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Examining the Science of Innovation Education

MITsdm

Hideyuki Horii
Executive director, i.school

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Hideyuki Horii

- 1983 Northwestern University, Ph.D.
- 1985 Assistant Professor, the University of Tokyo
- 1986 Associate Professor
- 1996 Professor
- 2018 Executive Director, Japan Social Innovation Center

- Micromechanics of rocks under compression
- Rock mechanics
- Socio-technology
- Innovation Education: i.school

Congestion charging in Stockholm is a typical example of socio-technology

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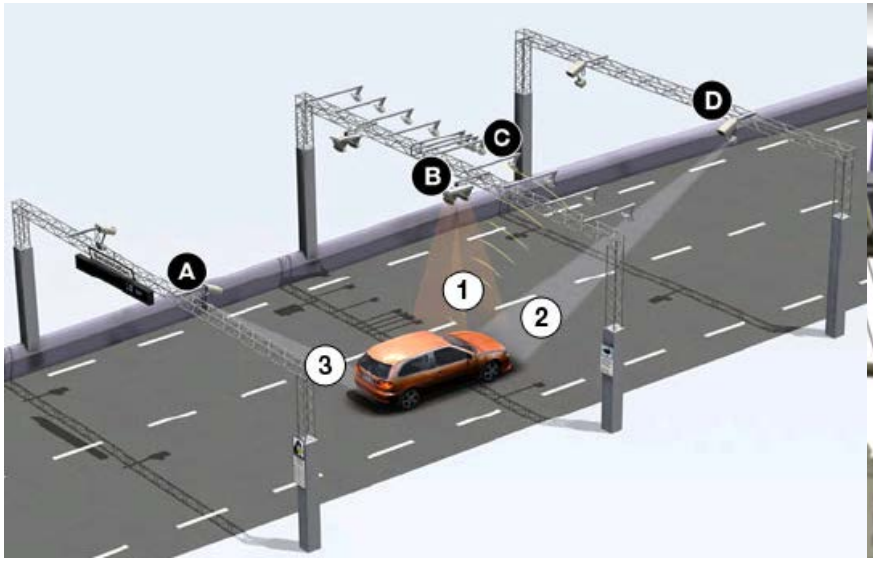
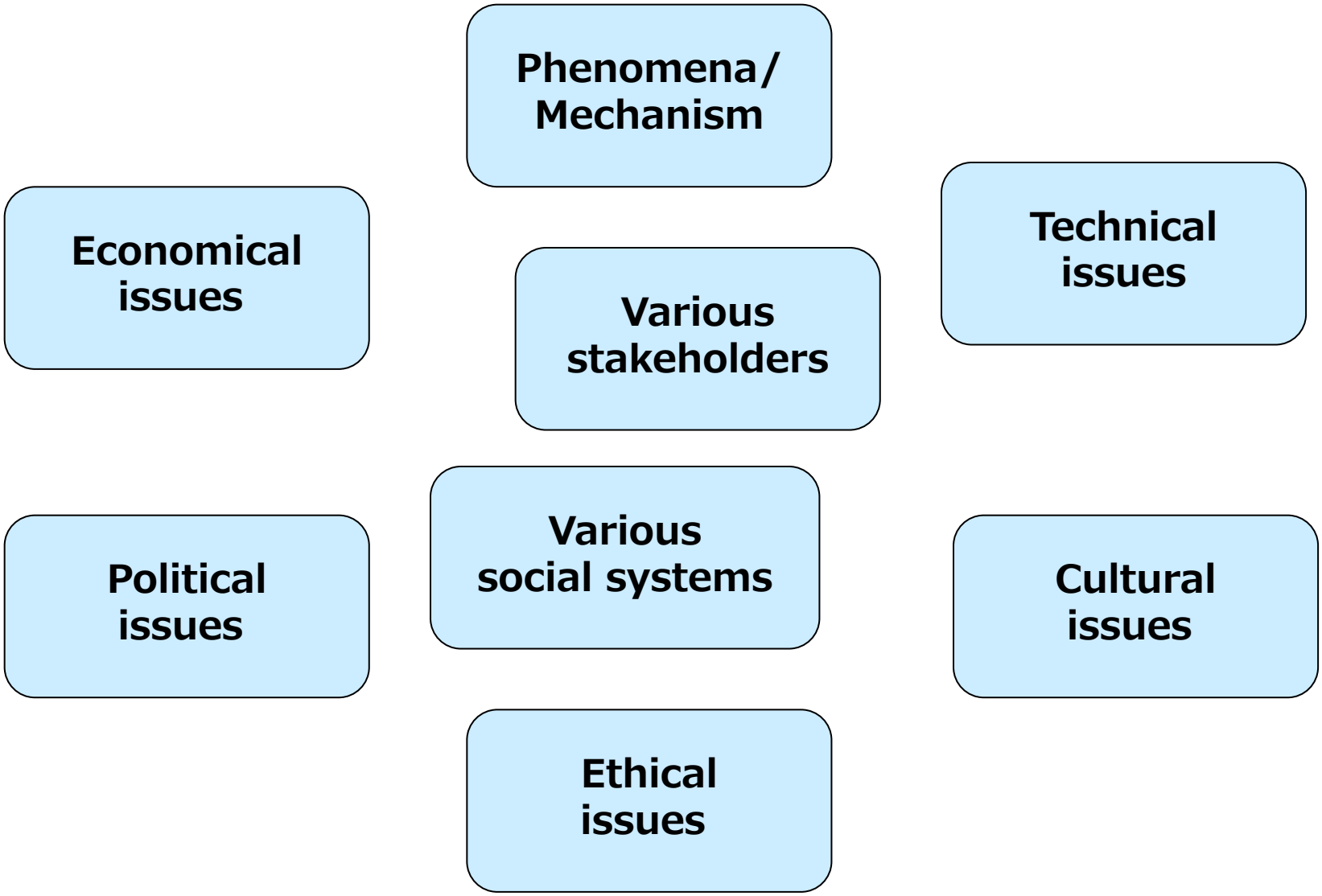
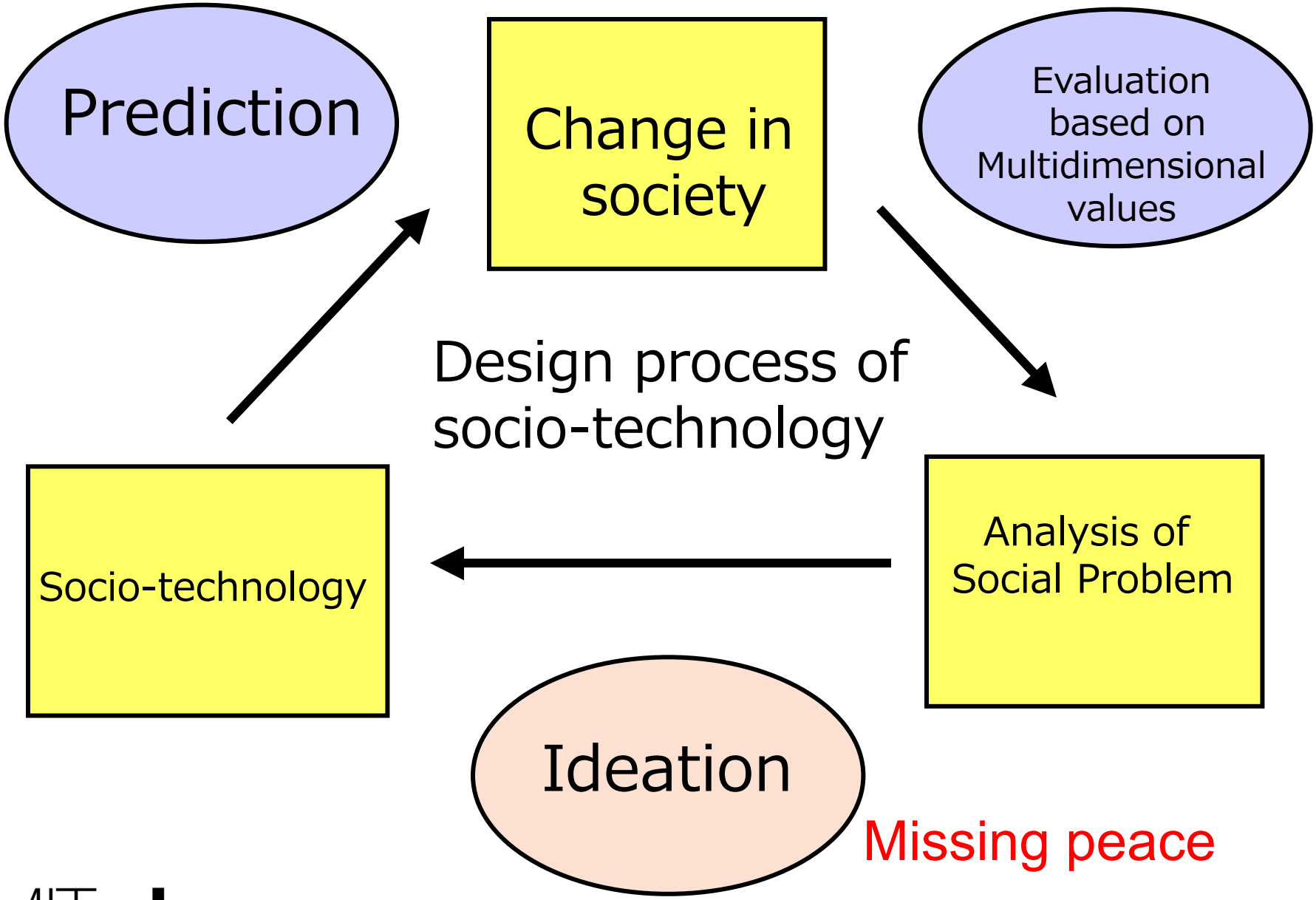


Socio-technology is a holistic solution
by combining engineering technology and social systems.

Socio-technology is a system of solution components.

Capturing a global picture of the problem




Prediction
Change in society
Evaluation based on Multidimensional values
Design process of socio-technology
Socio-technology
Analysis of Social Problem
Ideation
Missing peace

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2. i.school

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About i.school

- How can we create ideas of solution, product or system?

  → i.school : Educational program for innovation since 2009

- Ability to produce human-centered innovation: New products, services, business models, social systems

- Group works with students from different fields

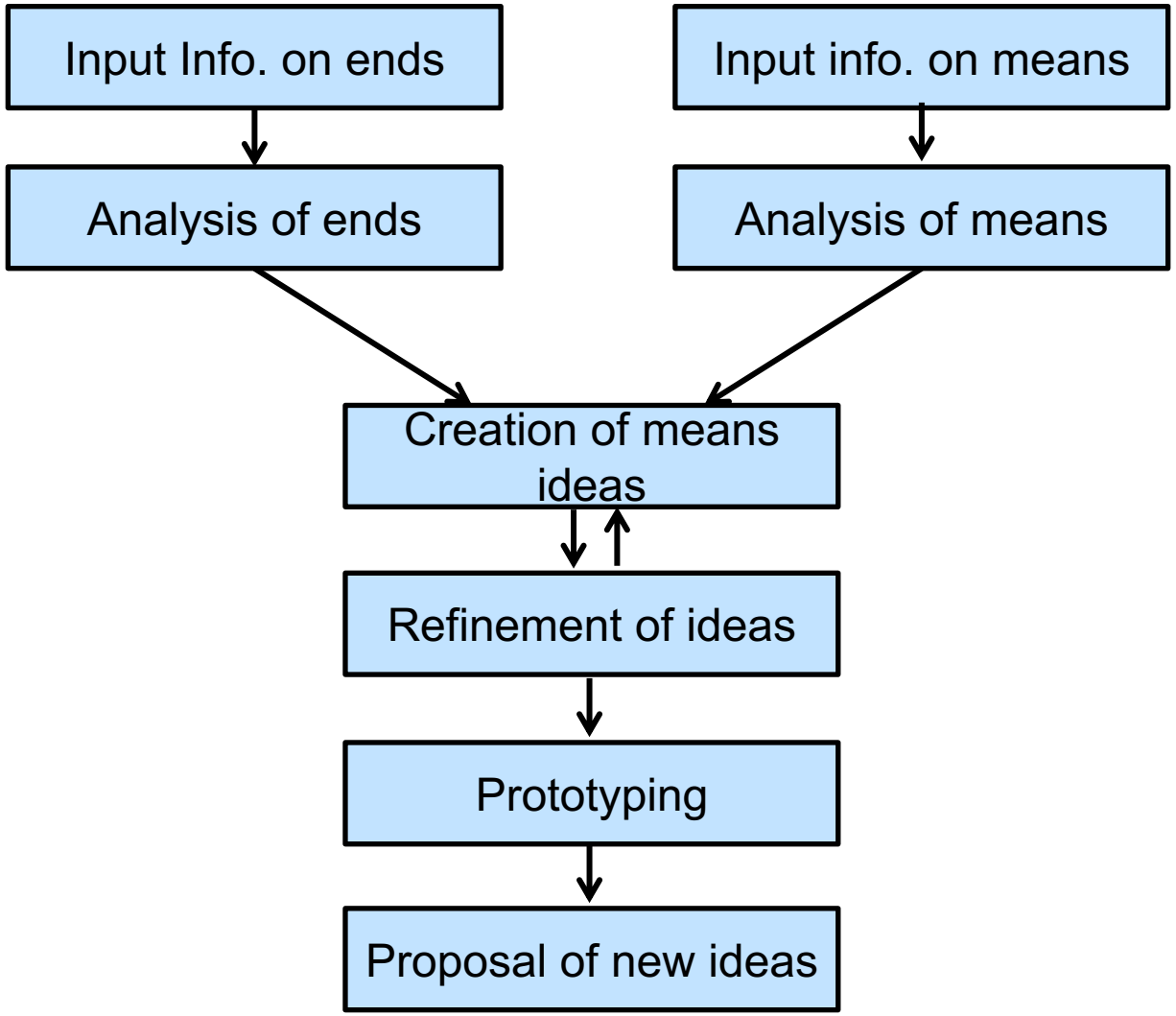
- No credits, no degrees; brilliant students to improve themselves

Innovation workshop = Information Processing by group of people

Process

- Can be described
- Can be modelled
- Can be designed
- Can be evaluated

Standard model of information processing



Three ways of creativity
Margaret A. Boden

- Combinational creativity
- Exploratory creativity
- Transformational creativity

Mechanisms for Novelty

1. Understanding others
2. Foresight
3. Clarifying concepts
4. Shifting cognitive pattern
5. Shifting value system
6. Finding new combination
7. Analogical thinking
8. New objective from unexpected use
9. Table flipping


Daiki


OUTSIDE


YUKI


PRINTER
Hiroki
Yamaoka
Canon

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3. Science of Innovation Education

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Definition

- Knowledge from study on educational activities for innovation

- Innovation workshops are subject of study
- All researchers from cognitive psychology, artificial intelligence, brain science, cognitive sociology, pedagogy, organizational behavior can contribute

Objective

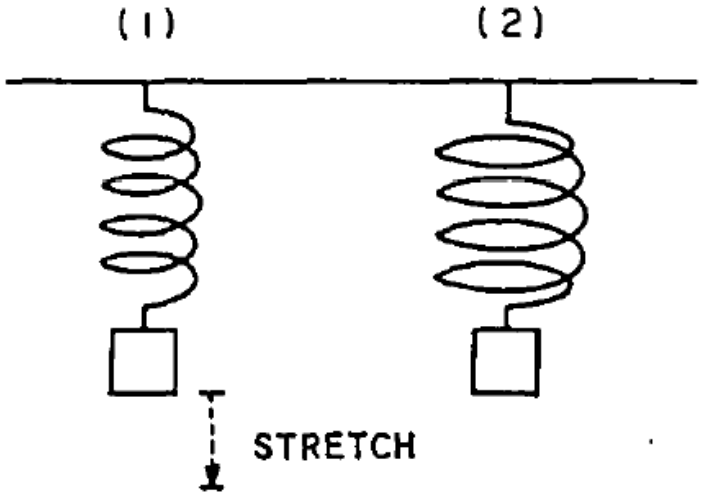
- To understand human creativity and effect of collaborative work in the real context
- To improve quality of innovation education
  - Establish design methodology of innovation workshop and guideline for workshop facilitation
- To establish a style of faculty members for innovation education appreciated in university community

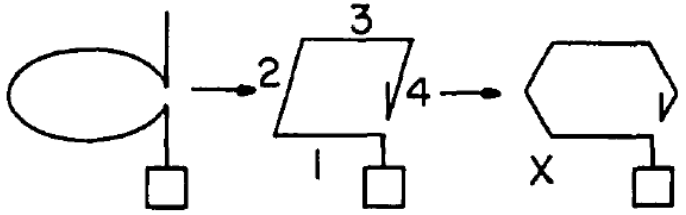
Approach

- What kind of research approach is suitable?
- Two examples are introduced:
  - Observed methods for generating analogies in scientific problem solving by John Clement (1988)
  -

Clement (1988)

- Ten experienced problem solvers were asked to think aloud while solving the spring problem.
- 7 subjects generated at least one analogy
- Only one subject arrive at torsion from analogy
- “Aha! Maybe the behavior of the spring has something to do with twist forces as well as bend forces”





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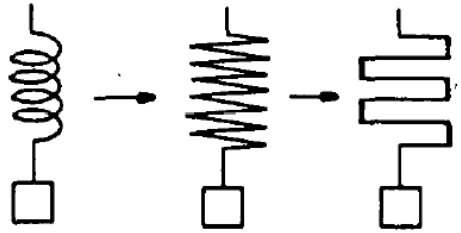

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Implication for Science of Innovation Education

- Hypothesis formation is more important than hypothesis validation
- Hypothesis formation:
  - Find important cases to be focused
  - Investigate the cases to derive hypotheses
- Hypothesis validation:
  - Design workshops to validate the hypothesis
  - Establish better workshop design

Paradox in analogical thinking: 1980 - 2000

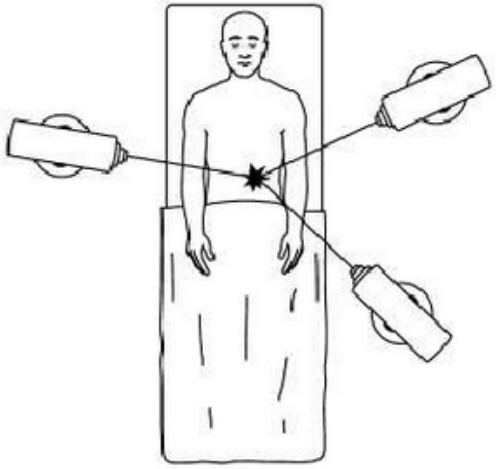
- Why analogy is so easy in naturalistic settings, yet so difficult in the psychological laboratory

[Experimental settings]

- Gick and Holyoak (1980)
  - Only 20%
  - With a hint, 90%

Base: Duncker's Fortress Problem

Target: Tumor



- Gentner et al. (1993)
  - Short stories for base and target
  - Ask the base stories reminded
  - In remind condition, only 20% used structural similarity

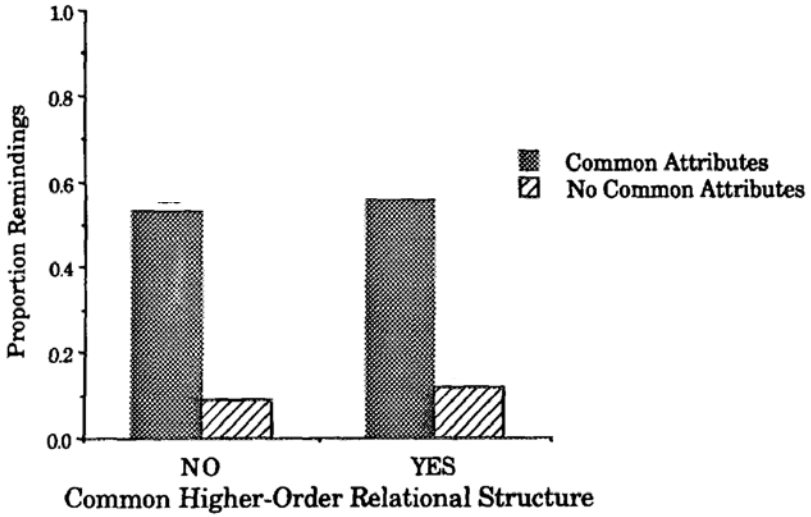
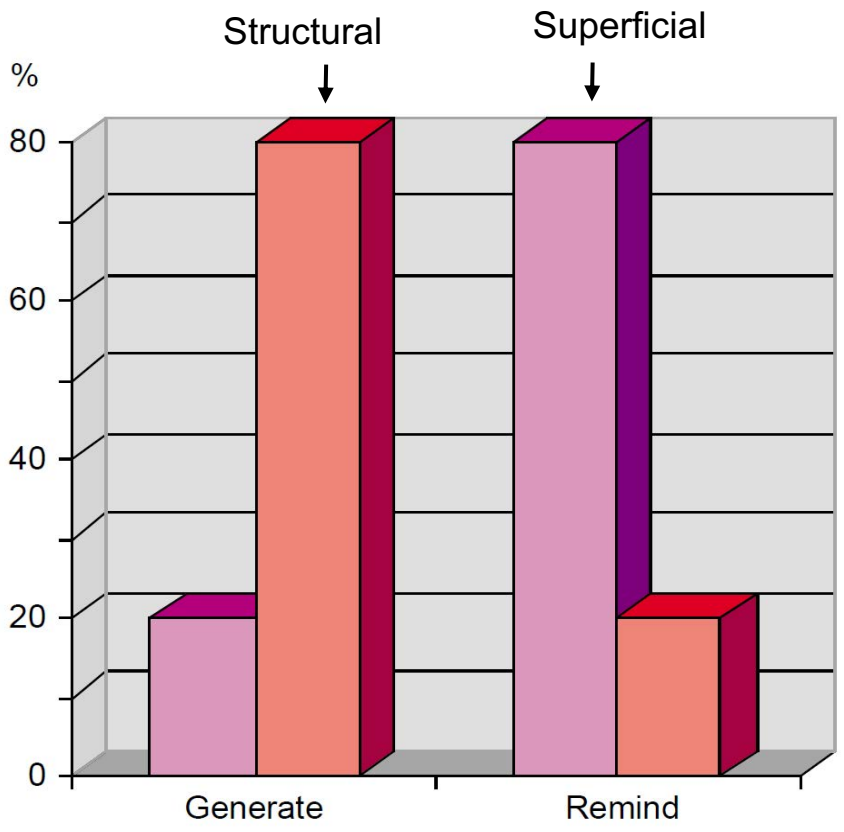


FIG. 4. Proportion recalled for the four similarity types in Experiment 2.

[Naturalistic settings]

- Dunbar (1995, 7, 9): Studies on scientific discoveries
  - 16 laboratory meetings in four laboratories
  - 99 analogies, 3 to 15 analogies in a one-hour meeting
  - Many analogies were within-domain
  - 25% of analogies were structural; 80% were used to formulate hypotheses

- Dunbar and Blanchette (2000): Paradox is resolved
  - Ask to generate analogies to justify the deficit cut by Canadian governments in the 1990s.
  - Most of the analogies generated (80%) were non-financial or non-political from a variety of domains.
  - When generating analogies people search memory for structural relations, but when they are asked to choose between different sources they will focus on superficial features.



Implication for Science of Innovation Education

- Meaningful to compare findings in experimental settings and those in naturalistic settings.

- Innovation workshops with group works can be either in experimental settings or in naturalistic settings depending on the process and/or facilitation of the workshop.

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4. Examples from i.school

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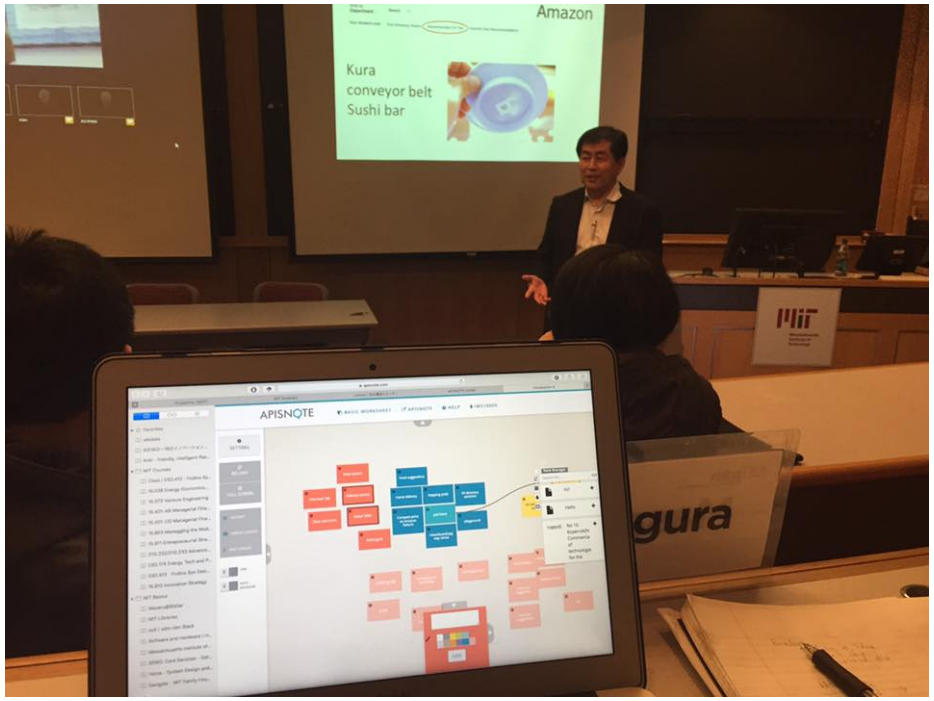
Data acquisition

- APISNOTE
- Voice recorder
- 360-degree video
- Interview



APISNOTE HOME | Starting D - ANNO | Starting C - ANNO | Team A - ANNOTI | Starting D - ANNO | Starting C - ANNO | Starting B - ANNO | Starting A - ANNO | Sample Horii - AN

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アプリ | login.flag • SILEX | Firefox を使いこな | 最新ニュース | PHP: クラスの基礎 | Firefox ブックマーク | Welcome to Code | ホーム - ウェルネ | APISNOTE HOME

Team A

RELOAD

FULL SCREEN

CAPTURE

END

NETWORK

AUTO LAYOUT

NEXT

PREVIOUS

LINK

VOTE

USER

PICTURE

2 / 414


Happiness Counter Viewer for Workshop
ファイル(F) ヘルプ(H)
2016/3/2
2:17:04 / 3:47:35

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4. Examples from i.school
4.1 Ideation

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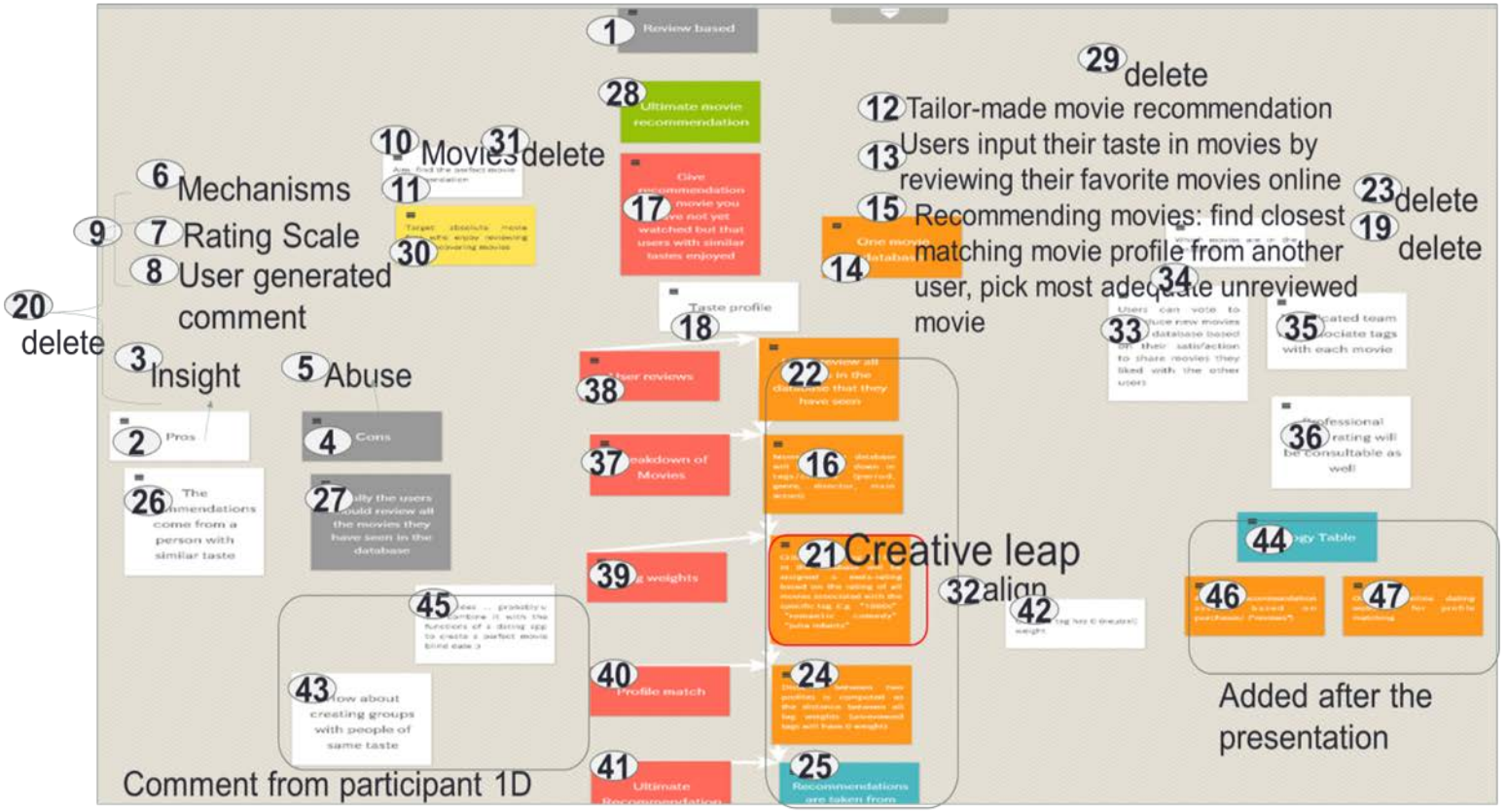
Investigation of the thinking process in idea generation

– Ideation process shown in APISNOTE

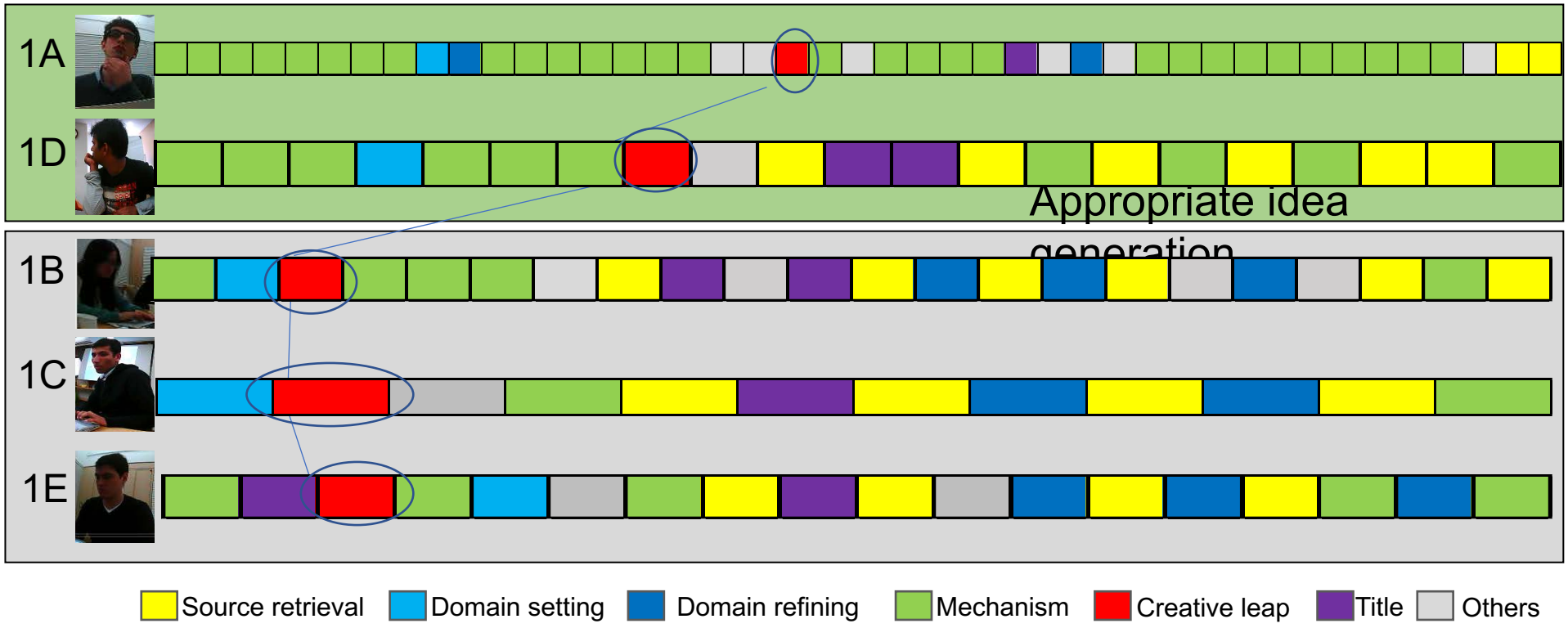
Eunyoung (2015)



Thinking process in the idea generation task can be identified with analysis of APISNOTE record and interview survey.

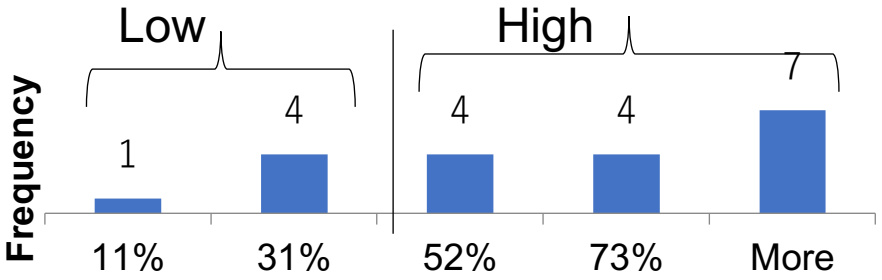
Deliberation before reaching the creative leap stage

In the interview, each participant indicated the note that makes creative leap.
Based on the time record in the APISNOTE, each process is coded as follows:

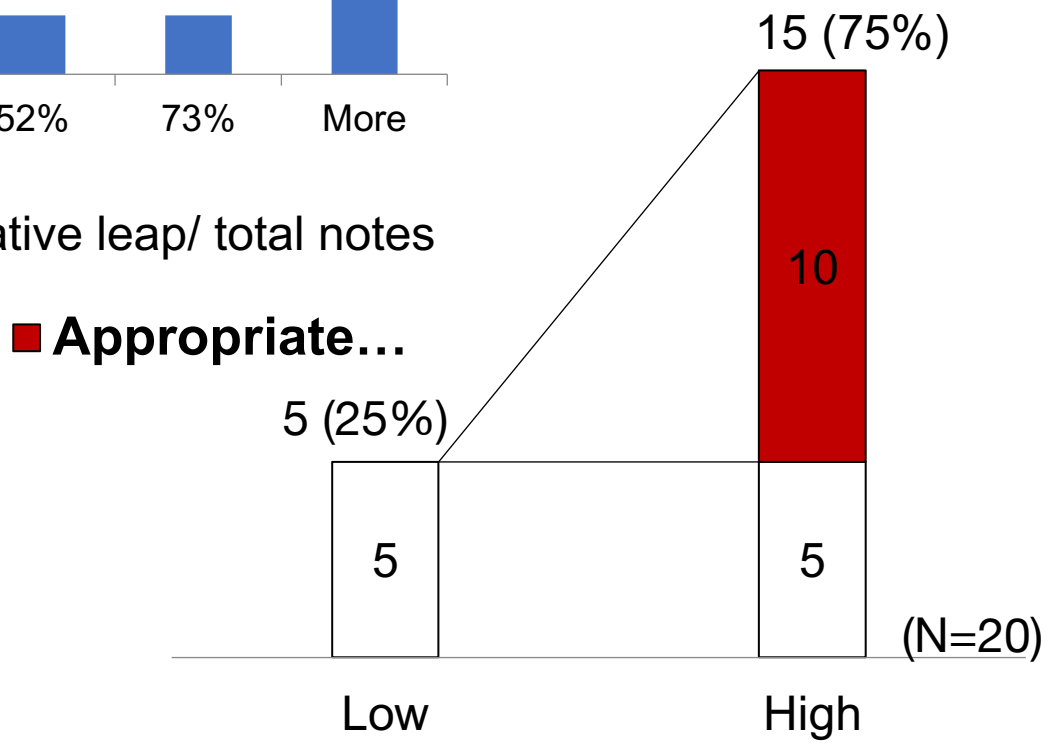


Participants who generated an appropriate idea had deliberation before reaching the creative leap.

Deliberation before reaching the creative leap stage



Deliberation =
the Nth note of creative leap/ total notes



Degree of deliberation before reaching the creative leap

Deliberation in the early stage of idea generation is prerequisite for an appropriate idea generation.

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4. Examples from i.school
4.2 Group work

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Workshop design

Yao LU (2016)

Workshop design

1. Task (Natural, Common)
2. Process

Example

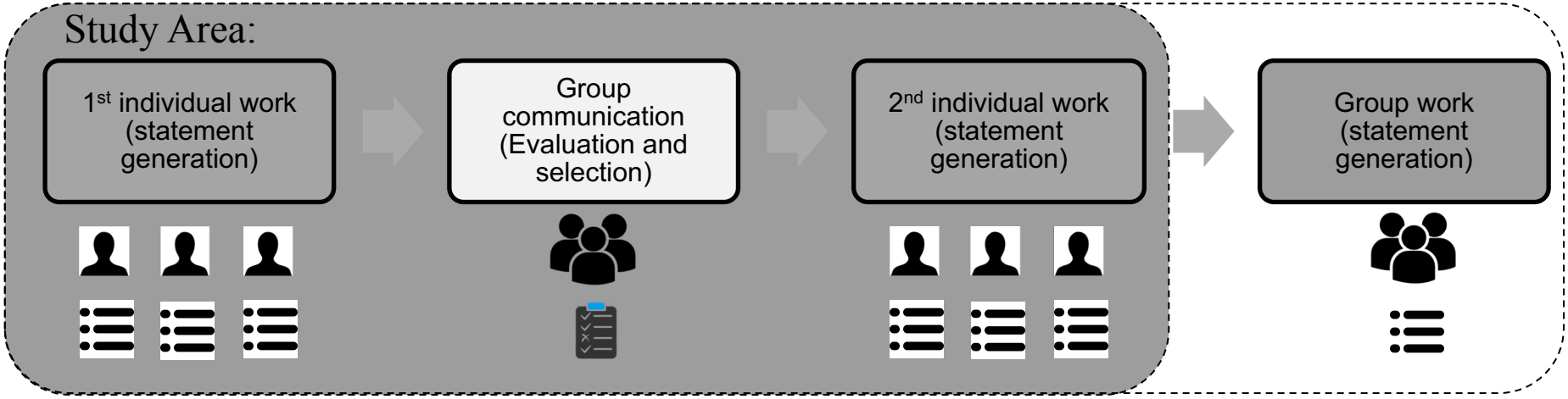
Policy*: foreign worker immigration (it is necessary for Japan)*
Promoting Statement*: "Japanese soil lacks nutrient, so it is necessary to apply fertilizer"*

Task: **Create promoting statements using analogic thinking**

Policy: Foreign worker immigration in Japan (Support)

3-person group, 4 groups

Workshop Process:



Evaluation of Workshop Output

Evaluated the output in two aspects, **Latent Semantic Distance** and **Structural Similarity**

1. ***Latent Semantic distance (LaSeD)****: a measurement for* ***superficial similarity*** *measuring the semantic distance between source object and target object. Latent semantic analysis is used to measure the semantic distance.*
2. ***Structural similarity (StSi)*** *is the similarity between relationships shown in statements and the source case.*

Example

"*Japanese soil lacks nutrient, so it is necessary to apply fertilizer*"

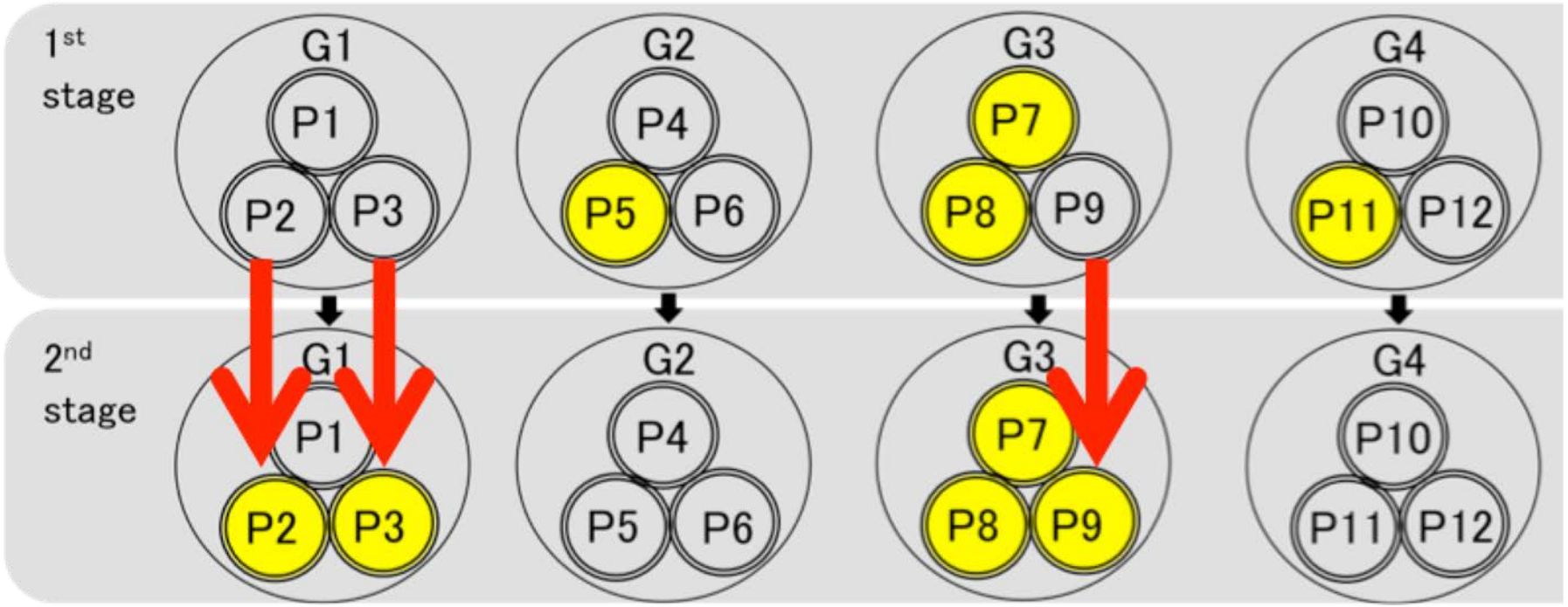
LaSeD

Target object: foreign worker

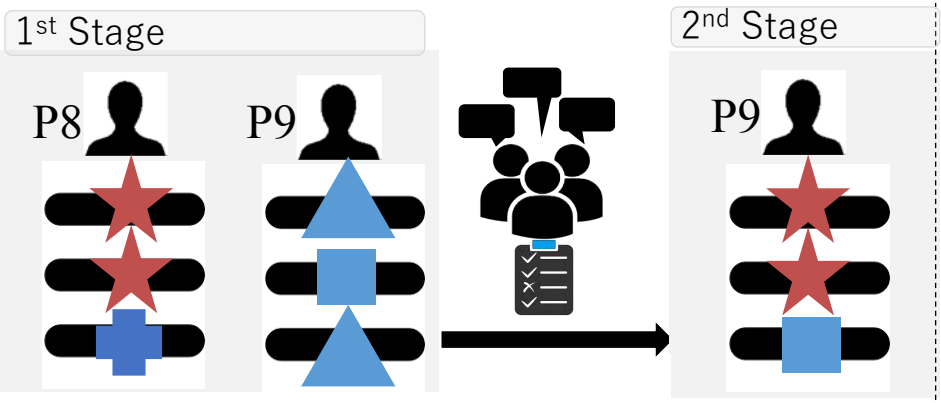
Source object: Fertilizer

Sentences: If LaSeD≥Average, high LaSeD; or else, low LaSeD

Participants: The percentage of high LaSeD>average percentage*1, high individual performance; or else, low



The process of Domain Transfer from P8 to P9



The self report of P9 about Domain Transfer

P9	…P8 is good at creating based on recent trend, but I'm not good at it…
P9	After discussion…And another thing impressed me is that P8 was focusing on a different aspect than me and P7. And he was trying to created something from far distance. Influenced by him, I tried and was able to find something with far distance that looks irrelavant at the first sight (but actually related).
P9	And at that time I was trying to find some far distance image that shows equal relationship…the famous flower song came into my mind.

**Data from Interview with P9*

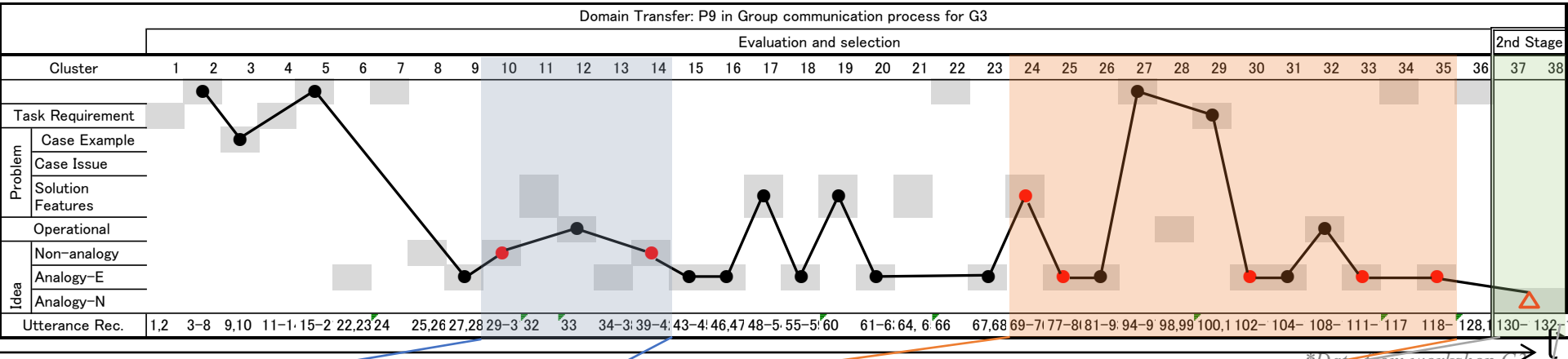
The process in which the influences of group communication was generated

Communication Content

: A cluster with the same topic

P9 participated

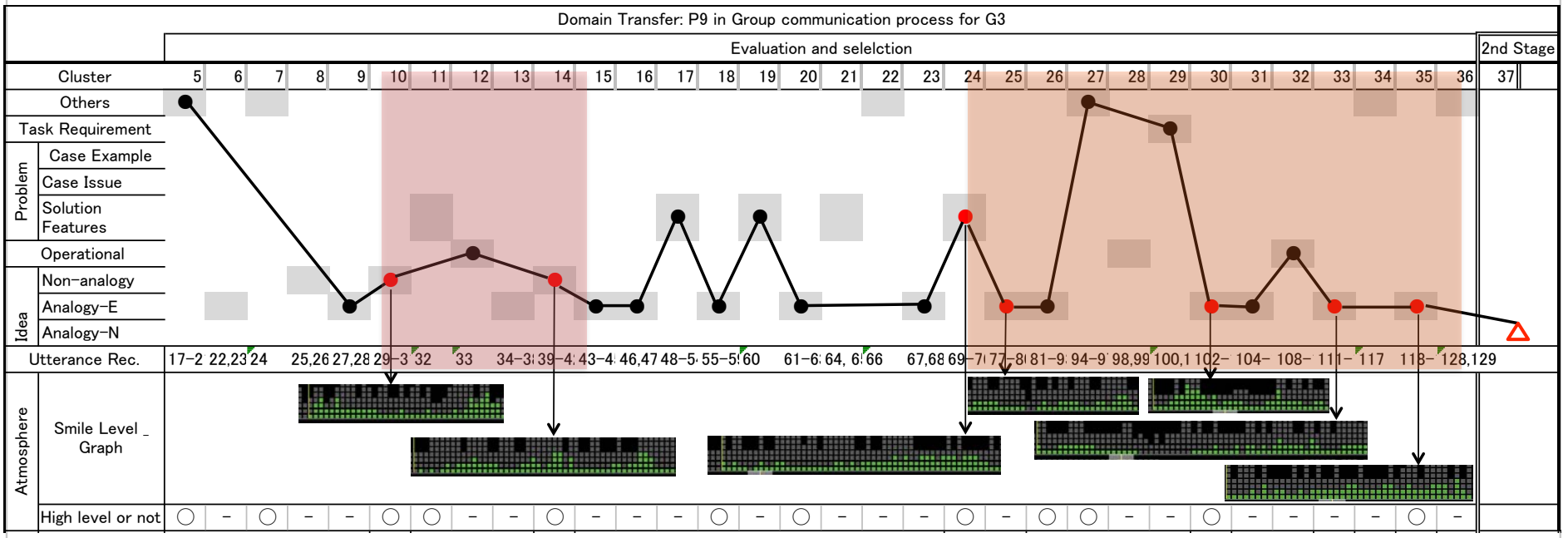
Influence



	Phase 1	Phase 2	Phase 3
	"I don't understand"	"I found something useful!"	New idea created
Topic	Creation purpose of an idea that is hard to understand	Evaluation and its Criteria; Extracting (domain) Features Trying out the (domain) Feature	
intention	Sharing	Comment, Meta-analysis	

Relationship between Smile and the influences

Smile Date



12 were high-level smile clusters from all 36 clusters. Out of 7 Domain Transfer related clusters, 5 were high-level smile clusters.

Concluding remarks

- Innovation workshops are promising subjects to study.
- The study should contribute to improve quality of innovation education as well as to deepen our understanding on human creativity and communication.
- Science of innovation education requests collaboration of researchers in various fields of study.
- Science of innovation education provides strong incentive for education.