Multifaceted Outcome of Collaborative Learning: *Call for Divergent Evaluation*

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Learning goals

- In-depth comprehension of the target contents and
- their integration

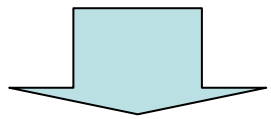
through collaborative learning experiences

plus

- Collaborative learning practices
- Learning skills

Many goals, many outcomes?

- What happens to each facet, do students achieve all uniformly, or does it have to be that way?



- Clear answer to the first question (*no*), and a possible direction to the second (*probably no, particularly so when we think good part of learning is the learning of skills to learn accommodating to individual needs*).

Research goals

1) Design a set of courses to teach cognitive science so that the students can,
   - Understand problem solving, memory, etc.,
   - Integrate important research findings, and
   - In order to make intellectual judgments about human cognition,

   as well as sustainable learning skills, based on their understanding of cognitive scinece,

   not at the end of the courses but in the future at real world settings.

2) Examine the learning process to better understand collaborative cognitive processes for learning (as well as of "cognitive science.")

Characteristics of such sustainable outcomes

- "Portable," or abstract chunk of knowledge
- Supported with detailed knowledge of realities
- Integrated with other related knowledge pieces

An example of an integrated, "portable" knowledge

Input	Output
Basics of general problem solving skills	Highly reflective problem solving skill, with careful monitoring about one's own approaches and conclusions.
The confirmation bias	
Cultural relativism of inferences	
Epistemic egocentrism	

Characteristics of learning skills

- Question asking
- Skills of hold constructive interaction with others,
- Find what they need to learn further
- Establish confidence in own learning experiences

To achieve such learning

- *We believe that the students need to engage* Iterative*ly in* Cycles of Learning
  - *the same learning content,* in order to gain firm understandings with details,
  - *at different times,*
  - *in different contexts, so that the students could abstract the gist and relate it to other pieces of knowledge.*

Scale of our study

JST CREST: 2000-2004; SORST: 2005-2007

- Two 90 min. classes per semester
- Four semesters for the first two years of college
- Dynamic jigsaw is for the sophomores.

- Seventy students per year on average
- Data collection since 2000
- Serious data collection since 2003

Classes

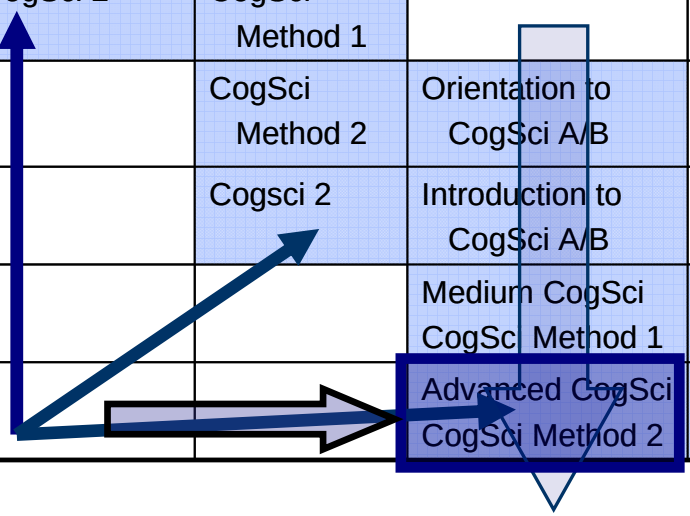
Freshmen Spring & Fall

Concept Mapping tool
for sharing externalizations

Sophomores Spring & Fall

Classes under study

	Admitted in 2001	Admitted in 2002	Admitted in 2003	Admitted in 2004
Spring 2001	Orientation to CogSci			
Fall 2001	CogSci Method 1			
Spring 2002	CogSci Method 2	Orientation to CogSci		
Fall 2002	CogSci 2	CogSci Method 1		
Spring 2003		CogSci Method 2	Orientation to CogSci A/B	
Fall 2003		Cogsci 2	Introduction to CogSci A/B	
Spring 2004			Medium CogSci CogSc Method 1	Orientation to CogSci A/B
Fall 2004			Advanced CogSci CogSci Method 2	Introduction to CogSci A/B



Research context

- Undergraduate cognitive science course
- Collaborative reading of 24 short scientific texts in the method called Dynamic Jigsaw.

Learning materials

- Material
  - Twenty-four literature pieces

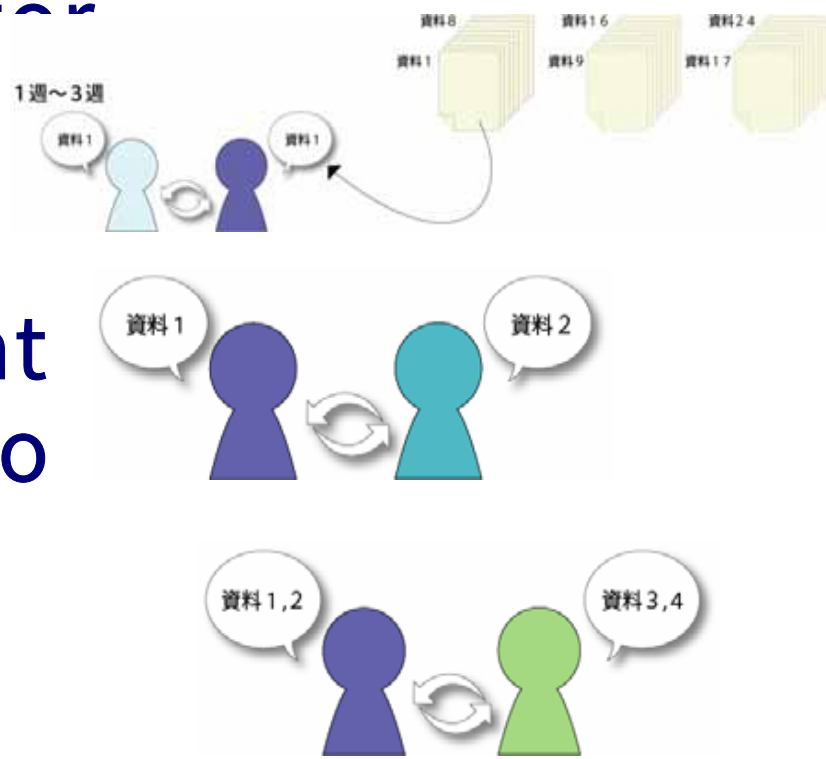
Eight on development
Eight on perception and knowledge representation
Eight from problem solving, culture and society

Essentialism

Two sided A4 each

Dynamic jigsaw

- Jigsaw as a tool for collaborative reflection, and
- Dynamically repeat this to cover 20 to 30 research findings.



Dynamic jigsaw as a scheme for repetition

Among N pieces of literature ($n_{1 \ldots N}$),

- Select one, n_i, to take charge of it.
- Become expert of n_i.
- Exchange and seek integration of n_i and n_{i+1}.
- Exchange and seek integration of n_i+n_{i+1} and $n_{i+2}+n_{i+3}$ (2X2).
- Exchange and seek integration of $n_i+n_{i+1}+ n_{i+2}+ n_{i+3}$ and other four (4X4).
- ...
- Write a summary of n_1 to N.

With 24 texts, what an n^{l+1} expert does

1 x 1	n^{i+1} and n^{i+2}
2 x 2	$n^{i+1} + n^{i+2}$ and $n^{i+3} + n^{i+4}$
4 x 4	$n^{i+1} + n^{i+2} + n^{i+3} + n^{i+4}$ and $n^{i+5} + n^{i+6} + n^{i+7} + n^{i+8}$
1st 8 x 8	$n^{i+1} + n^{i+2} + \ldots + n^{i+7} + n^{i+8}$ and $n^{i+9} + n^{i+10} + \ldots + n^{i+15} + n^{i+16}$
2nd 8 x 8	$n^{i+1} + n^{i+2} + \ldots + n^{i+7} + n^{i+8}$ and $n^{i+17} + n^{i+18} + \ldots + n^{i+23} + n^{i+24}$

Learning activities

- Aggressive reading focused on one's own point of view
- Concept mapping for integration of viewpoints
- Collaborative reflection
- Generating various explanations according to listener's needs within a given time
- Exchanging explanations
- Question asking and critiquing
- Integrating exchanged explanations

Outcome evaluation

- How does this compare against lectures?
- How integrated are their concept maps?
- How much relations could student make between cognitive science and its utility?
- What is the process of collaborative integration under ILC?

How does this compare against lectures?

Retrospective interview

Four to six months after the completion of the two-year course, comparing regular lectures and dynamic jigsaw classes.

Remembering "a lecture"

5 months later

EXP: What do you remember?
ST: … uhh, he talked about meta-cognition, and uhh, he talked about the baseball player, Ichiro, and, and …that's all."

Class type	# of targets	% recall Facts + Implication	% recall Keywords
Lectures	11	2.2%	56.1%

Remembering “a lecture”

5 months later

“ (What did you remember?) … uhh, he talks about meta-cognition, and uhh, he talks about the baseball player, Ichiro, and, and …nothing.”

Class type	# of targets	% recall Facts + Implication	% recall Keywords
Lectures	11	2.2%	56.1%

Remembering from jigsaw

EXP: What did you read? What kind of a story?
ST: Okay. It was about an experiment of pigeon's memory. If we destroy a particular part of her brain, it can still distinguish the edible things from the non-edible, but cannot tell a triangle from other figures. So, the functions needed for living are distributed among different parts of the brain, even pigeon's brain"

4 months later

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Jigsaw	22	15.8%	7.7%

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Process of collaborative integration

- Yes, we want to do the process analyses...

Class dialogue data of the dynamic jigsaw

One Recorder per Student

They talk in Japanese…

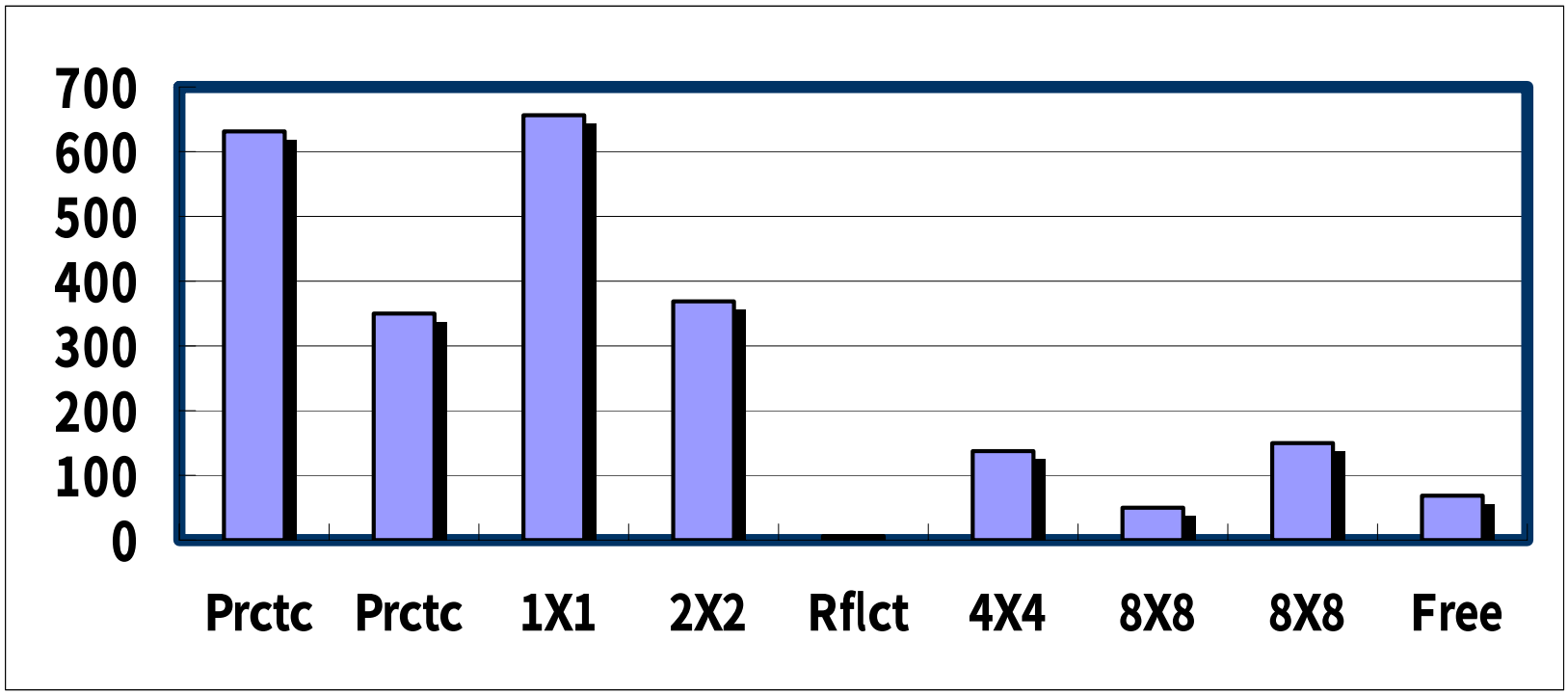
Cases of content learning

- Depth of understanding achieved by Y.O.

The dynamic jigsaw for Y.O.

19/Oct	Select 16 of (15, 16)
26/Oct	Answer quiz on 16, 15
02/Nov	Practice explaining 16 to TA
09/Nov	Practice explaining 15 to TA
16/Nov	1X1 15 & 16
30/Nov	2X2 (15,16)&(13,14)
07/Dec	Reflection on 2X2
08/Dec	4X4 (13-16)&(09-12)
14/Dec	8X8 (09-16)&(17-24)
15/Dec	8X8 (09-16)&(01-08)
22/Dec	Reflection on all 24

Length of explanations of 16

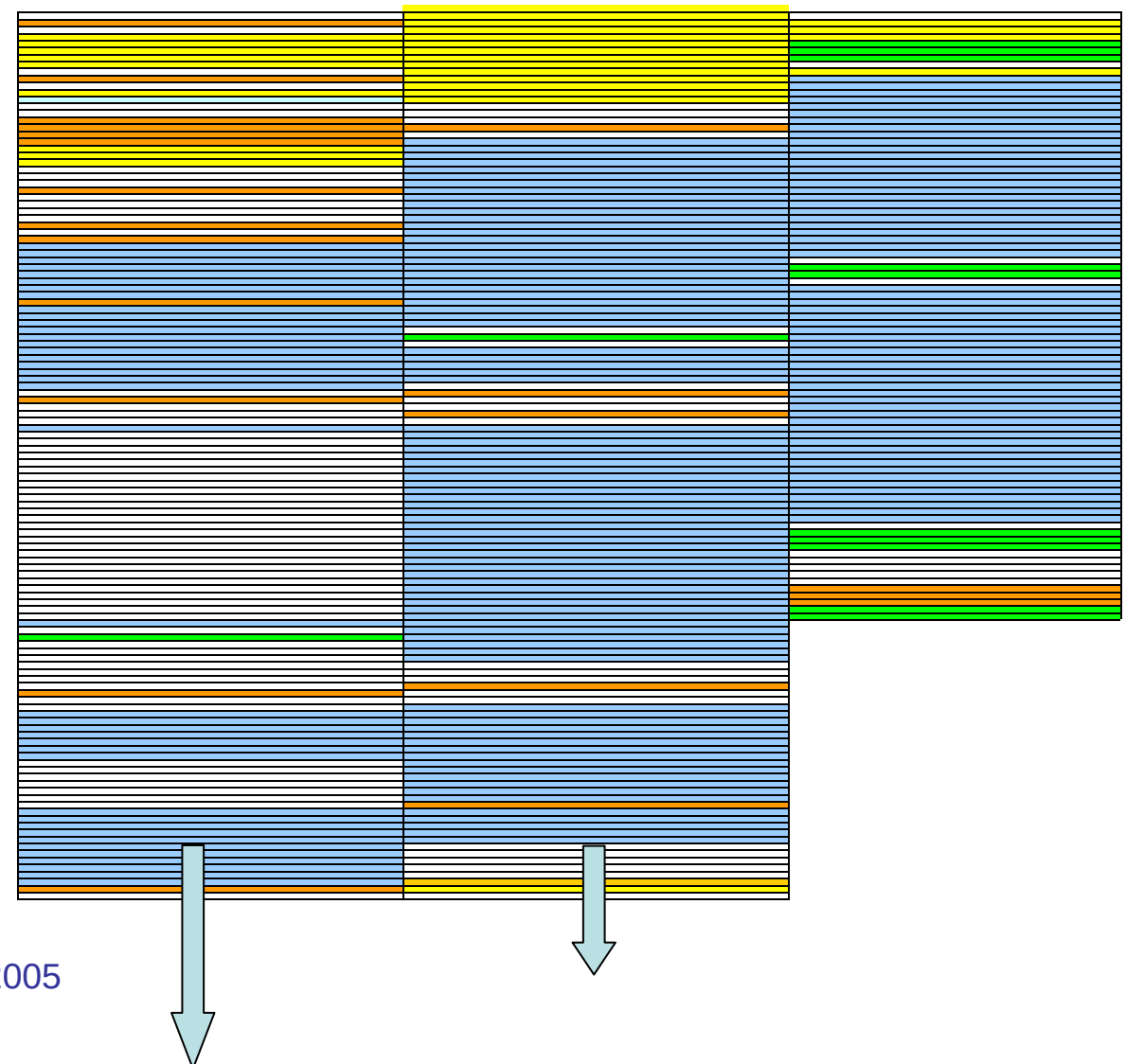


Y.O.

Component structure of the explanations

Theme	The theme of the findings
Evidence	Experiments, observations, systems, line of logic…
Implications	Author's interpretations and implications
Connections	Student's interpretations and abstractions

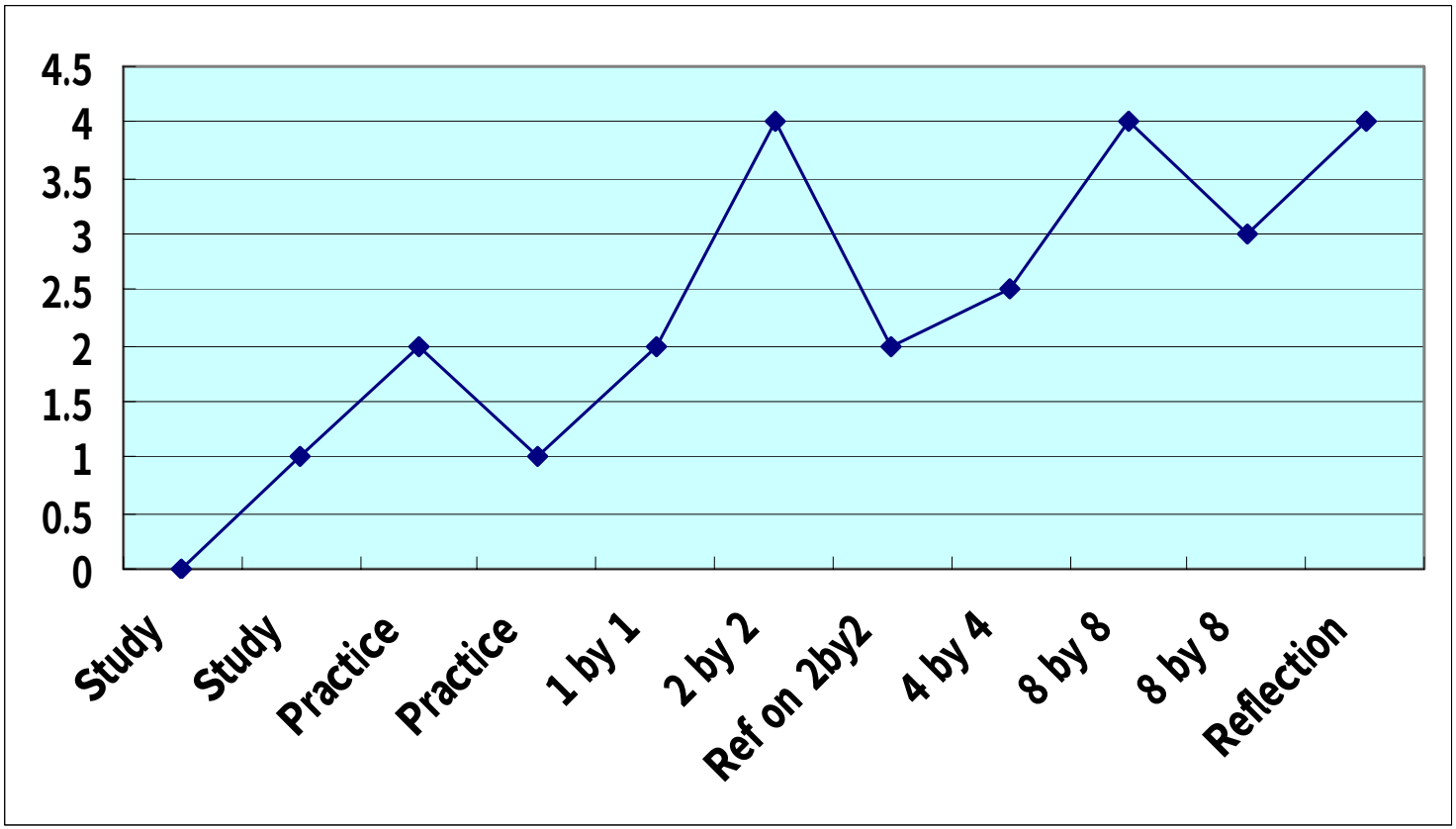
11/09 Prctc | 12/07 4X4 | 12/15 8X8



Very schematic description of Y.O.'s understanding process

Level 4	Integration with confidence, expansion
Level 3	Integration neutral
Level 2	Integration with doubts, misunderstandings
Level 1	Trials of integration

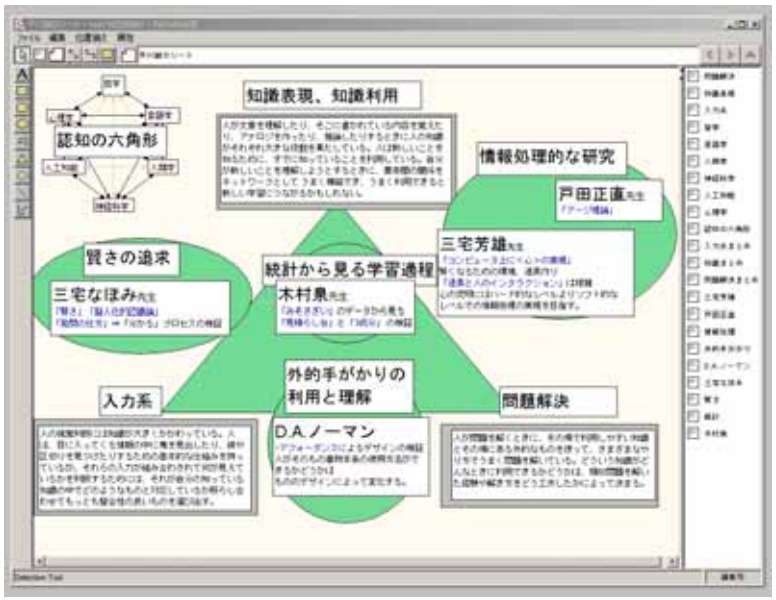
Pattern of growth (Y.O.)



Cases of content learning

- Breadth of integration of learning materials achieved by T.T.

ReCoNote: A concept mapping tool



- Notes on sheet, with relations
- Layered sheets
- Free referring to others' notes and sheets
- Free copying of others' sheets and notes

How integrated are the final concept maps?

- "Width"
  - How many research pieces on one layer?

by

- "Depth"
  - How many interlinked layers?

Concept map categories

Deep and Wide	26%
Shallow but Wide	22%
Deep but Narrow	20%
Shallow and Narrow	19%
No maps	13%

Growth of T.T's CM (1)

Growth of T.T's CM (2)

Growth of T.T's CM (3)

Cases of content learning

- Cognitive skills in general, and question asking skill by N.M.

Term papers

Part 1

- Short summaries of all 24 texts.

Part 2

- Your view of what cognitive science is, by integrating the 24.

Part 3

- How you could/would use this integrated knowledge in your everyday situations.

Usefulness of cognitive science

Concrete with evidence	45 %
Concrete without evidence	33 %
Abstract	12 %
No description	20 %

N.M.'s QA strategy

- Most of, maybe all of the materials come with some obvious halls inviting questions. I start with those, and think of a deeper question while my partner is giving me the expected answer—that gives me time to think.
- She tried this in upper level classes, and has found out so far that this does not always work, but...

Emerging pattern

- Y.O. gives more concise explanation towards the end, in apparently more “portable” form.
  - This pattern appears to be general …
- T.T. created a highly integrated grasp of all the materials.
  - The pattern is often more fragmental, quite satisfying for the creaters, and shows strong trace in retrospective interviews.
- N.M. acquied a rudimental QA skill, which she is willing to develop further.
  - This takes many different forms differing for each individual.
  - Thus a call for iterative learning cycles.

Thank you.