 [Mandin et al. '05]








# 3. Essay Writing 1/2



- Context:
  - Student attends a course, then writes out an essay about a given topic
  - Teacher compares the essay content to the course content, gives a grade
- ☺ Allow students to express their own ideas
- ☹ Assessment is time-consuming

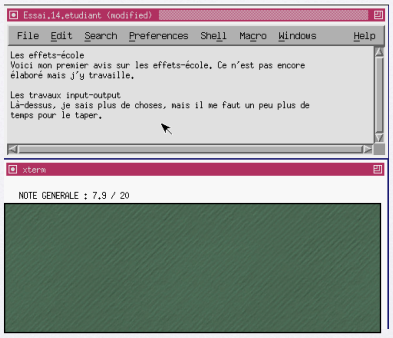




# 3. Essay Writing 2/2

[Lemaire & Dessus '01]





# 4. Summary Writing 1/2



- Context:
  - Students write out a summary or a synthesis of the course
  - The teacher (or the computer) can help students summarize

☺ Students have to grasp what is important. Multi-source learning. Rote learning not useful

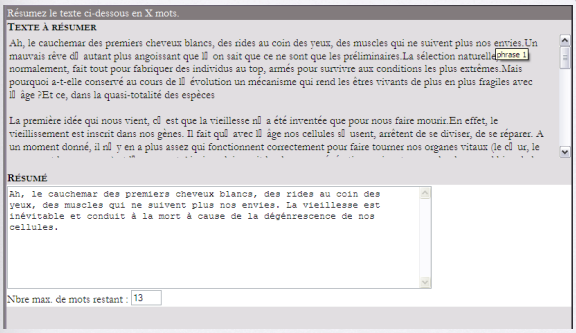
☹ Individual performance. Very difficult to assess



# 4. Summary Writing 2/2

[Mandin et al. '07]







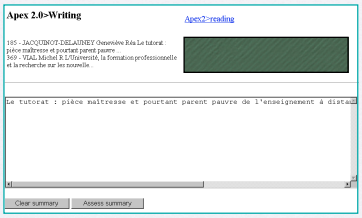



# 5. Adding SLR functionalities

[Dessus & Lemaire '02]



- Same situation as 3. Essay Writing. Compare computer-based judgment with this of the student








# Research Questions



- Learning design ≠ Instructional design. How to make closer relations between *learning* design and *instructional* design? Solution: scenario-based design [Rosson & Carroll '01]
- Software mostly focused on augmenting learning rather than reorganizing it [Pea '85]. Devising reorganization-based software?
- Psychological processes account. Solution: Computational psychology [Sun '08]



# I.2 Communication Theory

*Third Pillar*



# Communication Theory [after Spector '08]