Supporting Collaborative Reflection for Knowledge Integration:

Computer Support for Building a Collaborative Learning Community in Undergraduate Cognitive Science Courses

Naomi Miyake

School for Computer and Cognitive Sciences,

Chukyo University

Self-introduction

- **1977-1982 at UCSD to witness the birth of cognitive science**
- **1982 Ph.D. on “Constructive interaction”**
- **1984-1991 InterCultural Learning Network**
- **1991 Department of Cognitive Science in Japan**
- **…Developing collaborative learning courses at college-level cognitive science…**

Cognitive science view on collaboration

- **What is it?**
- **How does it work?**
- **What are the conditions for it to work right?**
- **How to implement such conditions into effective supports? (with technology, sometimes)**
- **Our current model course and its evaluation (qualitative).**

Collaborative Knowledge integration

- **An illustrative case: “Ice-making story”**
  - **Nursery school kids found out how to make ice collaboratively**

Ice-making story

- **Playing with ice is fun. Let's have ice everyday.**
- **"Does the pool freeze on rainy day?"**
- **"Put a bucket with water at your choice of location, and check and report next morning."**
- **Lots of positive and negative "answers."**
- **Lots of "Now I think water freezes when…"**
- **"Maybe temperature, maybe weather…"**

What's special with this class?

- **Children's self-knowledge construction.**
- **Children seem to have started to gain some conceptual understanding.**

What is Conceptual understanding and why is it important?

- **Abstracted knowledge**
  - **Of reasons, underlying mechanisms, conditions for application…**
- **Usable**
- **Sustainable**
- **Portable (transferable)**
- **Restructure-able**

Hard to reach…

- **Giving verbal explanations does not work.**
  - **At least, not sustainable or not much usable.**
- **Experiential knowledge does not form itself into an abstracted piece of knowledge.**

What happened at the ice-making class…?

- **The goal was shared.**
- **Kids could easily have different "initial hypotheses."**
- **There were lots of different answers.**
  - **They were variations of *the answer* to the same question.**
- **All the answers were sharable for comparison.**
- **The answers required integration.**
- **The integration required abstraction.**
- **The abstracted "theory" was testable and tested.**

Ice making class: What caused the abstraction?

- **There were variations of the answer to the shared problem.**
- **There was motivation for integrating these variations.**
- **Integration requires abstraction.**
- **Chances for evaluating such abstracted "theories."**

Ice making class: What caused the abstraction?

- **There were variations of the answer to the shared problem.**
- **There was motivation for integrating these variations.**
- **Integration requires abstraction.**
- **Chances for evaluating such abstracted "theories."**

Ice making class: What caused the abstraction?

- There were variations of the answer to the shared problem.
- There was motivation for integrating these variations.
- Integration requires abstraction.
- Chances for evaluating such abstracted "theories."

Ice making class: What caused the abstraction?

- There were variations of the answer to the shared problem.
- There was motivation for integrating these variations.
- Integration requires abstraction.
- Chances for evaluating such abstracted "theories."

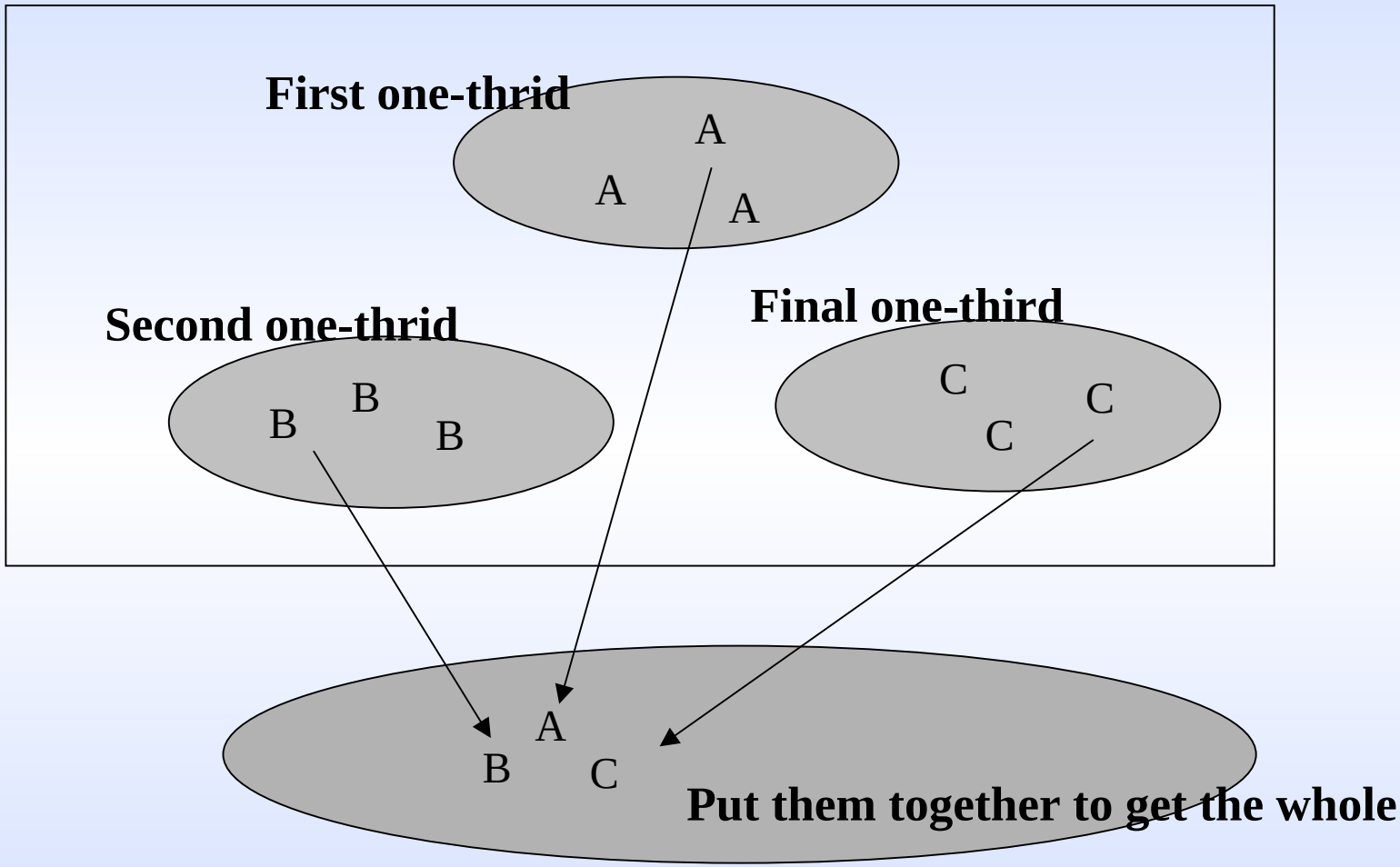
Conditions for effective collaboration

- **Shared goal**
- **Individual initial hypotheses**
- **Variations of solutions**
- **Integration**

Implementing support for each condition

Shared goal/Initial hypotheses

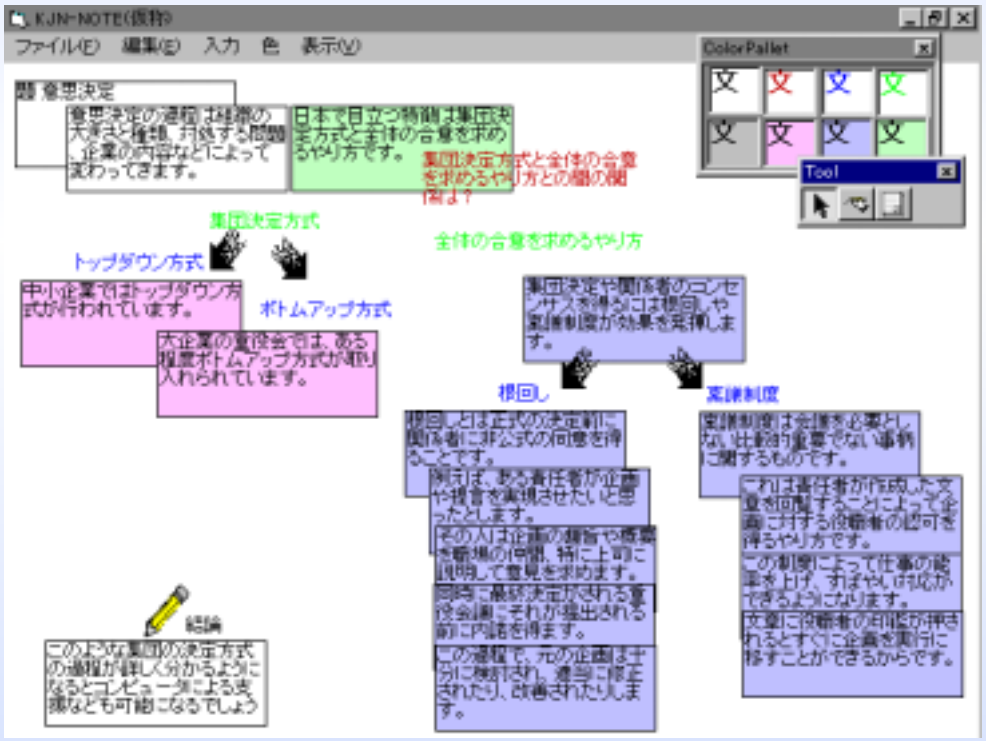
- **The internet**
  - **For forming virtual community of shared interest**
  - **For bringing in real world problems into classrooms**
- **The jigsaw method**


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

Variations of solutions

- **Note-sharing systems**
- **Record keeping of cognitive processes**
  - **e.g. CArD**

Card Arrangement Displayer



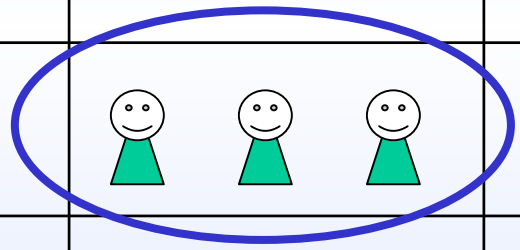
Integration

- **Providing frameworks**
  - **Structured jigsaw**

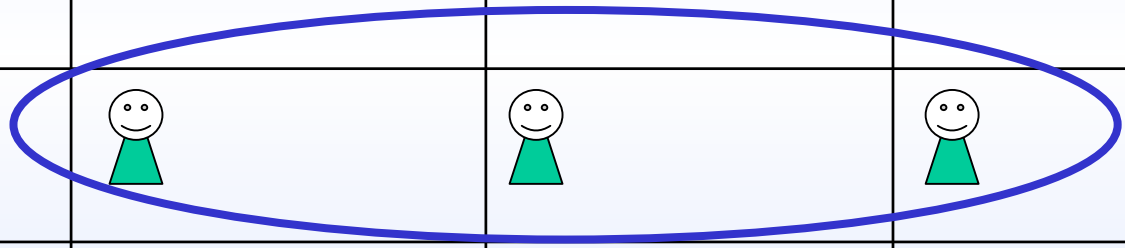
Structure of learning materials

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

Same theme, same approach…

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

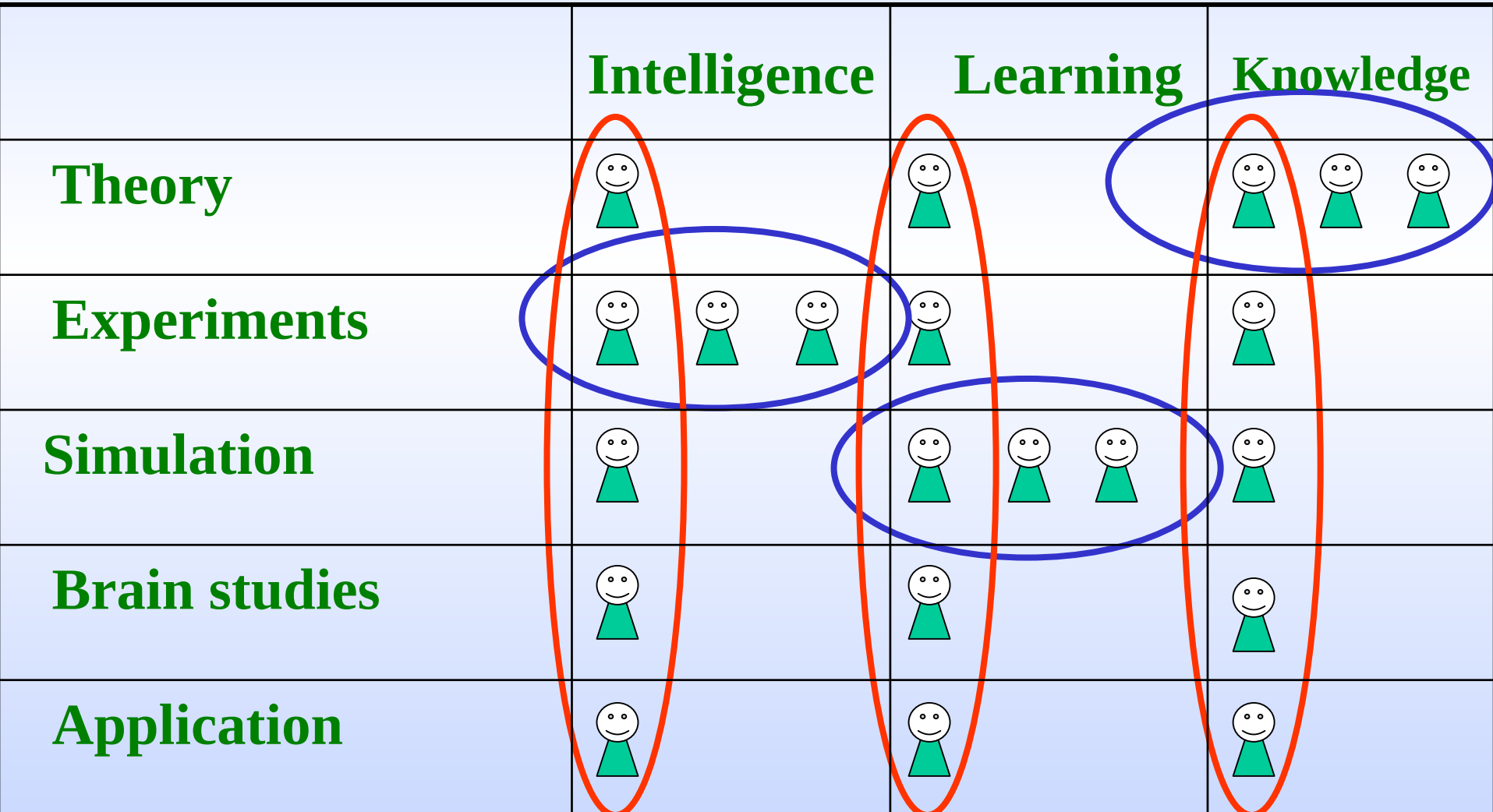
Different themes, same approach…

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

Same theme, different methodologies…

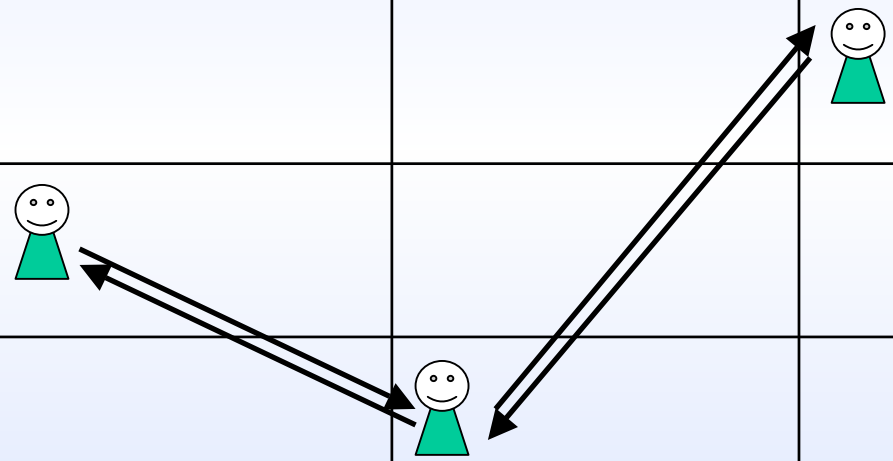
	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			

Lots of combinations…

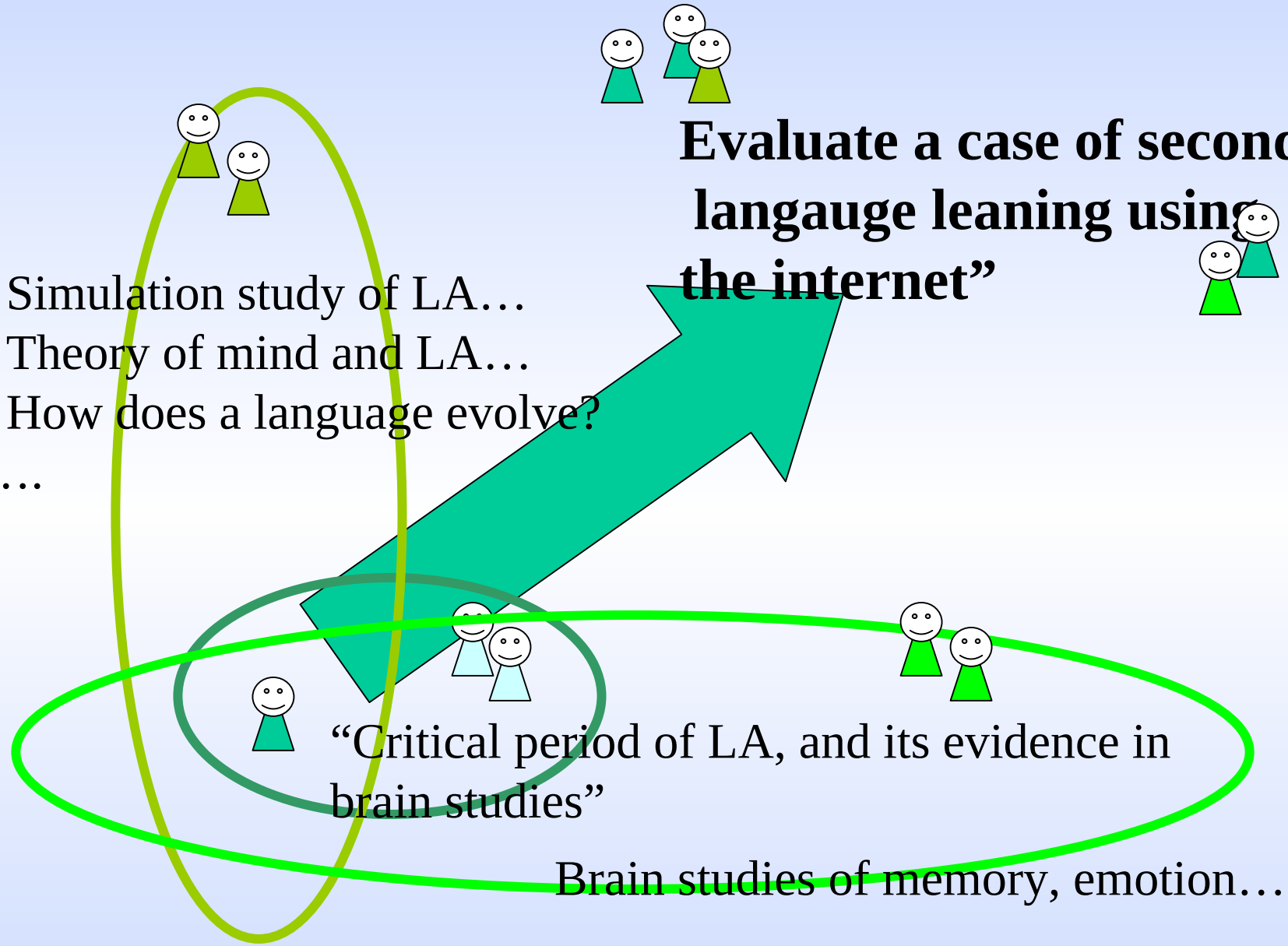


Project team of members with different backgrounds

	Intelligence	Learning	Knowledge
Theory			
Experiments			
Simulation			
Brain studies			
Application			



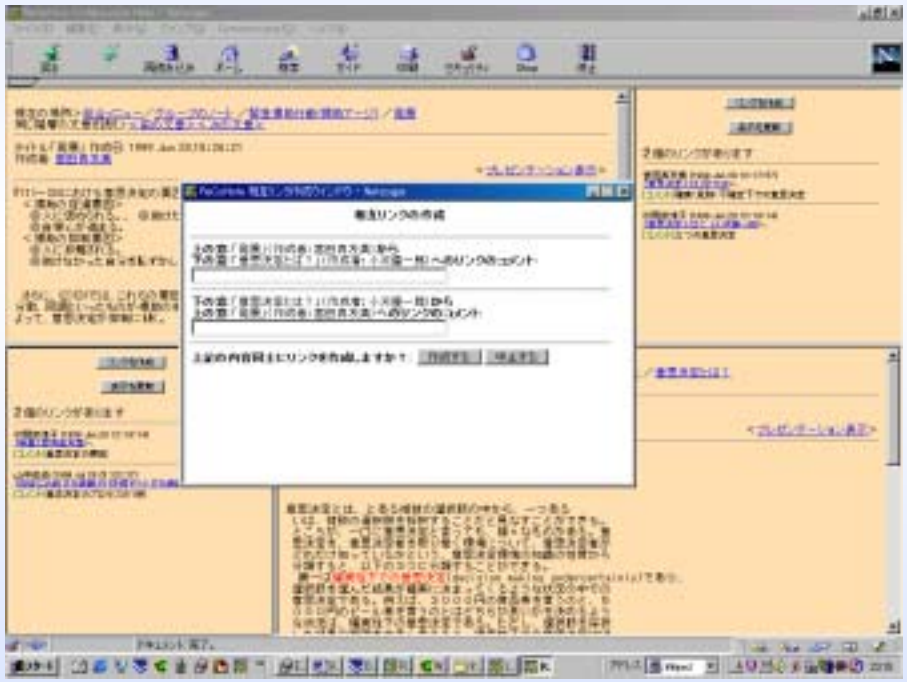
From a student's personal view...


Evaluate a case of second langauge leaning using the internet”
• Simulation study of LA…
• Theory of mind and LA…
• How does a language evolve?
….
“Critical period of LA, and its evidence in brain studies”
Brain studies of memory, emotion…

Integration

- **Providing frameworks**
  - **Structured jigsaw**
- **Sharing processes and results of linking and commenting (of notes, video clips…)**
  - **ReCoNote**

ReCoNote



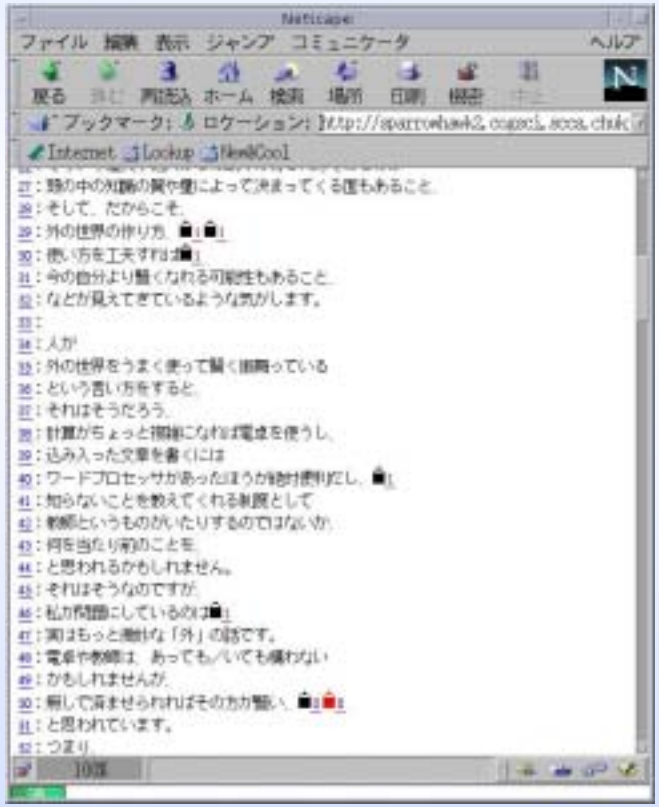
Conditions for effective collaboration

- **Shared goal**
- **Variations of solutions**
- **Integration**
- **Collaborative culture**

Collaborative culture

- From jigsaw to constructive interaction
- Peripheral participation support
  - IQ_R

Interactive Query Raiser



- **Our classroom goes…**

Evaluation

- **Performance measures**
  - **Better, more integrated term papers**
- **Process data (log analyses)**
  - **Number of comments, notes, links, visits…**
  - **Quality of them**
  - **Progress trace in relation to performance**

More integrated term papers

- **"How do you introduce Cognitive Science to your friends of different majors?"**
  - **1998: Centered around one study**
  - **1999: Began to tie two to three studies**
  - **2000: Tying together up to 7, 8 studies**

1998 vs. 2000 comparison

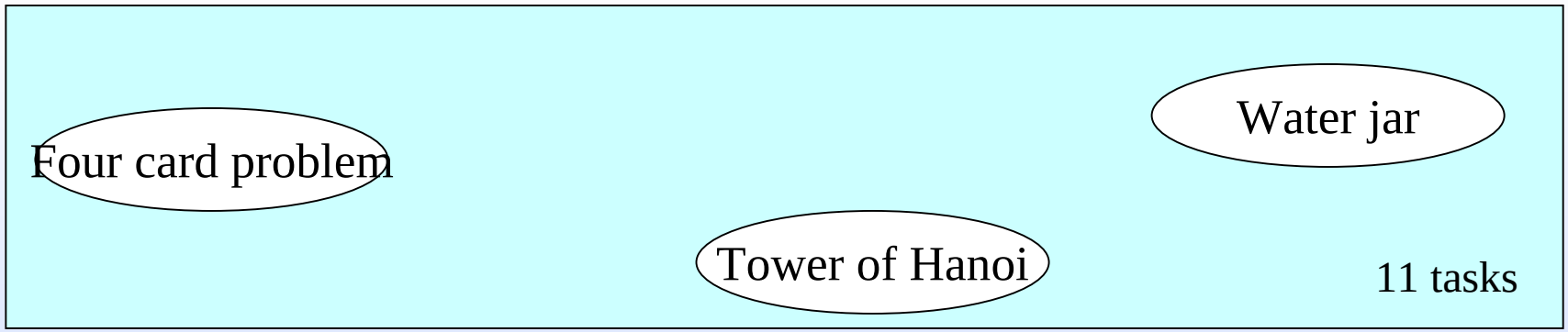
- **On junior (3rd year) level cognitive science courses**
- **Of ReCoNote use**

1998 practice

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

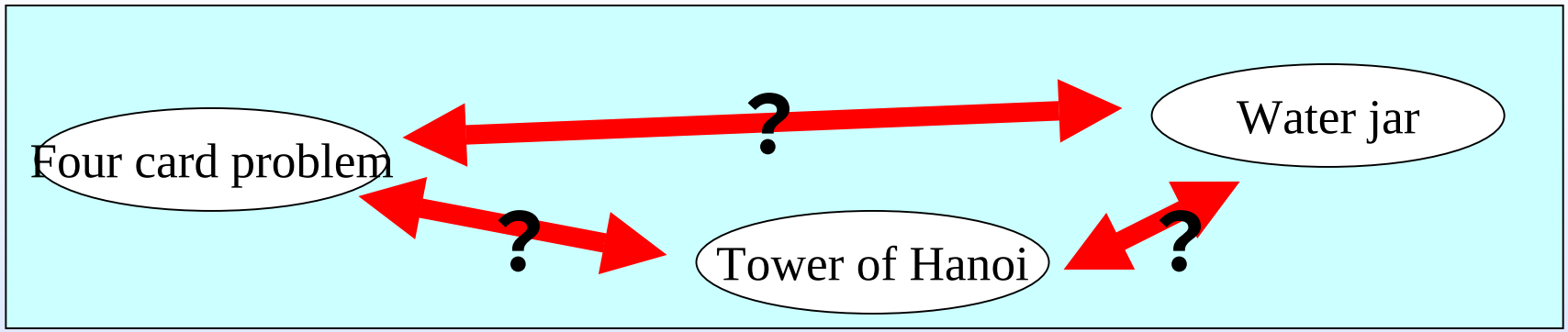
1998 design (1/3)

- **Literature study (10 weeks)**



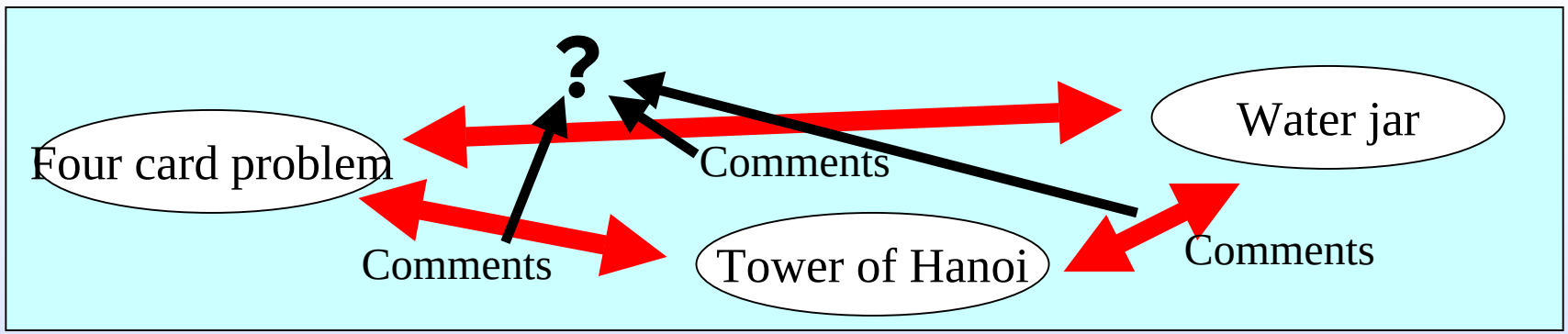
1998 design (2/3)

- **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.**



2000 practice

- **“Cognitive science of learning and development”**
  - **71 juniors or seniors**
  - **an intensive course, 3 days**
  - **Goal: “Propose and Evaluate a new design for a traditional college course based on findings of cognitive science on how people learn”**

2000 design

- **Literature study (1st day)**
- **Relation making (2nd day)**
- **Projects and Summary writing (3rd day + 10 days)**

- **Project: Design a new course.**

2000: The complex jigsaw method

- **4 approaches, 3 materials in each**

	Material A	Material B	Material C
“Situated cognition”	**Piece1,2,3**	**Piece1,2,3**	**Piece1,2,3**
“Developmental studies”	**Piece1,2,3**	**Piece1,2,3**	**Piece1,2,3**
“Conceptual understanding”	**Piece1,2,3**	**Piece1,2,3**	**Piece1,2,3**
“Collaboration”	**Piece1,2,3**	**Piece1,2,3**	**Piece1,2,3**

Overall

	1998	2000
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

* First 4 weeks not included

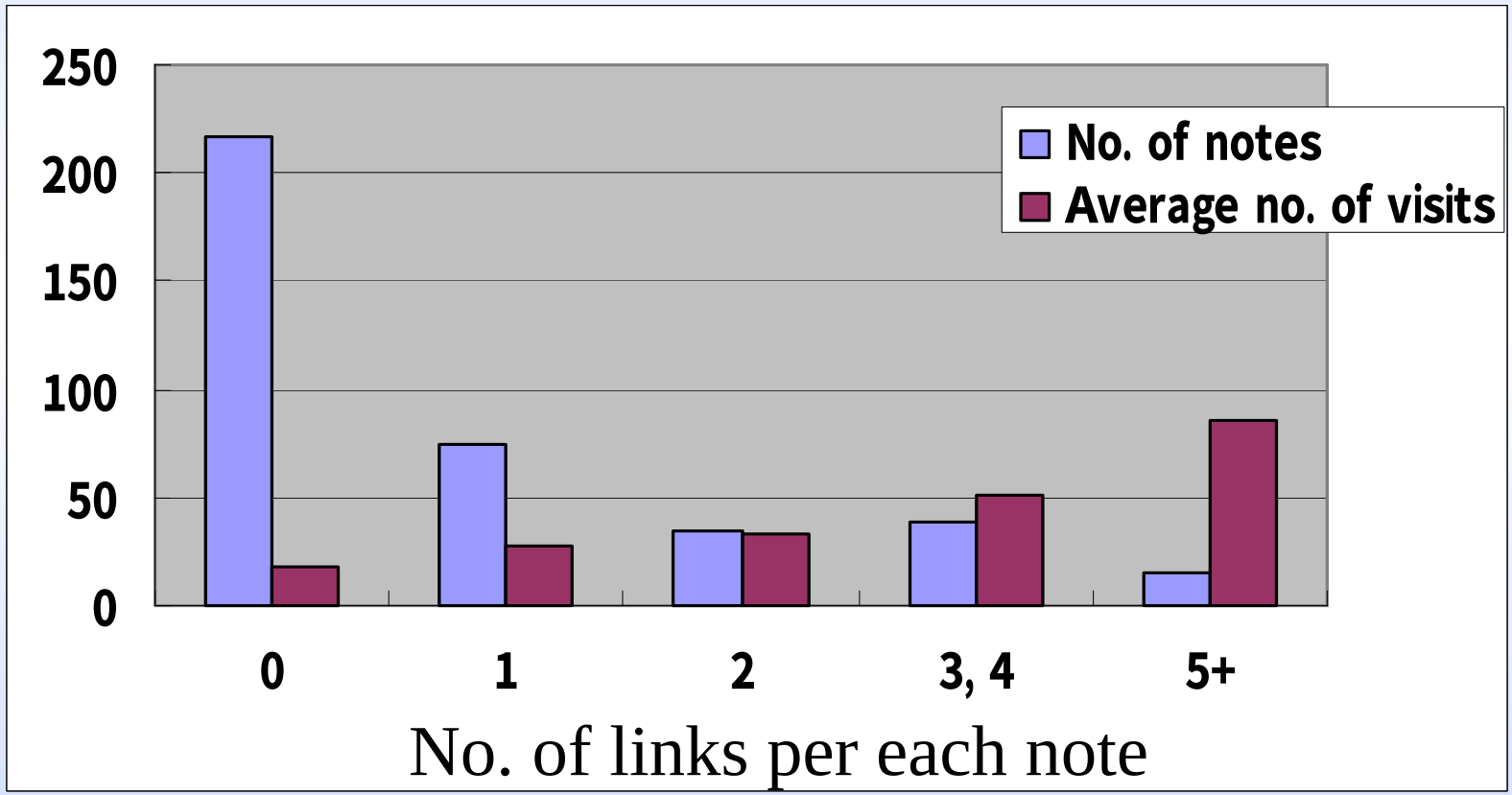
Focuses of analyses

1. **Did the mutual-linking help the students explore the materials?**
2. **Did the structure of the materials scaffold collaborative knowledge construction?**
3. **Did the activities help students learn the materials?**

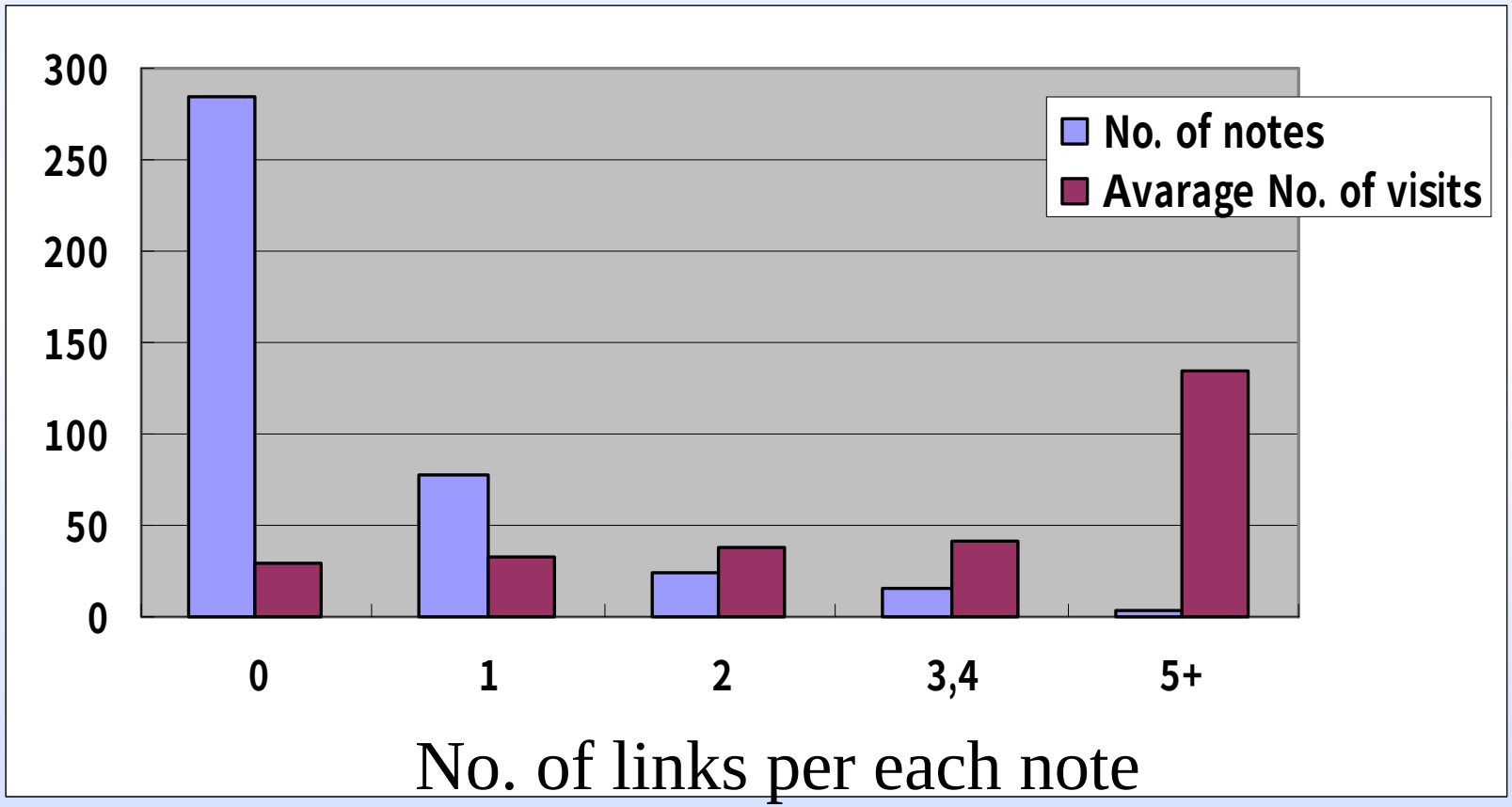
1. Did the mutual-linking help the students explore materials?

- **Notes with more links were visited more.**

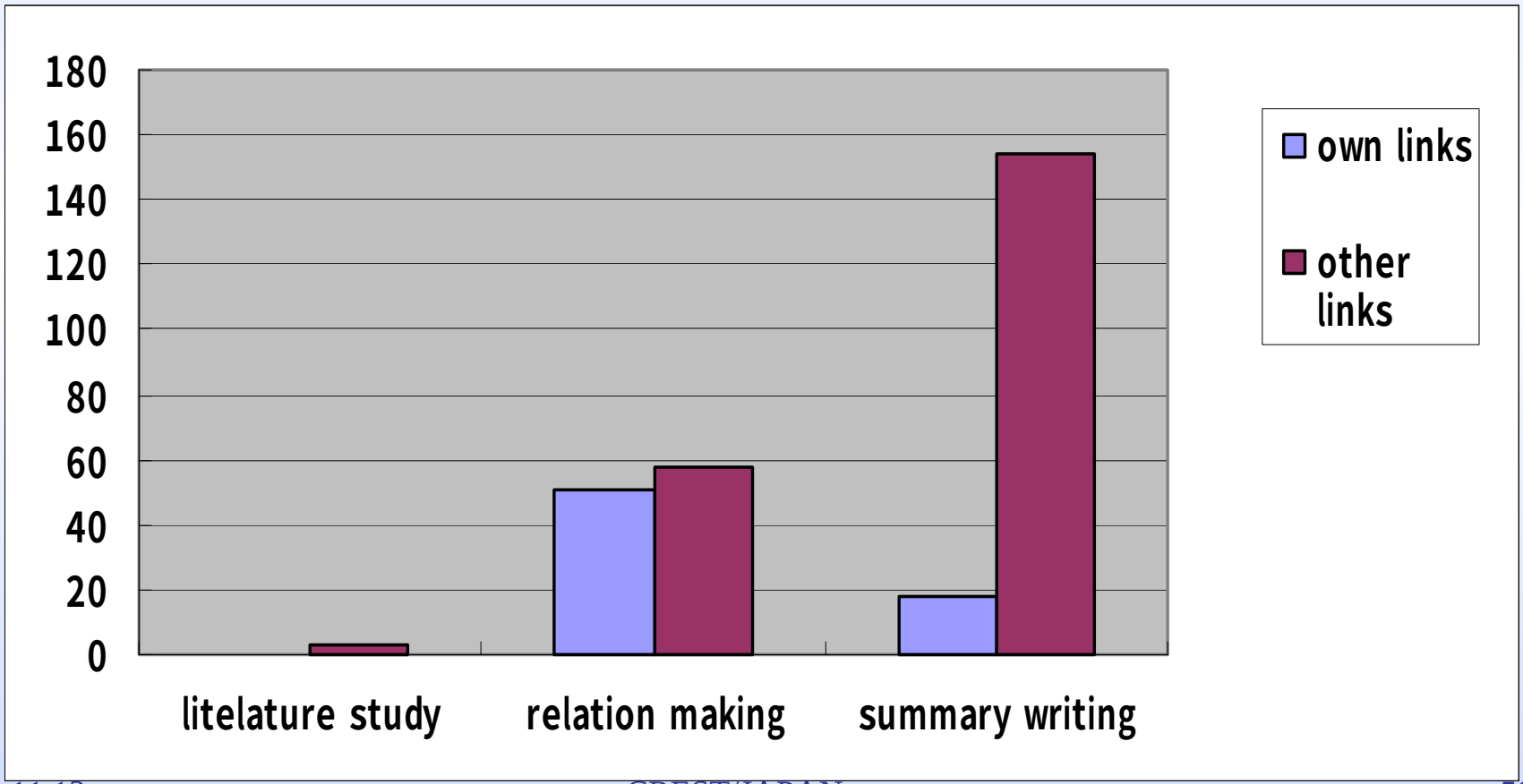
(1998) More links, more visits



(2000) More links, more visits



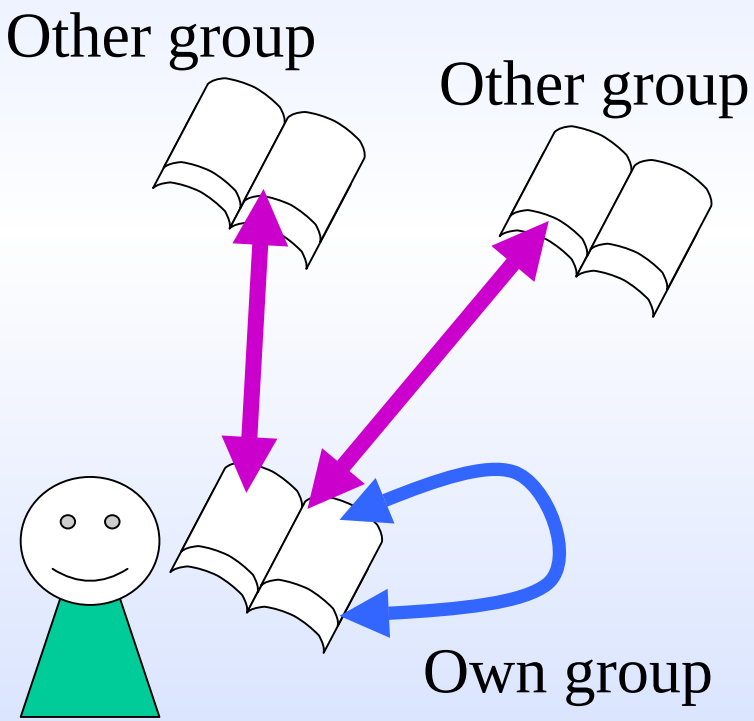
(2000) Use of mutual-links: one's own vs. others'



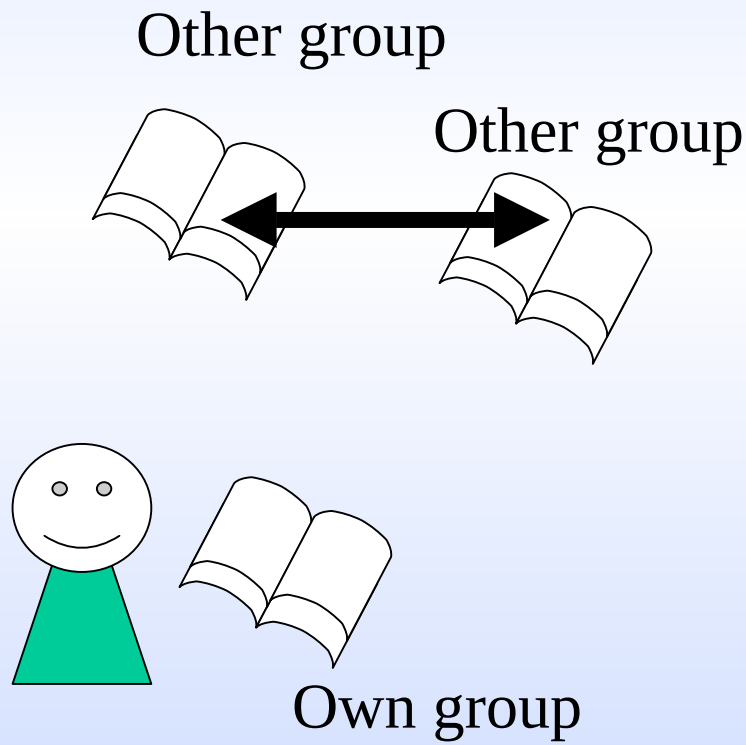
2. Did the structure of the materials scaffold collaborative knowledge construction?

- **Notes were actively linked.**
- **The 2000 students made more relations among others' notes than the 1998 students.**

“Self-centered” to “among other’s”

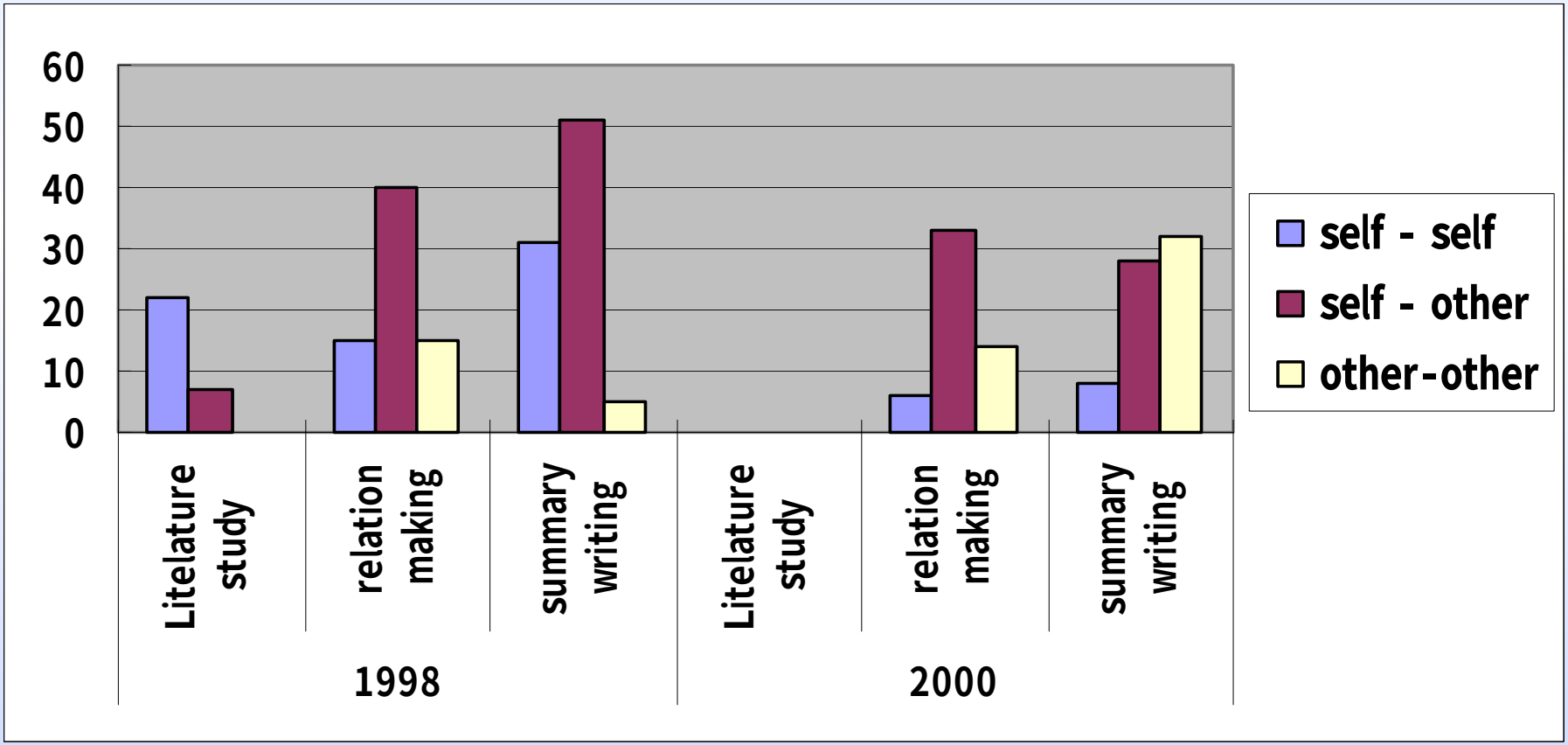


Self-centered



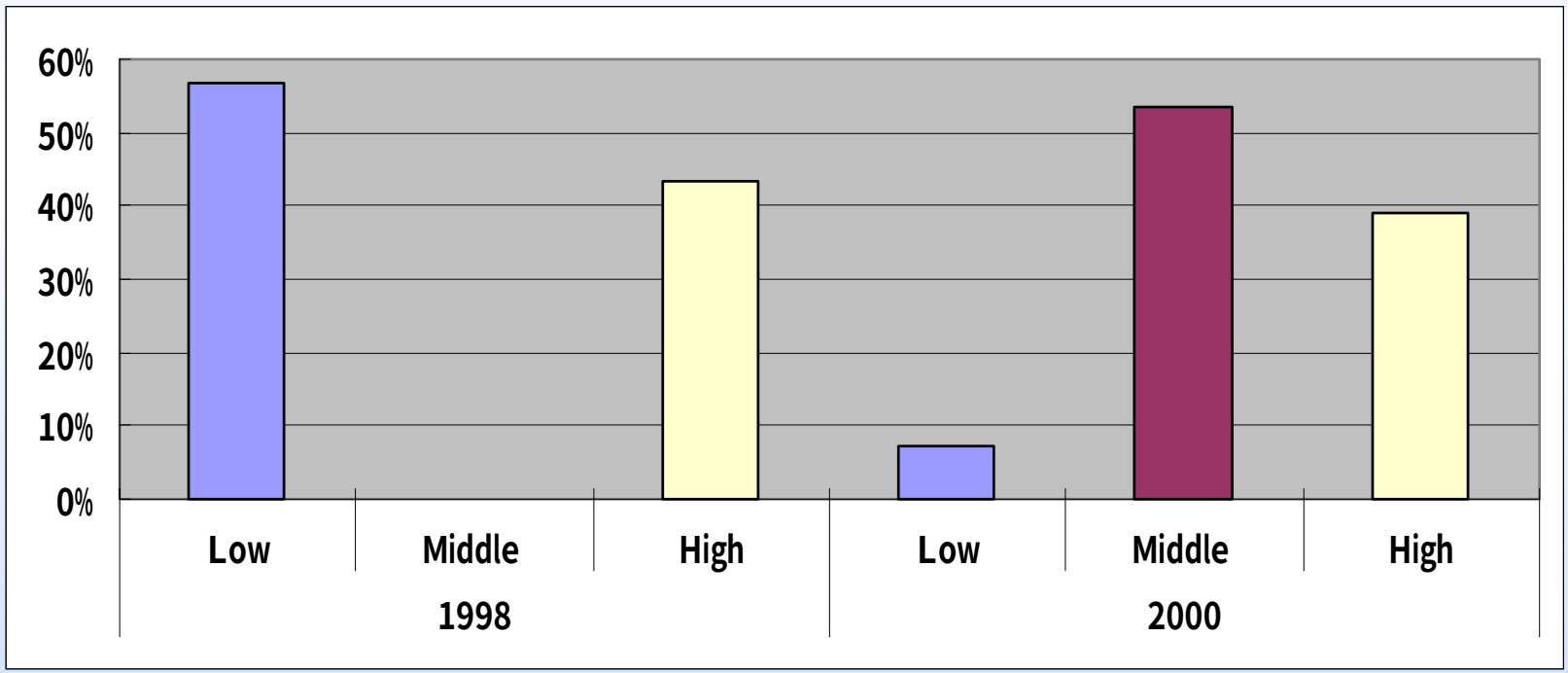
Other to Other

Link types by study phases



3. Did the activities help students learn?

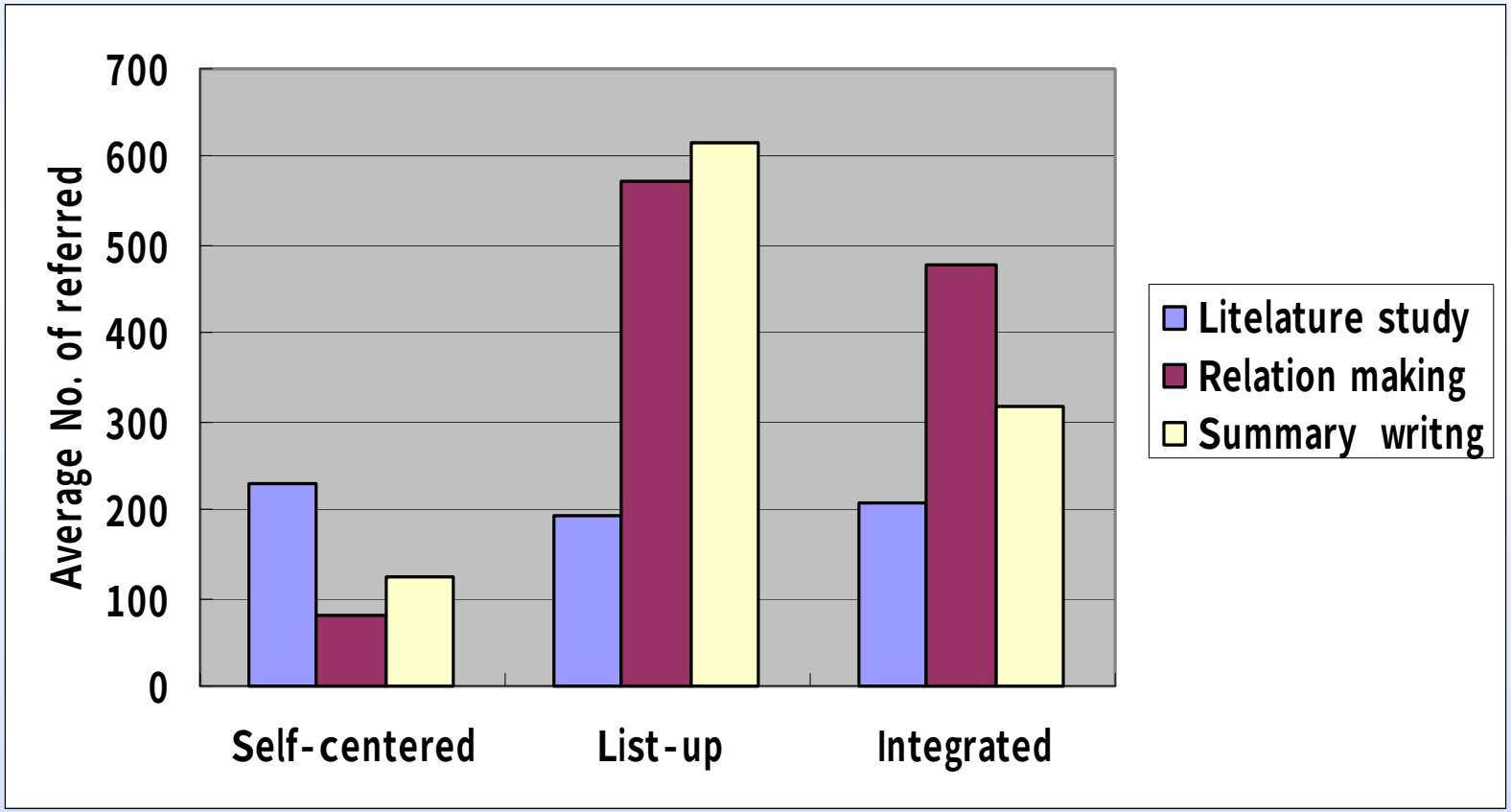
- **Moderate to high quality term papers**



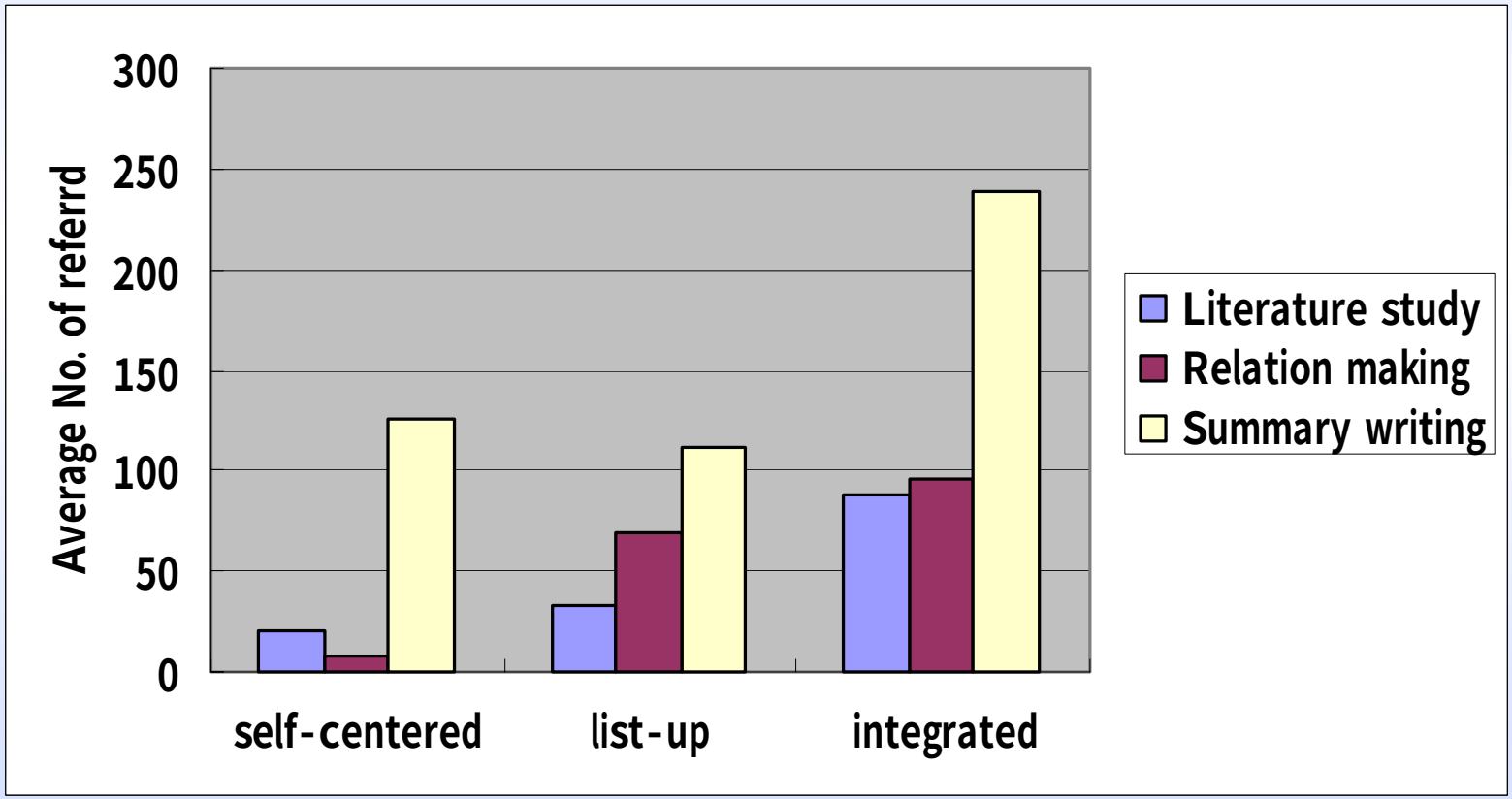
Report types

	1998	2000
Self-Centered	**3**	**3**
List-Up	**4**	**3**
Integrated	**3**	**8**

(1998) Note sharing activities by report types



(2000) Note sharing activities by report types



“Super” curriculum?

- 1st year “Orientation to CogSci”
  - Comment on each lecture and tie them together using Jigsaw, IQ_R & CArD
- 2nd year “Introduction to CogSci”
  - Provide your own literature survey and tie the contributions together with Structured jigsaw, & ReCoNote
- 3rd year “leaning sciences”
  - Apply what you learned to evaluate web information

What we are facing now is…

- **Renovating and integrating computer supports**
- **Exploring new types of learning activities**
- **Preparing better learning materials**
- **Redefining goals of learning: “what do the students really need to learn?”**
- **Realizing keener needs for better understanding of how people learn.**

Toward the learning sciences…

Thank you.

http://www.crest.sccs.chukyo-u.ac.jp/