AERA 2002 at New Orleans, 2002.4.2.

Mutual links as externalized resources for students' collaborative reflection

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External representations

- Not always prepared by others/teachers.
- Not necessarily easy to understand or explain.

Cognitive traces

- Traces of conscious/subconscious cognitive processes we leave on external world.
- Differences of perspectives one can take on such traces.

Theory behind practice

- What are cognitive traces for?
- How does collaboration work (with traces)?
- What kinds of external representation do we want for collaboration be more effective?

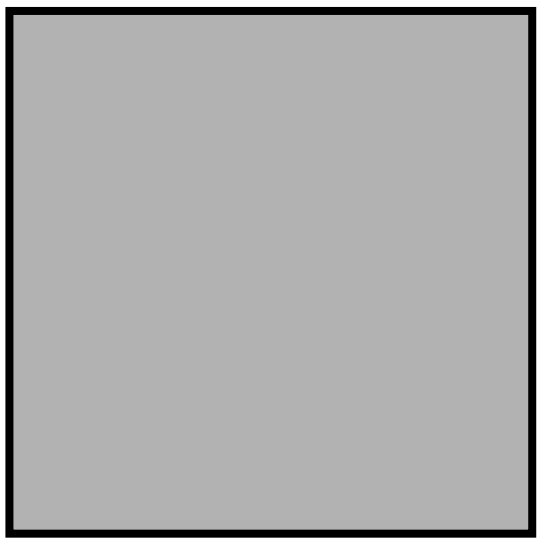
- …going back to do some basic research…

Task

3/4 × 2/3 = 1/2

"Shade 2/3 of 3/4 of the *origami* paper with oblique lines."

(Shirouzu, Miyake, & Masukawa, 2002)



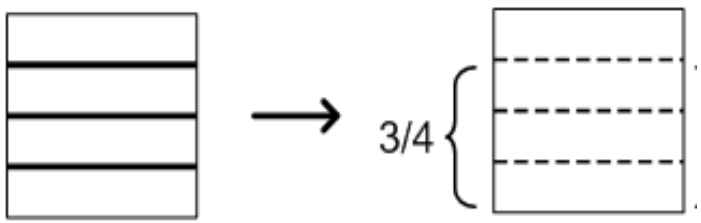
Summary of findings

- People do not calculate.
- They use external resource extensively.
- There are different ways to solve this problem, which vary in degrees of abstraction.

Getting 2/3 of 3/4 (1)

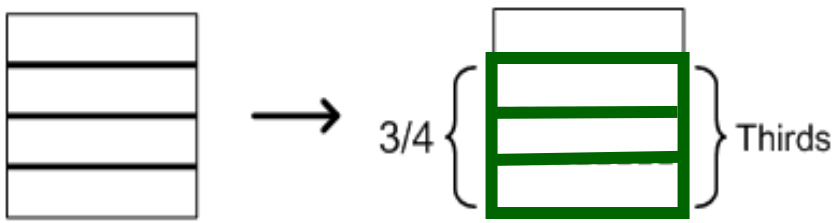
i) Original

Getting 2/3 of 3/4 (1)



i) Original

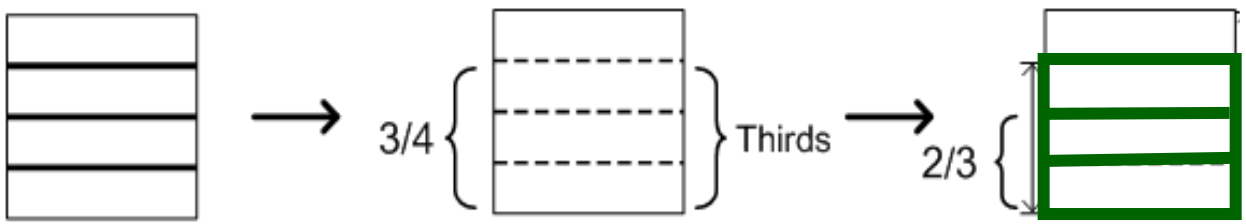
Getting 2/3 of 3/4 (2)



i) Original

ii) 1st Re-interpretation

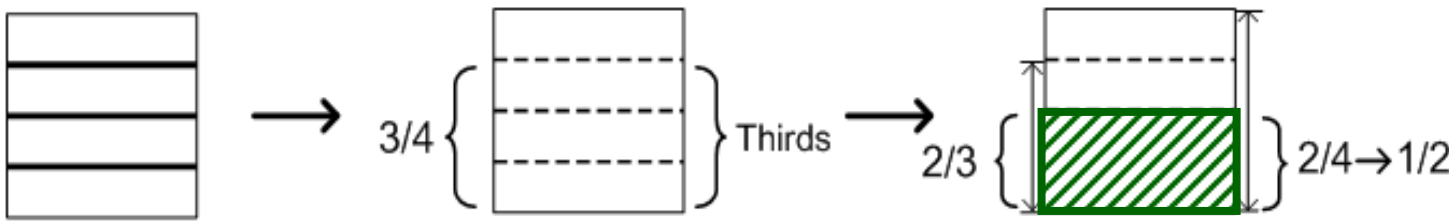
Getting 2/3 of 3/4 (3)



i) Original

ii) 1st Re-interpretation

Getting 2/3 of 3/4 (5)

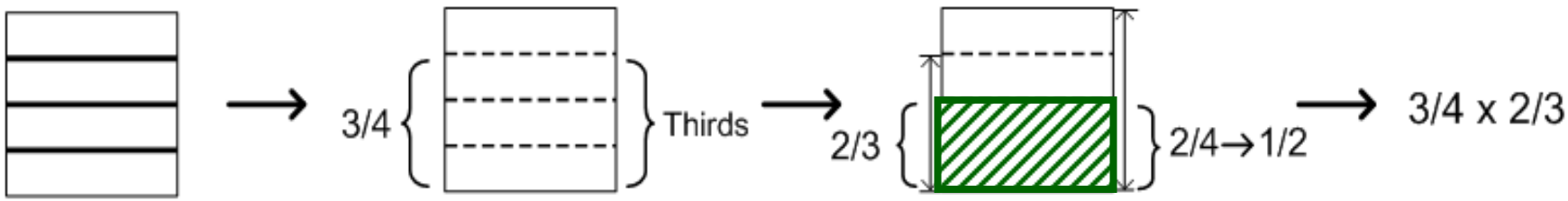


i) Original

ii) 1st Re-interpretation

iii) 2nd Re-interpretation

Getting 2/3 of 3/4 (6)



Different solutions

- It was not easy for an individual to see the scope of this variation.

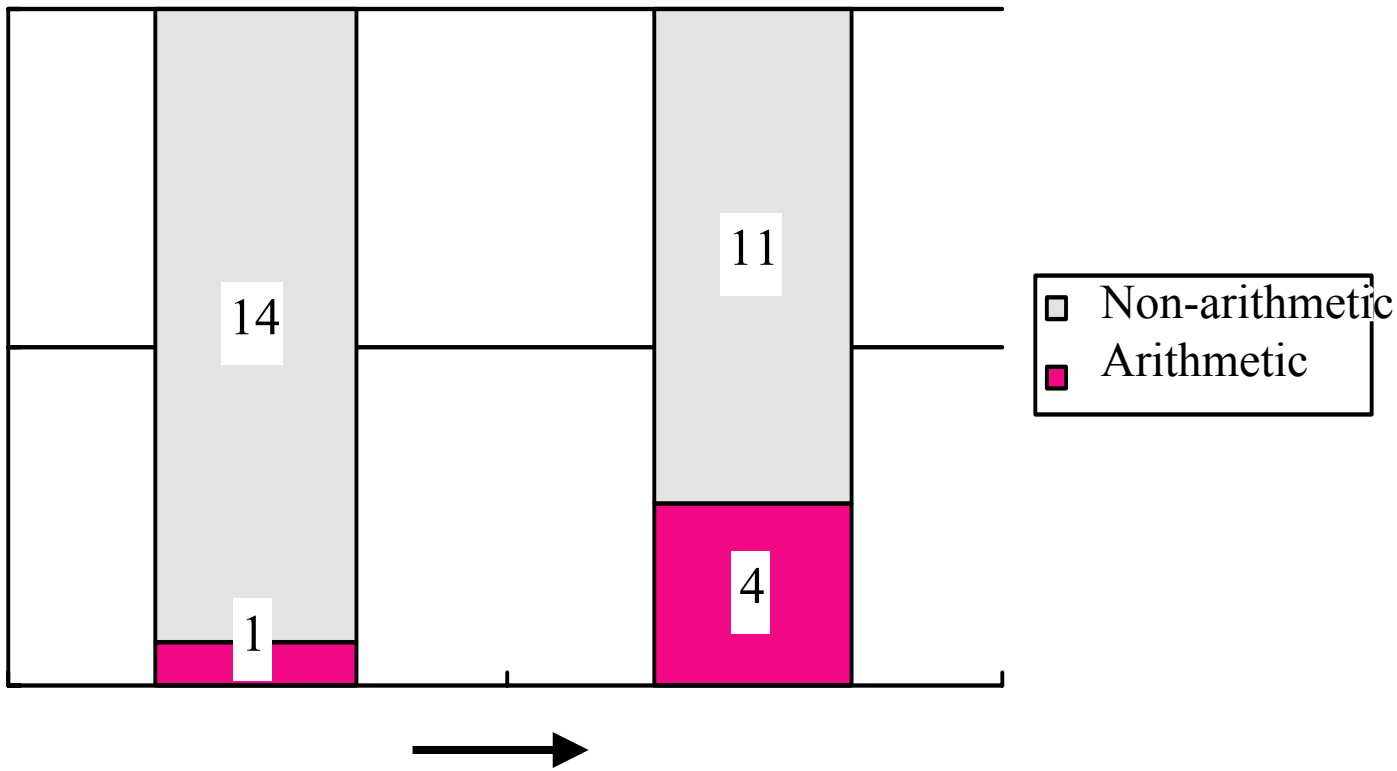
Sequential trials?

First trial : 2/3 of 3/4

↓

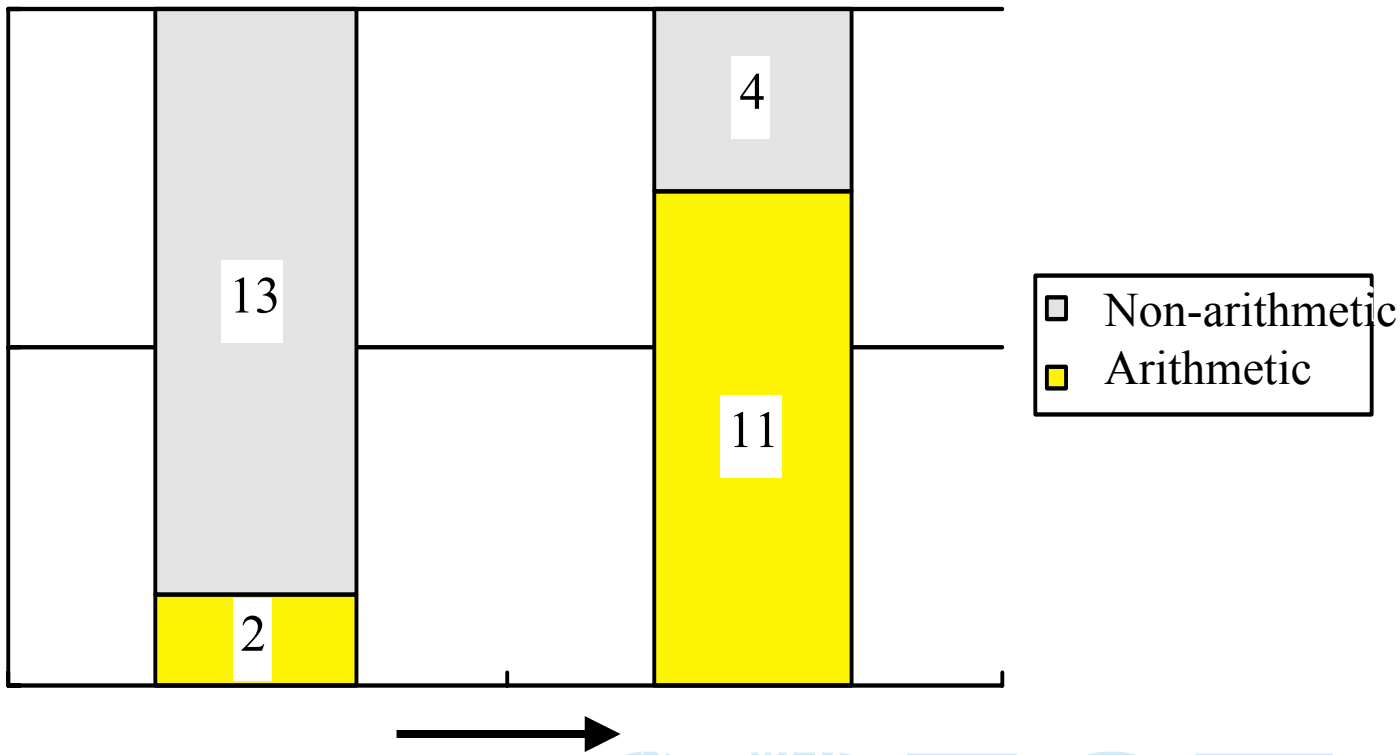
Second trial : 3/4 of 2/3

Solo subjects



2/3 of 3/4 **3/4 of 2/3**

Paired subjects

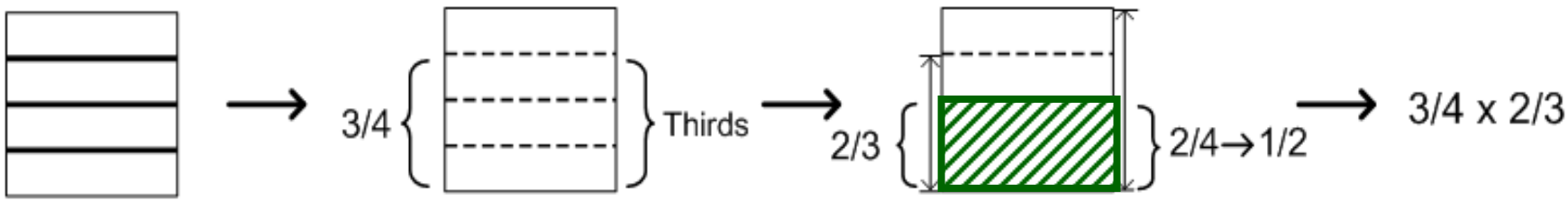


2/3 of 3/4 **3/4 of 2/3**

Getting 2/3 of 3/4 (7)

Person 1

Task-doing → Monitoring → Task-doing →



Monitoring → Task-doing → Monitoring

Person 2

Collaboration works because…

- There are variations of solutions differing in the degree of abstraction, which sort of works as a *"ladder."*
- Integration process involves language use for abstracted schema formation.

- Motivations for integration

Guidelines designing collaborative learning situations

1) Encourage externalization
2) Solicit multiple re-interpretations

3) Iterate re-interpretation
4) Support integration of different solutions

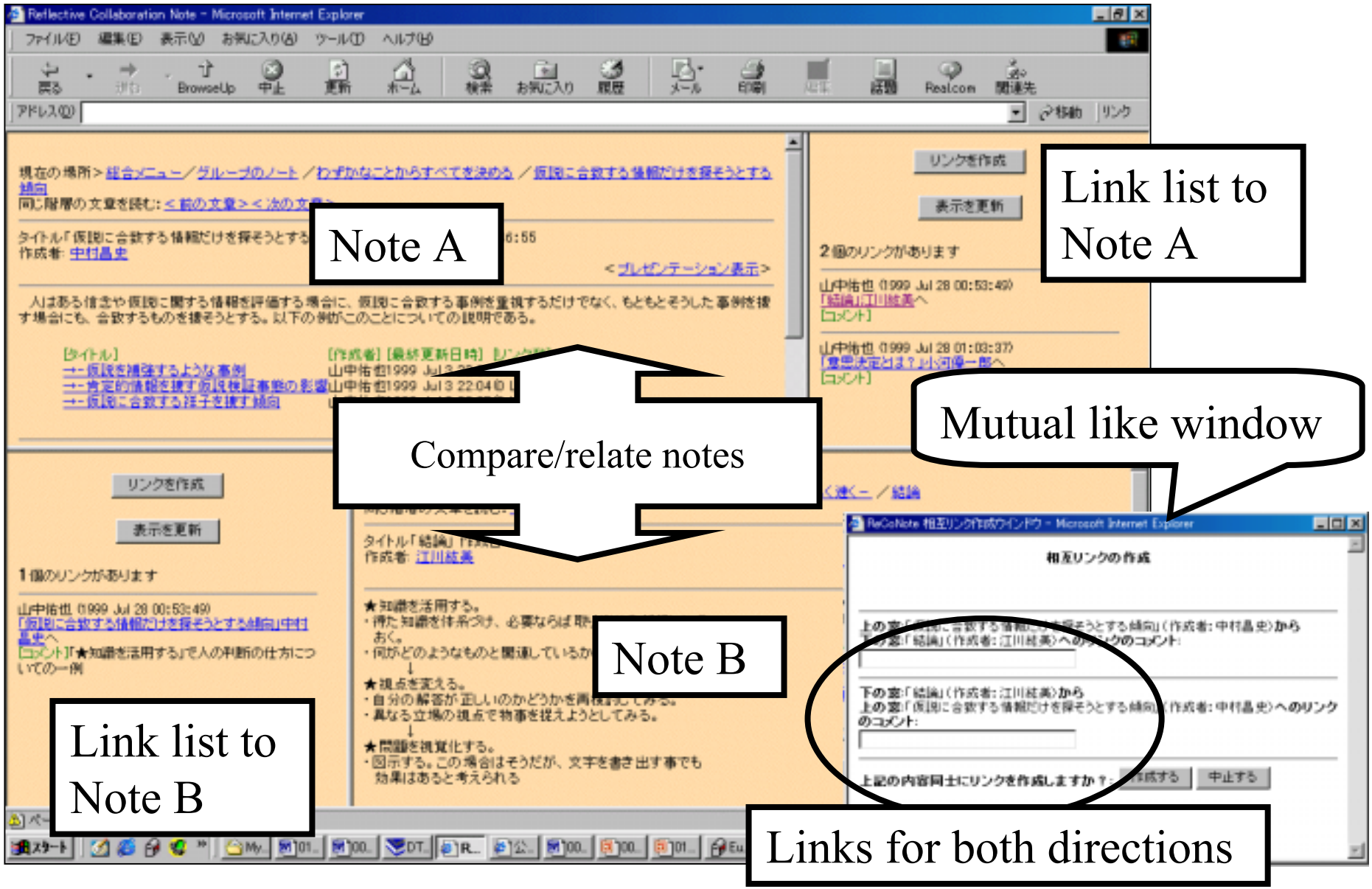
Context

- Teaching cognitive and learning sciences to undergraduates (grades 13 to 14)

- Main task: Integrate different research findings to come up with “applicable” theory-like understanding

Reflective Collaboration Note

Reflective Collaboration Note



Discussion with cards to help writes notes

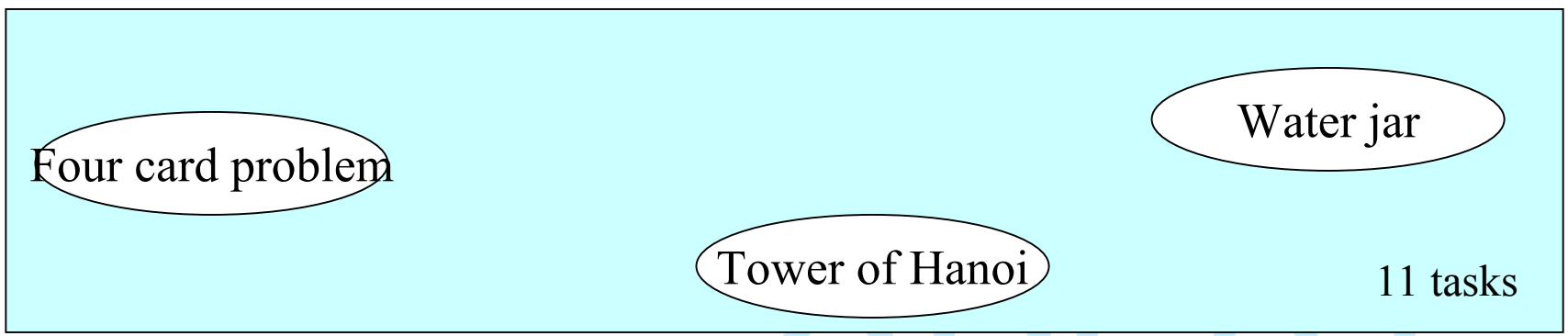
Class with ReCoNote

1998 practice (3 months+1 month)

- "Human problem solving"
  - 57 juniors in 23 groups
  - A semester course
  - Goal "Understand the fundamental characteristics of human problem solving"

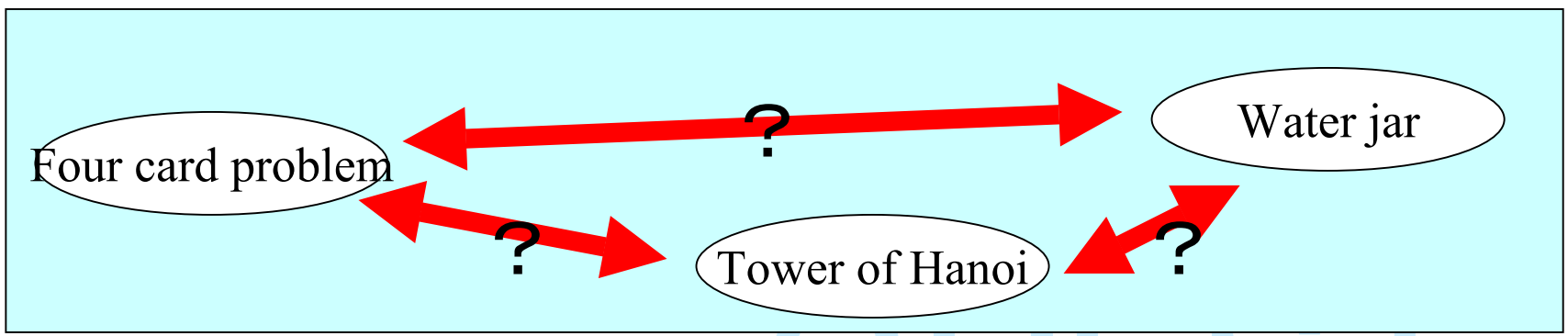
1998 design (1/3)

- Literature study (10 weeks)



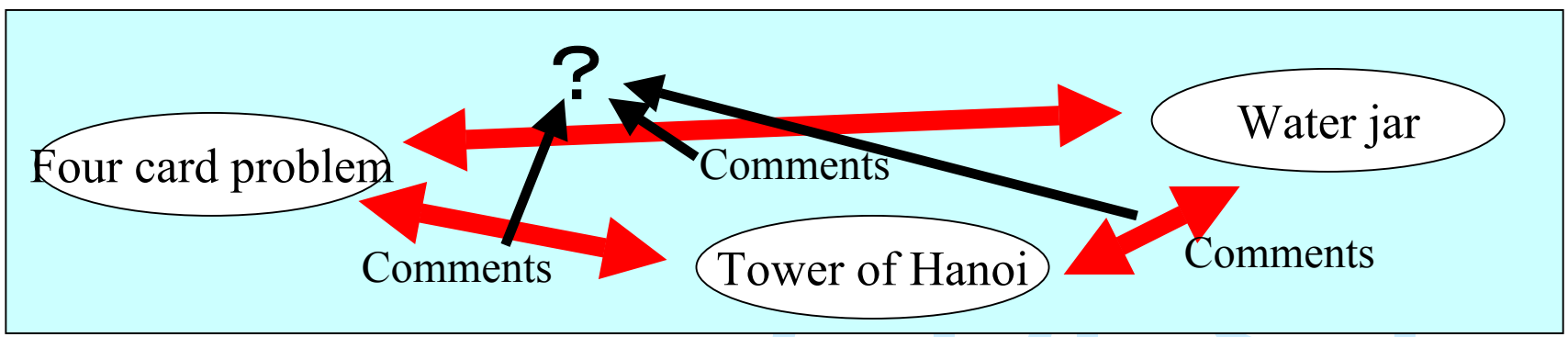
1998 design (2/3)

- Relation making (4 weeks)
  - Listen carefully and make links



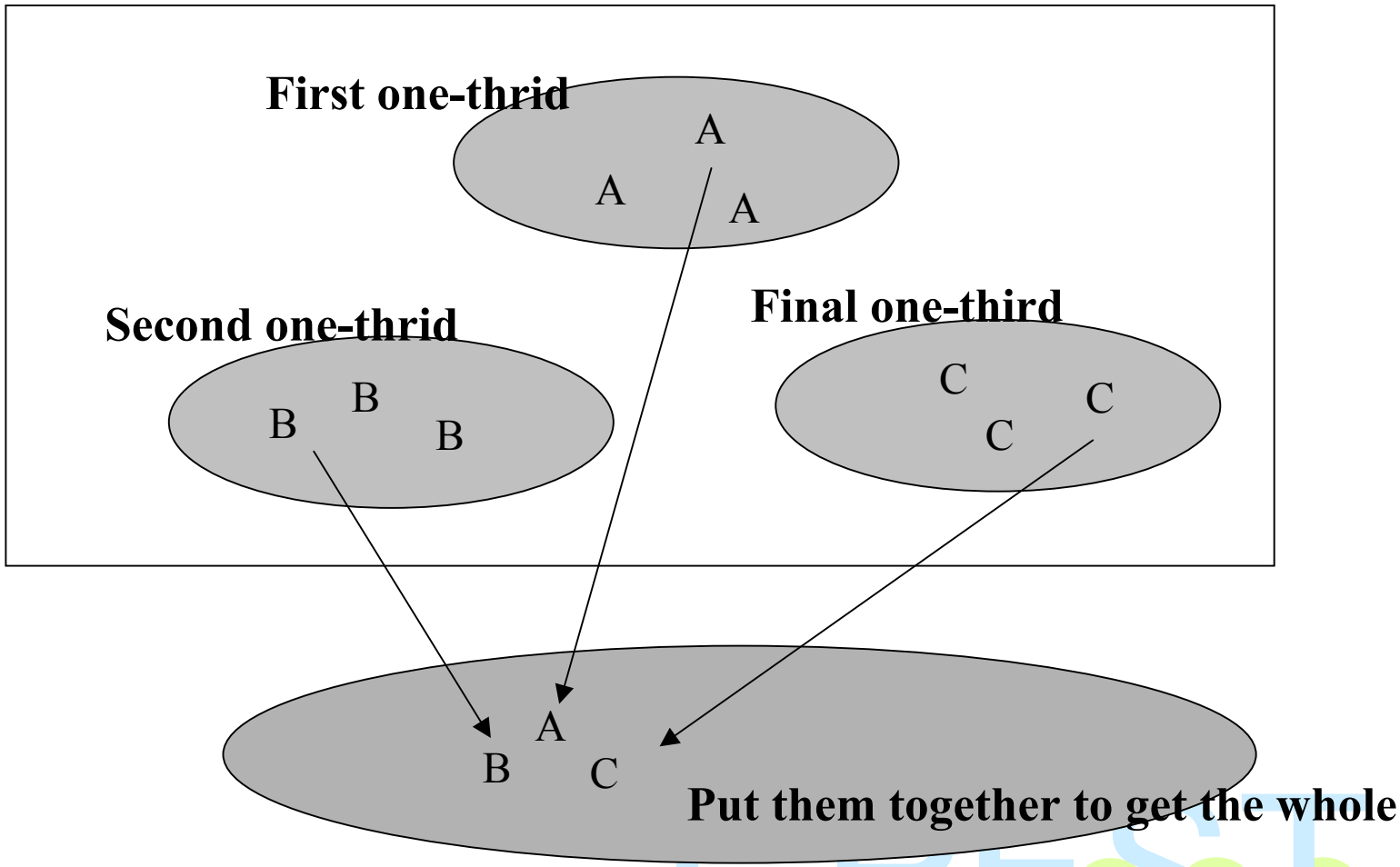
1998 design (3/3)

- Summary writing (4 weeks)
  - Go over all the materials contributed by the entire class.



Design changes

- 1999 introduced Jigsaw, to
- Structured jigsaw in 2000 and 2001


First one-thrid
A
A
A
Second one-thrid
B
B
B
Final one-third
C
C
C
A
B
C
Put them together to get the whole

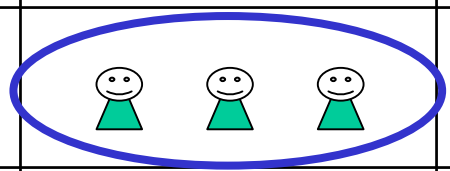
2000 practice (3 days+ a week)

- "Introductory learning sciences"
  - 57 juniors in 23 groups
  - An intensive course
  - Goal "Understand how people learn and design and evaluate a mini-course."

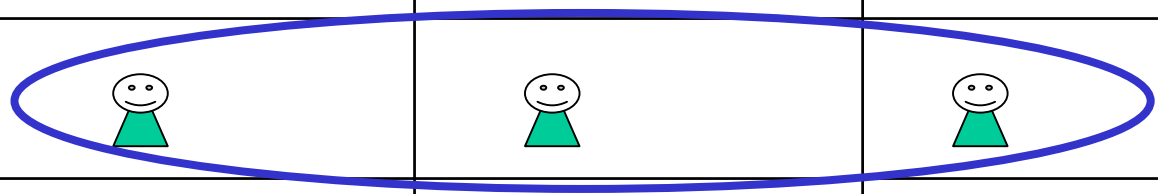
Structure of learning materials

	Theoretical	Experimental	Observational
K. representation			
Conceptual change			
Everyday cognition			
Collaboration			

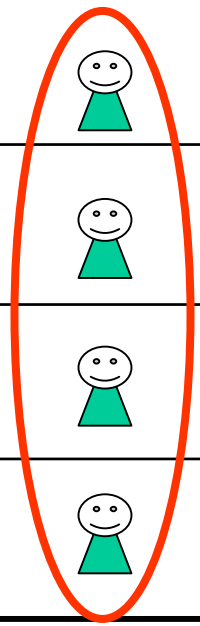
Structure of learning materials

	Theoretical	Experimental	Observational
K. representation			
Conceptual change			
Everyday cognition			
Collaboration			

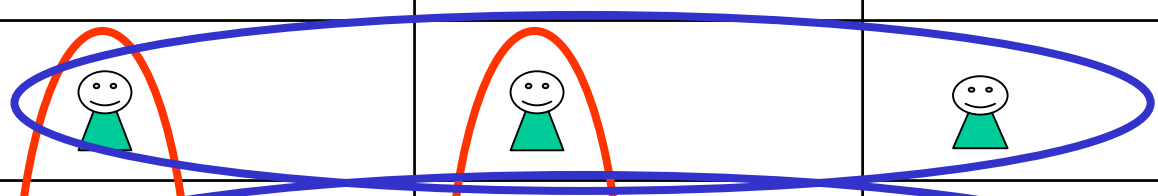
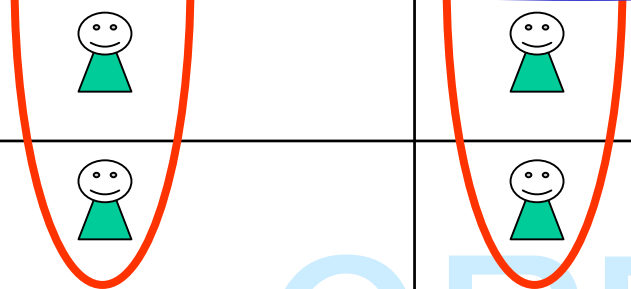
Structure of learning materials

	Theoretical	Experimental	Observational
K. representation			
Conceptual change			
Everyday cognition			
Collaboration			

Structure of learning materials

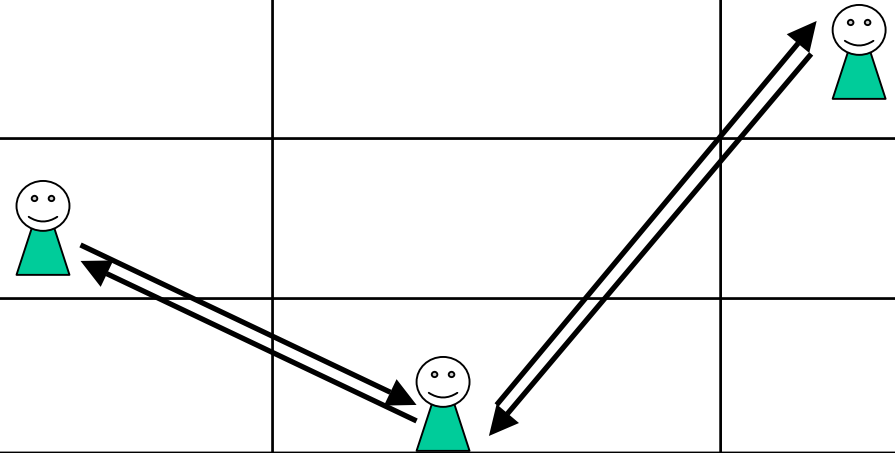
	Theoretical	Experimental	Observational
K. representation			
Conceptual change			
Everyday cognition			
Collaboration			

Structure of learning materials

	Theoretical	Experimental	Observational
K. representation			
Conceptual change			
Everyday cognition			…
Collaboration			…

Structure of learning materials

	Theoretical	Experimental	Observational
K. representation			
Conceptual change			
Everyday cognition			
Collaboration			



Quality of final reports

- 1998: Students started to turn in more integrated term papers, referring to many of the research covered in the class (50% to less than 10% in previous years).
- 2000: 80% of the papers applied integrated "theory-like" understanding, referring to more than three concrete research examples.

Data analyses

- Numbers of notes and links
- Content types of notes and links
  - What kinds of links did students make?
  - Any effects of raised “visibility” of links to the use of notes?

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Overall

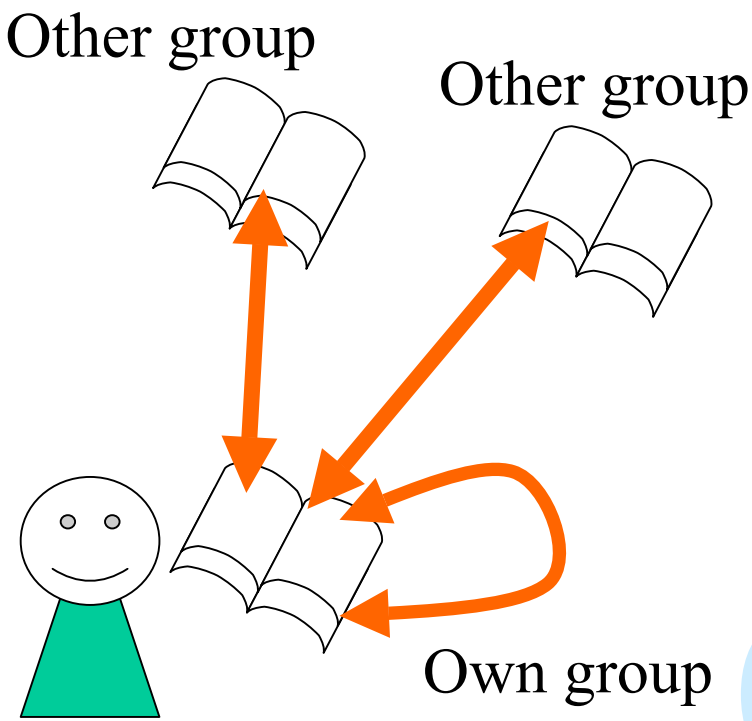
	1998 (3 months)	2000 (3 days)
ReCoNote Users	57	71
Group notes	192	177
Individual notes	114	230
Mutual links	189	106
Refer notes (own)	379*	3504
Refer notes (other)	6786*	12152

- * without first 4 weeks

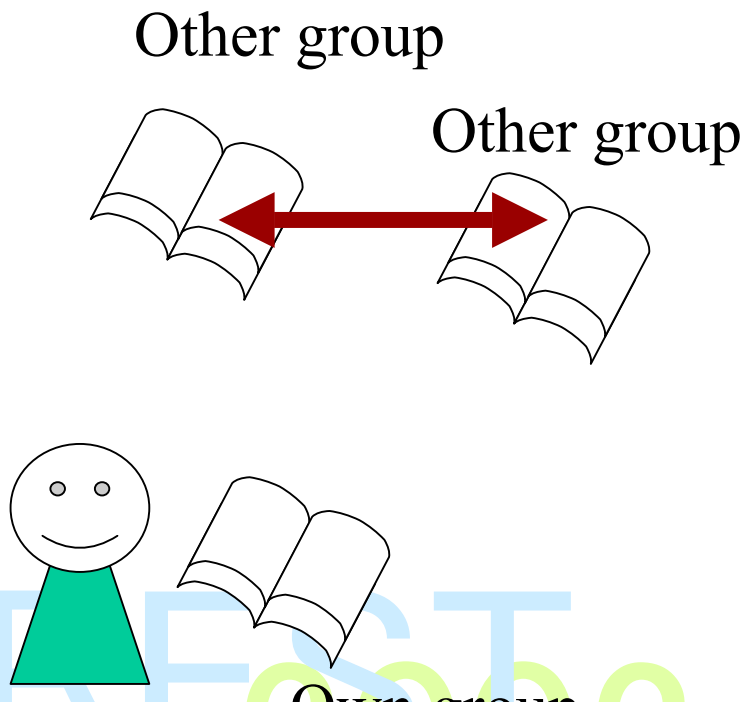
1. Link types

- Whose notes were linked?

Self-centered to among other's

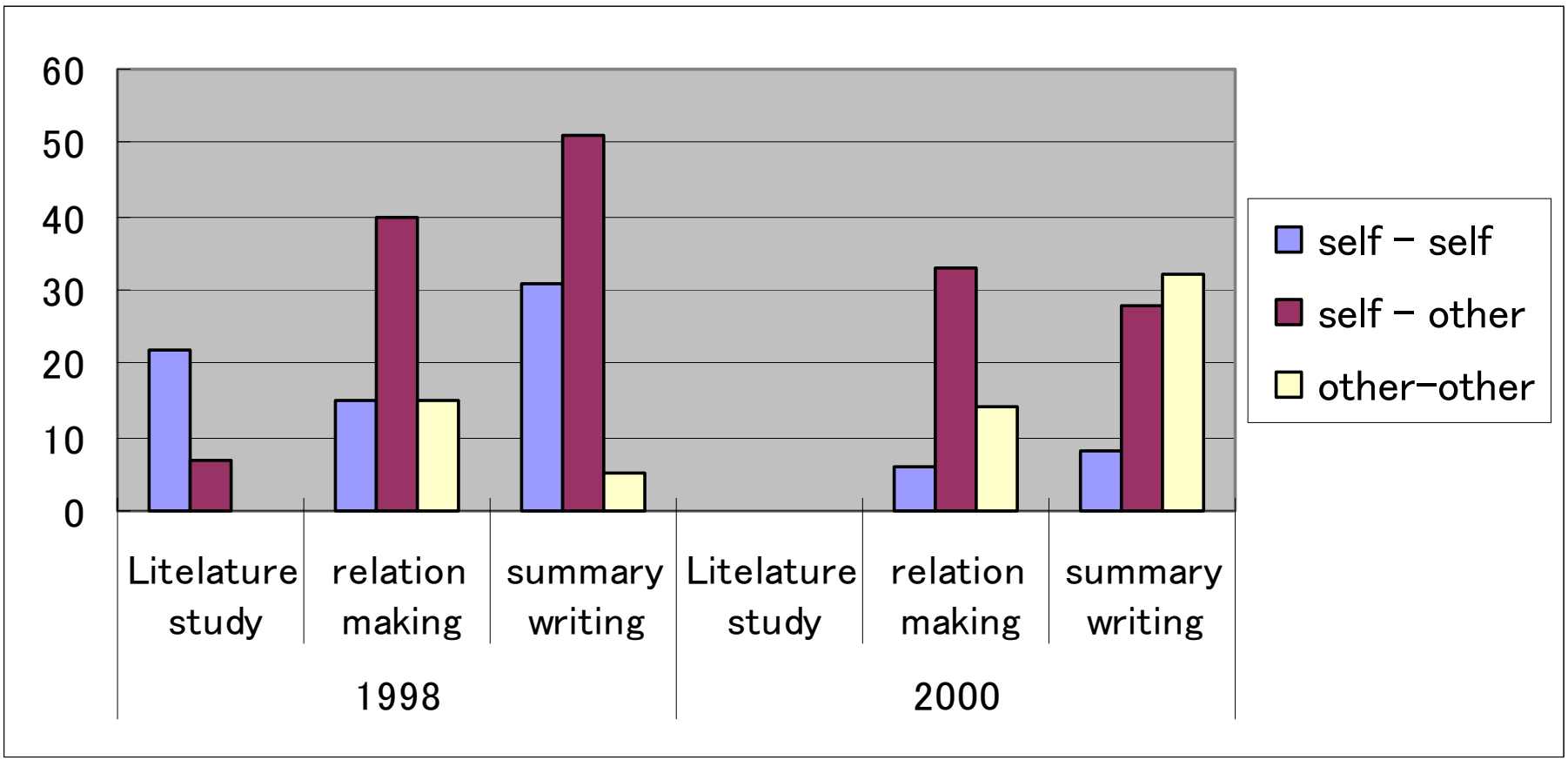


Self-centered



Other to Other

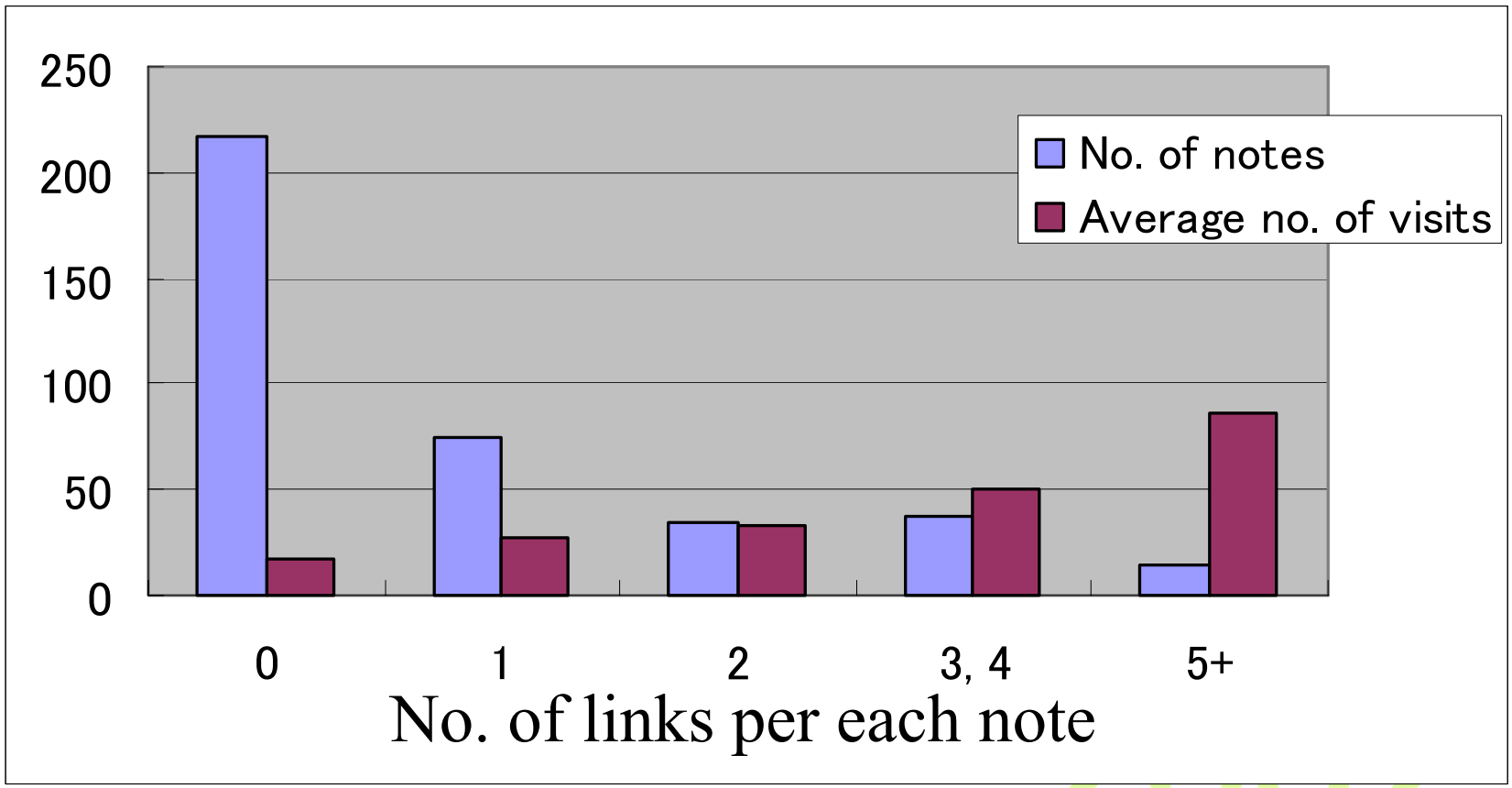
Link types by study phases



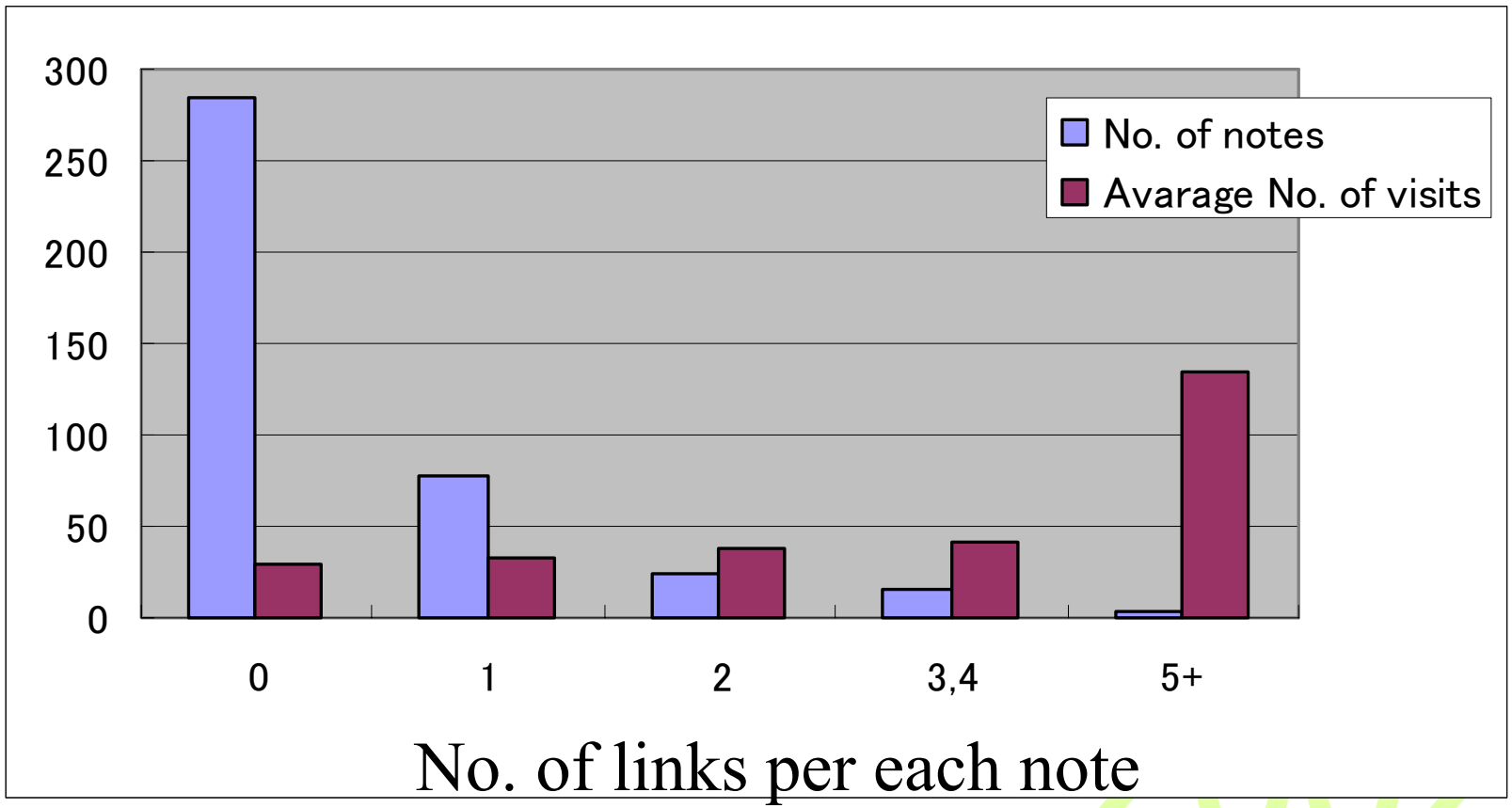
2. Links and visits

- Were notes with more links visited more frequently?

(1998) More links, more visit

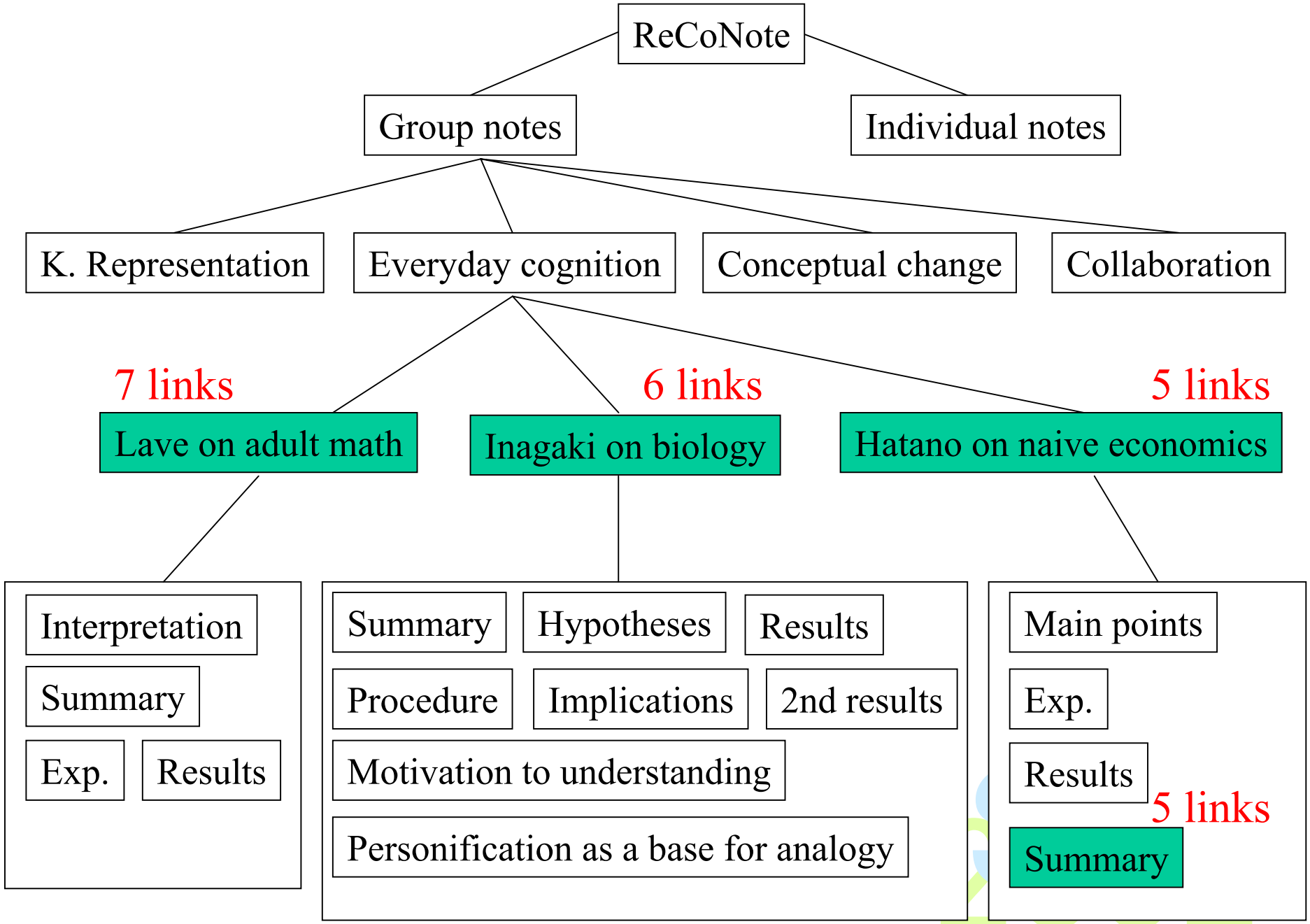


(2000) More links, more visit



3. Content of notes with many links

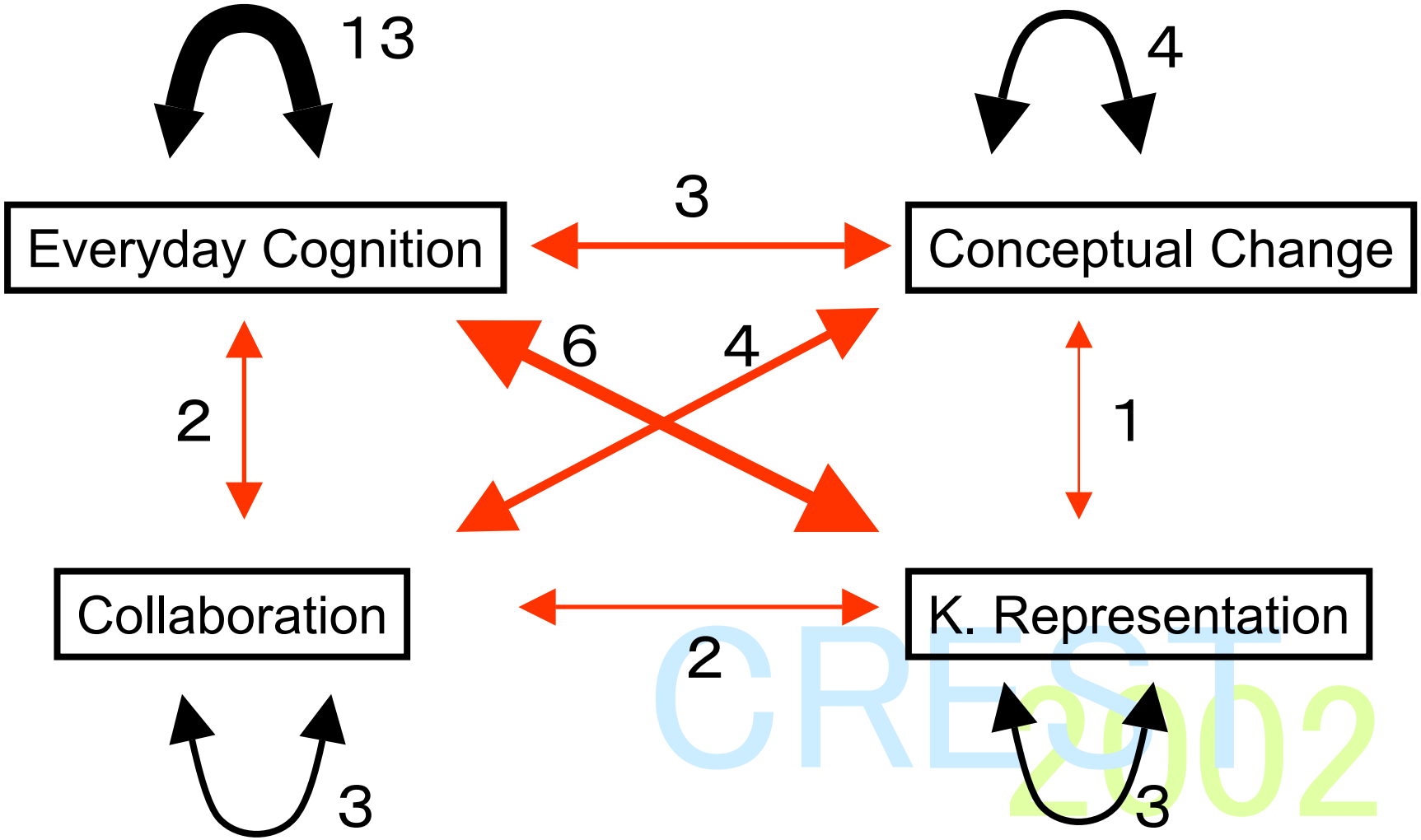
- Four notes had more than 5 links.
- “Table of contents” notes, referring to the structure of the notes below.


ReCoNote
Group notes
Individual notes
K. Representation
Everyday cognition
Conceptual change
Collaboration
7 links
6 links
5 links
Lave on adult math
Inagaki on biology
Hatano on naive economics
Interpretation
Summary
Exp.
Results
Summary
Hypotheses
Results
Procedure
Implications
2nd results
Motivation to understanding
Personification as a base for analogy
Main points
Exp.
Results
5 links
Summary

Sub-note structures

	Visits	Papers	Structured sub-notes
K. Representation	536	3	1
Everyday cogniton	524	3	3
Conceptual change	487	3	1
Collaboration	366	3	1

Where and how often notes were linked



Roles of externalized links

- Structure of the links seems to affect integration.

- Visibility of links helps higher-order integration, but also requires support for higher quality basic note-taking.

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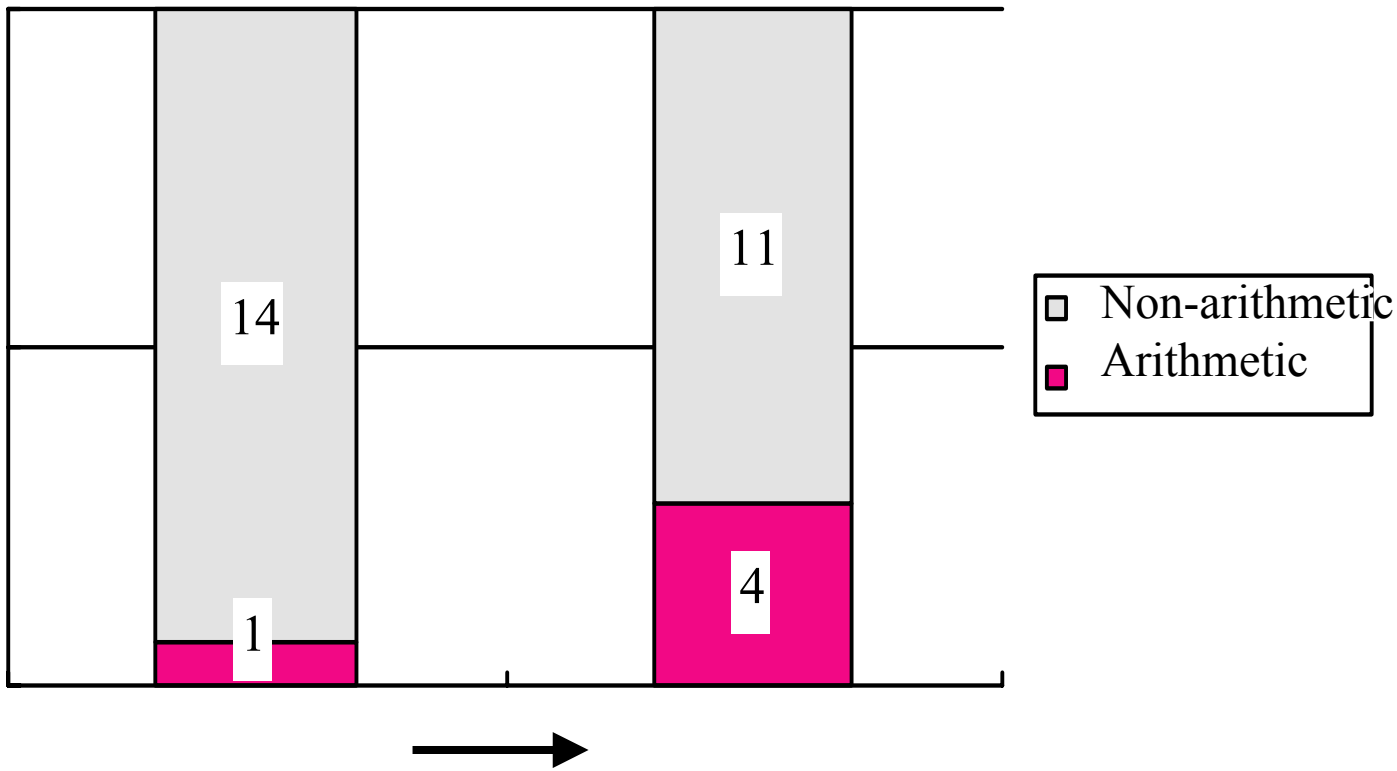
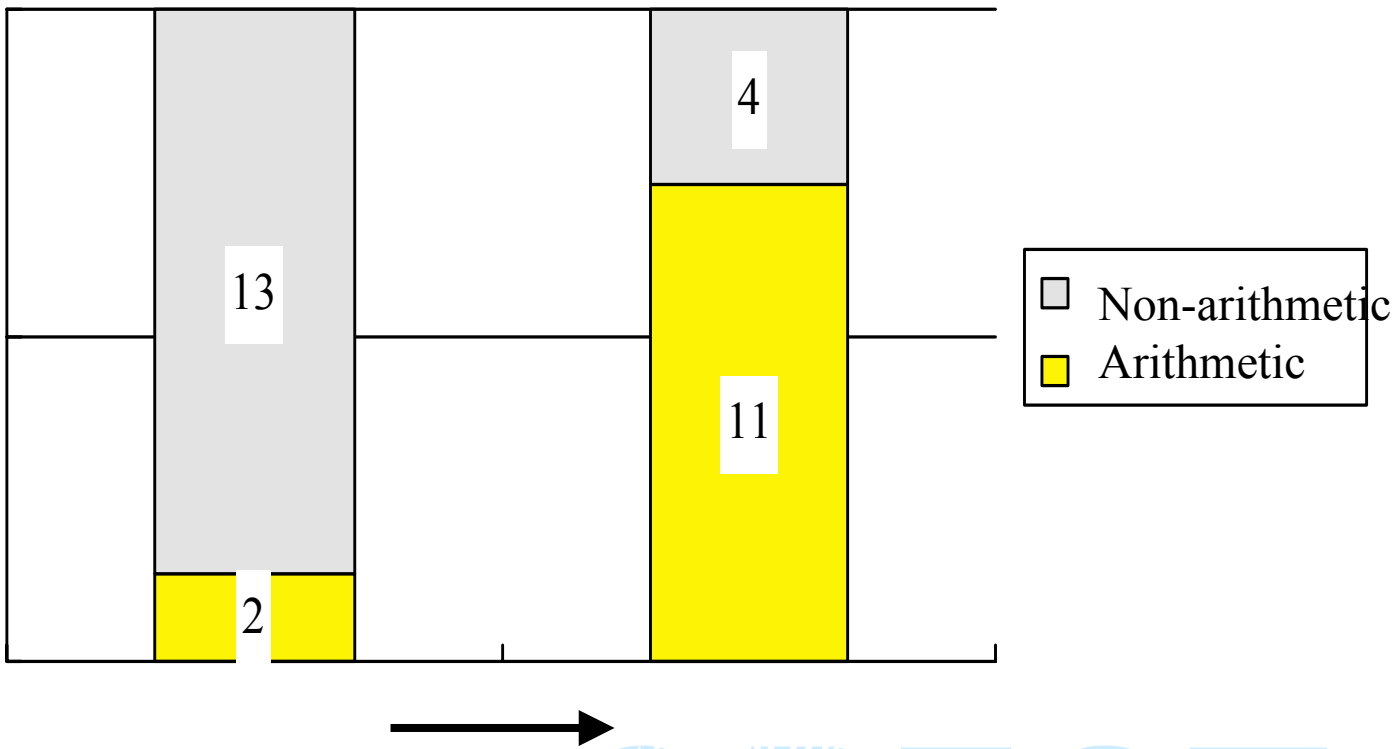
Solo subjects



2/3 of 3/4 **3/4 of 2/3**

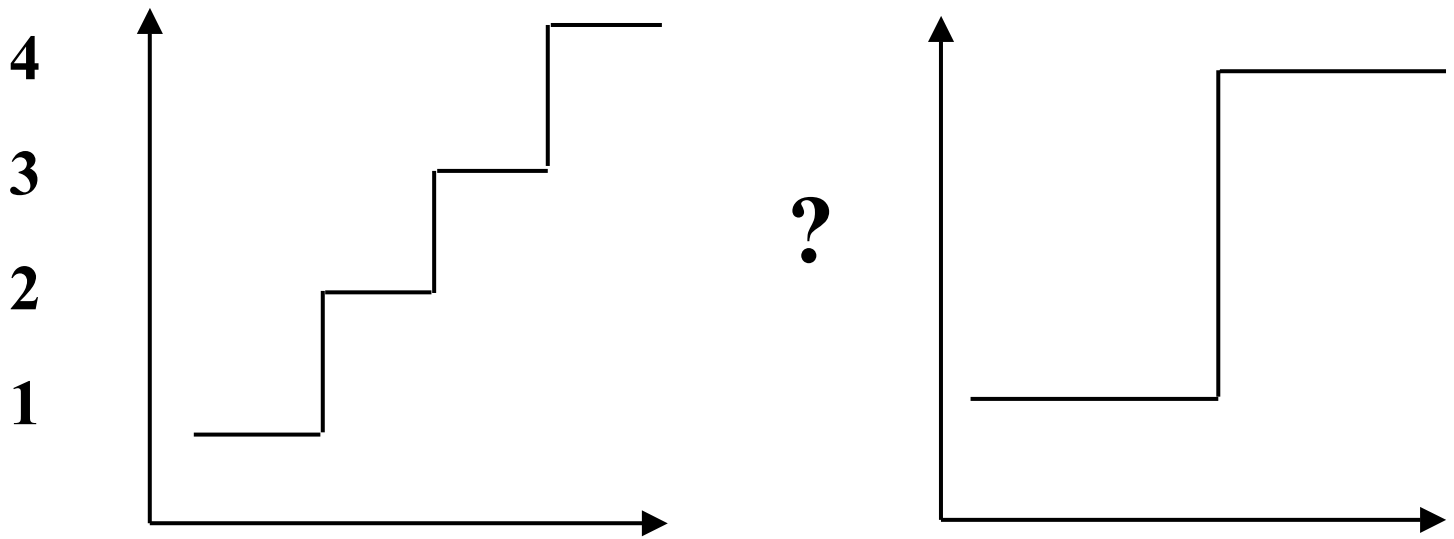
Paired subjects



2/3 of 3/4 **3/4 of 2/3**

Schematic shifts

Levels



Expected moves

Level 1 to Level 2	**7**
Level 2 to Level 3	**5 (7)**
Level 3 to Level 4	**3 (5)**
Sum	**15 (19)**

Who initiated the shifts?

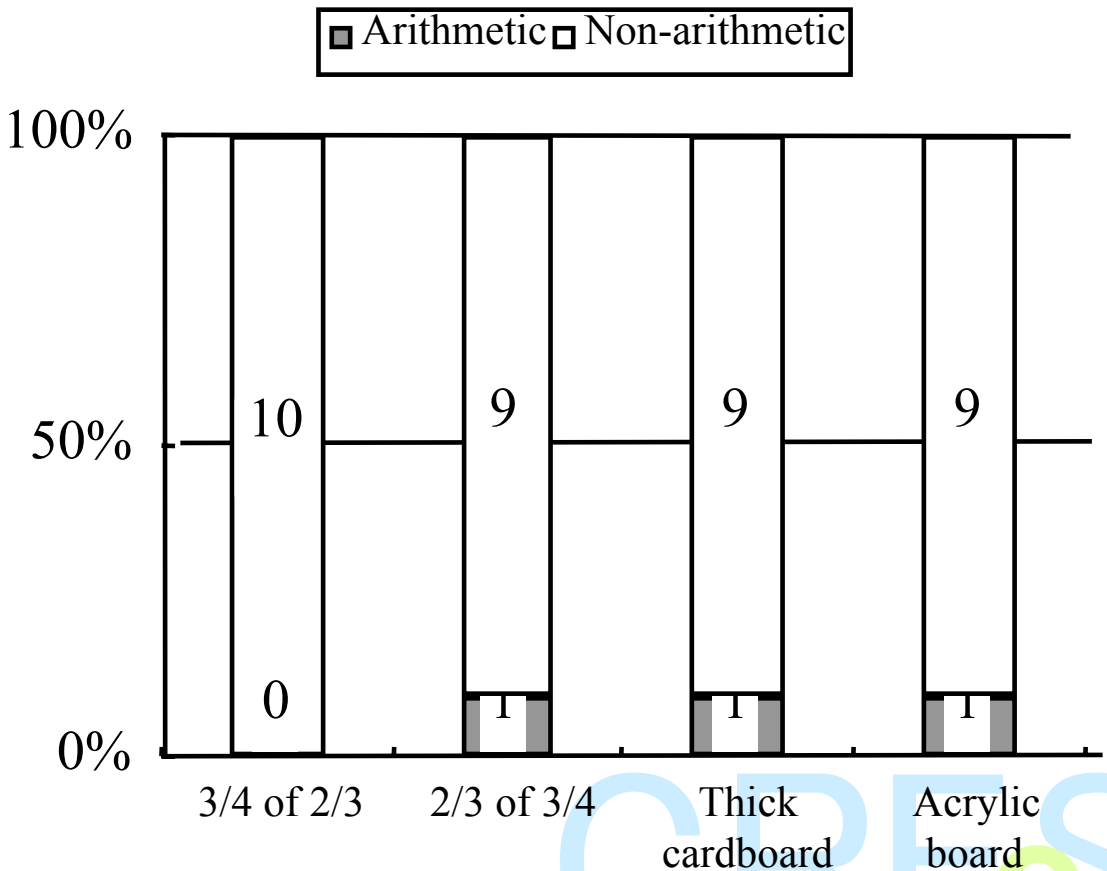
	Total	Monitor	Doer
Level 1 to Level 2	7	7	0
Level 2 to Level 3	5 (7)	3 (4)	2 (3)
Level 3 to Level 4	3 (5)	1 (1)	2 (4)
Level 2 to Level 4	2 (0)	1 (0)	1 (0)
Sum	17 (19)	12 (12)	5 (7)

Note. Numbers in parentheses are those when implicit Level 3 is included as Level 3.

What would you expect?

- Would 2/3 of 3/4 be different from 3/4 of 2/3?
- What if not origami paper but thick construction paper, or acrylic board?

Less than 10% calculated

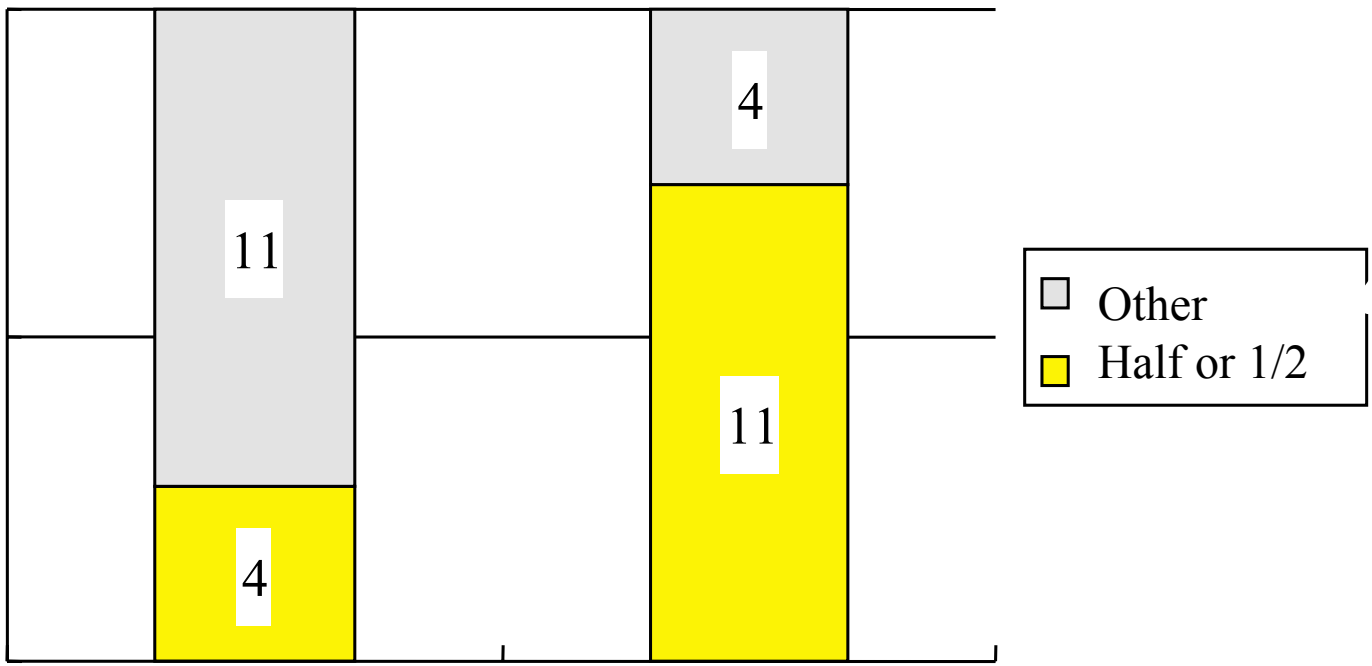


Creases as the trace of solving

- Come in different shapes
- “What is the answer?”

Solos vs. pairs on "what is the answer?"

“A half” or “1/2”



What happens in pairs??

Collaboration yielded abstraction

- Among Paired subjects, 11/13 went up to 3rd to 4th level of abstraction.
- Solos did so only 4/13 times.

- Role exchange appears to be responsible.

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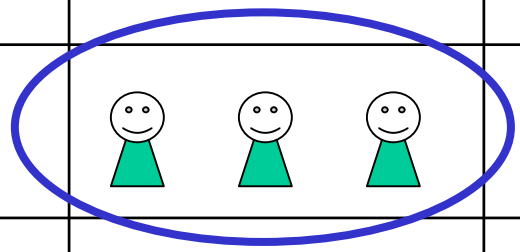
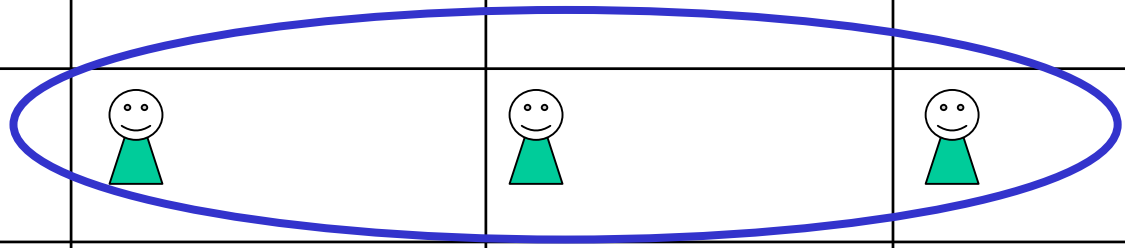
Same theme, same approach…

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

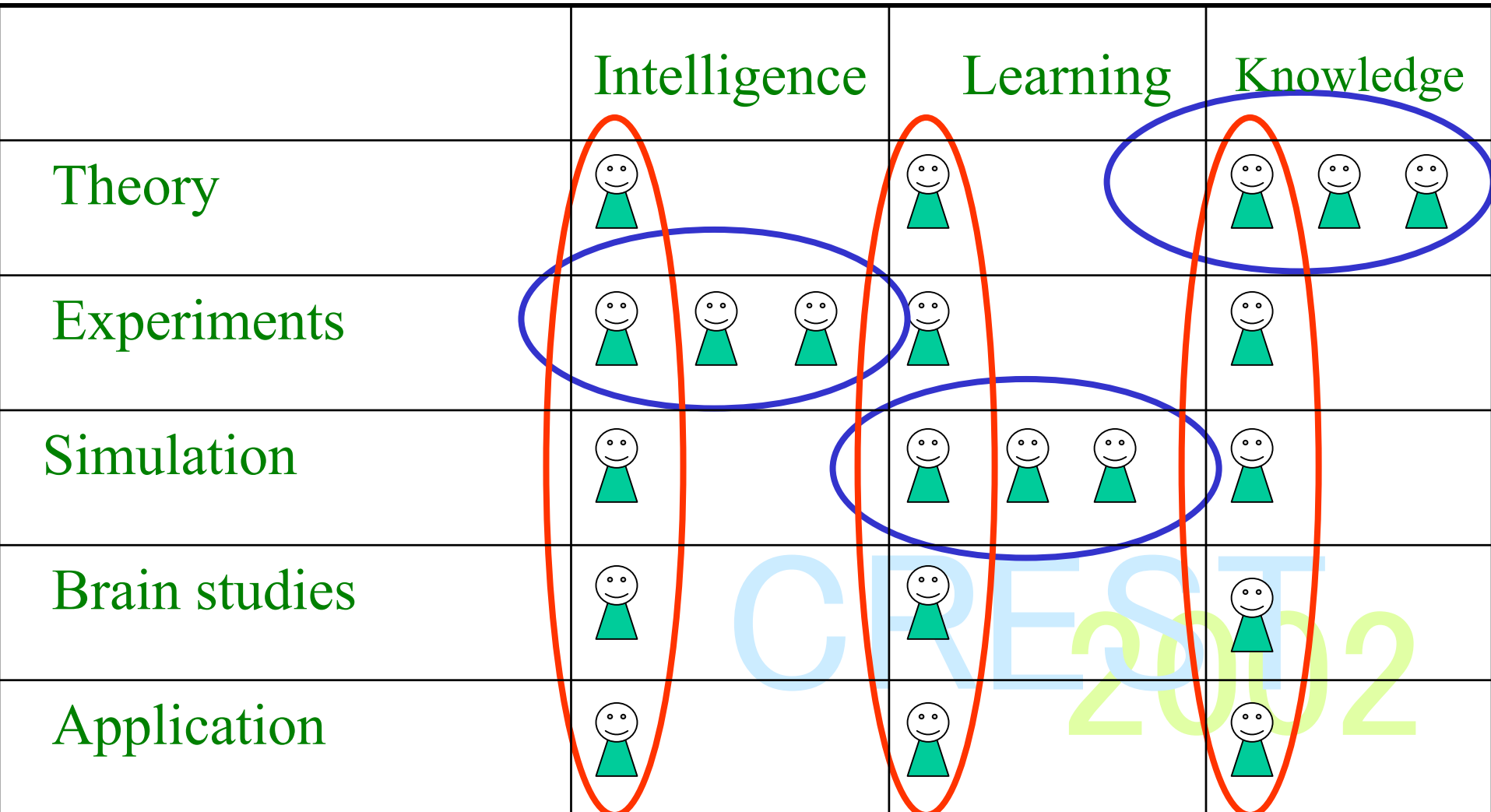
Different themes, same approach…

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

Same theme, different methodologies…

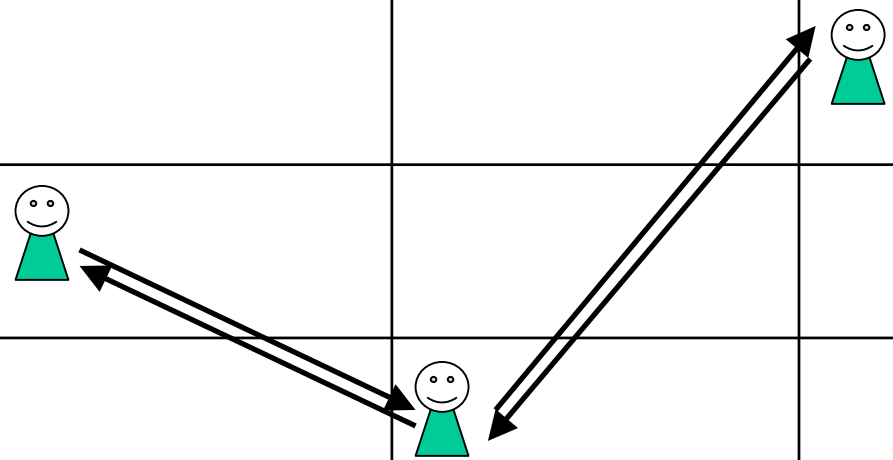
	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

Lots of combinations…

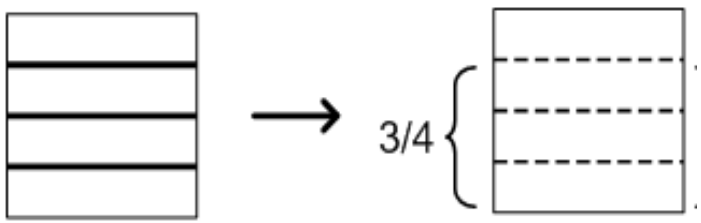


Project team of members with different backgrounds

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

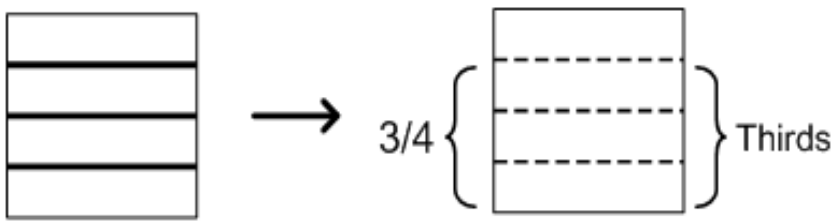


Getting 2/3 of 3/4 (1)



i) Original

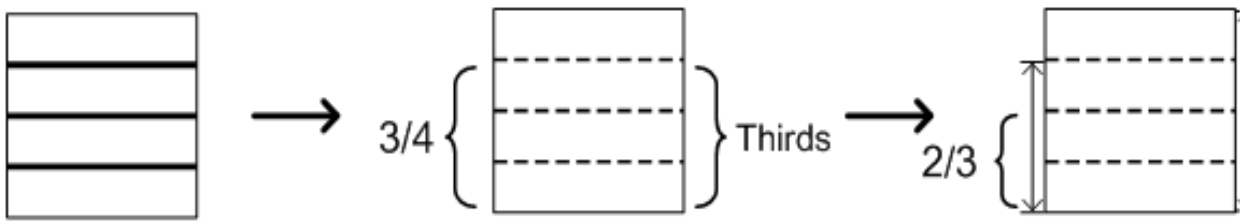
Getting 2/3 of 3/4 (2)



i) Original

ii) 1st Re-interpretation

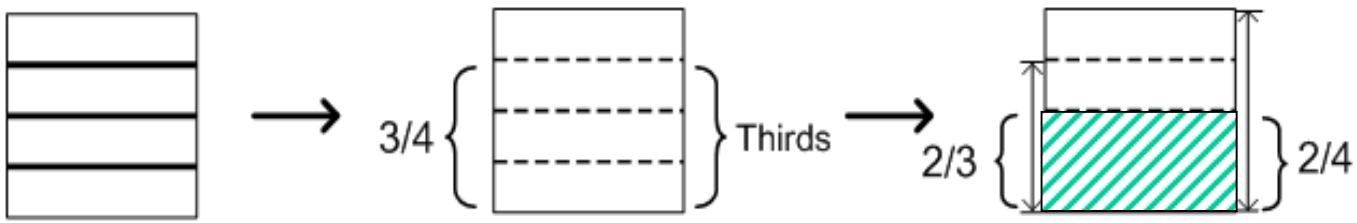
Getting 2/3 of 3/4 (3)



i) Original

ii) 1st Re-interpretation

Getting 2/3 of 3/4 (4)

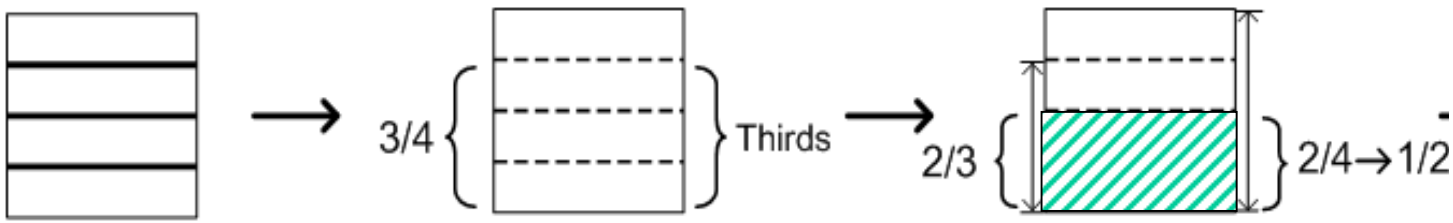


i) Original

ii) 1st Re-interpretation

iii) 2nd Re-interpretation

Getting 2/3 of 3/4 (5)

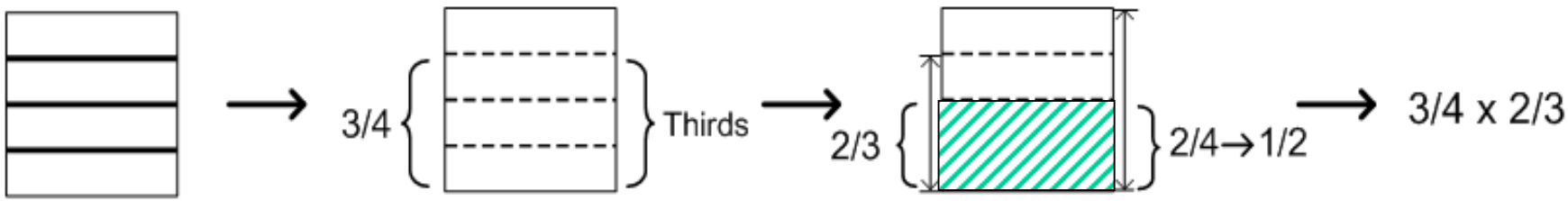


i) Original

ii) 1st Re-interpretation

iii) 2nd Re-interpretation

Getting 2/3 of 3/4 (6)

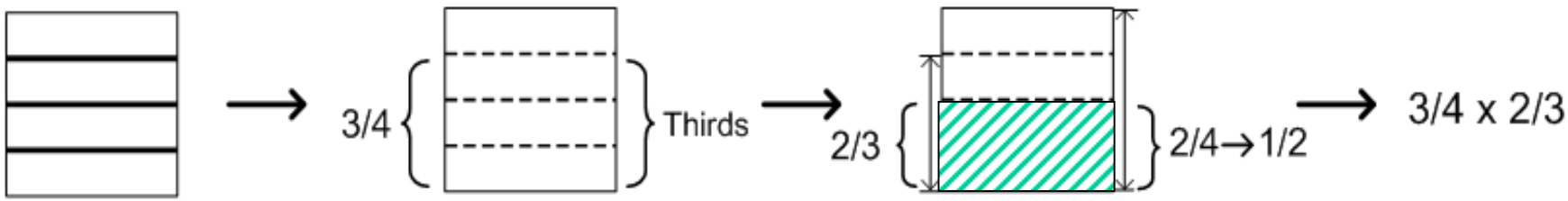


i) Original ii) 1st Re-interpretation iii) 2nd Re-interpretation iv) Calculation

Getting 2/3 of 3/4 (7)

Person 1

Task-doing → Monitoring → Task-doing →



Monitoring → Task-doing → Monitoring

Person 2