

# Distance Learning System (遠隔教育システム工学)

1W. *Introduction*

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How do you imagine?

What do you think about  
“Distance Learning System”?

Download materials from lecture archive system!  
<http://dlc-lms.jaist.ac.jp/>



# What is “DLS”?

## Definitions

- Theoretical, Technological & Practical Fields for Education & Learning with ICT
  - Creating New Form of Education & Learning
  - By Using ICT and/or AI, Media, & Software Tech.
  - For Human Learning Process in Diverse Situations
  - Not “Art” But “Science”!

## Goals

- To analyze & design “New” DLS
- To practice & develop DLS with Contents
- To evaluate DLS from Data
- To improve your 21st Century Skills



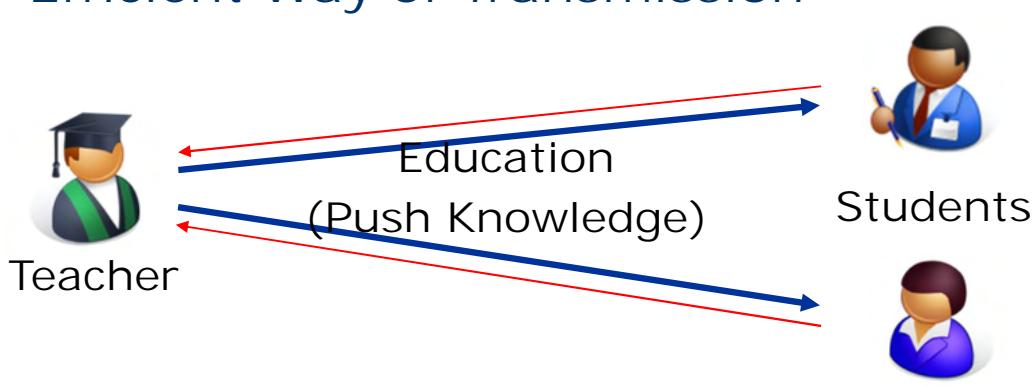
## Why is “DLS”?

### Not Corresponding to Japanese

- 遠隔 = “Distance”
  - 教育 = “Education”
  - システム = “System”
- } Distance Learning System?

### Traditional Classroom

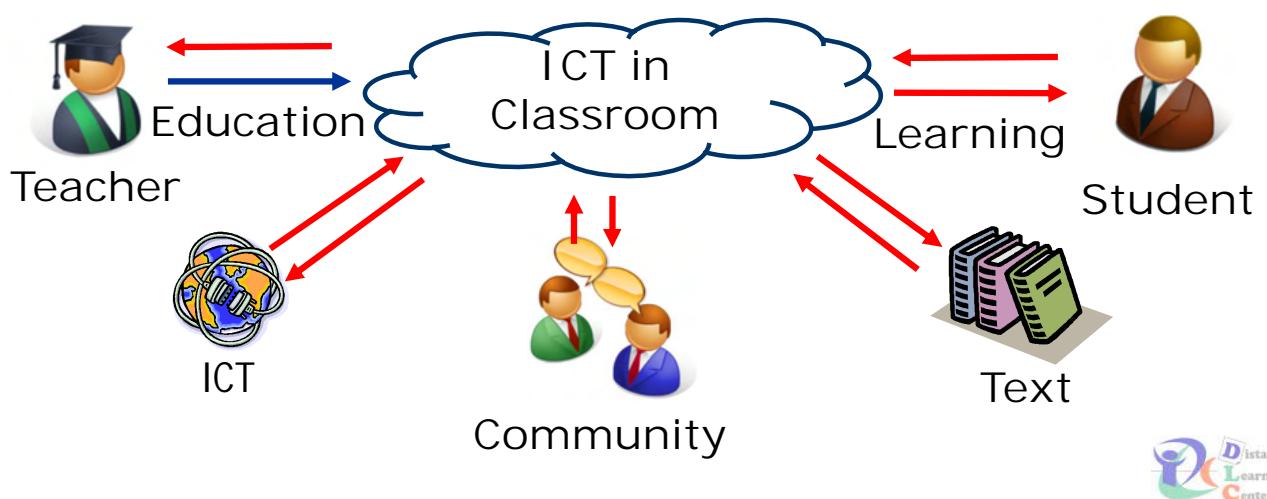
- Efficient Way of Transmission



# Why is “DLS”?

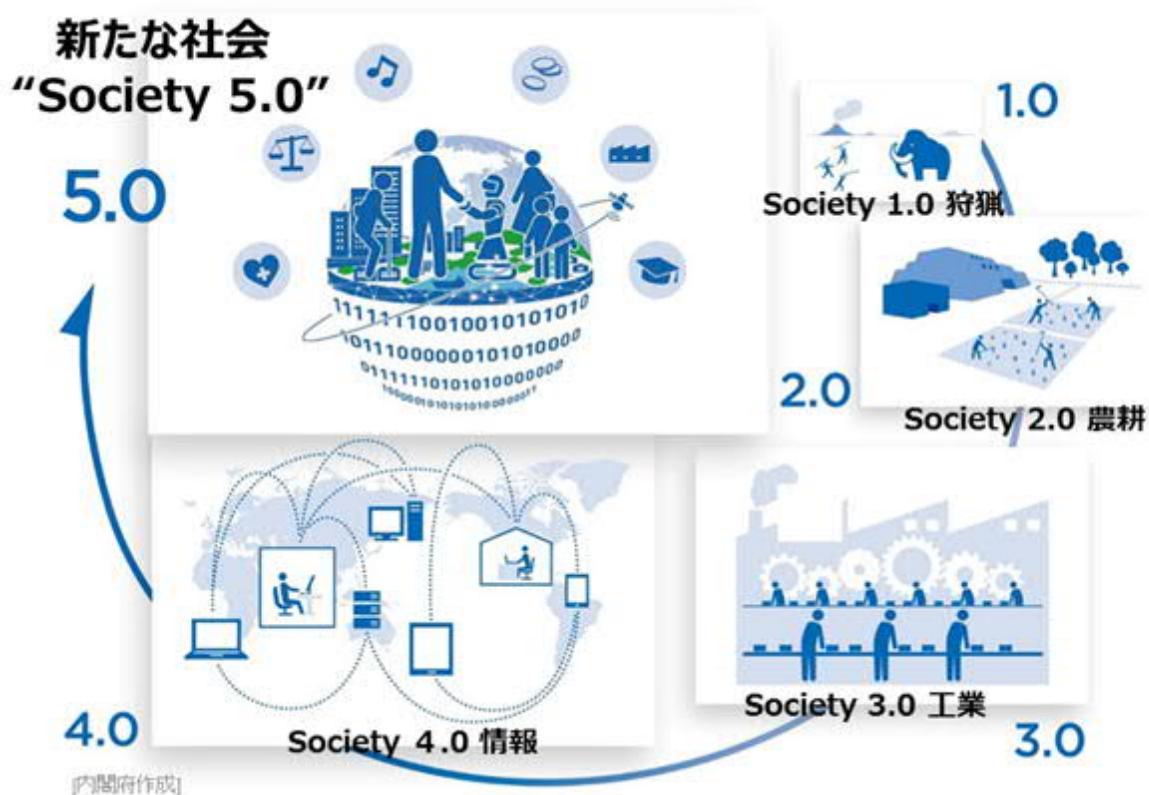
## Education << Learning

- Learning through Interaction with ICT  
→ Paradigm Shift
- But, Education > Learning in Japan
  - Japan Society for Educational Technology



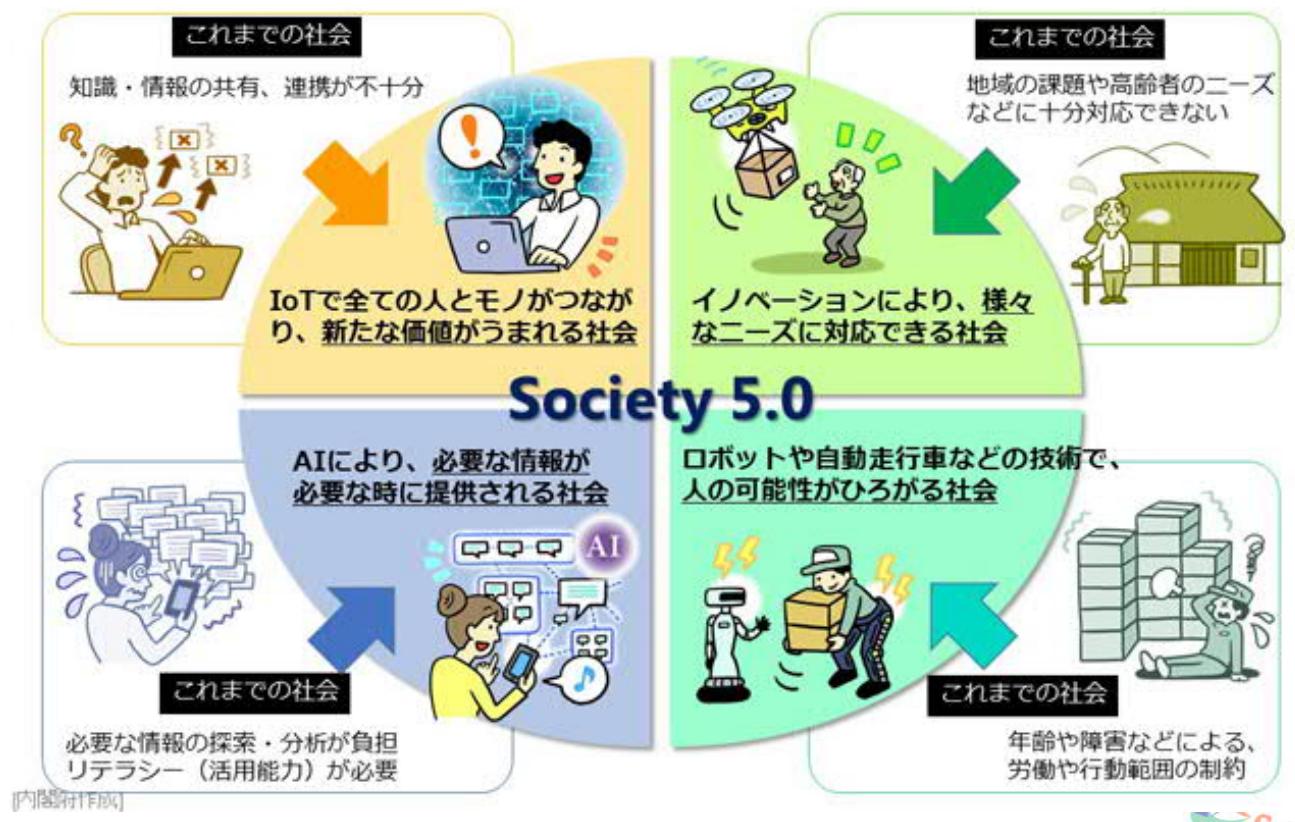
# Society 5.0

[https://www8.cao.go.jp/cstp/society5\\_0/index.html](https://www8.cao.go.jp/cstp/society5_0/index.html)



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[https://www8.cao.go.jp/cstp/society5\\_0/index.html](https://www8.cao.go.jp/cstp/society5_0/index.html)



## Changes by COVID-19

**Important notice for preventing COVID-19 outbreaks.**

### Avoid the “Three Cs”!

- 1. Closed spaces** with poor ventilation.
- 2. Crowded places** with many people nearby.
- 3. Close-contact settings** such as close-range conversations.



### Before COVID-19



### With COVID-19



# What are 21st Cent. Skills?

Definitions ATC21S:Draft White Papers,(2010)

- Learning to Collaborate with Others and to Connect through Technology
- Ways of Thinking
  - Creativity, Innovation, Critical Thinking, Problem Solving, Decision Making, & **Learning to Learn**
- Ways of Working
  - Communication & Collaboration (Teamwork)
- Tools for Working
  - Information Literacy & ICT Literacy
- Living in the World
  - Citizenship, **Personal & Social Responsibility**

(ATC21S:The Assessment and Teaching of 21st Century Skills Project) 

## Different from 20<sup>th</sup> Cent.

	20 <sup>th</sup> Cent. Skills	21 <sup>st</sup> Cent. Skills
Objective	Basic academic skills	Zest for living
	Standardization	<b>Diversity</b> , Originality
Focus	Knowledge amount, Knowledge operation	Motivation, Creativity
Evaluation	Universal scale	Individual scale
Attitude	Cooperativeness, Homogeneity	Activeness, <b>Interpersonal skills</b>
Effort	Closed effort	Opened effort
Setting	Given goal	Own goal
Process	Routine effort	Sensitivity
Goal	Structured knowledge	<b>Unification of academic skill &amp; personality</b>

# Evaluation Criteria

## Report: 40% (10+20+10)

- To design distance learning class for your own topic.
- To apply evaluation or AI technique to distance learning system data.

## Final Exam: 50%

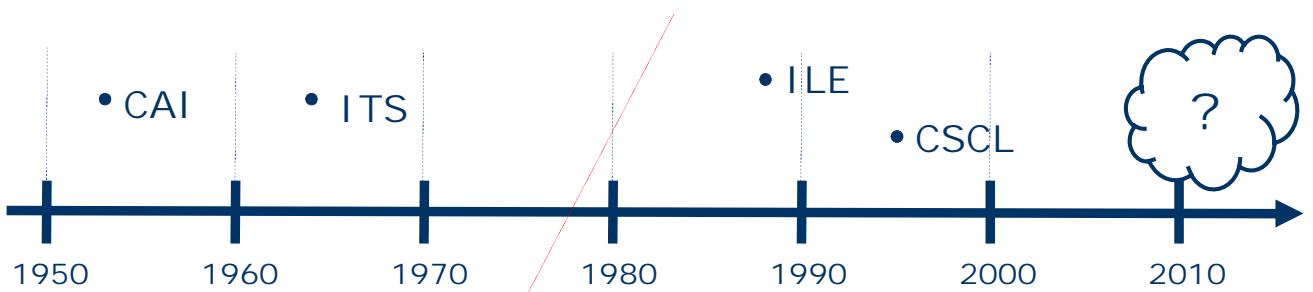
- To answer your thought using what you will learn in this course by Application of Evaluation/AI in DLS

## Discussion: 10%

- To participate in course constructively.
- Feel free to ask by chat/forum/voice.



# History of Educational/ Learning Technology



## Main Approaches

- Computer Assisted Instruction
  - First use of computers in education.
- Intelligent Tutoring System
  - Application of AI technology
- Interactive(Intelligent) Learning Environment
  - GUI & hypermedia
- Computer Supported Collaborative Learning
  - Rapid development of Internet

# CAI

## Computer Assisted Instruction

- Computer is used to present instructional materials and monitor learner's learning.
  - Drill & practice, tutorial, games, simulation
- CAI was first used during the 1950s.
  - To realize program learning

## Pros & cons

- thumb up One-to-one interaction
- thumb up Instant response / immediate feedback
- thumb up Self-pacing / individual attention
- thumb down Just page turning
- thumb down Difficult to keep motivation



## Example of CAI



<https://www.youtube.com/watch?v=6jhEYVEmc>

# ITS

## Intelligent Tutoring System

- System aims to provide personalized instruction or feedback to learners.
  - Domain, student, tutoring, and interface model
- ITS was implemented based on AI tech.

### Pros & cons

- thumb up Academic improvement
- thumb up Learning speed
- thumb down Too expensive to develop / implement
- thumb down Evaluation is difficult
- thumb down Subject areas are limited



## Example of ITS

A screenshot of the AutoTutor software interface. At the top, a menu bar includes File, Edit, Session, Plugins, and Help. A question is displayed: "How does the operating system interact with the word processing program when you create a document?" On the left, there is a video window showing a female tutor. On the right, there is a diagram of a computer system with labels for HARD DISK, OS, WORD PROCESSING PROGRAM, DOCUMENT, ROM, and CPU. Arrows indicate the flow of interaction between these components. At the bottom, there are two text boxes: "Log of previous responses:" and "Enter your response here:". The "Log of previous responses:" box contains a transcript of a conversation between the student and the tutor. The "Enter your response here:" box is empty.

## Interactive Learning Environment

- System support interaction among learners, teachers, and the system.
  - More situational and passive
- ILE has no semantic understanding.

### Pros & cons

- thumb-up Wide spread with hypermedia
- thumb-up Subject areas are wide
- thumb-up Easy to monitor learners' activity
- thumb-down Difficult to adapt materials to learners
- thumb-down Evaluation is hard



## Example of ILE

Two windows illustrating an Interactive Learning Environment (ILE) for plate tectonics:

**Left Window: Plate Tectonics (プレートテクトニクス)**

This window displays a diagram of plate tectonics showing two plates moving relative to each other. One plate is labeled "リソスフェア" (Rheosphere) and the other "アセノスフェア" (Asthenosphere). Arrows indicate the direction of movement. A text box explains the concept of plate tectonics: "地球の表面は、いくつかの硬い岩盤の板で覆われていると考えることができます。これらの板のことを「プレート」と呼びます。地球の表面は球面なので、プレートは平らな板ではなく、卵の殻のような球面状の薄い殻のようです。" Below the diagram, it says: "部分をアセノスフェアとよびます。アセノスフェアの上にある部分は、温度が低くて硬い性質を持ち、リソスフェアとよばれます。" Another text box states: "このリソスフェアがプレートの実体です。つまり、硬くて変形しない薄いプレートが、軟らかくて流れやすいアセノスフェアの上に浮いていると考えればよいのです。"

**Right Window: Interactive History (Interactive\_History)**

This window shows a learning history interface. The title bar reads "Interactive\_History". The main area is titled "Interactive History" and lists learning objectives from 1 to 10. Arrows indicate interactions between the objectives: "Rethink" arrows point from objective 2 to 3 and from 3 to 4; "Supplement" arrows point from 3 to 5 and from 5 to 6; "Elaborate" arrows point from 4 to 7, 6 to 7, 6 to 8, and 8 to 9.

- 1) index\_menu
- 2) Introduction to Seismology
- 3) The Mechanism of Occurrence of Earthquake
- 4) Animation of the Mechanism
- 5) Seismic Waves
- 6) Magnitude
- 7) Kind of Earth Faults
- 8) Normal Fault
- 9) Adverse Fault
- 10) Plate Tectonics

# CSCL

## Computer Supported Collaborative Learning

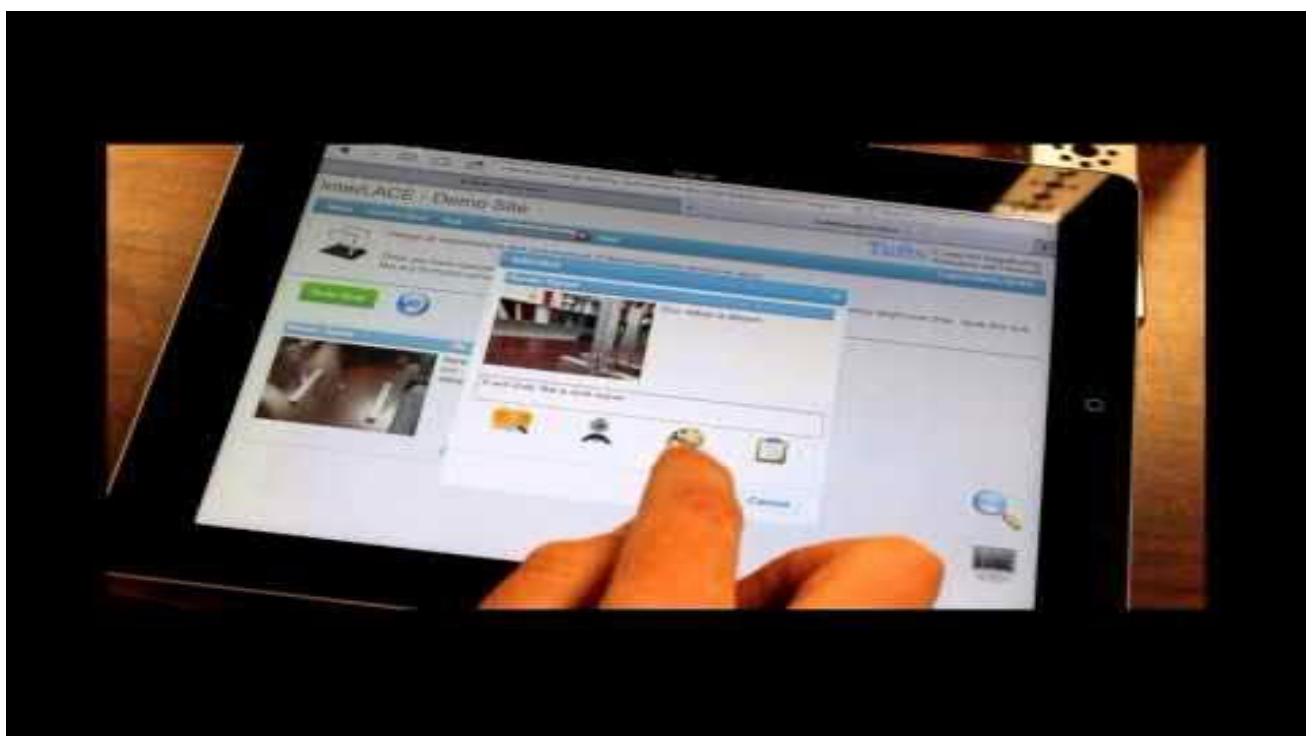
- Learning takes place via social interaction using computer.
  - Knowledge construction among participants
  - Among any three persons, one is my teacher (Confucius)

## Pros & cons

- thumb up Multiple perspectives and expertise
- thumb up Promote critical thinking skills
- thumb up Student centered instruction
- thumb down Difficult to arrange group & task
- thumb down Enough skill needed for collaboration



## Example of CSCL



# What do you imagine?

What do you imagine as  
"New (Distance) Learning"  
in 21th century?



## ICT in Education, Japan Case

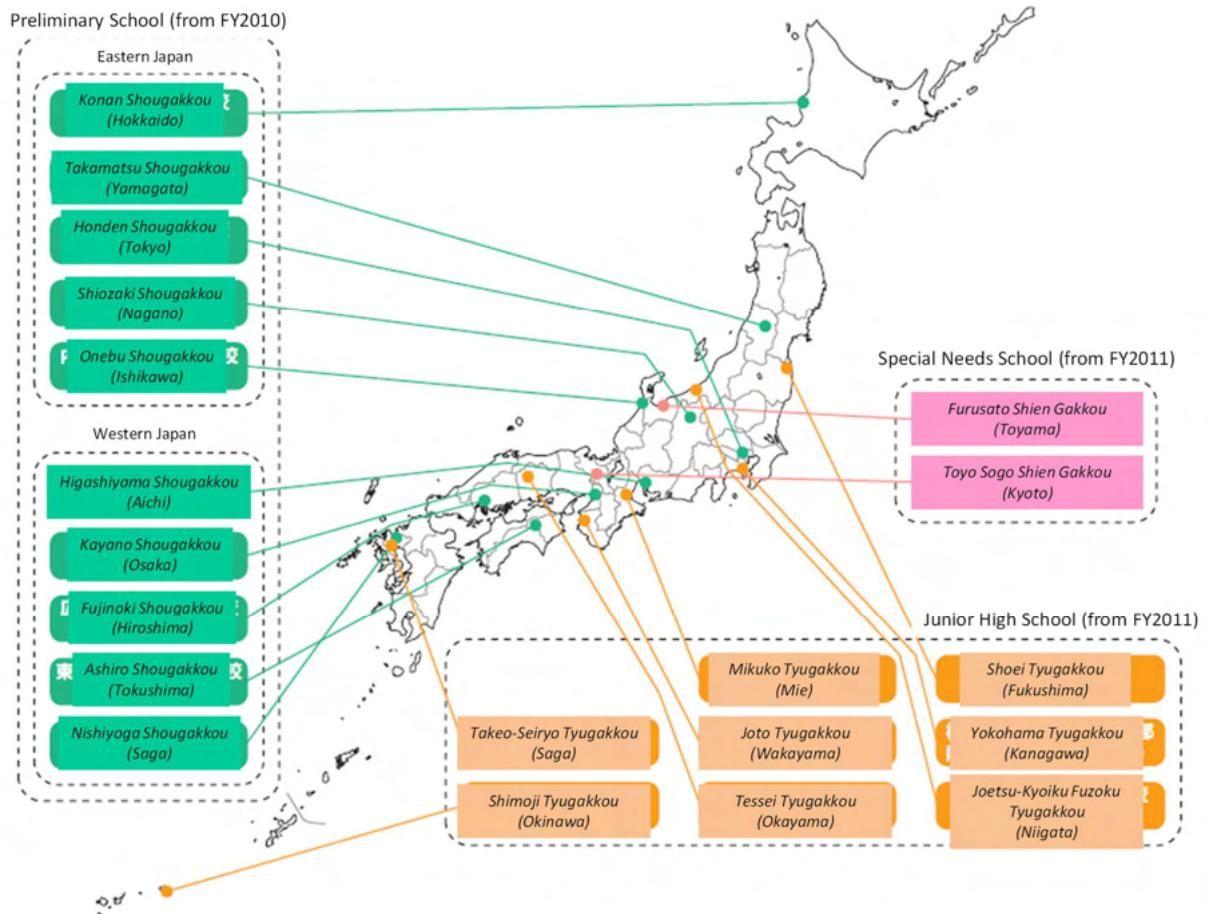
### Not So Advanced :-(

- Some government policies have been shown in 2010 (New Growth Strategy, Japan).
  - Research & promotion for full-scale use of ICT device by each student in classroom should be achieved by FY2013.
  - Implementation of appropriate school education in the 21st century should be reached by FY2020.

### Future School Promotion Project (FSPP)

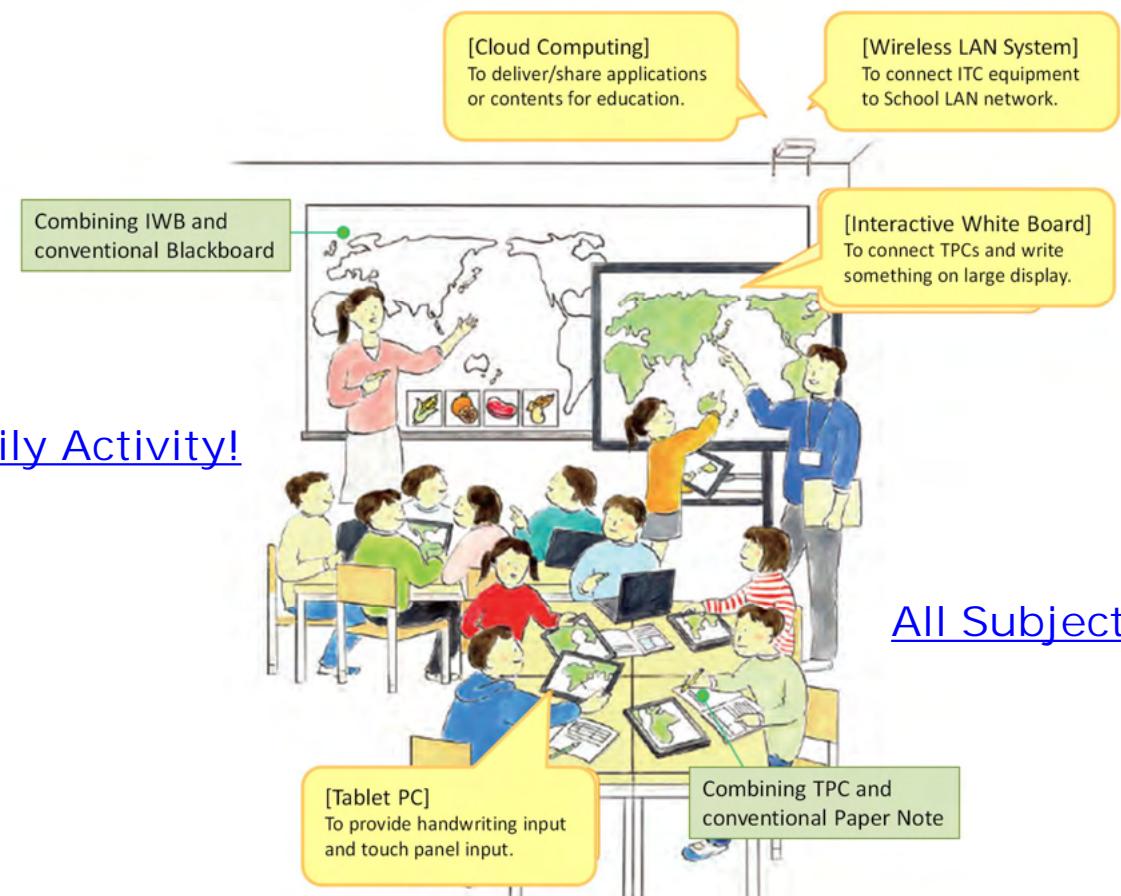
- By MIC in cooperation with MEXT from 2010.
  - Selected 20 public elementary, secondary schools.
  - Aims to make guidelines for ICT in education.
  - I am a committee member of this project

# Location of Selected Schools

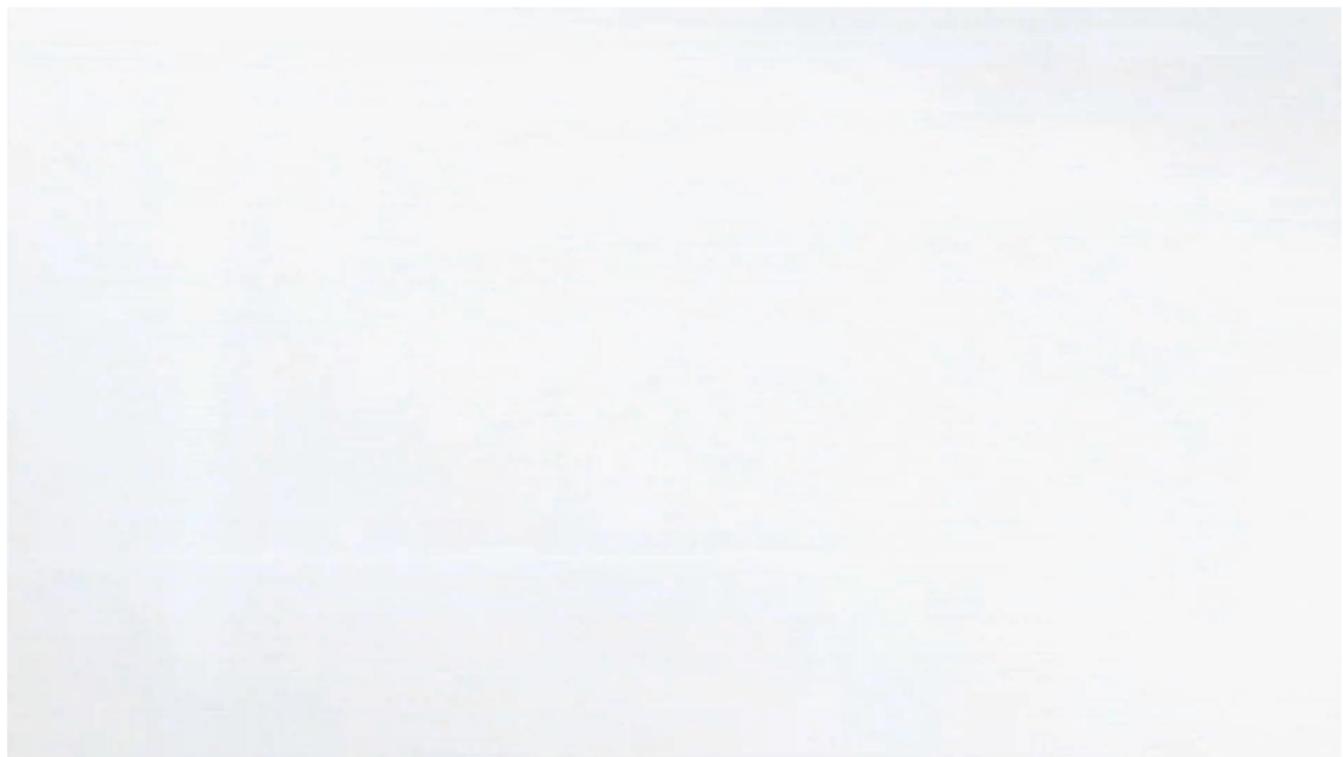


Distance Learning Center

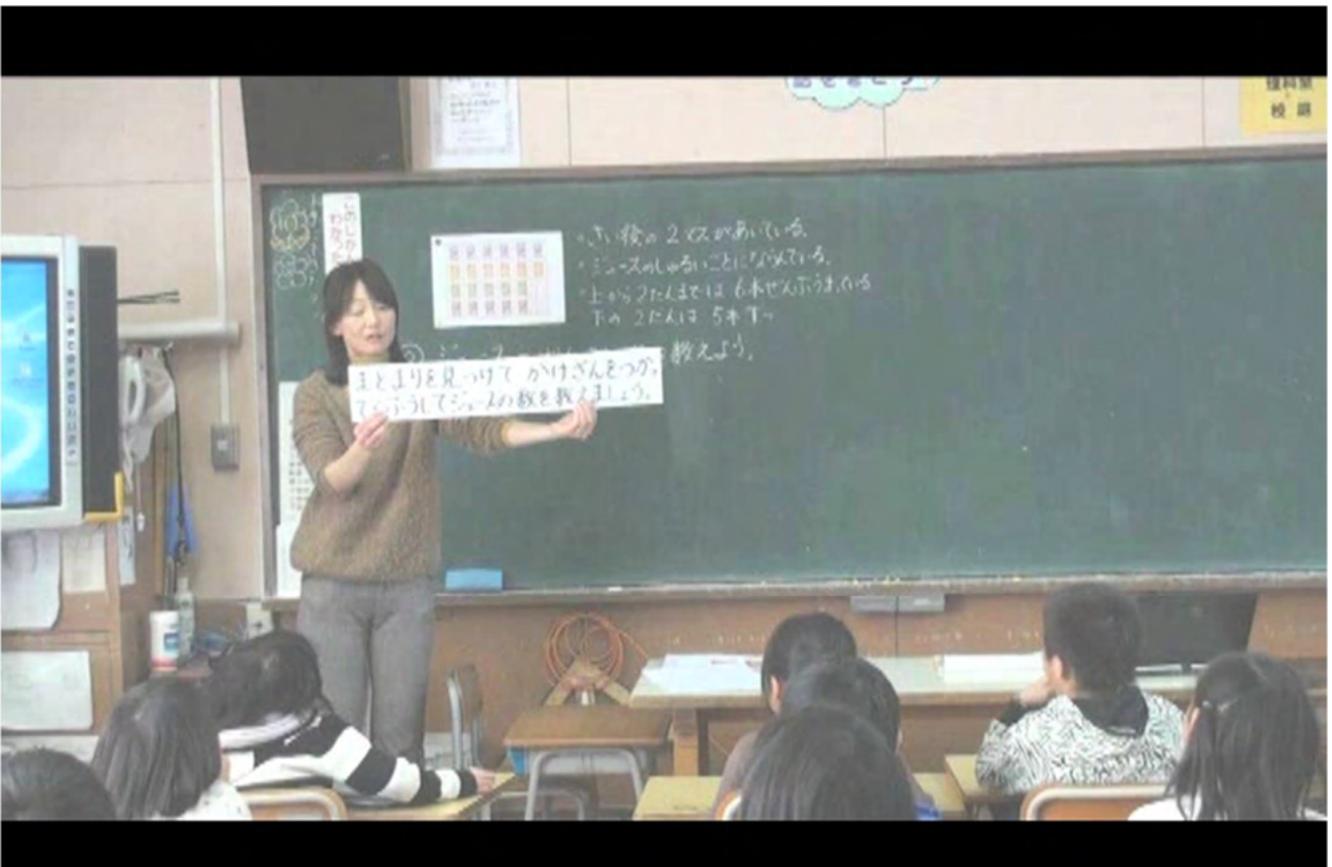
## Basic Configuration in FSPP



# Introduction in FSPP



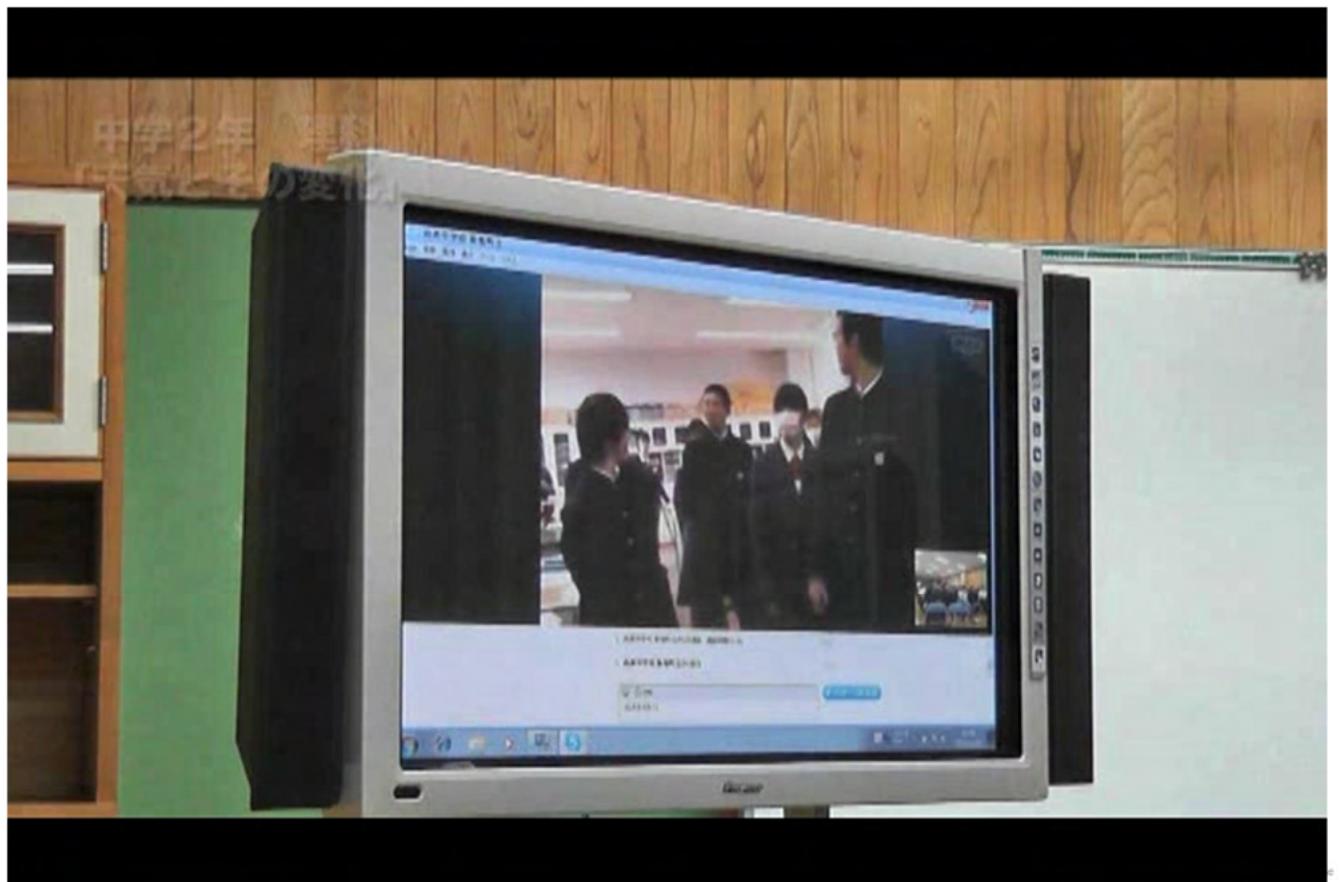
## Some examples in FSPP



# Some examples in FSPP



# Some examples in FSPP



# Some examples in FSPP



## Summary of FSPP

- Every teacher and student use TPC.
  - TPC: Tablet PC
- Every classroom is installed IWB.
  - IWB: Interactive White Board
- Wireless network is installed as school LAN.
- Conventional equipment is combined.
  - Such as Blackboard, notebook and so on.
- By using cloud computing technology, all TPCs download applications and contents.
- Some schools enable students to take TPCs back to their home to do homework.



# What are advantages?

What do you think about  
“advantages”  
of ICT in classroom?



# What are advantages?



# What are advantages?

## For Teachers

### 1. Increasing

in classroom.

- To see students' learning process.
- To deliver learning contents quickly.

### 2. Enhancing

for knowledge & learning contents.

- To use/re-use diverse types of information as learning contents.

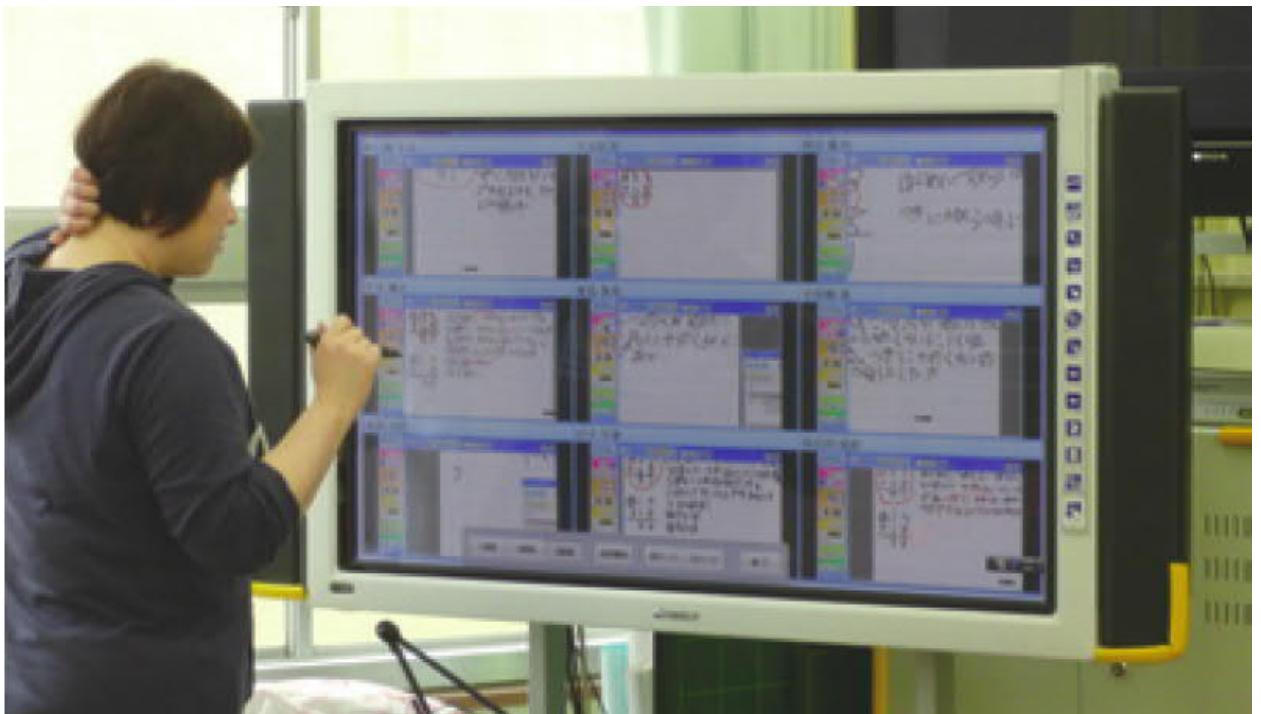
### 3. Developing

for living age of information.

- To teach topics by using actual equipment.

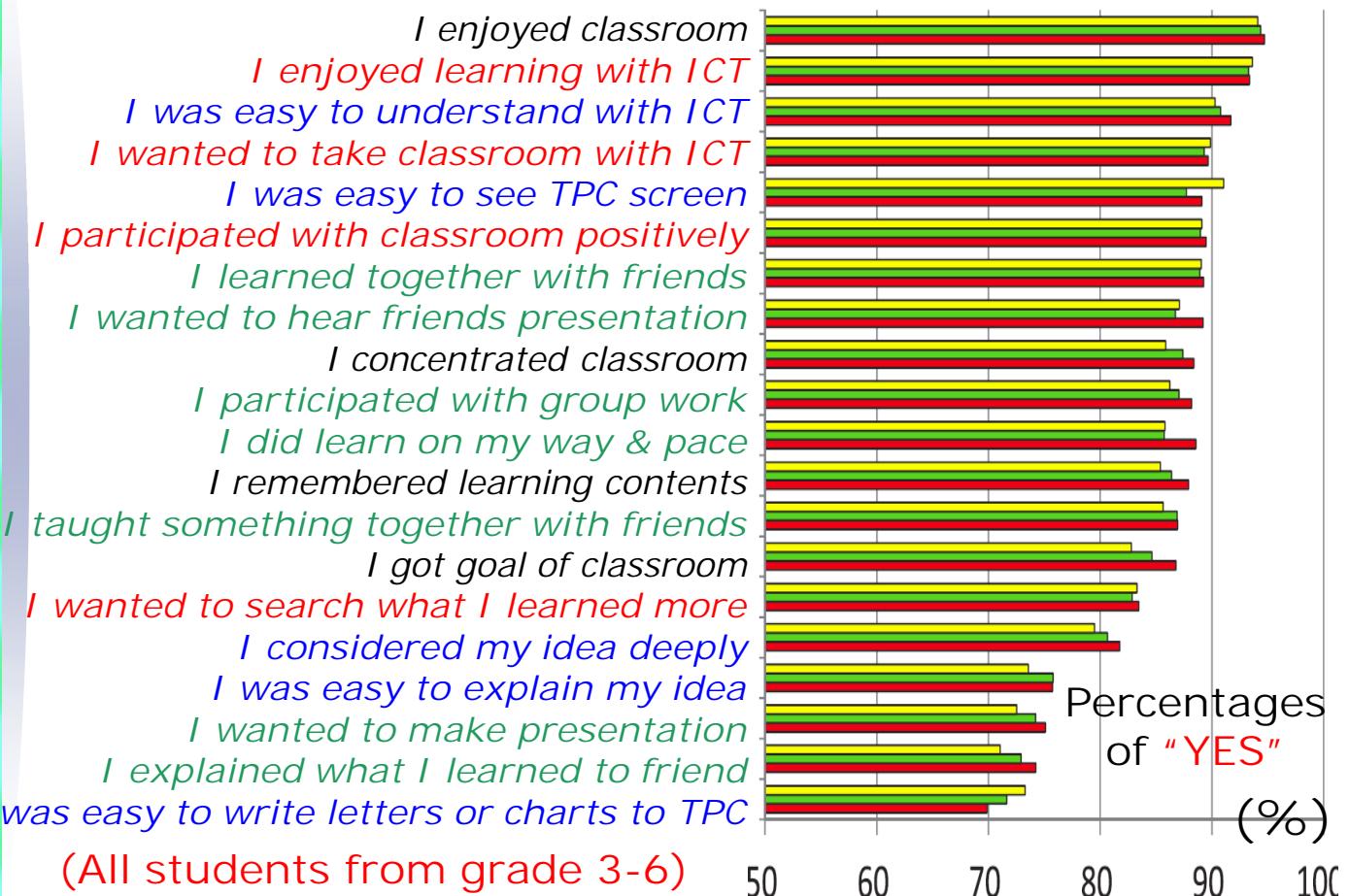


## Advantage by TPC & IWB



Teacher can see students' TPC screen images  
( ) divided in **multiple pieces**

# Survey Results (From 2010-2012)



## What are advantages?

### For Students

1. Increasing  in classroom.
  - To participant in classroom deeply.
  - To teach and learn each other.
  
2. Enhancing  for knowledge & learning contents.
  - New technology engages their attention.
  - To understand others ideas/processes.
  
3. Developing  for living age of information.
  - To acquire how to associate with ICT.
  - To change verbalization to visualization.

# Self evaluation for teachers

(From 2009-2012)

*Skills for using ICT to design & evaluate lecture*

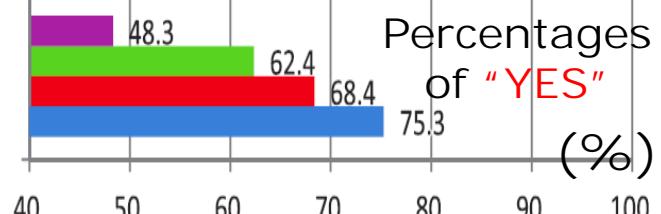


*Skills for teaching Lecture with ICT*

*Skills for developing ICT literacy for students*

*Skills for teaching information moral*

*Skills for using ICT for school duties*



(%)

## What are difficulties?

### For Teachers

1. Initial  (& cost) is high barrier to apply ICT in classroom.
  - Half of teachers didn't have skills to teach with ICT before project started, but no chance to train.
2. Difficulties in  with ICT & combining ICT & conventional equipment.
  - Feature of teaching equipment is quite different.
  - (First) preparation takes much time.
3. Difficulties in  of lecture & time.
  - Teacher cannot focus on teaching but on helping students to use of ICT.
  - If one thing doesn't work, next lecture will fail.

# What are difficulties?

## For Students

1. Taking much time to use TPC in classroom.
  - To Take/Put TPC from/to Cabinet
  - Low Battery, Wake up Time, etc.
2. Confusing by varying in computer literacy.
  - Some use it quickly but others use it slowly
  - Someone play games or browse internet
3. Causing careless/unexpected breakdown of equipment.
  - Students sometimes drop or lost TPC or others.
  - Over network traffic is similar as breakdown.



# Diverse Forms of DLS

## Examples

- OCW (Open Course Ware)  
<https://www.youtube.com/watch?v=tbQ-FeoEvTI>
- MOOC (Massive Open Online Course)  
[https://www.youtube.com/watch?v=b\\_N\\_NHbC8OE](https://www.youtube.com/watch?v=b_N_NHbC8OE)
- Active Learning  
<https://www.youtube.com/watch?v=dwxmPrBdIcQ>
- Flipped Classroom  
<https://www.youtube.com/watch?v=iQWvc6qhTds>
- Programming Education  
[https://www.youtube.com/watch?v=-6G\\_Es3CEmc](https://www.youtube.com/watch?v=-6G_Es3CEmc)

# Open Education/Learning

- Open Access: OpenCourseWare
    - Free access to educational resources
    - MIT OpenCourseWare (<http://ocw.mit.edu/index.htm>)
    - Khan Academy (<https://www.khanacademy.org/>)
  - Open Enrollment: MOOC
    - Massive Open Online Course
    - Coursera (<https://www.coursera.org/>)
    - edX (<https://www.edx.org/>)
  - Open License: OER
    - Open Educational Resources
    - OER Commons (<https://www.oercommons.org/>)
- What impact “Open Education” has on society in the future?



## Summary of OCW

### Main Features

- Digital publications of educational materials as open source via Web.
  - Started by MIT from 2003.
  - Lecture notes, course outlines, reading lists, lecture videos, and assignments
  - Contribution to society by open publication of courses in university
- Open Education Consortium
  - <http://www.oeconsortium.org/>
- Japan OCW Consortium
  - [http://www.jocw.jp/index\\_j.htm](http://www.jocw.jp/index_j.htm)

# Summary of MOOC

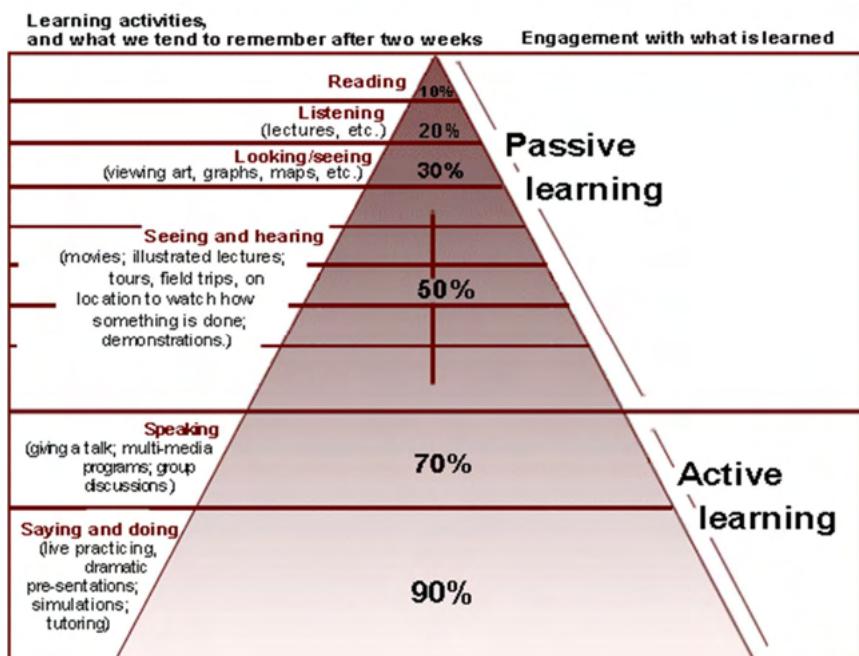
## Main Features

- Online course aimed at unlimited participation and open access via Web.
  - Anyone takes lecture anytime & anywhere.
- Providing videos, problem sets (CBT), forums with community as resources.
- Some providers give certifications.
  - edX: MIT, Harvard University, UC Berkeley, Kyoto University, Beijing University, etc.
  - Coursera: Stanford University, University of Virginia, University of Tokyo, etc.
- Completion rates are typically lower than 10%.



# Summary of Active Learning

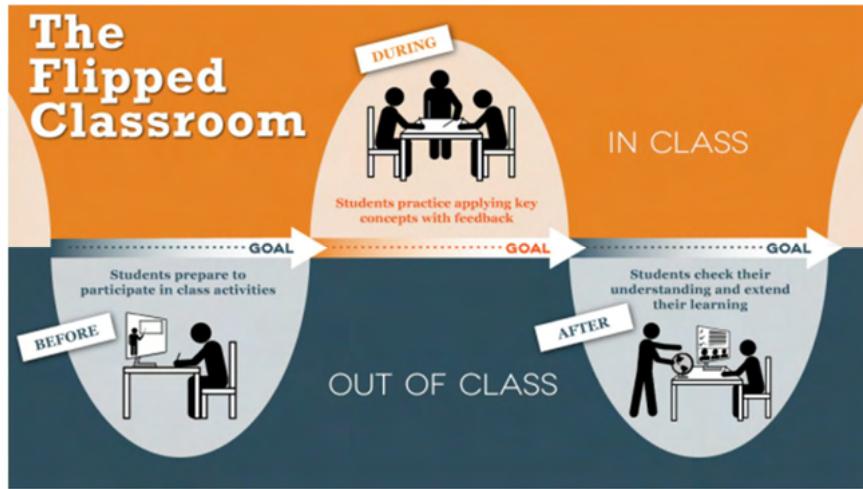
- Process whereby students engage in activities, such as discussion.



(<http://www.studygs.net/activelearn.htm>)

# Summary of Flipped Learning

- To **invert** typical cycle of content acquisition and application so that
  - Students gain knowledge before class
  - Teacher guides them to actively during class.



(<http://ctl.utexas.edu/ctl/teaching/flipping-a-class>)



# Summary of PG Education

- Compulsory subject of Programming in Japan
  - From 2020 in elementary school

小学校段階におけるプログラミング教育の在り方について（議論の取りまとめ）													
<b>プログラミング教育の必要性の背景</b> <p>・近年、飛躍的に進化した人工知能は、所与の目的の中で処理を行なう一方、人間は、みずみずしい感性を駆けさせながら、どのように社会や人生をよりよいものにしていくのかなどの目的を考え出すことができる。その目的に応じた創造的な問題解決を行うことができるなどの強さを持っている。こうした人間の強さを伸ばしていくことは、学校教育が長年目指してきたことでもあり、社会や産業の構造が変化し成熟社会に向かう中で、社会が求める人材像とも合致するものになっている。</p> <p>・自動販売機やロボット掃除機など、身近な生活の中でもコンピュータとプログラミングの働きの恩恵を受けていることは、時代の要請として受け止めなければならぬ。</p> <p>・小学校段階におけるプログラミング教育については、コーディング（プログラミング言語を用いた記述方法）を見ることでプログラミング教育の目的であるとの誤解が広がりつつあるのではないかとの指摘もある。</p>													
<b>プログラミング教育とは</b> <p>子供たちに、コンピューターに意図した処理を行なうように指示することができる「いふことを体験させながら、将来どのような職業に就くとしても、時代を超えて普適的に求められる力としての「プログラミング的思考」などを育成するもの</p>	<b>プログラミング的思考とは</b> <p>自分が意図する一連の活動を実現するために、どのような動きの組合せが必要であり、一つ一つの動きに対応した記号を、どのように組み合わせたらいいのか、記号の組合せをどのように改善していくか、より意図した活動に近づくのか、といったことを論理的に考えていく力</p>												
<b>プログラミング教育を通して目指す育成すべき資質・能力</b> <p><b>知識・技能</b> （小）身近な生活でコンピュータが活用されていることや、問題の解決には必要な手順があることに気付く学び （基）思考力・判断力・表現力等</p> <p><b>学びに向かう力・人間性等</b></p> <p><b>思考力・判断力・表現力等</b></p>													
<p>ごした資質・能力を育成するプログラミング教育を行う単元について、各学校が適切に位置付け、実施していくことが求められる。また、プログラミング教育を実施する前提として、言語能力の育成や各教科における思考力の育成など、全ての教育の基盤として長年重視されている資質・能力の育成もしっかりと図っていくことが重要である。</p> <p><b>【小学校段階におけるプログラミング教育の実施例】</b></p> <table border="1"> <thead> <tr> <th>総合的な学習の時間</th> <th>自分た自身とプログラミングの関係を考え、そのときに気付く学び</th> <th>音楽</th> <th>創作用のICTツールを活用しながら、音の種類や周波数の組合せなどを実行検証し、音楽をつくる学び</th> </tr> </thead> <tbody> <tr> <td>理科</td> <td>電気製品にはプログラミングされた条件に応じて動かしていることを気付く学び</td> <td>图画工作</td> <td>表現しているものを、プログラミングをして動かすことにより、新たな発見や感覚を生み出す学び</td> </tr> <tr> <td>算数</td> <td>図の作成において、プログラミング的思考と数学的な思考の関係やよろこび気付く学び</td> <td>特別活動</td> <td>クラブ活動において実施</td> </tr> </tbody> </table> <p><b>【実施のために必要な条件整備等】</b></p> <ol style="list-style-type: none"> <li>ICT環境の整備</li> <li>教材の開発や指導事例集の整備、教員研修等の在り方</li> <li>指導体制の充実や社会との連携・協働</li> </ol>		総合的な学習の時間	自分た自身とプログラミングの関係を考え、そのときに気付く学び	音楽	創作用のICTツールを活用しながら、音の種類や周波数の組合せなどを実行検証し、音楽をつくる学び	理科	電気製品にはプログラミングされた条件に応じて動かしていることを気付く学び	图画工作	表現しているものを、プログラミングをして動かすことにより、新たな発見や感覚を生み出す学び	算数	図の作成において、プログラミング的思考と数学的な思考の関係やよろこび気付く学び	特別活動	クラブ活動において実施
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([http://www.mext.go.jp/b\\_menu/shingi/chukyo/chukyo3/074/siryo/\\_\\_icsFiles/afieldfile/2016/07/07/1373891\\_5\\_1\\_1.pdf](http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo3/074/siryo/__icsFiles/afieldfile/2016/07/07/1373891_5_1_1.pdf))



# Diverse Services of DLS

## Examples

- Udemy  
<https://www.youtube.com/watch?v=UmKRevigZUg>
- ShareWis  
<https://www.youtube.com/watch?v=pCZT8rlhGc8>
- Lang-8  
<https://www.youtube.com/watch?v=ykTbEPSjT5A>
- CodeAcademy  
<https://www.youtube.com/watch?v=hn5Hlusj6Nc>
- Lecture Archiving System in JAIST  
<http://dlc-lms.jaist.ac.jp>



## What are advantages?

What do you think about  
“advantages”  
of these “New” ways for learning?

# JAI ST Online Lectures 2020

- All lectures moved to online from April ...
  - Only 20 days to realize online style of lectures

Pattern	KS	IS	MS	GCC	Sum
Case1 (Archive)	0	14	16	1	31
Case2 (Live)	3	8	3	5	19
Case3 (Live)	15	9	6	8	38
Sum	18	31	25	14	88

- “Data Diet” were requested to share internet ...

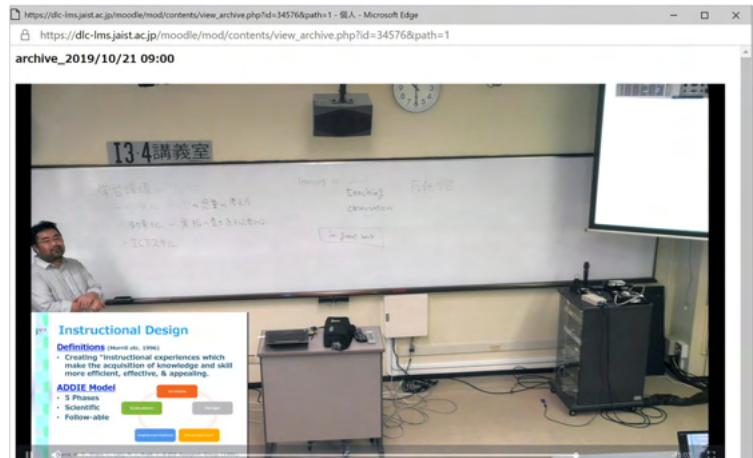
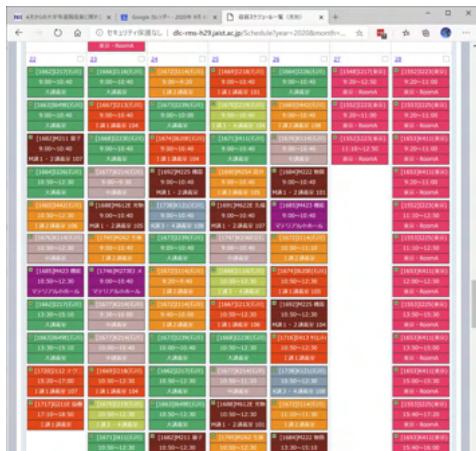
1. Turning off unnecessary cameras
2. Sharing materials rather than videos
3. Not all lectures should be “live”
4. Using internet in uncongested time
5. Designing practices without internet

National Institute of Informatics  
<https://www.nii.ac.jp/event/upload/datadiet.png>



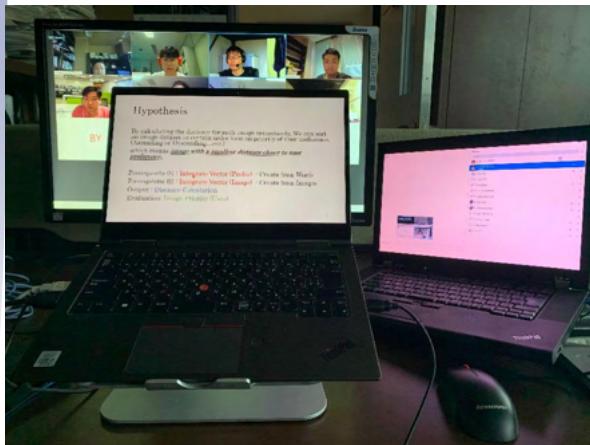
## CASE1 : Archive Style

- Recorded in lecture rooms & Delivered from Moodle
  - For knowledge-transfer (like math/science) lectures
    - Interaction on Moodle Forum
  - Step-by-step system construction from 2006
  - Camera operation by TAs in some lectures
  - “Data Diet”: Full HD/300kbps/0.5fps

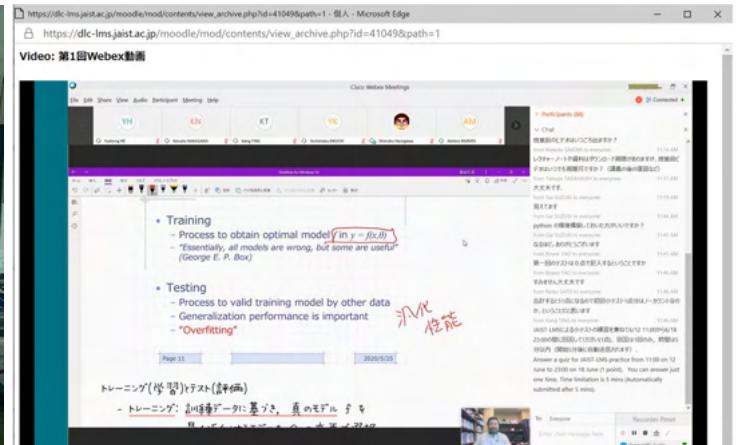


# CASE3 : Live Style

- Live lectures with Webex (PC conference system)
  - For discussion and groupwork lectures
  - Interaction by Webex chat and online talk
  - University-wide contracts: 12,360 meetings (4-8. 2020)
  - Setting up by Faculties or TAs (Multi PC/monitors)
  - "Data Diet": Muting students' camera



Faculty's Desk

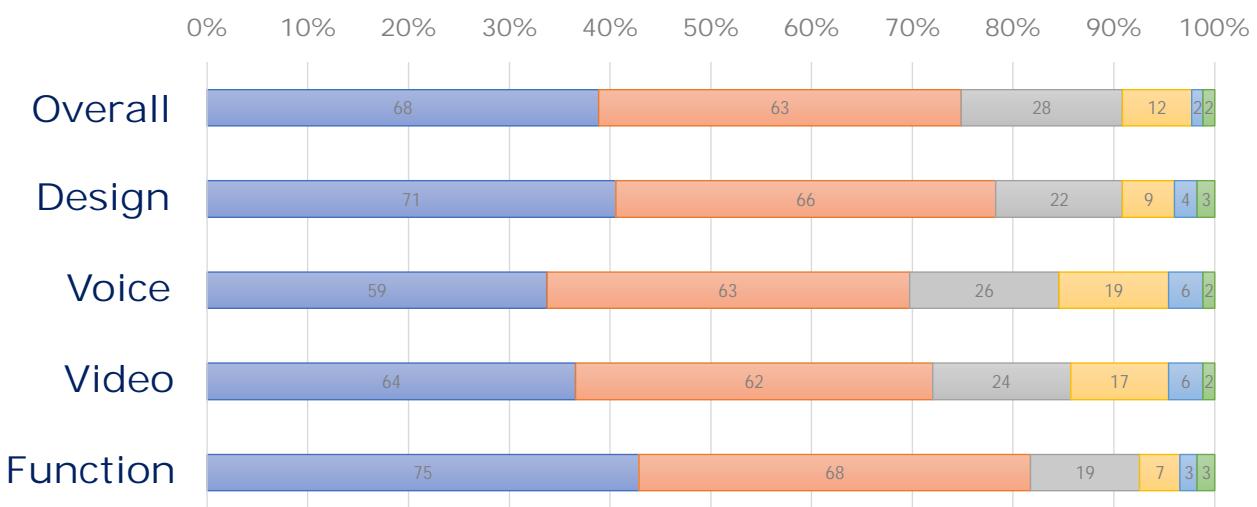


Webex Lecture



## Degree of Satisfaction (DoS)

- DoS by students to Case 2/3 (Live) [N=195]



### Positive Impacts :

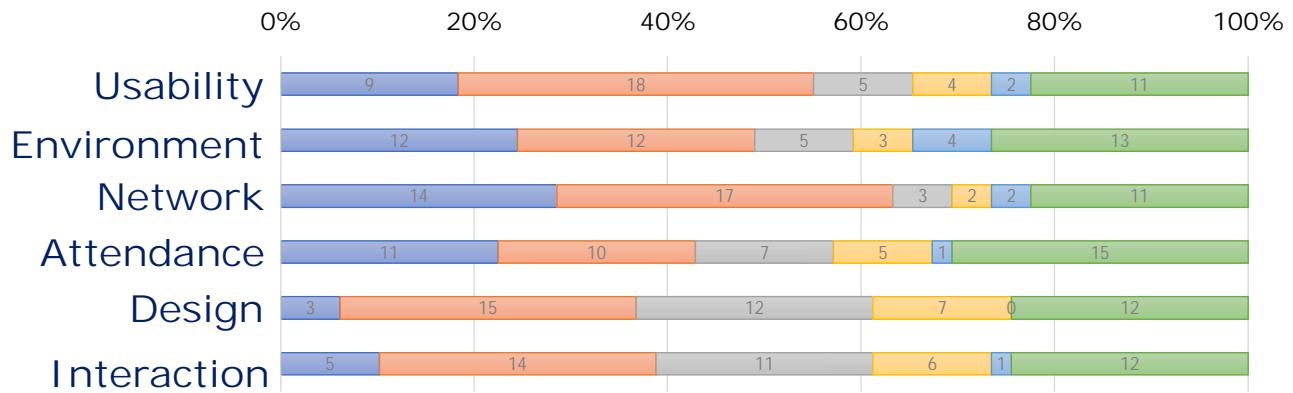
- Learning at own pace : 40
- Easy to ask questions : 18
- Accessing from anywhere : 12

### Negative Impacts :

- Anxiety in system : 25
- Building relationship: 20
- Lack of interaction : 17

# Degree of Satisfaction (DoS)

- DoS by faculties to Case 2/3 (Live) [N=49]



## Positive Impacts :

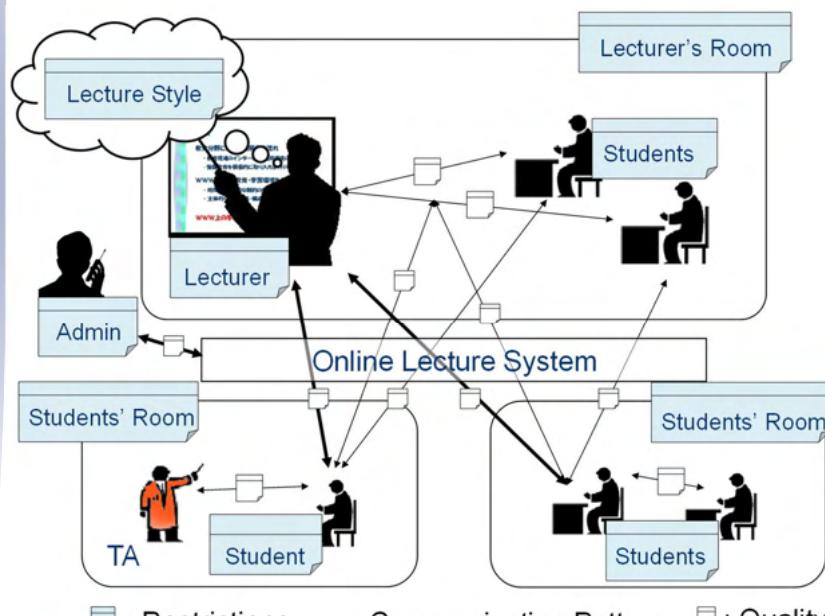
- Learning at own pace : 17
- New advantages : 12
  - Remote work, Avoid 3C  
Material distribution,  
Student acquisition, ...
- Easy to receive questions : 5

## Negative Impacts :

- Lack of interaction : 17
- Other difficulties: 17
  - Student motivation & understanding, progress
- Different environment: 4
- Difficult to fair exam: 3

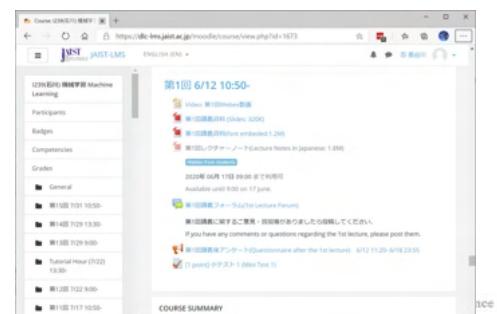
# To New Normal

- Hybridization: Integration of online & offline lectures
  - New model for teaching/learning
  - Resilient & sustainable systems:



## Hybrid System

- Hub for Live & Archive
- Interactive Tools
  - Learning Analysis  
Engagement
- Online Exams



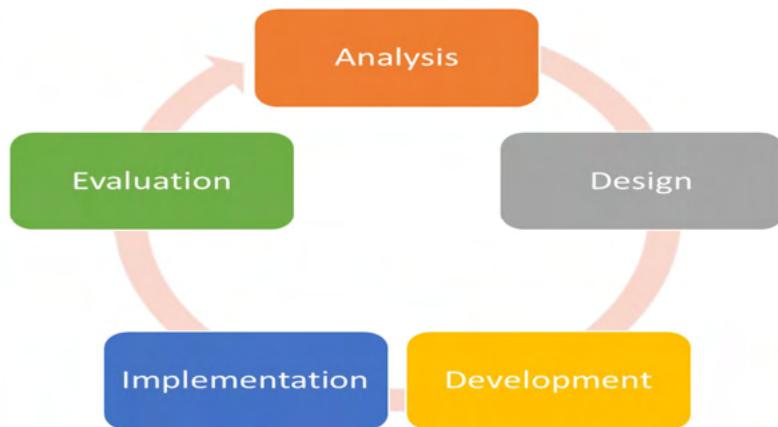
# Instructional Design

## Definitions (Merrill etc. 1996)

- Creating “instructional experiences which make the acquisition of knowledge and skill more efficient, effective, & appealing.

## ADDIE Model

- **5 Phases**
- **Scientific**
- **Follow-able**



Merrill, M. D., Drake, L., Lacy, M. J., Pratt, J., & ID2\_Research\_Group. (1996). Reclaiming instructional design. Educational Technology, 36(5), 5-7.

## Why Instructional Design?

### Another Definitions (Reiser etc. 2007)

- A systematic process that is employed to develop education and training programs in a consistent and reliable fashion.

### Why use ID?

- To Improve Effectiveness of Instruction
  - Increasing what learners are able to do & know
- To Improve Efficiency of Instruction
  - Learning more things in limitation time
- To Improve Appeal of Instruction
  - Providing interesting contents & environments

Reiser, R. A. & Dempsey, J. V. (2007). Trends and Issues in Instructional Design (2nd ed.). Upper Saddle River, NJ: Pearson Education, Inc.

# Difference btwn US and JP

ID Approach	Traditional Approach
Educational goal is highly related to actual work.	Educational goal is defined by textbook or teacher's knowledge.
Educational method is based on practical proofs.	Educational method is based on teacher's skills.
Educational goal is notified at the beginning. Learners know what they are required.	Learners need to imagine educational goal. They may be surprised in examination.
Most learners are required high level of results.	The results may be normally distributed and depend on learners skill.
Course has to be revised if it does not achieve high effectiveness.	Teacher & learners have to improve if it does not achieve high effectiveness.

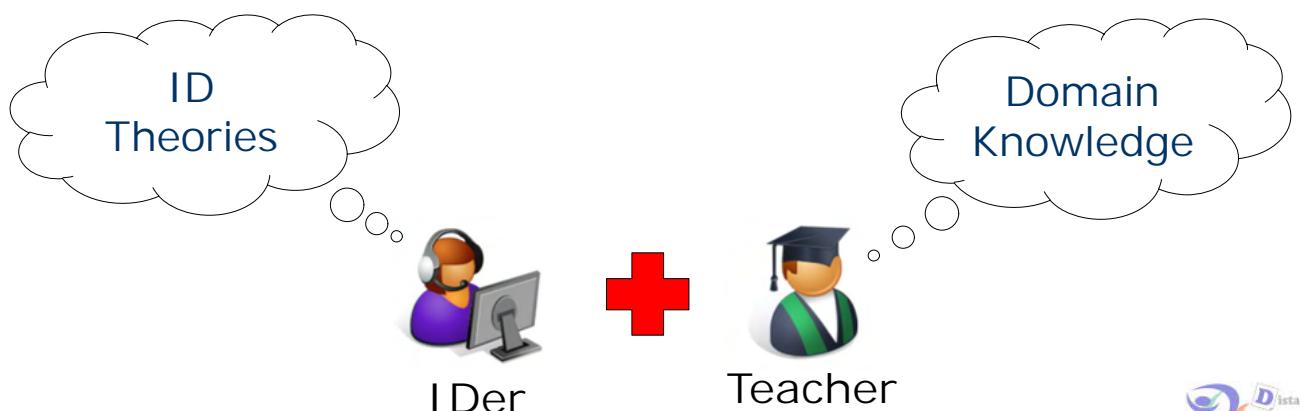
鈴木克明（編著）(2004) 詳説インストラクショナルデザイン：eラーニングファンダメンタル（パッケージ版テキスト）． 特定非営利活動法人日本イーラーニングコンソシアム

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# Instructional Designer

## Definitions

- A specialist for connecting educational theories to educational practices through designing “instruction”.
- IDer consists “way of learning” in an instruction process.



# Who is suitable for I Der?

What do you think  
“Who is suitable for I Der”?



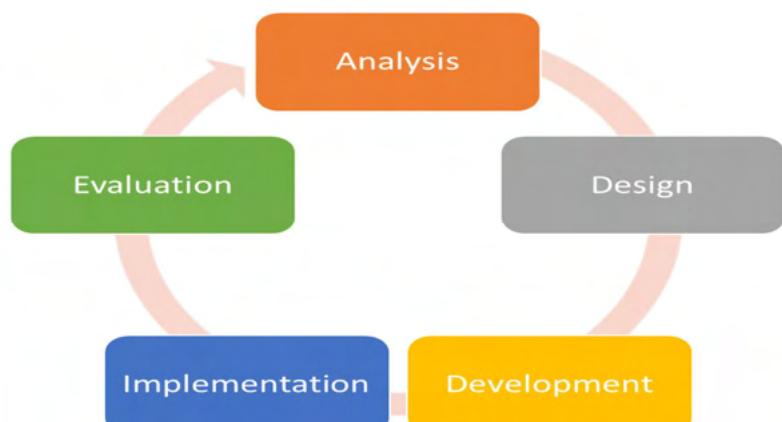
## Instructional Design

### Definitions (Merrill etc. 1996)

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### ADDIE Model

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- **Scientific**
- **Follow-able**



# Analysis Phase

## Definitions

- Referring to the gathering of information about audiences, tasks, & goals.
- Classifying the information to make the content more applicable and successful.
- **Analysis makes requirements of instruction clear before design & the following phase.**

- Needs Analysis
  - Goals Analysis
  - Tasks Analysis
  - Other Analysis
- } Modeling



## Needs Analysis



## Needs Concretion:

- Recognition of Current Situation
  - Why do they have such needs?
- Set of Goal
  - What is an ideal situation?
- Meaning of Instruction
  - Is instruction suitable for method?
- **Analysis (making gaps clear) through questionnaire, interview, observation.**

# Goals Analysis

## Goals Concretion:

- Learning Goal: To be achieved in instruction.
- Ex.) Learning Goals of This Lecture
  - To analyze & design "New" DLS
  - To develop & implement DLS with Contents
  - To evaluate DLS from Data
  - To improve your 21st Century Skills

## Observable Goals:

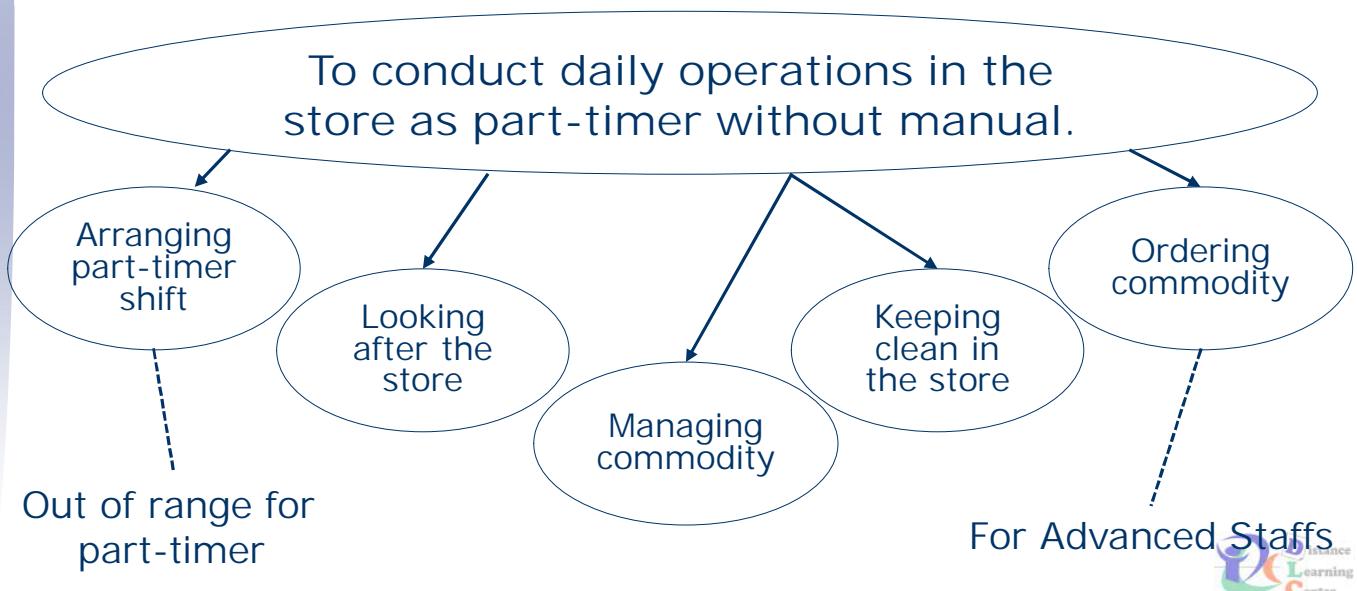
- Desired Activity:
  - What activity are they required to be achieved?
- Acceptance Criteria:
  - What criteria are suitable for acceptance?
- **What instructor expect learners is clear before instruction.**



# Tasks Analysis

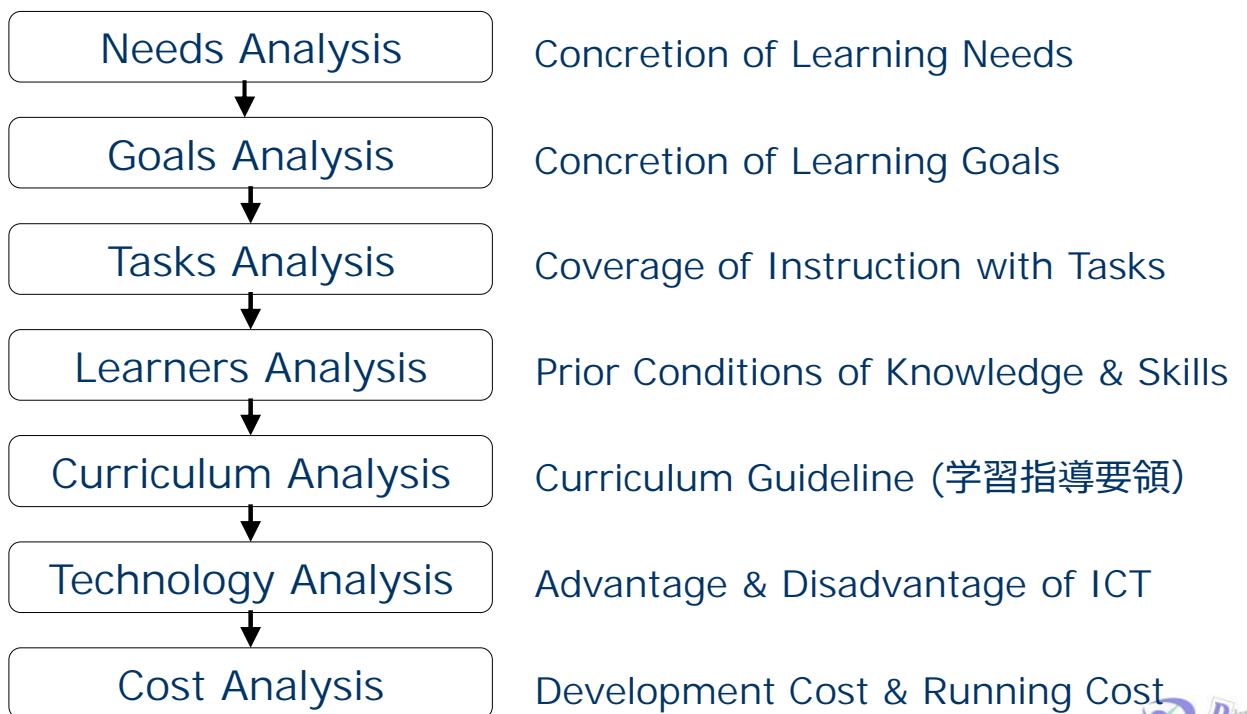
## Definitions:

- To define coverage of instruction
  1. To divide learning goal into learning tasks
  2. To select the learning tasks to be instructed



# Other Process for Analysis

## Process Flow:



# Why do we need model?

# Significances

- Effective instruction must understand human learning process but can't do that without any approximate approach.
  - Modeling is an approximate representation about human learning process.

# Requirements

- Current situation with difficulties
  - Gaps to ideal situation after learning
  - System Design (How to do) should be based on model of Who, Where, When, Why, & What to do.

# What are difficulties?

## ICT in Education For Teachers

1. Initial training (& cost) is high barrier to apply ICT in classroom.
  - Half of teachers didn't have skills to teach with ICT before project started, but no chance to train.
2. Difficulties in designing lecture with ICT & combining ICT & conventional equipment.
  - Feature of teaching equipment is quite different.
  - (First) preparation takes much time.
3. Difficulties in management of lecture & time.
  - Teacher cannot focus on teaching but on helping students to use of ICT.
  - If one thing doesn't work, next lecture will fail.



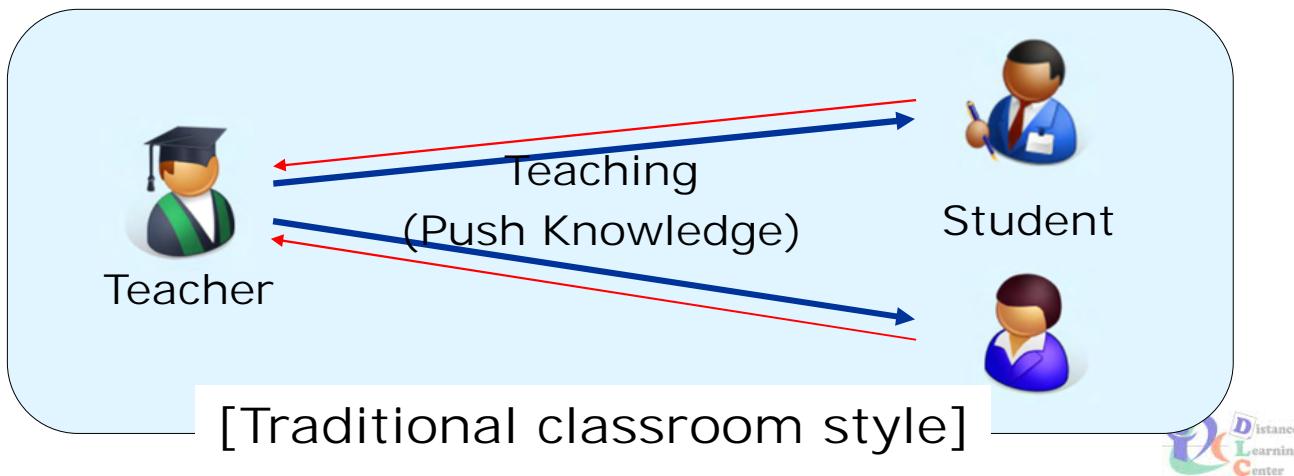
## How do we make model?

What do you think about  
"How to make model"  
for improving teachers skills?

# Who need help?

## Teacher & ICT supporter

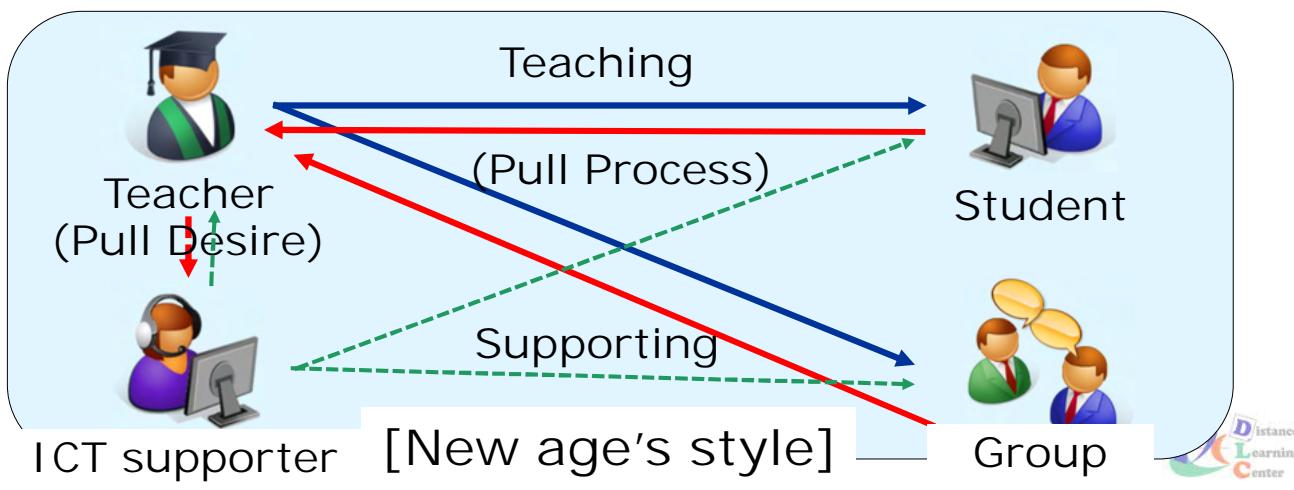
- Students can adjust new situation easily.
- Teacher & supporter need new skills to manage
  - from "Push" to "Pull"
  - from "one to all" to "one to groups"
  - with new technology (combined traditional one)



# Who need help?

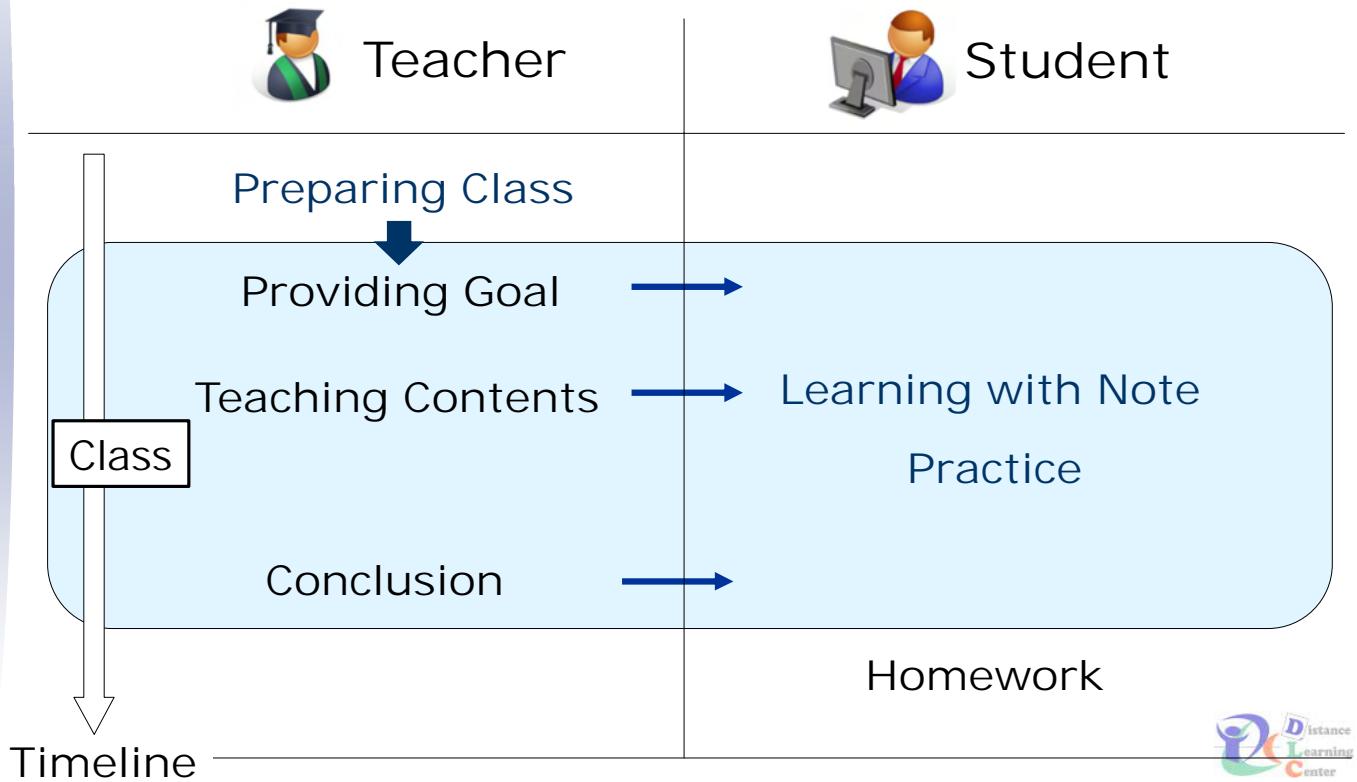
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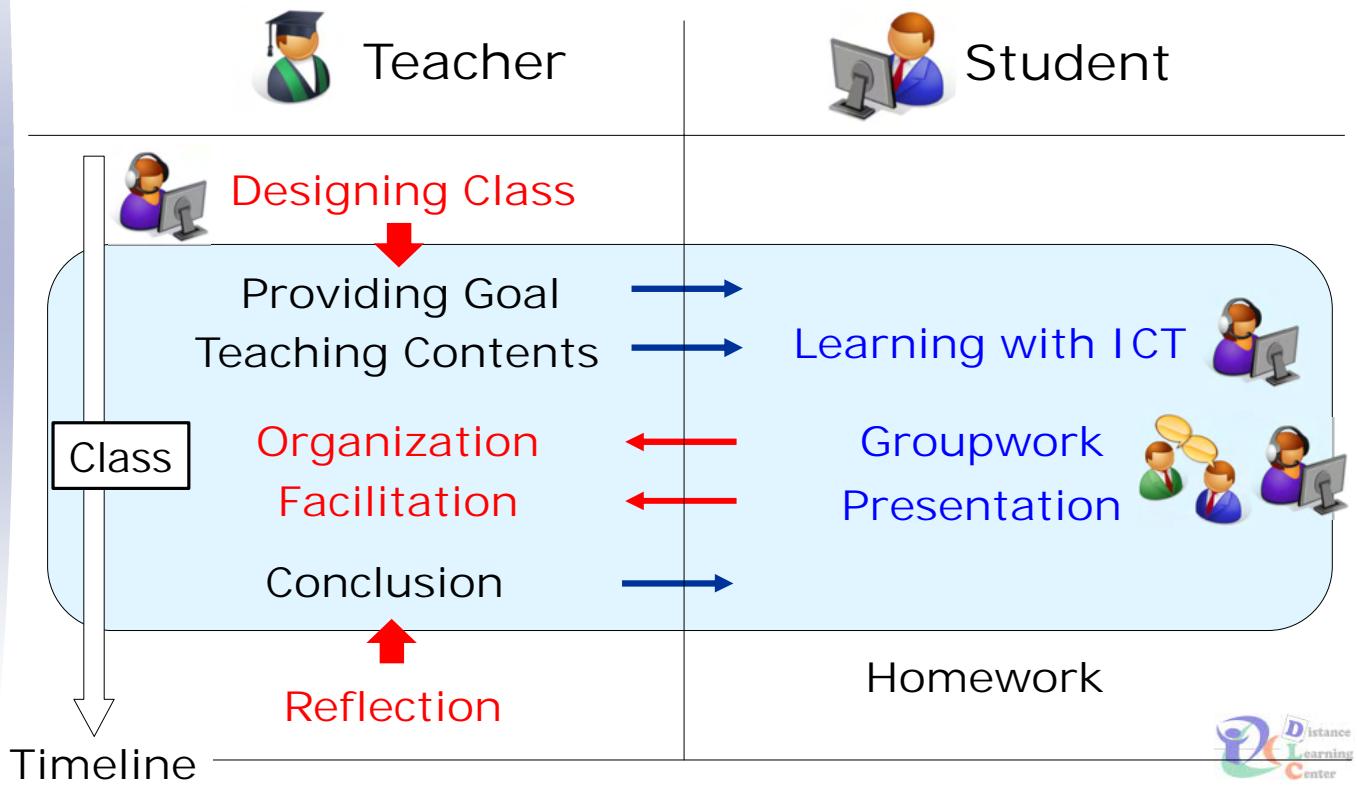
# When need help?

## Traditional Class



# When need help?

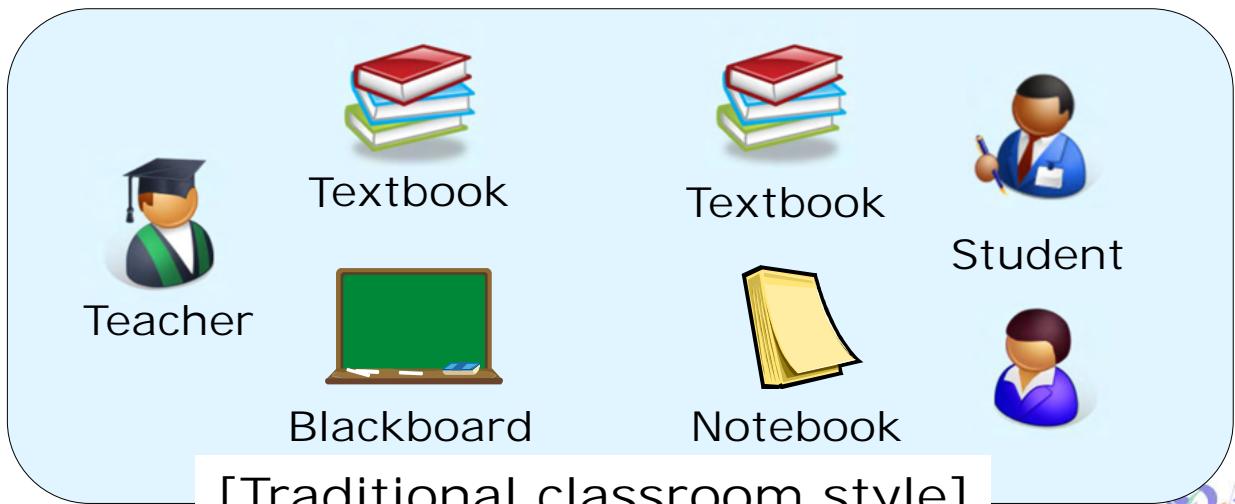
## Before-during-after ICT Class



# Where need help?

## Traditional Classroom

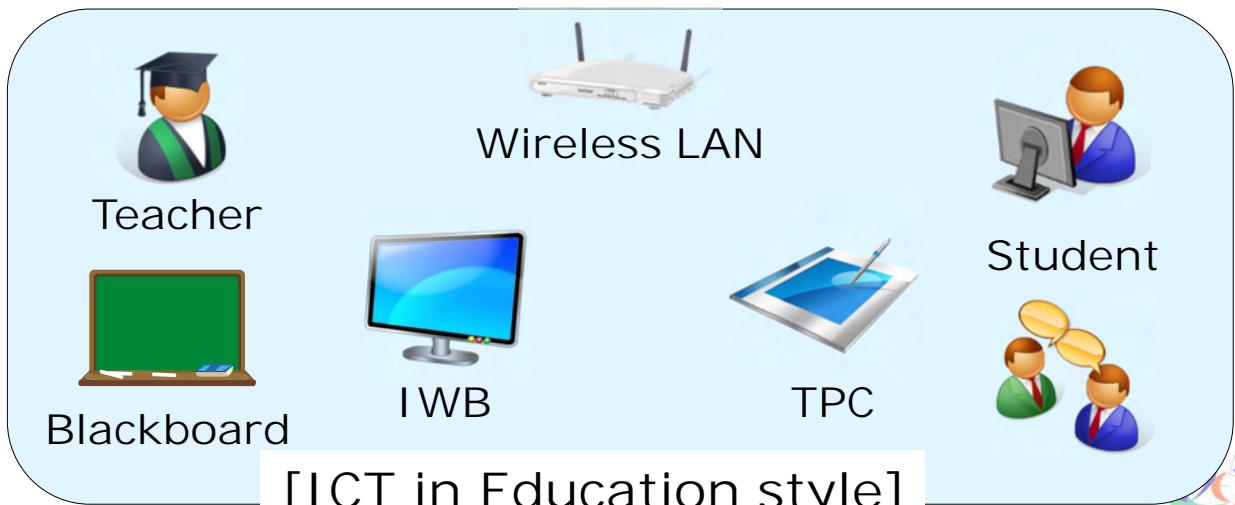
- Teacher's talk is based on a textbook & sometimes described on blackboard.
- Students read a textbook & take a note to learn the talk.



# Where need help?

## ICT in Classroom

- Teacher & students use TPC (including e-text).
- Teacher shows anything on IWB
- These equipment is connected by wireless LAN.
- Traditional equipment is also used



# Why need help?

## As mentioned before

Targeted!

1. Difficulties in training
  - To take initial & follow-up training
  - To reflecting on teacher's own lecture by oneself
2. Difficulties in designing class
  - To know which equipment & way of use are suitable
  - Not to just replace traditional equipment to ICT's ones
3. Difficulties in managing class
  - To take care of ICT usage by students
  - To confirm learning process of each student



## What need to manage?

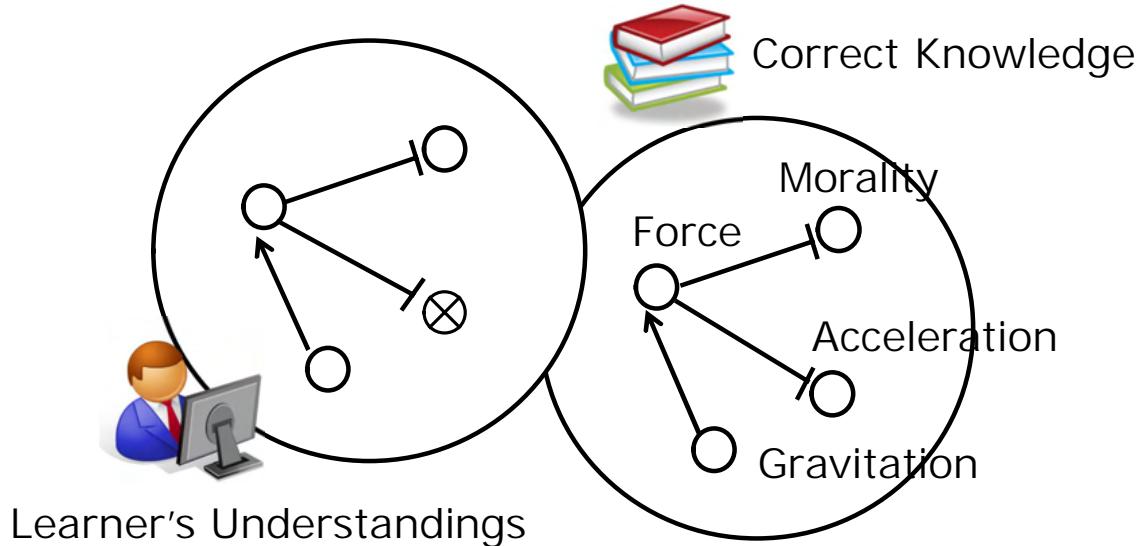
### Issue is “Skill” rather than “Knowledge”

- Instruction should improve “Skill” of teaching.
  1. To provide basic knowledge.
  2. To manage good materials for re-use.
  3. To gather good use cases together with goal.
  4. To provide chances for reflecting.

What do you think about  
“How do we do that”  
for designing effective instruction?

# Overlay Model

- Overlaying learner's understandings to correct knowledge. (Carr 1977)

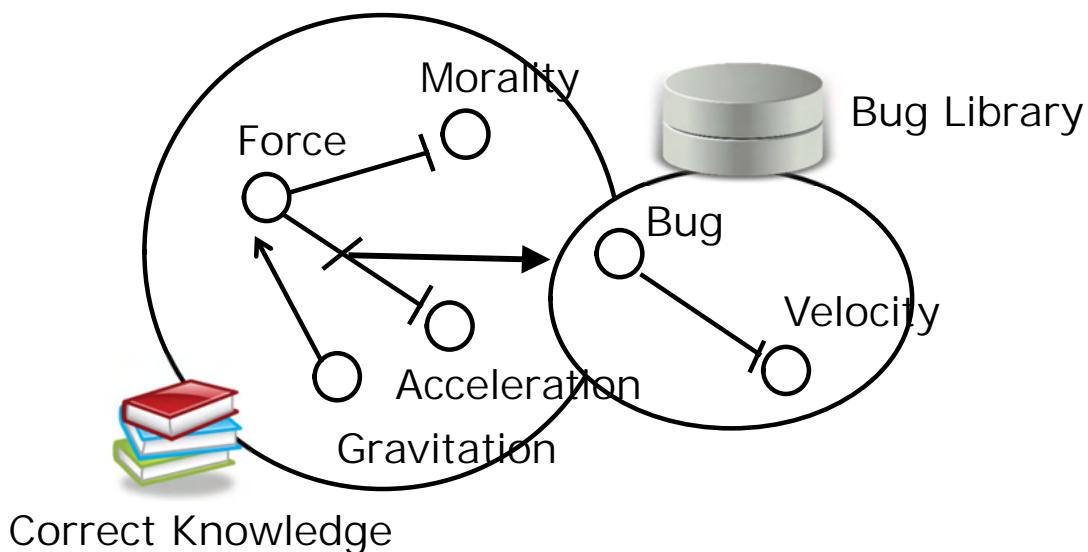


→ Limited to lack of knowledge as mistake



# Bug Model

- Representing misunderstanding of knowledge (Brown 1978)



→ Bug patterns should be stored in bug library.



# Ex. of Persona Model

## Base for User-centered Design

- Persona is a virtual character to represent properties & difficulties in situation.



Age: 20's  
Sex: Male  
School: JH  
Subject: Math

### Education Activities:

Class Plan: Never fixed  
Class Style: Blackboard centered  
Class Management: Note centered  
School Activity: Busy

### Current Situation:

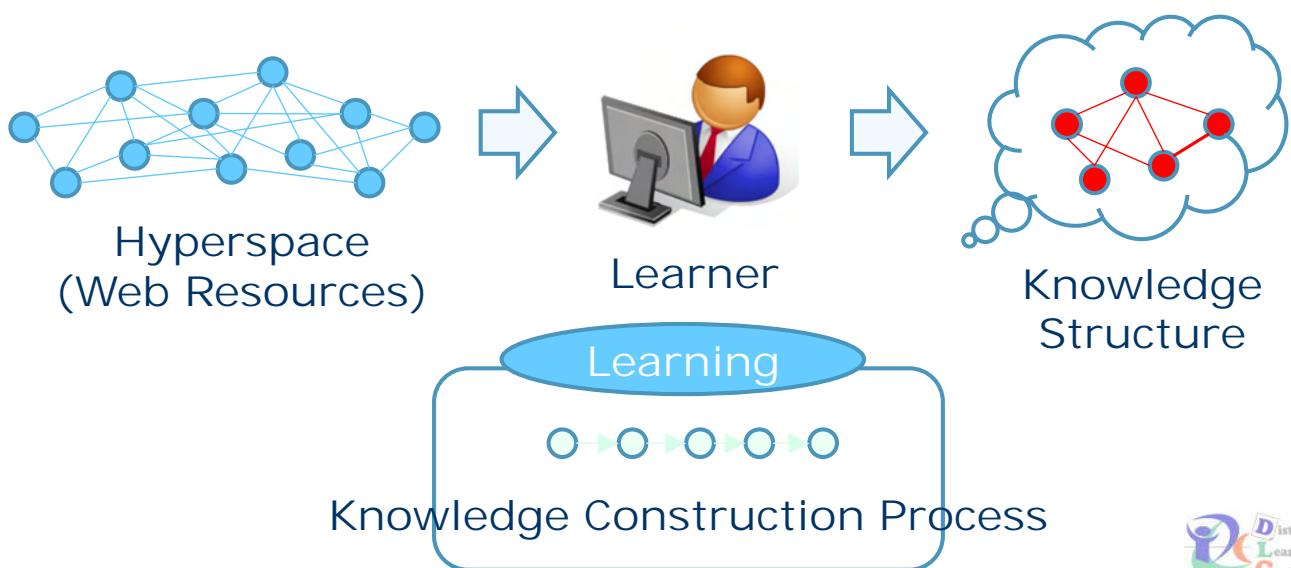
- He need to prepare new class.
- He face some schedule changes by troubles in time management.



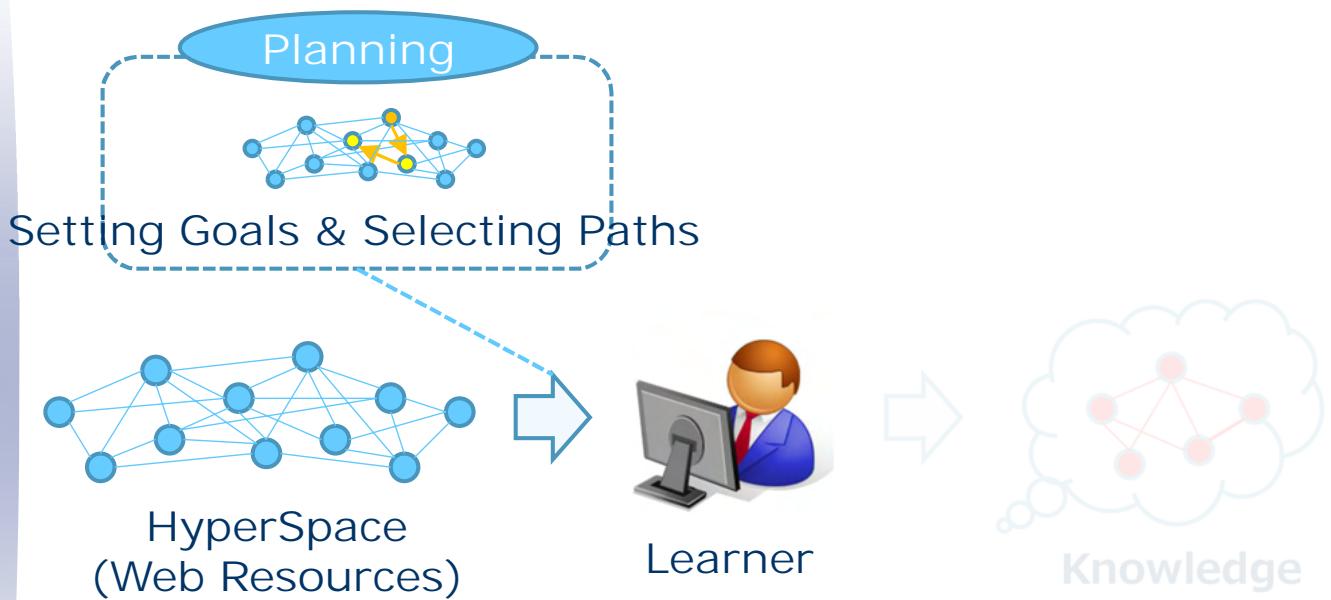
# Ex. of Task Model

## Learning Task in Web-based Learning

Learner learns web resources & makes relations among concepts & consists knowledge structure.



# Ex. of Task Model

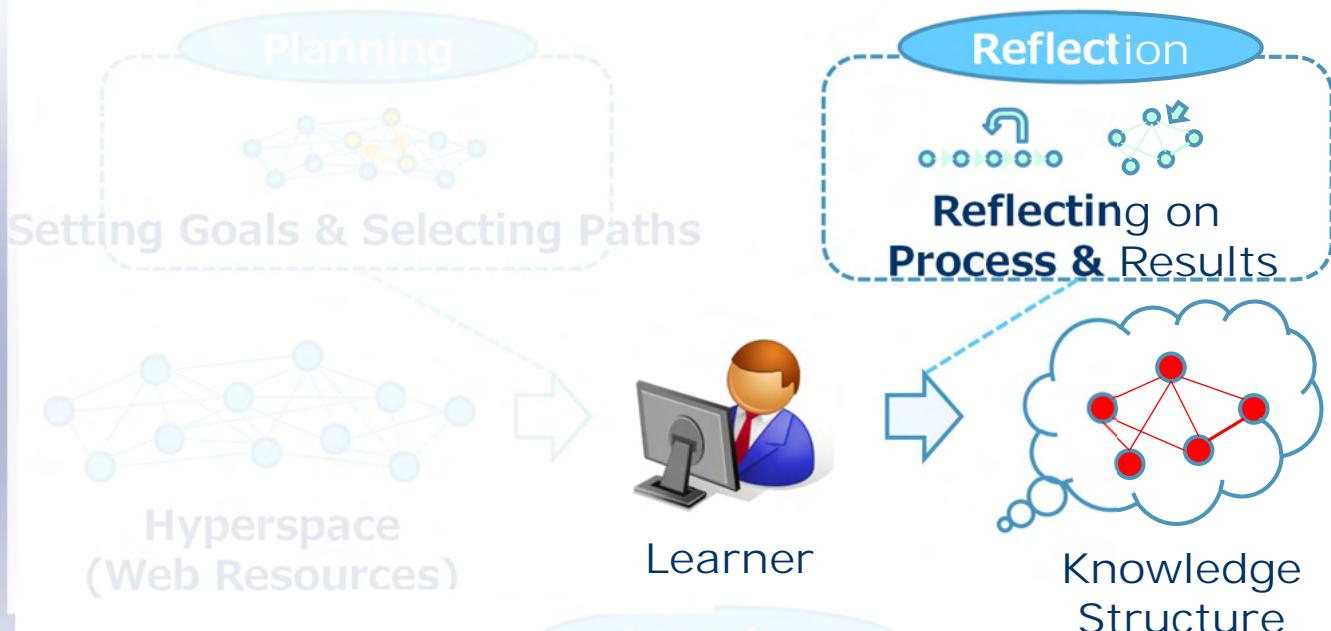


## Planning Task (Meta Cognitive Activity)

Controlling learning task by setting  
learning goals & learning space.



# Ex. of Task Model

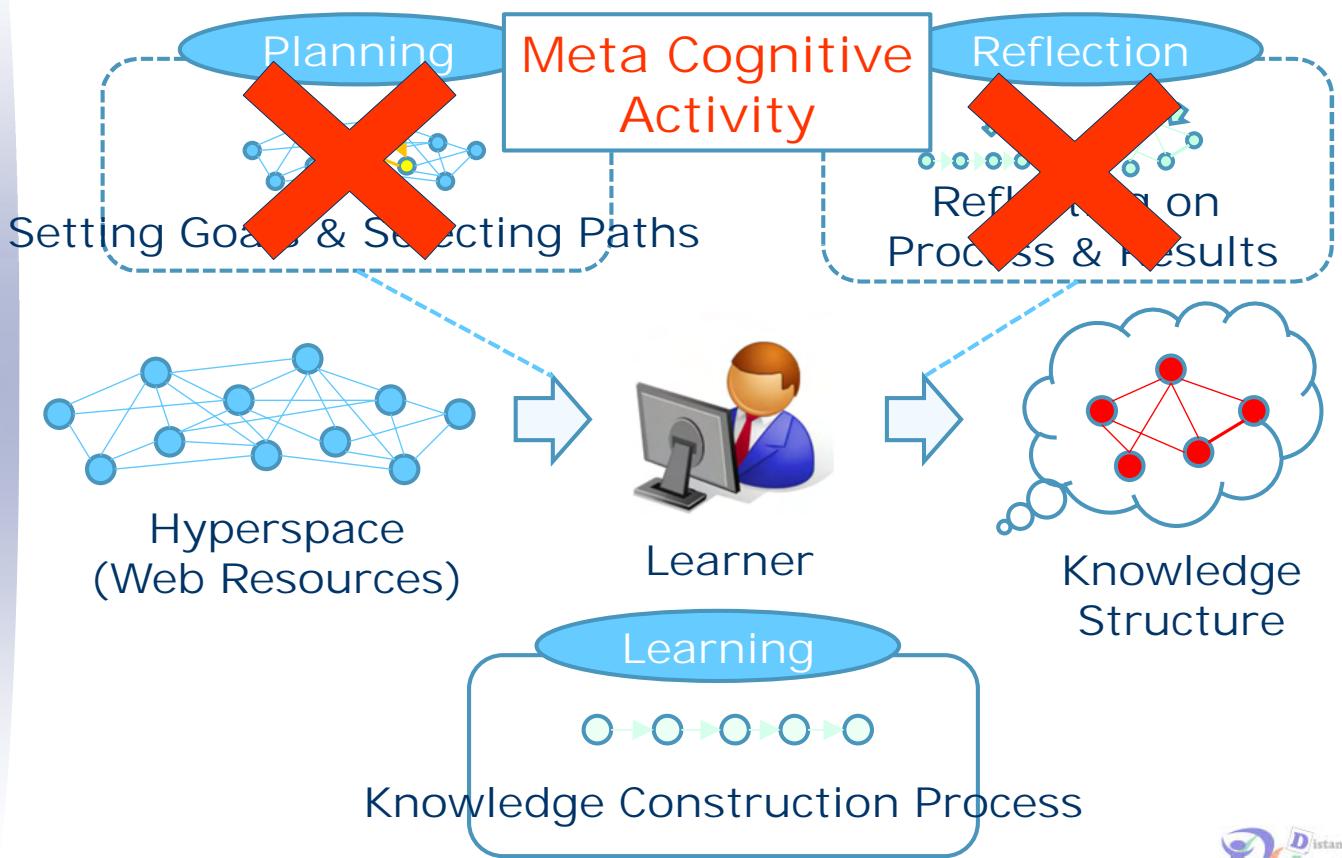


## Reflection Task (Meta Cognitive Activity)

Brushing up knowledge structure by  
reflecting on process & results.



# Ex. of Task Model



# UML as System Modeling

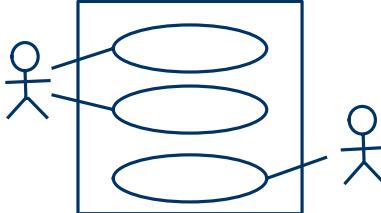
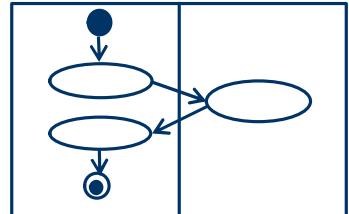
## Unified Modeling Language

- Object Oriented Modeling Language
  - Software Engineering
  - Defined 13 types of diagram as standard
  - Informative, Understandable

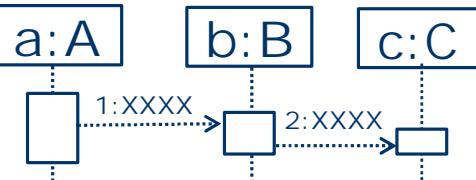
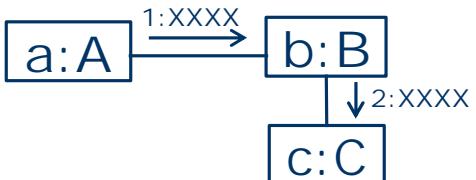
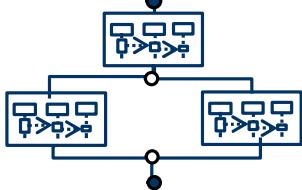
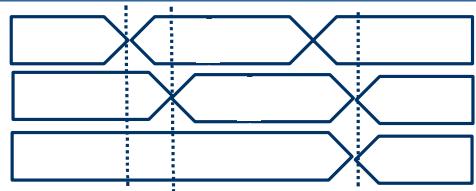
## Notes for Modeling

- Modeler should make purpose of modeling clear.
  - Is the diagram informative for development?
  - Why does he/she use UML? Share? Documentation?
- There are some difficulties in modeling
  - Individual difference in skill of modeling
  - How does he/she check quality of modeling?

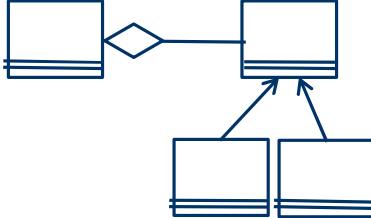
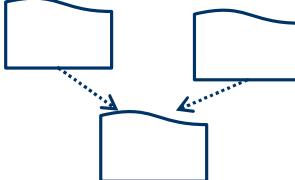
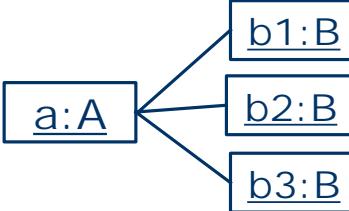
# Behavior Diagrams in UML

Use Case Diagram		Describing the functionality provided by a system in terms of actors, their goals represented as use cases.
Activity Diagram		Describing the step-by-step workflows of components in a system.
State Machine Diagram		Describing the states and state transitions of the system.

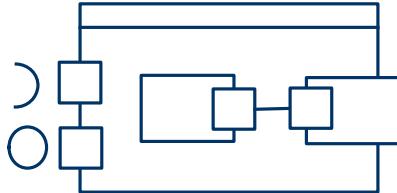
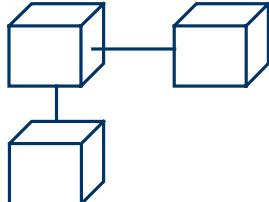
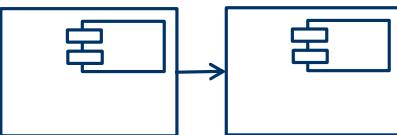
# Interaction Diagram in UML

Sequence Diagram		Visualizing how objects communicate with each other in terms of a sequence of messages.
Communication Diagram		Representing the interactions between objects or parts in terms of sequenced messages
Interaction Overview Diagram		Providing an overview in which the nodes represent communication diagrams.
Timing Diagram		A specific type of interaction diagram where the focus is on timing constraints.

# Structure Diagrams in UML

Class Diagram		Describing the structure of a system by showing the system's classes, their attributes, and the relations among the classes.
Package Diagram		describes how a system is split up into logical groupings by showing the dependencies among these groupings.
Object Diagram		Showing a complete or partial view of the structure of an example modeled system at a specific time.

# Structure Diagrams in UML

Composite Structure Diagram		Describing the internal structure of a class and the collaborations that this structure makes possible.
Deployment Diagram		Describing the hardware used in system implementations and the execution environments and artifacts deployed on the hardware.
Component Diagram		Describing how a software system is split up into components and shows the dependencies among these components.

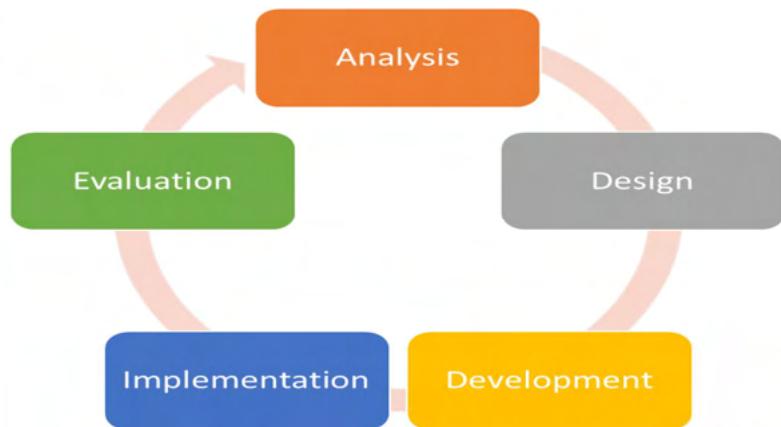
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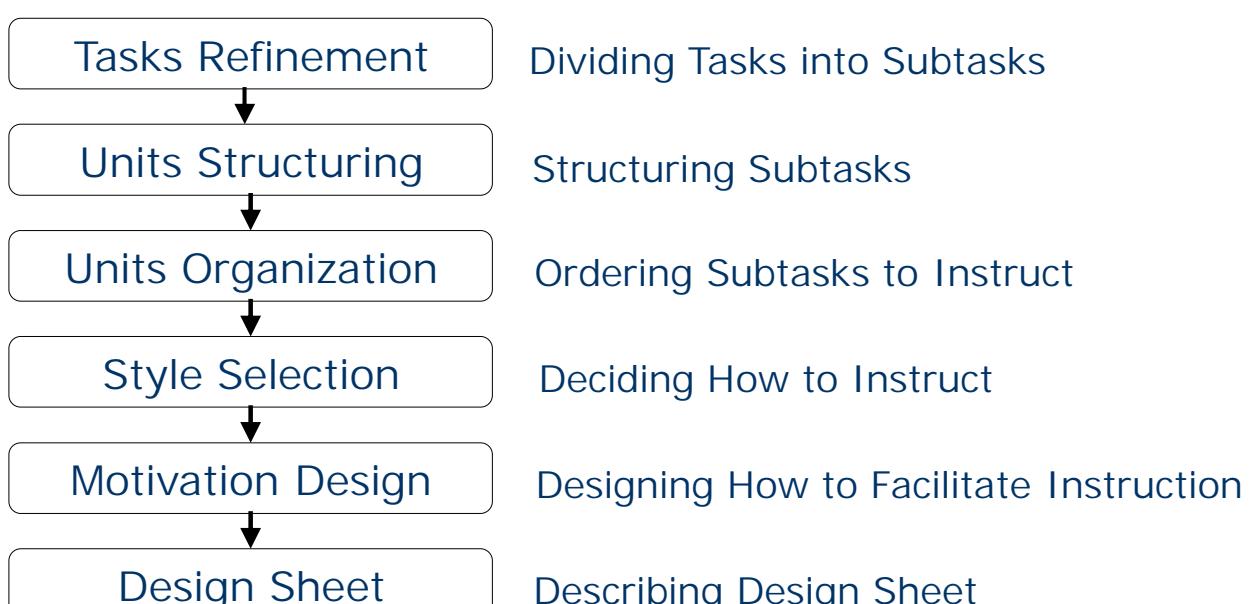


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## Process for Design

### Process Flow:



# Tasks Refinement

## Definitions

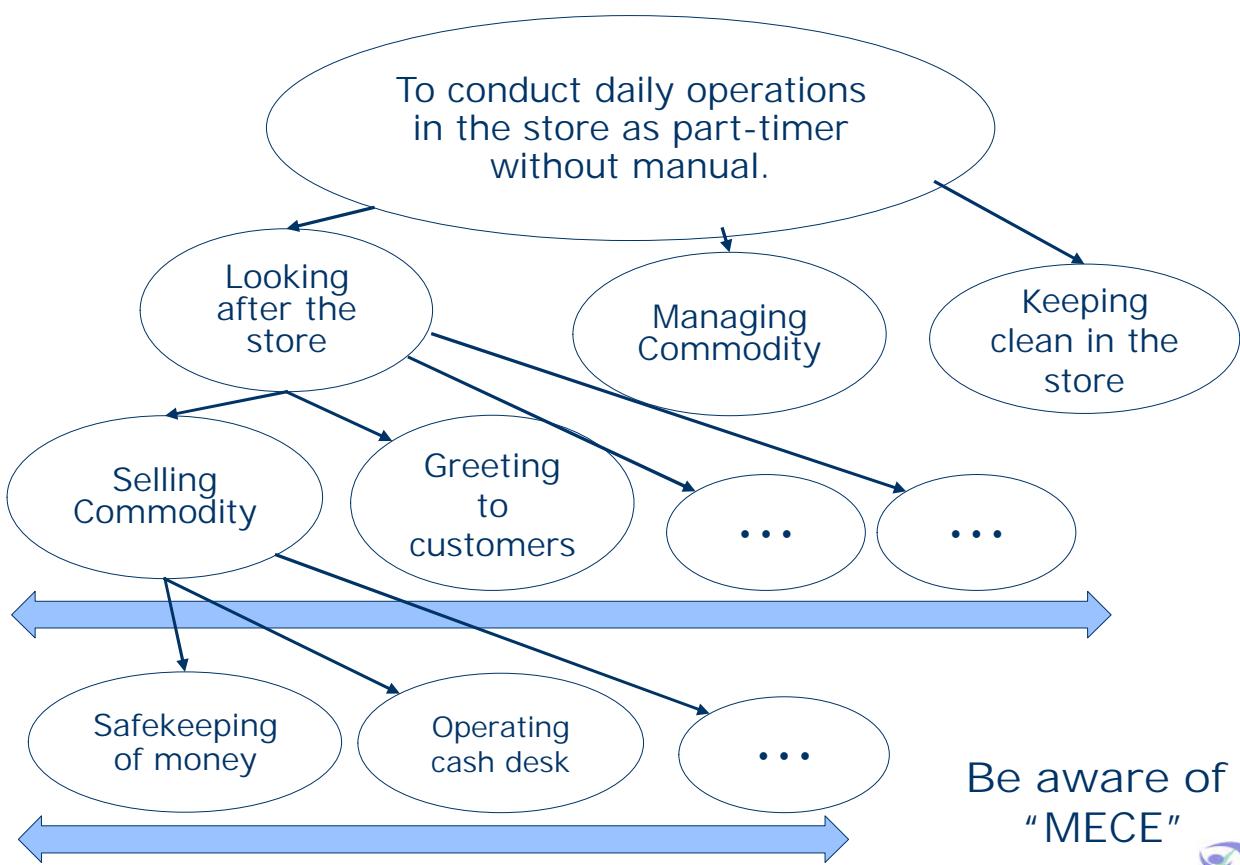
- Dividing tasks into minimum units for lectures or materials.
  - To keep examination in your mind.
  - To consider pre-requirement of target learner
- Top Down Approach:
- Bottom Up Approach:
  - Collecting up units from actual activity

## MECE as Criteria for Dividing

- Mutually Exclusive Collectively Exhaustive
  - Not to overlap with each other
  - To be similar grain size of the units
  - To cover all tasks by collecting the units



## Ex. of Tasks Refinement



# Bloom's Taxonomy

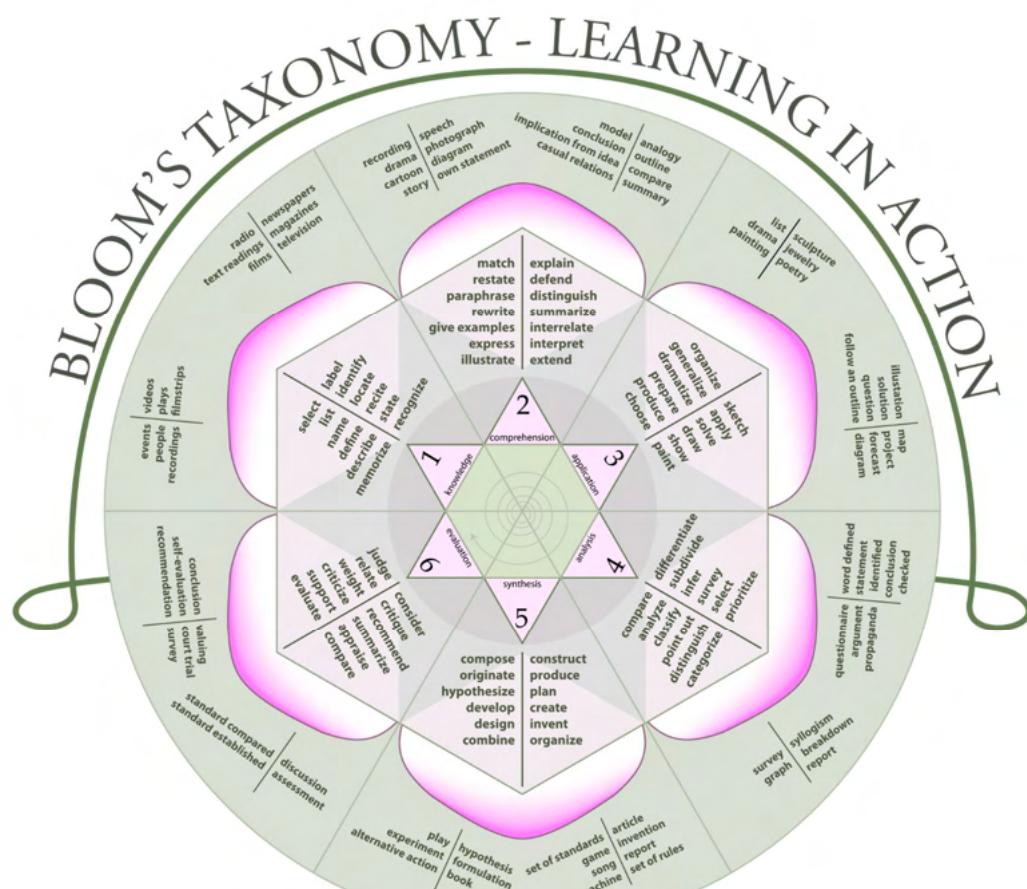
(Bloom, 1958)

Level	Cognitive	Affective	Psychomotor
Low ↓ High	Knowledge Comprehension Application Analysis Synthesis Evaluation	Receiving Responding Valuing Organizing Characterizing	Imitation Manipulation Precision Articulation Naturalization

- To motivate educators to focus on all domains to create a more holistic form of education.



## Bloom's Wheel



# Tips for Tasks Refinement

## From Cognitive Point of View

- Average attention span is around [ ] (Healy, 1991)
- Short term memory is [ ]. (Miller, 1956)
  - Topics in each unit should be kept 2 or 3.

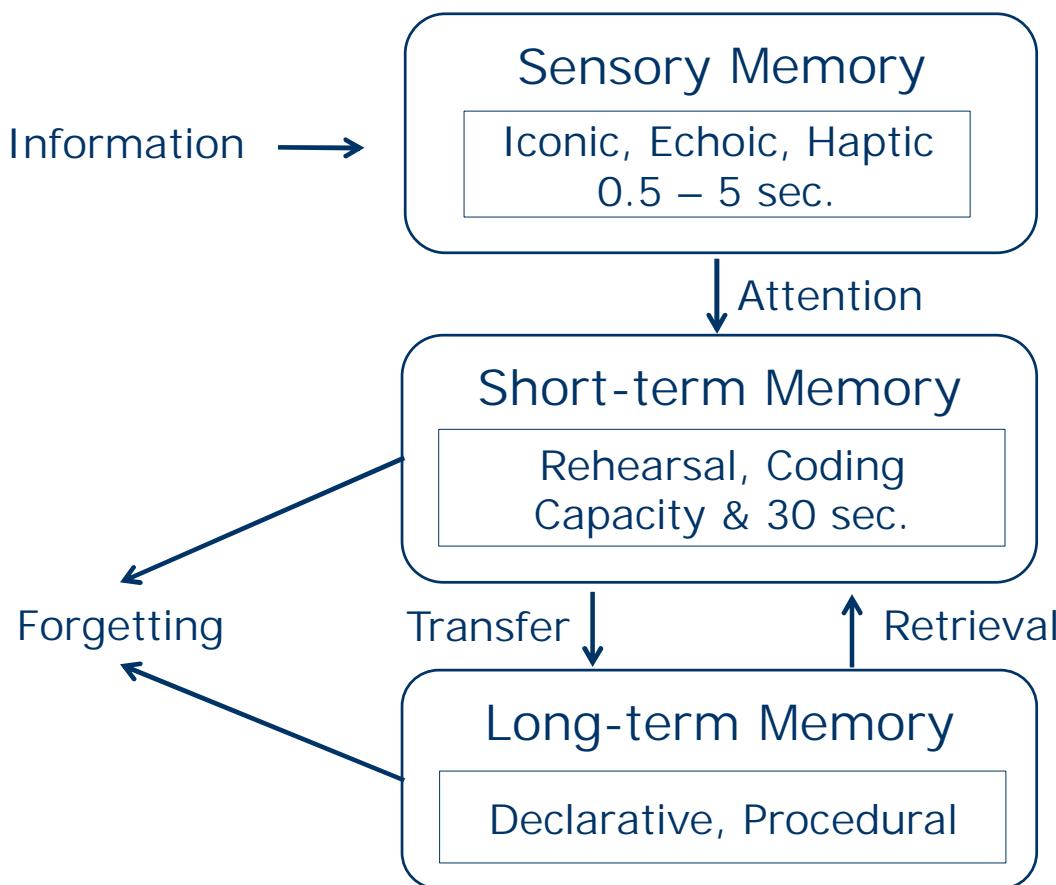
## From Assessment Point of View

- To design examination corresponding to the units at the same time.
  - Verifying the contents of units for instructor.
  - Pointing out the lack of study for learner.
  - Required to assess learner's achievement degree.
- **Agreement with instructor & learner.**



## Memory Model

(Atkinson & Shiffrin, 1968)



# Units Structuring

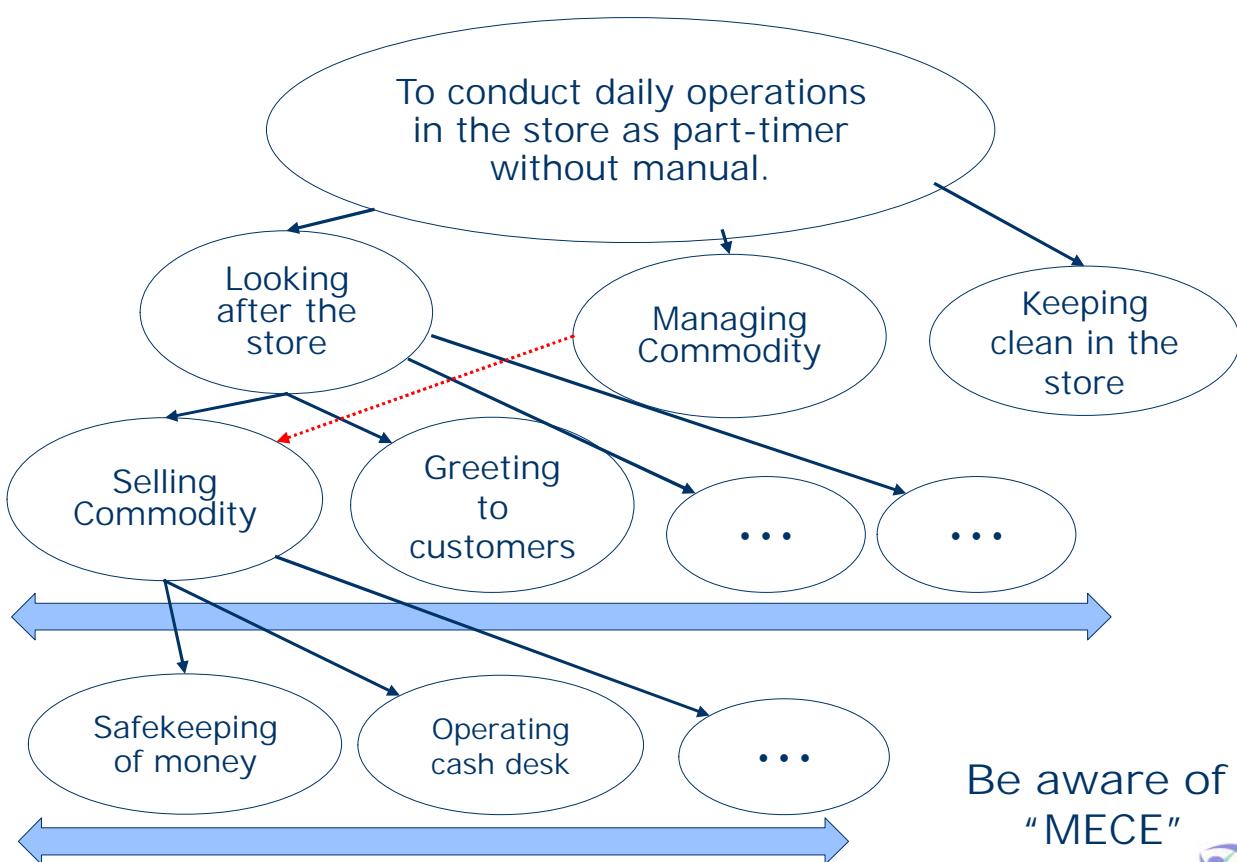
## Definition

- Consisting structure & relationships among units to guide how to learn as concept map.

## Typical Relationships

- Prerequisite
  - From basic to application
  - From easy to hard
  - From theory to practice
- Similar Task Group
  - Dealing with related concepts

## Ex. of Units Structuring



# Units Organization

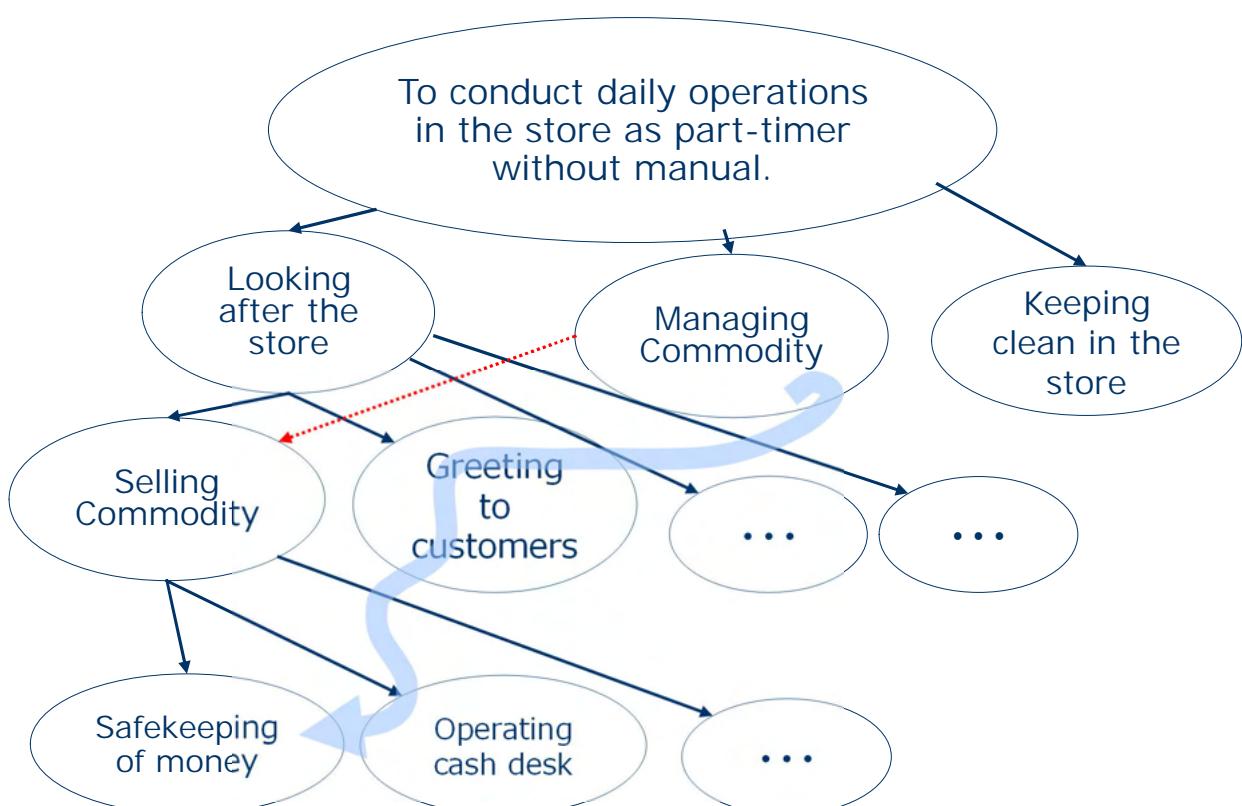
## Definition

- Ordering units based on the structure so that learner can study them as course.

## Typical Approaches

- ISM teaching objective structural chart analysis (Sato, 1978)
  - ISM: Interpretive Structural Modeling
  - Method for easy to view
- Units Sequencing Method (Takeya, 1990)
  - "Potential" is defined by the number of reachable unit.
  - "Coherence" is defined by the number of shared prerequisite unit.

## Ex. of Units Organization



# Report 1

## Assignment

- Need, Goal, and Task Analysis & rough sketch of teaching/learning method/system for your own Topic.

## Submission Deadline

- Submit PDF by 23:55 5 Nov. From LMS
- A4 1~2 pages
- The reports will be shared to the registered students.

## Evaluation Criteria

- Explain your own Modeling process
  - Why & what to learn/teach is important
- Show initial ideas of how to learn/teach



# Distance Learning System (遠隔教育システム工学)

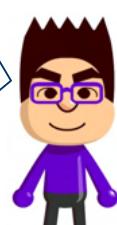
## 05. Synchronous Distance Learning System

Koichi Ota  
ota@jaist.ac.jp



### Agenda

- What is Synchronous DLS?
- Pattern of SDLS
- Video Conference System
- PC Conference System
- Examples of SDLS
- Problems of SDLS
- Layout of SDLS
- Design Pattern Approach



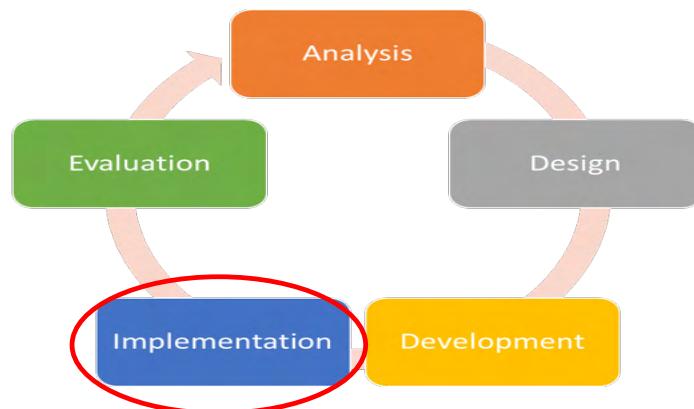
# Instructional Design

## Definitions (Merrill etc. 1996)

- Creating “instructional experiences which make the acquisition of knowledge and skill more efficient, effective, & appealing.

## ADDIE Model

- **5 Phases**
- **Scientific**
- **Follow-able**



Merrill, M. D., Drake, L., Lacy, M. J., Pratt, J., & ID2\_Research\_Group. (1996). Reclaiming instructional design. Educational Technology, 36(5), 5-7.

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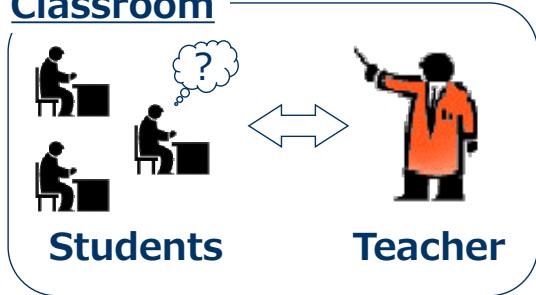
## Have you attended SDLS?

Have you attended  
“Synchronous Distance Lecture”?

What do you think  
“Difference between face-to-face  
& distance lectures”?

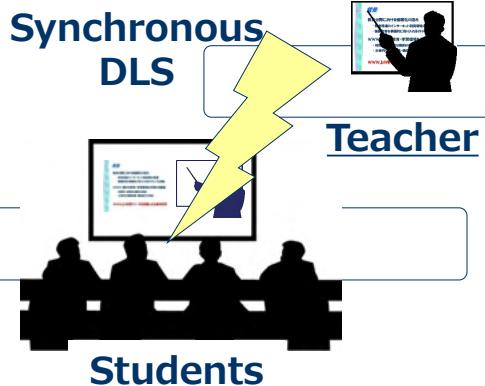
# What is Synchronous DLS?

## Classroom



## Face-to-face Lecture

- Interaction between teacher & students
- Time & geographical restrictions.

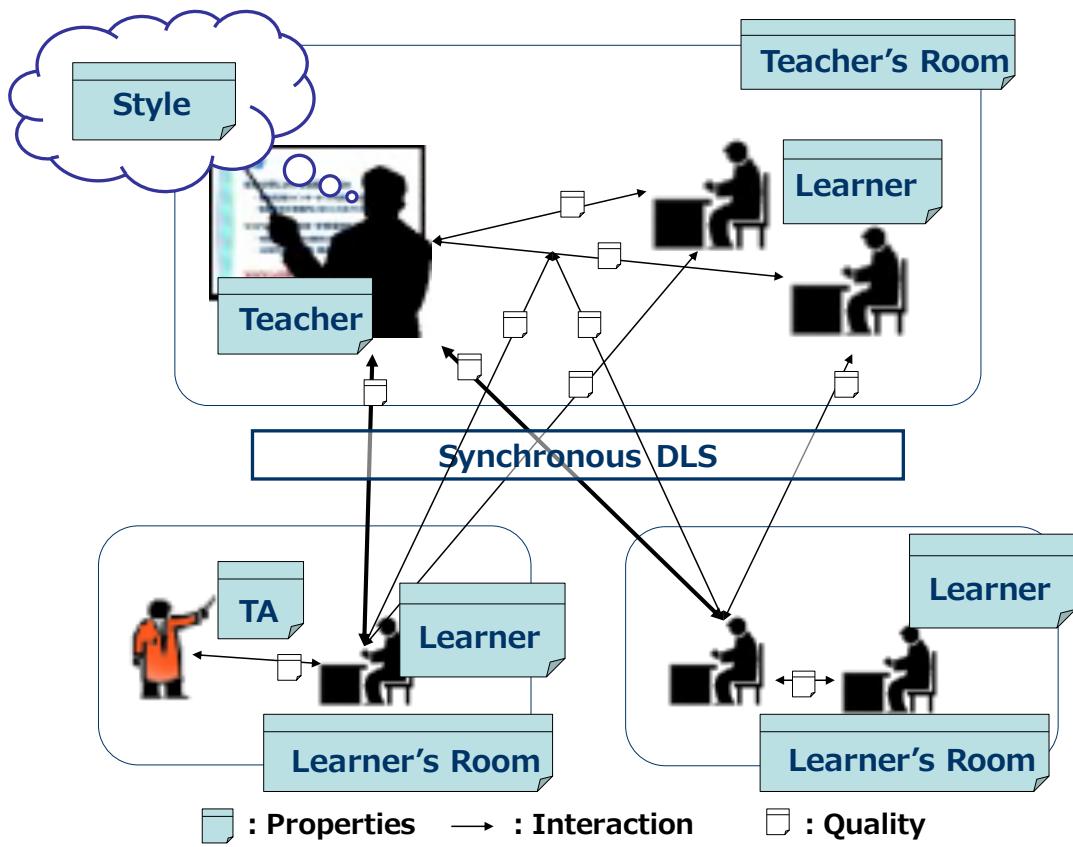


## Synchronous DLS

- Less Geographical restrictions
- Difficulties in interaction
  - by lecture style
  - by lecture media



# Model of SDLS



# Pattern for SDLS

## Participants (Who)

Items	Choices	
<b>Teacher's Room</b>	<ul style="list-style-type: none"> <li>- Teacher only</li> <li>- Teacher &amp; Learner</li> </ul>	
<b>Learner's Room</b>	<ul style="list-style-type: none"> <li>- Learner only</li> <li>- TA &amp; Learner</li> </ul>	<ul style="list-style-type: none"> <li>- Number of Rooms</li> </ul>
<b>Support Staffs</b>	<ul style="list-style-type: none"> <li>- T-Room only</li> <li>- L-Room only</li> <li>- All Rooms</li> <li>- None</li> </ul>	<ul style="list-style-type: none"> <li>- Local Support</li> <li>- Remote Support</li> </ul>



# Pattern for SDLS

## Environments (Where)

Items	Choices	
<b>Materials &amp; Tools</b>	<ul style="list-style-type: none"> <li>- Textbook, e-Textbook</li> <li>- Slide (PPT)</li> <li>- Blackboard, WBT</li> <li>- Notebook, TPC</li> <li>- Forum, SNS</li> </ul>	
<b>Network</b>	<ul style="list-style-type: none"> <li>- Campus Network</li> <li>- Internet</li> <li>- Bandwidth</li> </ul>	<ul style="list-style-type: none"> <li>- Domestic</li> <li>- International</li> </ul>



# Pattern for SDLS

## Actions (When/What)

Items	Choices	
<b>Style</b>	<ul style="list-style-type: none"> <li>- Lecture/Presentation</li> <li>- Practice/Experiment</li> <li>- Discussion/Q&amp;A</li> </ul>	
<b>Communication</b>	<ul style="list-style-type: none"> <li>- 1 to 1</li> <li>- 1 to Many</li> <li>- Many to Many</li> </ul>	<ul style="list-style-type: none"> <li>- Inter-Room</li> <li>↑</li> <li>- Exter-Room</li> </ul>



# Polycom HDX Series

## Video Conference System

- Exclusive solution for video conference
- Max HD(1080p) quality video
- High quality voice without echo & noise
- Dual stream (video & PC screen)
- Interoperability with standards
- Multi connection unit (option)



Camera



Microphone



Codec



# Polycom HDX Series

## Video Conference System

- Over 20 sets installed in JAIST:
  - Distance Learning Room & Studio
  - IS: Lecture Rooms & Collaboration Rooms
  - KS: Lecture Rooms & Collaboration Rooms
  - Tokyo Satellite: Rooms & Meeting Rooms



# Poly Studio X50

## Video Conference System

- Exclusive solution for video conference
- Max **UHD(3840 x 2160)** quality video
- High quality voice without echo & noise
- Dual stream (video & PC screen)
- Interoperability with standards
- Multi connection unit (option)



- IS: Collaboration Rooms

# H.323

**Standard for multimedia & real-time communication on IP network (ITU-T)**

- Including diverse protocols and codecs

For Audio  
G. 7xx

For Video  
H.26x

Etc.  
H.239

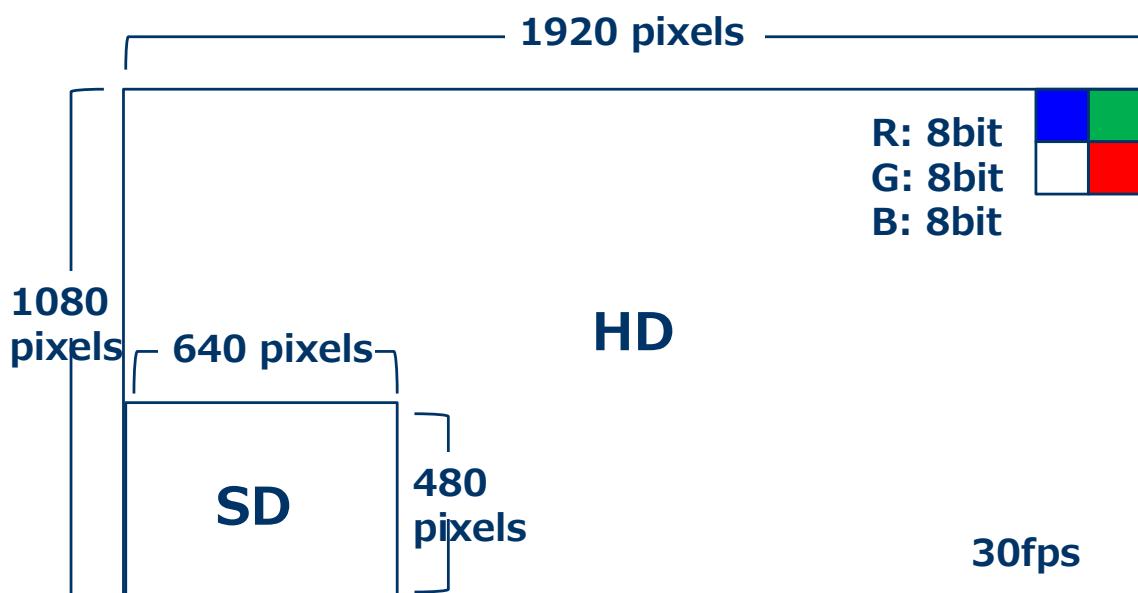
For Communication  
H.245, H.225, etc.

H. 323

- Interoperability
- For non guaranteed QoS



## How do we send image?



$$1920 \times 1080 \times 30 \times 24 \div 1.5 \text{ Gbps!}$$

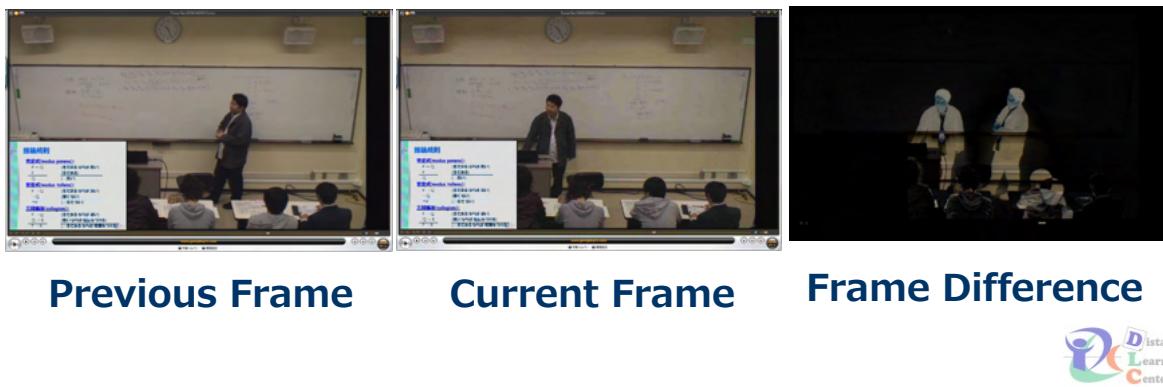
# Concept for Video Coding

## Video Compression

- Converting analog movie signal to compressed digital signal.

## Frame Difference Method

- Sending only frame difference information.



# Restrictions for VCS

## Quality is high but ...

- Difficulty in connectivity on NAT & over Firewall.
- Problem in actual interoperability
  - Polycom, Lifesize, Sony, Cisco, ...
  - How do we install all vendors VCS?
- Restrictions of MCU
  - Limitation of bandwidth & screen size
- Not file transfer function
  - Just sending image of PC screen
- Not sharing whiteboard
  - Other equipment is needed

# MeetingPlaza (~2019)

## Browser based Conference System

- Web browser plug-in
- SXGA video & FM quality voice
- Application sharing, file sharing, whiteboard
- Max 32 clients in a conference
- Auto quality control



Web Browser  
(Plug-in)

Web Camera



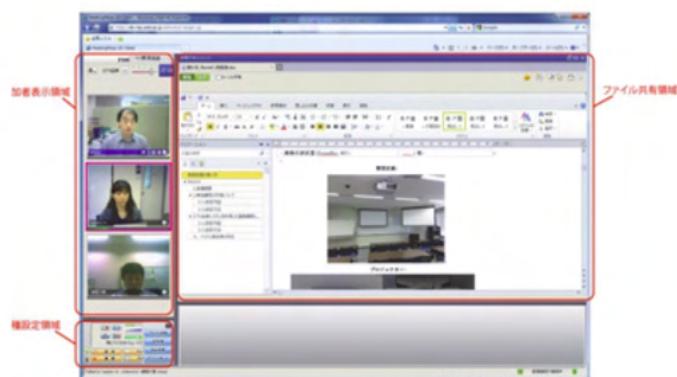
Laptop PC



# MeetingPlaza(~2019)

## Browser based Conference System

- Web browser plug-in
- SXGA video & FM quality voice
- Application sharing, file sharing, whiteboard
- Max 32 clients in a conference
- Auto quality control



# Webex Meeting

## PC based Conference System

- Application & Web browser plug-in
- 720p video & FM quality voice
- Application sharing, file sharing, whiteboard
- Max 1000 clients in a conference
- Auto quality control



Web Camera



Laptop PC

Application or Web Browser  
(Plug-in)

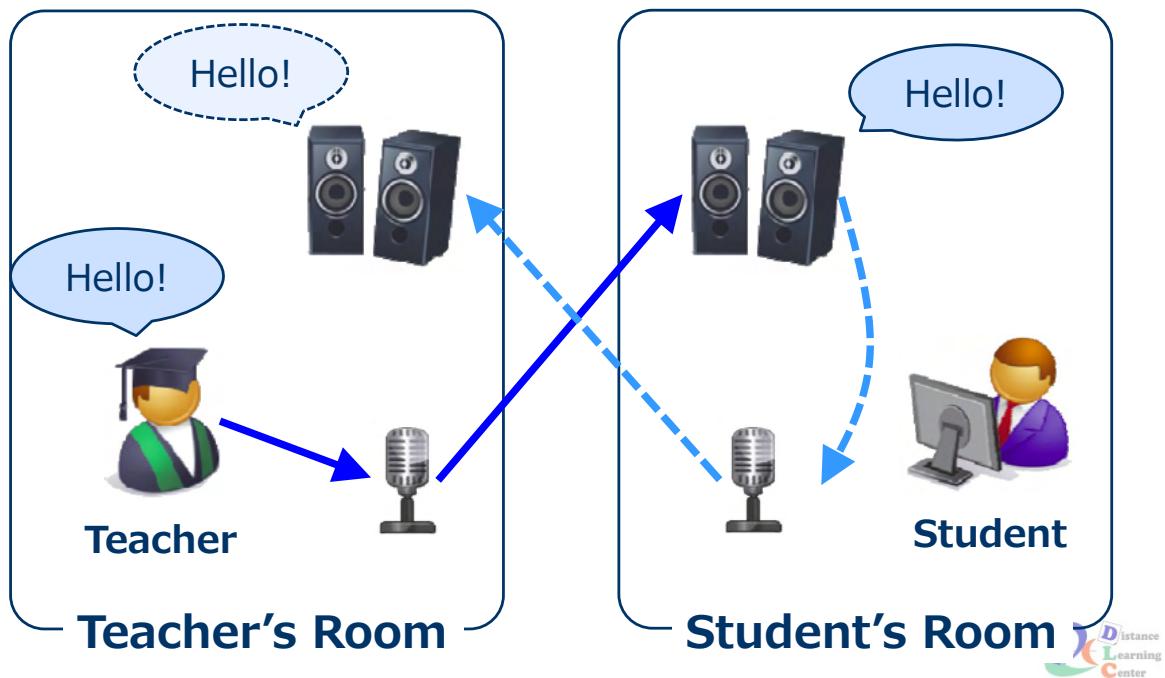
## Comparison

	HDX Series	MeetingPlaza
<b>Place</b>	Installed Room	Any PC with NW
<b>Scene</b>	Rooms Connection	Individuals Connection
<b>Connection</b>	1-3 (built-in MCU)	1-1000
<b>Media</b>	Video, Voice, & PC Screen	Video, Voice, Chat & Application Sharing
<b>Quality</b>	High	Low (NW depending)
<b>Bandwidth</b>	128K-6Mbps	32K-6Mbps
<b>Operation</b>	Remote Controller	Application /Web Browser
<b>Notes</b>	Immersive presence may depend on room layout.	Echo is often caused. Using headset is recommended



# What is Echo Problem?

Echo makes discussion difficult



## Example for Lecture



Backward in Teacher's Room



Front in Students' Room

- Teacher (with Whiteboard) ← Students
  - Readable whiteboards by HD quality
- Teacher ← Students (with Q&A Voice)
  - Volume depends on their seat positions
- Remote management by administrator
  - Sony < (Difficulty in support) < Polycom

# Example for Multi-point



Room for Meeting



Room for Presentation

- **7 points meeting by using exclusive MCU**
  - Sharing network bandwidth by combined video
- **4 points seminar by using built-in MCU**
  - If different equipment joins, all quality & functions are restricted
  - Room layout should be changed by pattern

# Example for Web Meeting



Laptop PC for Meeting



Meeting on Meeting Plaza

- **2 points meeting with Web page sharing**
  - If requested, user can control other PC screen remotely.
- **Voice quality is limited**
  - User should use headset so that they cannot face echo problem.

# Problems of SDLS (1)

- **Problems in network**
  - Packet loss & disconnection in distance lecture (especially international SDLS)
  - Access deny by FW & NAT
- **Immersive presence in conference**
  - Difficulty in interaction by delaying
  - Restriction by microphone
    - Difficulty in verbally communication
- **Connectivity in different equipment**
  - Connection with lower quality of image
  - Troubles in sending video or PC screen image
- **Problem in echo**
  - Hearing my voice through the other side system



# Problems of SDLS (2)

- **Distribution of analog information**
  - Pointing position of laser pointer
  - Difficulty in reading whiteboard
- **Image quality fall by lighting**
  - Difficulty in watching teacher's expression or slide contents
- **Physical restriction**
  - Less number of camera & mic.
  - Eye level is different
  - Participants cannot move freely



# Problems of SDLS (3)

- **How to fix in trouble occurred**
  - Additional system for remote support
  - Support rules among rooms (especially different institutions).
  - Administrators' relationships
- **How to facilitate learning in each room**
  - Confirming way of indication for intention.
- **Difficulty in use**
  - Someone is afraid to break SDLS  
→ Mostly resolved by restart & reconnect
  - It is important to provide such environment to be easy to use anytime

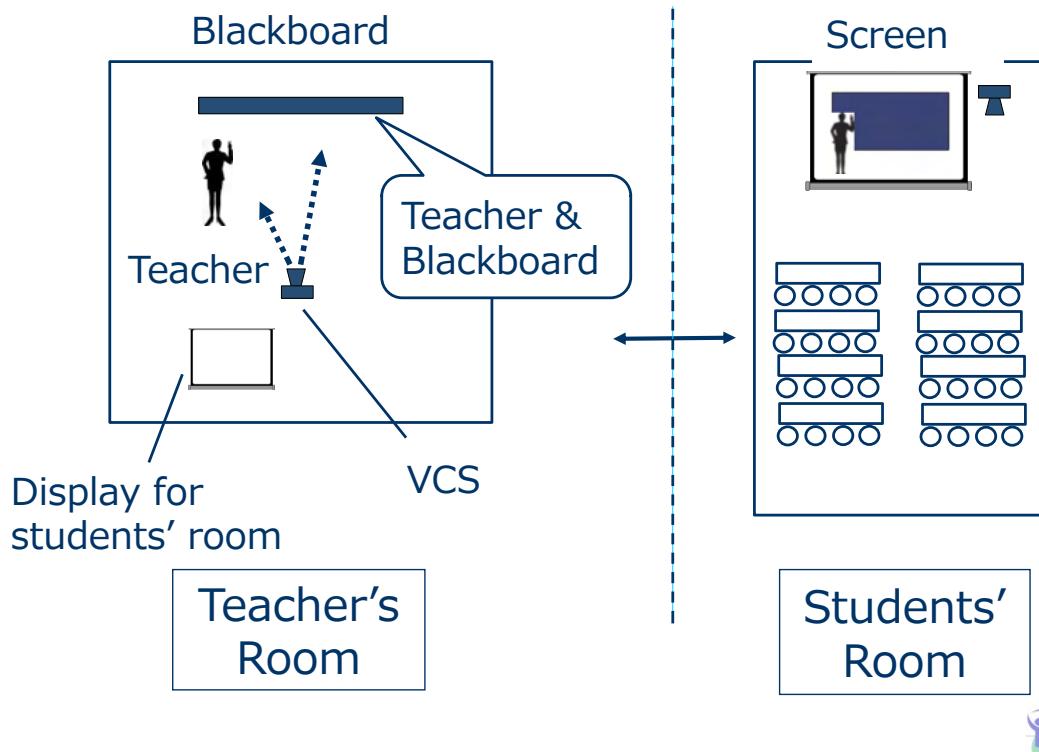


# System Layout

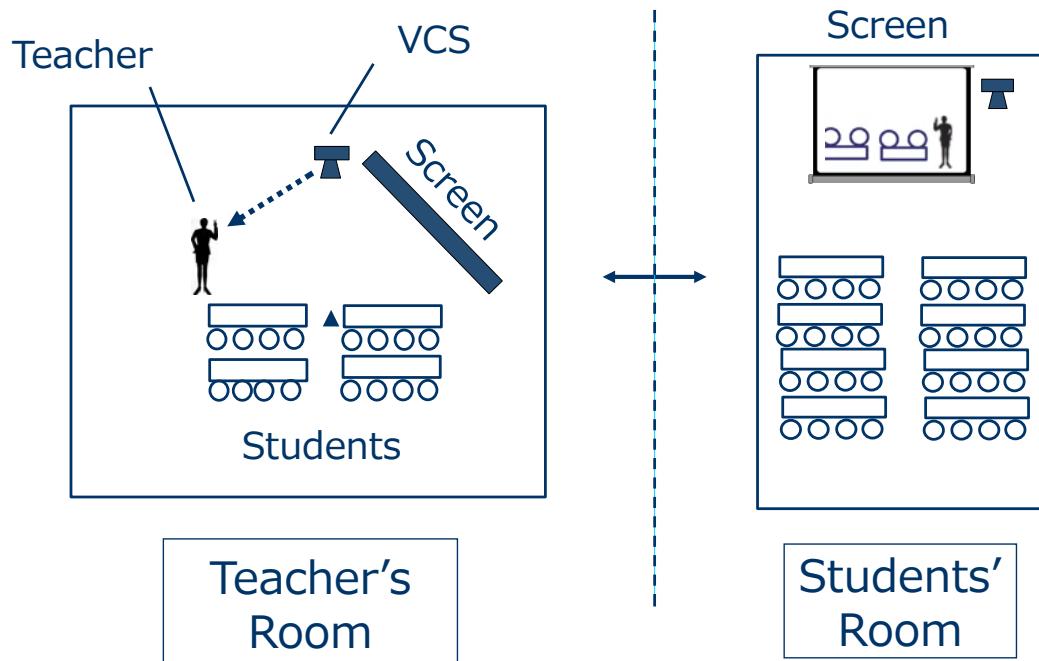
## Depending on Lecture Style

Items	Examples of well taken points
<b>Video</b>	<ul style="list-style-type: none"> <li>• Does the camera cover all students?</li> <li>• Can the camera zoom in all students?</li> <li>• Is lighting position suitable?</li> </ul>
<b>Display</b>	<ul style="list-style-type: none"> <li>• Can all students see the display?</li> <li>• Is the display position near enough?</li> <li>• Does the display show the teacher naturally?</li> </ul>
<b>Voice</b>	<ul style="list-style-type: none"> <li>• Can all students talk by the microphones?</li> <li>• Is the cable length of wired mic. enough?</li> </ul>
<b>Network</b>	<ul style="list-style-type: none"> <li>• How are the rooms connected?</li> <li>• Is the bandwidth among the rooms enough?</li> </ul>

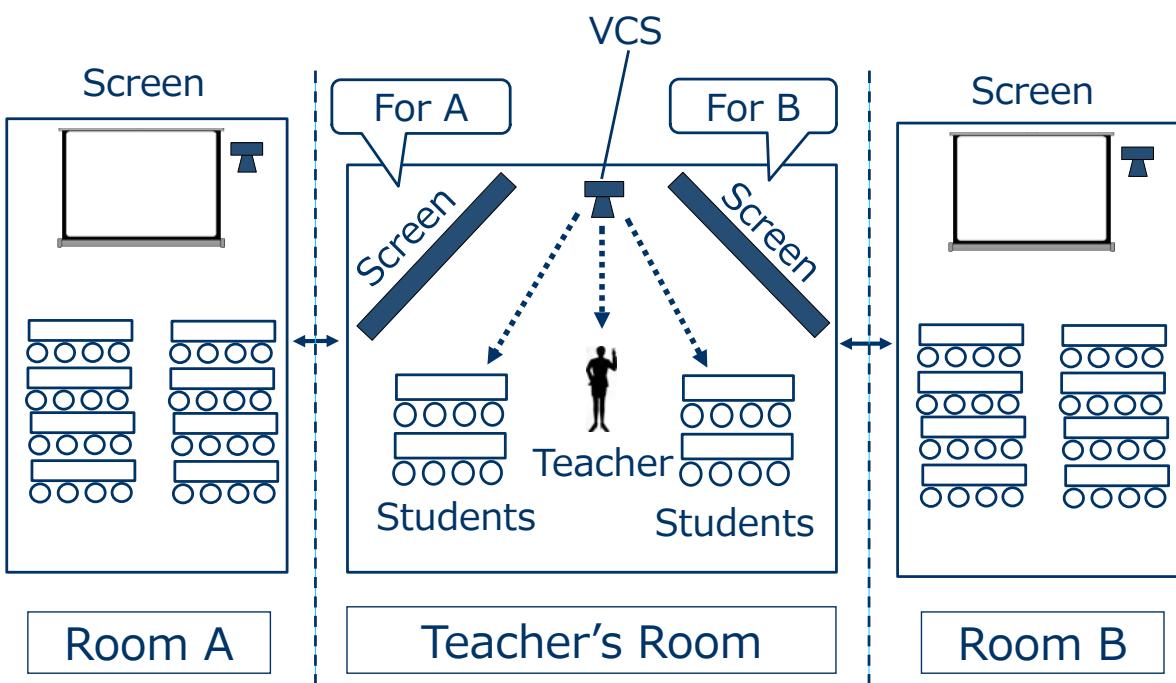
# Layout like Usual Lecture



# Layout for Discussion



# Layout for Multi-point



# Design Pattern Approach

## Design Pattern in Architecture (C. Alexander)

- Approach for systematic usage of previous cases as patterns in design of building & city streets.

## Design Pattern in Software (H. Gamma)

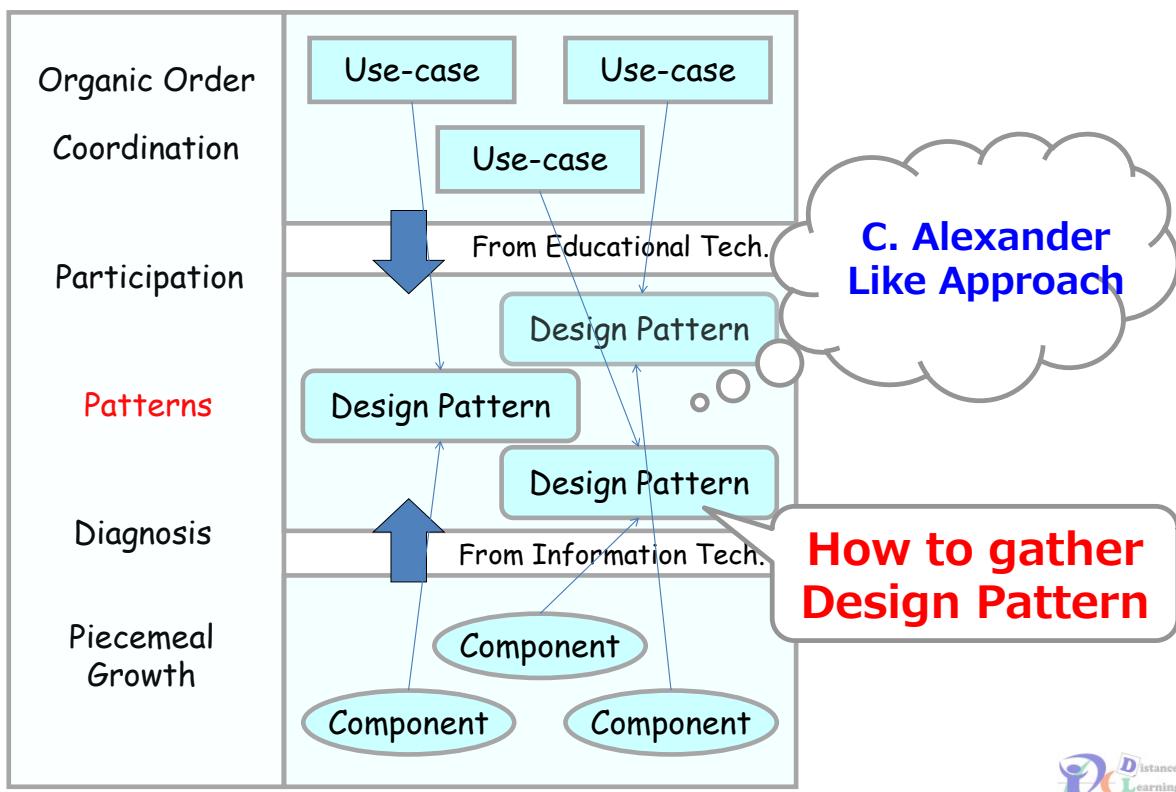
- Methodology for aggregation of know-how in software design as reusable patterns.

## Design Pattern in DLS

- Methodology for aggregation of know-how in DLS as reusable patterns.
  - Framework for organization of previous cases.
  - Evolving Approach



# Concept of Design pattern



## Elements of Distance Com.

### 1. Target

Teacher, Students,  
Contents, Atmosphere, etc.

### 2. Direction

Teacher→Students,  
Contents→Students, etc.

### 3. Contents

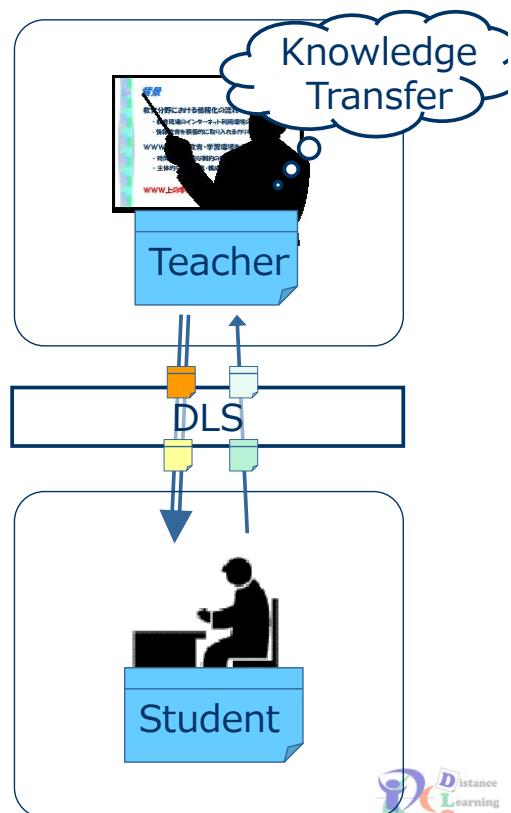
Lecture, Q&A,  
Discussion, etc.

### 4. Frequency

Quantity of Communication

### 5. Quality

Video quality, Camera Angle,  
Voice quality, Ease of talking



# Communication Constraint

## 1. Target

- Purpose of Com.
- Number of Students

## 2. Direction

- Purpose of Com.

## 3. Contents

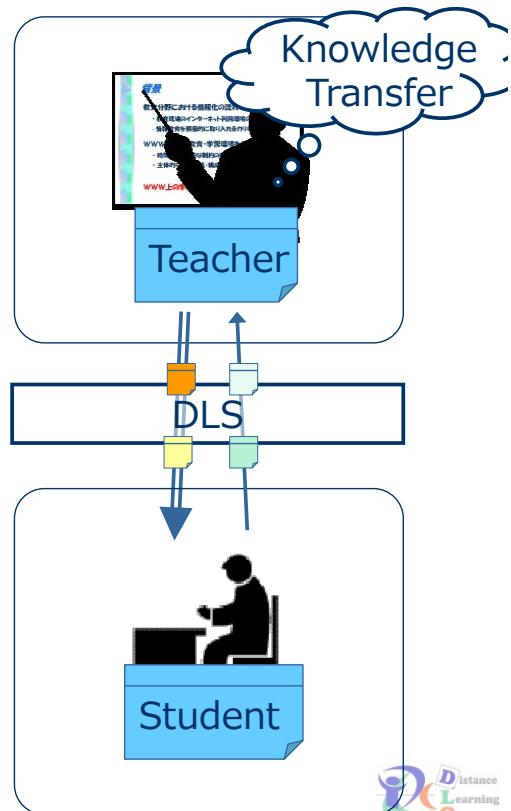
- Purpose of Com.
- Types of Media

## 4. Frequency

- Purpose of Com.
- Number of Students

## 5. Quality

- DLS
- Network Bandwidth
- Lecture Style



# デザインパターンの例

ユースケース	目的	講義・講演会(知識伝達)		
	方向	[講師] ⇒ (講義内容) ⇒ [受講者]		
	メディア	ホワイトボード／黒板		
	その他	接続拠点 1:1	受講者数 n	TA数 0
コンポーネント 映像入力	<u>SDカメラ映像による配信</u> 長所：従来のシステムで配信可能／講師負担なし 短所：全体表示には解像度が不足／カメラ操作必要			
	<u>HDカメラ映像による配信</u> 長所：全体表示(2m程度)にも対応可能／講師負担なし 短所：HD配信可能なシステムが必要			
	<u>電子黒板化ユニットによる配信</u> 長所：講師負担が少ない 短所：読み取り精度が悪い／消去時の処理などが独特			
	<u>電子黒板による配信</u> 長所：資料への書き込み／双方向書き込みが可能 短所：サイズが小さい／使い方を把握する必要がある			
		<u>PC会議システムによる配信</u> 長所：資料への書き込み／双方向書き込みが可能 短所：Tabletが必要，受講側にPCが必要		

# How Immersive Presence?

**Do you have any idea to support  
“immersive presence”  
in synchronous DLS?**



## Future SDLS

### Production by Virtual Reality

- Immersion by wide viewing angle
  - Head-mounted display or VR screen
  - Immersive VR: Projection to the whole wall
  - [http://www.youtube.com/watch?v=dW27i2oi\\_i0](http://www.youtube.com/watch?v=dW27i2oi_i0)  
(UCHIDA YOKO Co. LTD.)
  - <https://www.youtube.com/watch?v=-SubxgRBESw>  
(NTT R&D Forum 2015)

### 4K Video Conference

- Super high quality video & large display
  - New codec: H.265
  - <https://www.youtube.com/watch?v=7b8lman1WyQ>  
(First 4K Teleconference from Barco and Vidyo)



# Distance Learning System (遠隔教育システム工学)

## 6. Asynchronous Distance Learning System

Koichi Ota  
ota@jaist.ac.jp



## Agenda

- What is Asynchronous DLS?
- Framework of ADLS
  - LMS
  - SCORM
- Lecture Archiving System
  - Comparison among systems
  - Results of questionnaire
- Use cases in JAIST
- Copyright



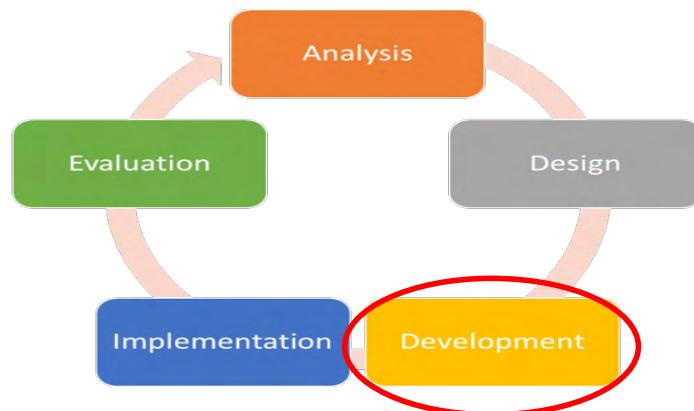
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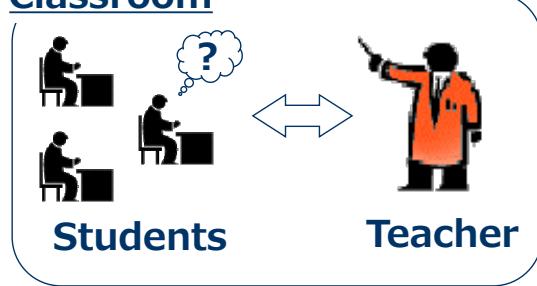


Merrill, M. D., Drake, L., Lacy, M. J., Pratt, J., & ID2\_Research\_Group. (1996). Reclaiming instructional design. Educational Technology, 36(5), 5-7.

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# What is Asynchronous DLS?

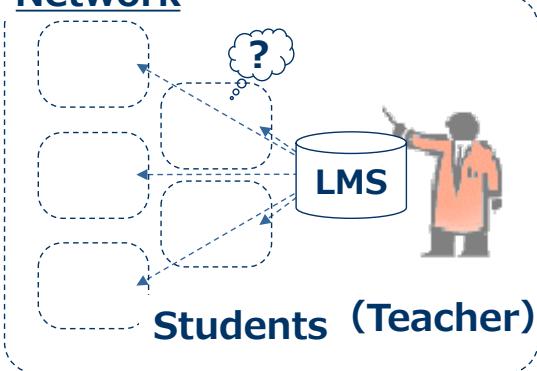
## Classroom



## Face-to-face Lecture

- Interaction between teacher & students.
- Geographical & time restrictions.

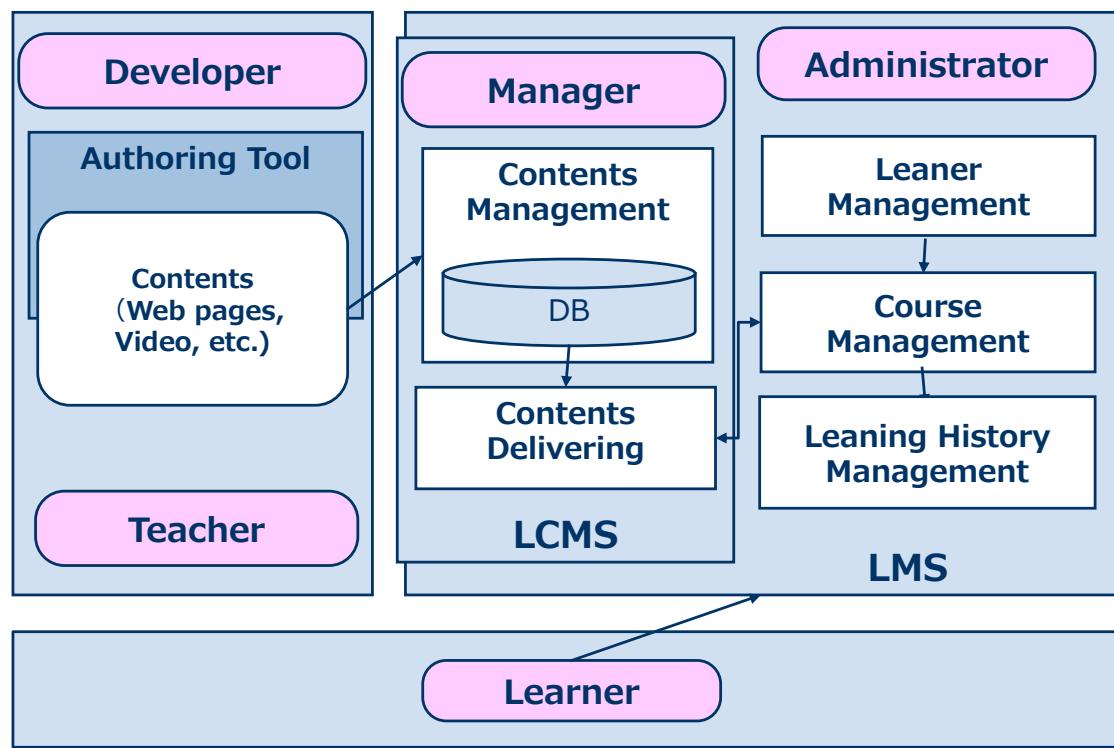
## Network



## Asynchronous DLS

- Less geographical & time restrictions.
- Difficulties in following students
  - One-direction, massive online

# Framework of ADLS



## LMS

### Learning Management System

- **Learner Management**
  - Profile information, Competency information
  - LIP (Learner Information Package)
  - PAPI (Private And Public Information)
- **Course Management**
  - To provide contents according to learning aim.
  - LOM (Learning Object Metadata)
  - SCORM (Sharable Contents Object Reference Model)
- **Learning History Management**
  - To provide learner tracking function
  - For leaner: progress management, assessment
  - For teacher: status of utilization, system failure

# What is SCORM?

## De facto Standard for LMS By ADL

- How contents may be packaged
- Communication between LMS and content
- Simple sequencing (in SCORM 2004)
- Reusability, Accessibility, Durability, Interoperability
- Promotion initiatives in Japan
  - Ministry of Economy, Trade and Industry
  - e-Learning Consortium Japan (so-so)
    - <http://www.elc.or.jp/>
  - Advanced Learning Infrastructure Consociation (close)

ADL: Advanced Distributed Learning (<http://www.adlnet.org>)



# Before SCORM

## Too many standard association

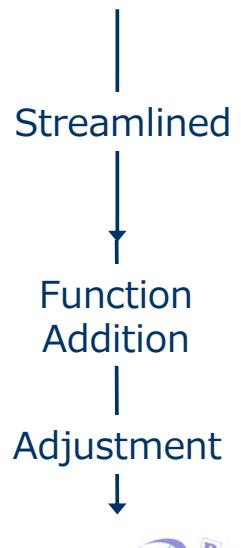
- AICC
  - The Aviation Industry CBT Committee
  - <http://www.aicc.org/>
- ARIADNE
  - Alliance of Remote Instructional Authoring & Distribution Networks for Europe
  - <http://www.ariadne-eu.org/>
- IEEE LTSC
  - Institute of Electric and Electronics Engineers, Learning Technology Standards Committee
  - <http://ltsc.ieee.org/>
- IMS
  - IMS Global Learning Consortium
  - <http://www.imsproject.org/>



# SCORM's History

- Picking points up from conventional standards

- 2000.1 SCORM ver.1.0 Release
- 2001.1 SCORM ver.1.1 Release
  - Design for assembly
- 2001.10 SCORM ver.1.2 Release
  - Contents packaging
- 2004.1 SCORM2004 Release
  - Simple sequencing
- Now SCORM2004 4th Ed.
  - Minor version up



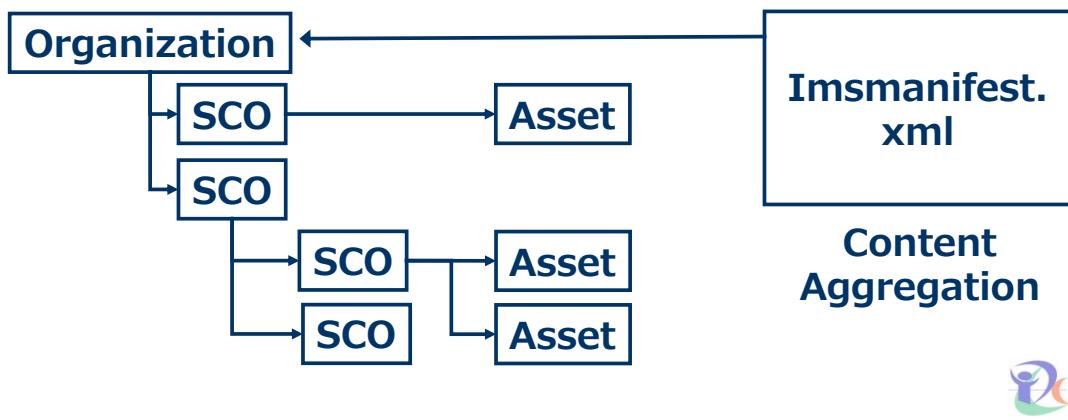
# SCORM Specification

- Overview
- Content Aggregation Model (CAM)
  - Meta-data: Contents overview
  - imsmanifest.xml: Contents structure
- Run-Time Environment (RTE)
  - DataModel: Data type for management
  - API: Interface between LMS & contents
- Sequencing and Navigation (SN)
  - Contents Ordering
  - Navigation
- Addendum
- SCORM\_12\_To\_2004\_Changes

# Content Aggregation Model

## Process of creating e-learning contents

- **Asset:** Electronic files of media
  - text, images, sound, web pages, etc.
- **SCO:** Collection of assets to connect with LMS
- **Organization:** Learning unit structured SCOs



## SCO Metadata

```

E:\KAMIO_LMS\LMSSdev\course\MySCO\DesignPattern\Singleton.xml - Microsoft Internet Explorer
ファイル(F) 編集(E) 表示(V) 気に入り(A) ツール(T) ヘルプ(H)
アドレス(D) E:\KAMIO_LMS\LMSSdev\course\MySCO\DesignPattern\Singleton.xml 移動 リンク Web アシスタント 地図 ヘルプ
<?xml version="1.0" encoding="Shift_JIS" ?>
- <lom>
  - <general>
    - <title>
      <langstring>Singleton</langstring>
    </title>
    - <description>
      <langstring xml:lang="jp">インスタンスが一個しか存在しないことを保証するパターン</langstring>
    </description>
    - <keyword>
      <langstring xml:lang="jp">インスタンスの生成</langstring>
    </keyword>
    - <keyword>
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    - <keyword>
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    </keyword>
  </general>
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  </metametadata>
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  - <educational>
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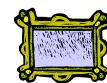
```

SCORM1.2 SCO Metadata (2004 Kamijo)



# Object-oriented Approach

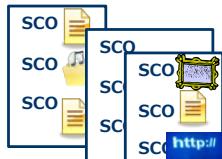
Learning Object



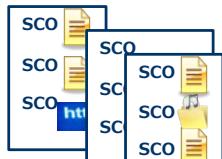
Integration by SCORM

Learning Contents

Course 1

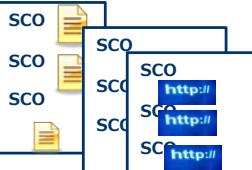


Course 2



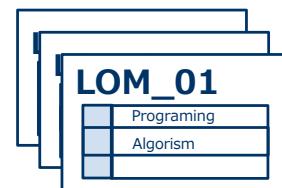
Course XX

...



Characterizing by LOM

Learning Course

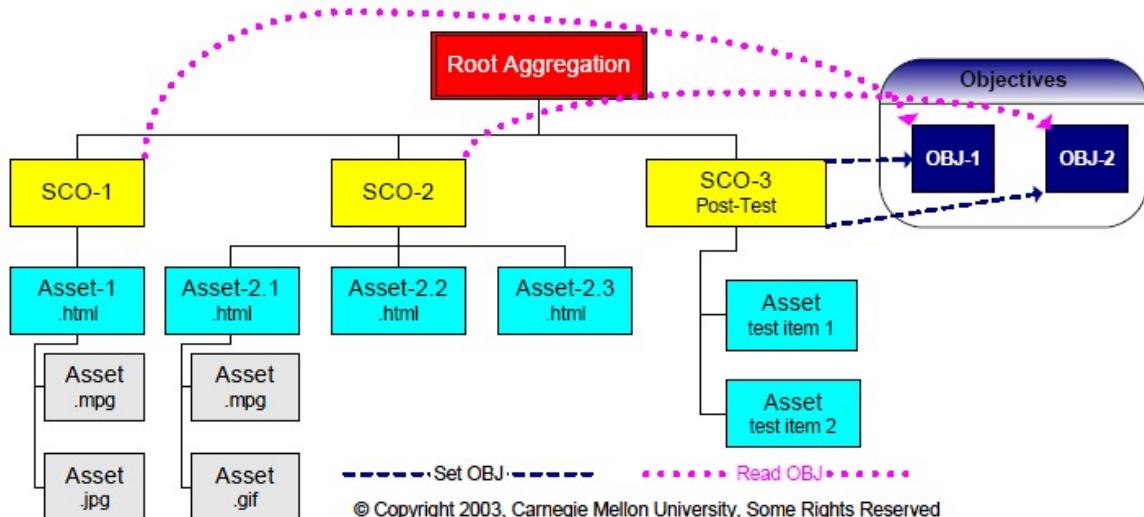


e-Learning  
Materials



## Simple Sequencing

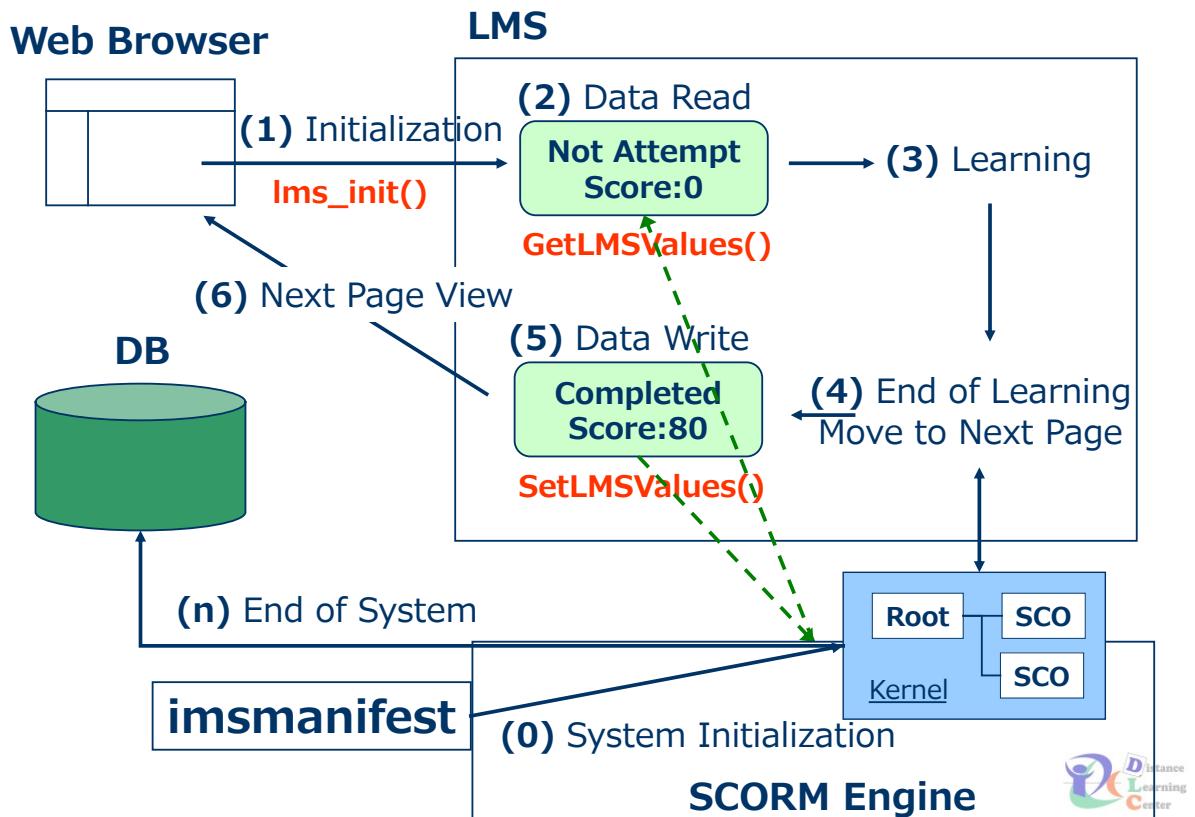
TEMPLATE 5: Remediating Using Objectives



from SCORM Best Practices Guide for Content Developers



# LMS with SCORM



# Lecture Archiving System

## Definition in JAIST

- To record, manage & deliver education scenes in JAIST
- Preparation & review asynchronously
  - Supplemental for face-to-face lecture

## Features of LAS

- Slide segmentation
- Video forum by students
- Auto recording
- Remote management



# 1st Lecture Archiving



1st Version of VOD



Recording Kit

## 1st Lecture Archiving in IS (2005)

- Preparation by student's part-time job
  - Sometime he missed or mistook recording.
- Single WMV streaming distribution



## Material for Part-timer

11/12/13・4講義収録手順書（写真なし）

[トップページに戻る](#)

・機器の準備

※1限目や前の講義がない場合に機器の準備を行います  
※2限目で前の講義がある場合はその担当者と協力して準備します

・機器の準備

※1限目や前の講義がない場合に機器の準備が必要です  
○収録セットの受け取り  
(1) 2F大講義室構の会場で各講義室用のセット受け取り  
※ C Planの場合は12と大講義室の2セットを受け取ること  
(2) 収録セットに過不足がないか確認  
※ 錄はAM9:00, AM10:50に遅延または学生課のスタッフが受けます  
※ セット詳細



<11/12セット>



<13・4セット>

・三脚の設置

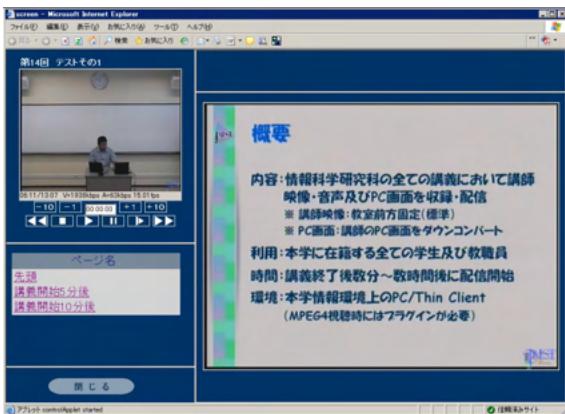
(1) 脚を伸ばし適切な場所に設置  
⇒ カメラが水平でない場合は…



- A student was assigned to each lecture.



# 2nd Lecture Archiving



2nd Version of WBT



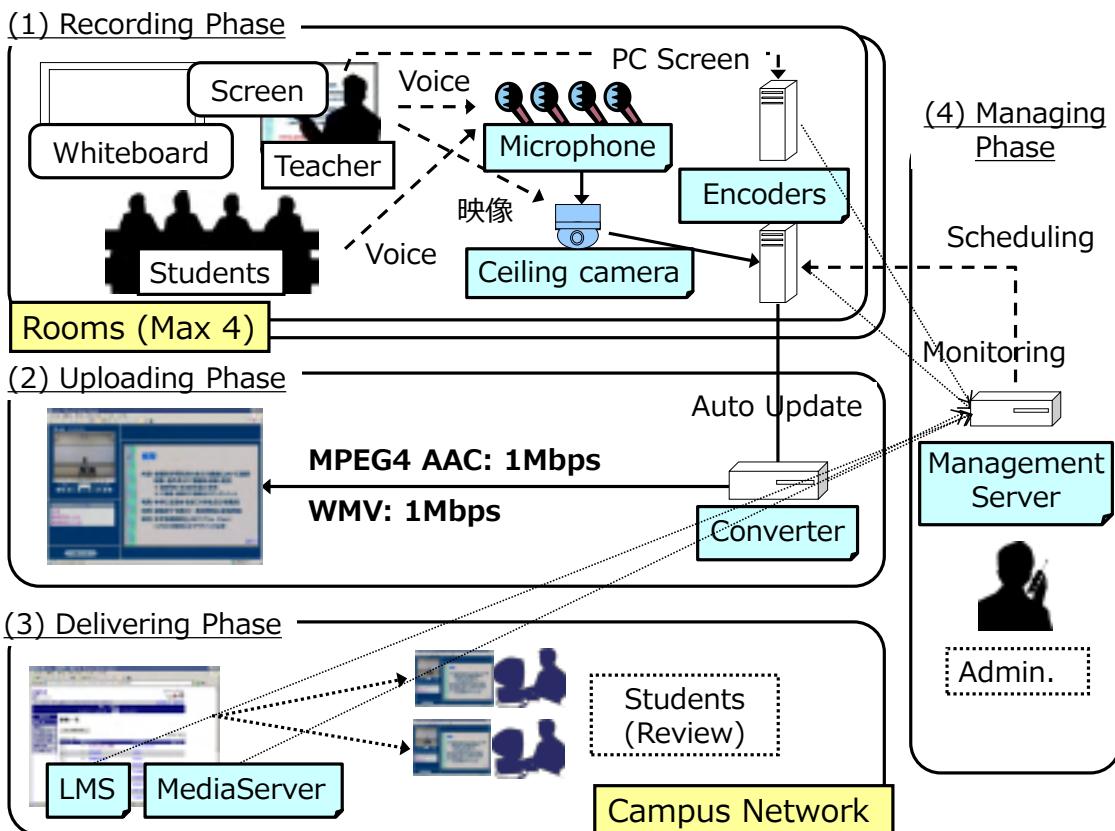
Room Recording System

## 2nd Lecture Archiving in IS (2006-2009)

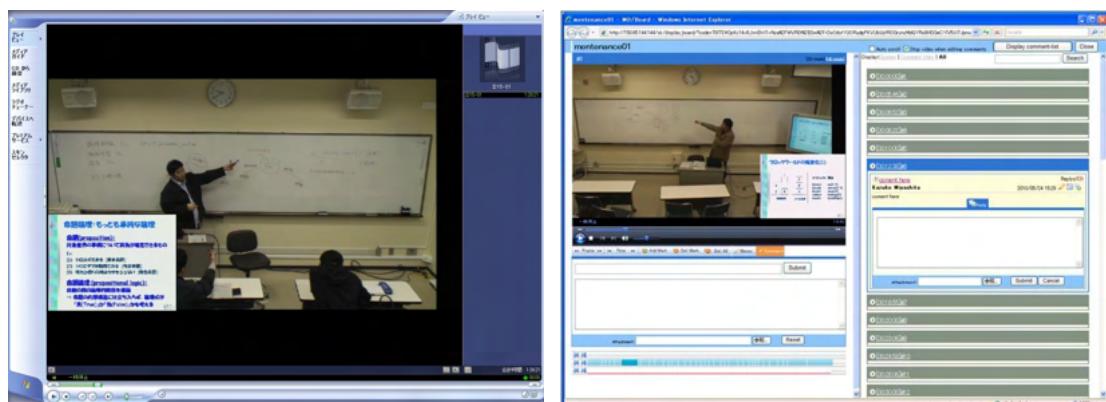
- Celling-mounted SD camera & PC screen
- Automatically recording in 4 rooms
- Dual MP4/WMV streaming



# 2nd System Outline



# 3rd Lecture Archiving



3rd Version HD Archive

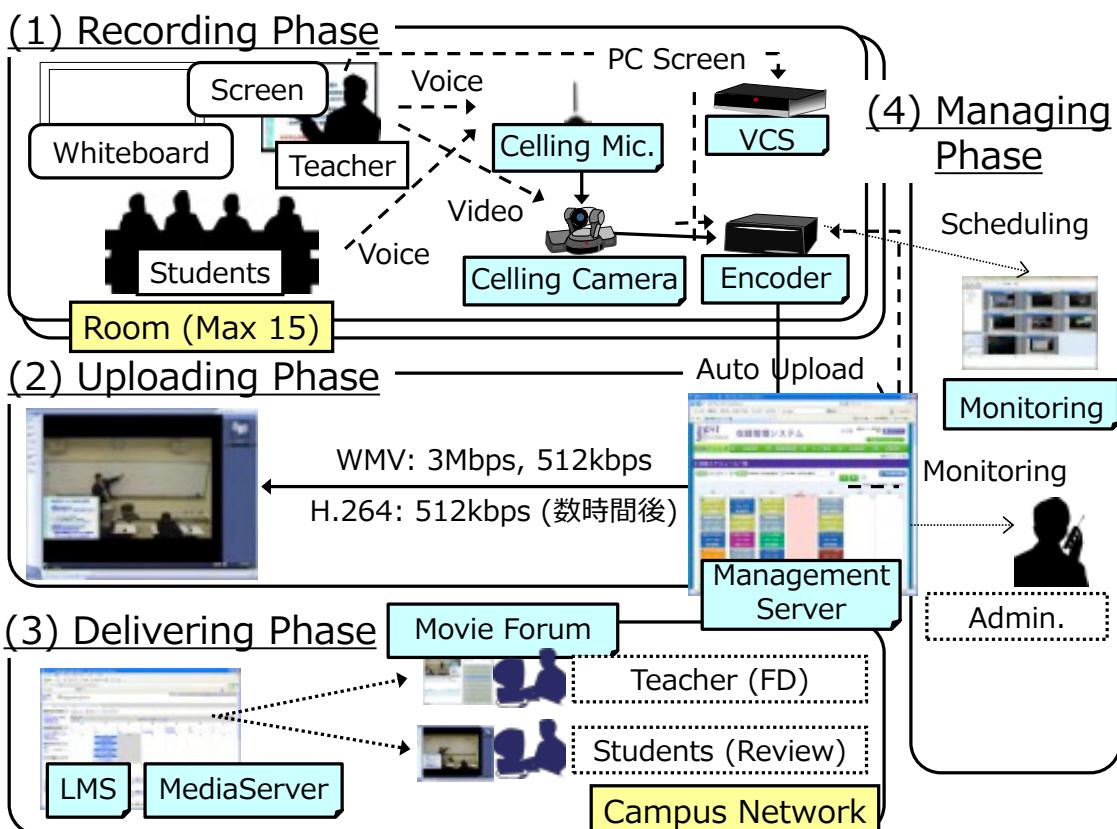
Video Forum

## 3rd Lecture Archiving in IS (2010-)

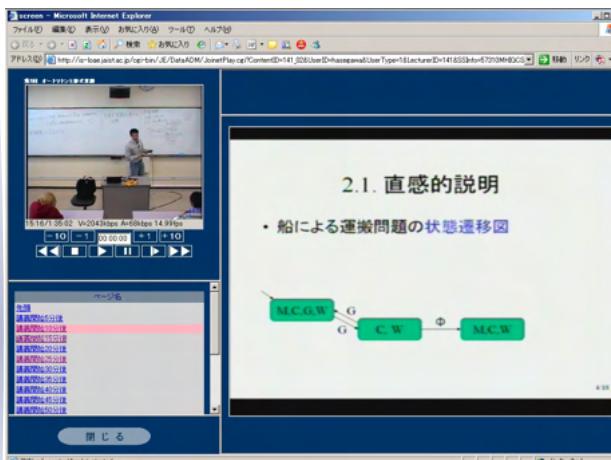
- Ceiling-mounted HD camera & Video Forum
- Automatically recording in 15 rooms
- Single WMV streaming imposing PC screen



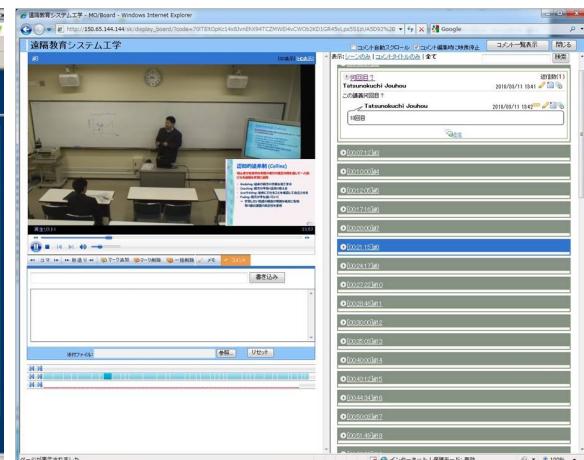
## 3rd System Outline



# System Improvement



2006 System



2010 System

Recording: 2SD (Lecturer & PC Screen) -> 1 HD within PC Screen  
 Authoring: Indexes every 5min. -> Indexes by Slides  
 Distribution: Video Synchronizes -> Video BBS  
 Administration: Automatic Archiving -> System Monitoring



## Video Forum

Lecture Archive

Comment Form

Slide Segmentation

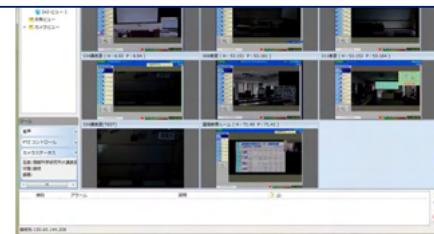
# Administrative Functions



- Setting for recoding schedule
- Confirming encoder status
- Monitoring whole system

## Centralized Monitoring

- Monitoring for difference types of encoder
- Monitoring image & sound



- Controlling room camera from web browser (I1xx)
- Remote restart / update

## Remote Management

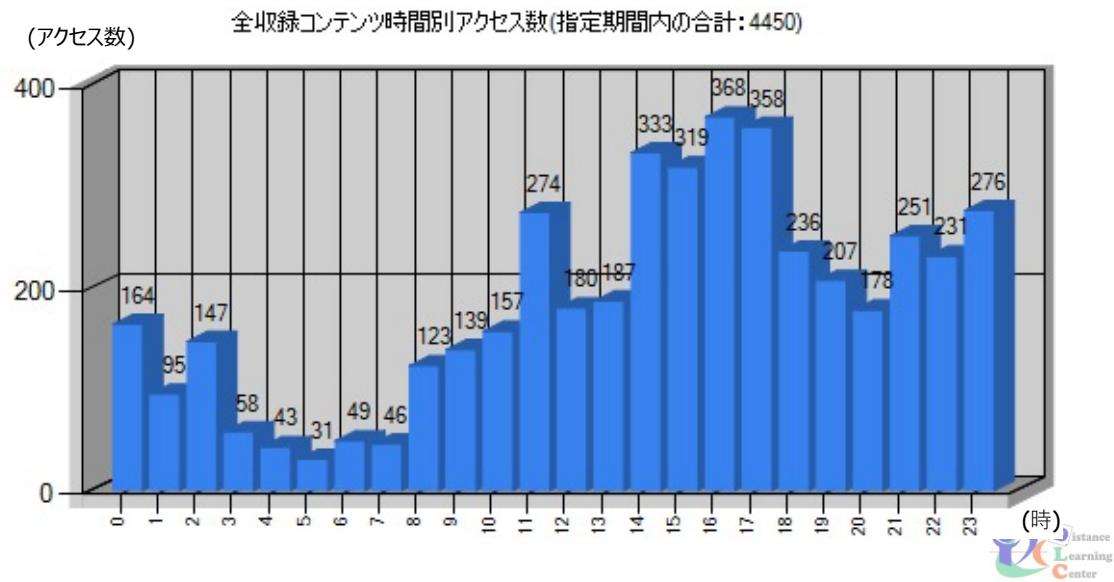


# Comparison among systems

	1st (2005)	2nd (2006)	3rd (2010)
Video	1 Camera	Celling SD camera + PC screen	Celling HD camera + PC screen
Mic.	1 Wireless mic.	4 Wireless mic.	Celling Mic.
Record	Preparation (Part-timer) Encoding (Administrator)	Auto Recording & Encoding	Auto Recording & Encoding
Deliver	1~2 days after WMV(750kbps)	10 min. after MPEG4 or WMV (1Mbps)	A few min. after WMV (3M, 512kbps)
Image			

# Access Pattern in 2010

- **390 lectures of 26 courses (from Apr.2010 to Jun.2010)**
- **Average of access: 76.7 times per day**
- **Two peak of access: evening and midnight**

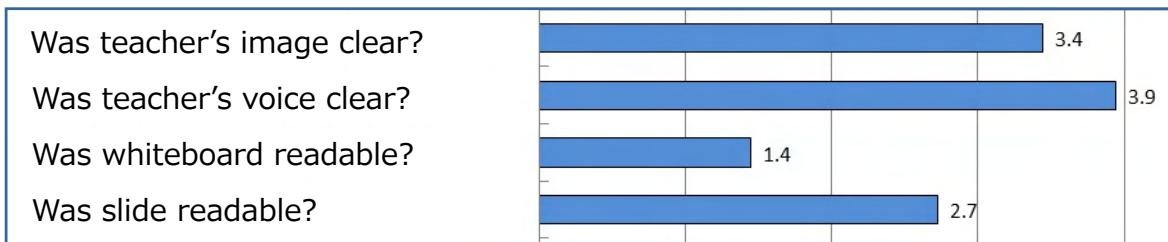


# Results of Questionnaire

N=18 (2010)

## Q. Quality for Lecture Archive (Average)

[1: Strongly Disagree ⇔ 5: Strong Agree]



- **Although video image & audio is clear, it was difficult to confirm whiteboard & slide contents after lecture because of fixed camera angle.**

# Results of Questionnaire

N=18 (2010)

## Q. Usage of Lecture Archive (Average)

[1: Strongly Disagree ⇔ 5: Strong Agree]



- Students seemed to support on demand learning environment.**



# Results of Questionnaire

N=18 (2010)

## Q. Open Answers

### For Recording :

- It would be well if teacher makes pointing to screen by using mouse pointer.**

### For Delivering :

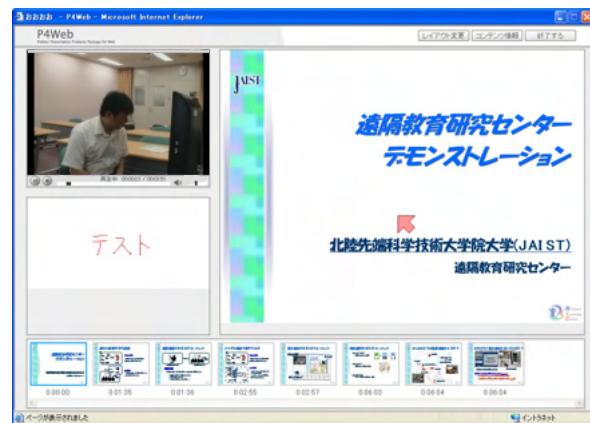
- Sometime video is stopped in playing.**
- It is difficult to hear teacher's voice if it was on and off.**
- It is better if it can be played in 2x speed.**



# WBT Authoring System



DLC Studio



P4Web

## Mediasite (2011-)

- SL Contents with Video, Slide, Etc.
- High Quality Recoding by Studio Facilities



# Copyright for Contents

## Typical Examples by NIME

1. Work-for-hire: Organization has copyright
2. Faculty has copyright and transfers it to organization
3. Faculty has copyright and organization get permission for use

## Discussions

- If faculties develop contents as a part of university's educational activity, does its copyright belong to the university?
- If the contents is based on faculties original teaching method, does its copyright belong to the faculties?
  - In this case, how to deal with developing cost by university?

# When Using Existing Work

Except for the following conditions, it is necessary to obtain a license from the authors of the existing work.

## 1. Not a copyrighted work

- Sentences: Simple factual explanation, extremely common expression etc.
- Charts: Simple graph and table of data etc.
- Photos, Videos, Audios: Copyrighted work
- Others: National laws, government survey statistics etc.

## 2. Expired copyrighted work

- 70 years after the author's death (with exceptions)

## 3. Copyright holder has consented to use in advance

- Creative Commons, license free contents (check license condition), licensed contents etc.

## 4. Quotation

If a person appears in a photo or video, obtain permission from the person and be careful not to infringe on portrait rights.



# Quotations

Article 32 "(1) It shall be permissible to quote from and thereby exploit a work already made public, provided that such quotation is compatible with fair practice and to the extent justified by the purpose of the quotation, such as news reporting, critique or research."

「公表された著作物は、引用して利用することができる。この場合において、その引用は、公正な慣行に合致するものであり、かつ、報道、批評、研究その他の引用の目的上正当な範囲内で行なわれるものでなければならない。(著作権法32条)」

1. The quoted documents have already published.
2. The main part can be distinguished from the quoted part.
3. The quoted part is smaller than the main part.
4. The quotation is inevitable.
5. The quoted part is not modified from the original work.
6. The quotation source is specified.



# Creative Commons License

## How others may use your work



Attribution, BY



Noncommercial, NC



No Derivative Works,  
ND



Share Alike, SA



[https://www.youtube.com/watch?v=q0VzUigrb\\_g](https://www.youtube.com/watch?v=q0VzUigrb_g)



# Future of ADLS

## Ubiquitous Learning

- **Integration among diverse environments**
  - Contents development methodology
  - Quality assurance & assessment

## e-Portfolio

- **Collection of electronic evidence assembled and managed by learner**
  - Demonstrations of the learner's abilities
  - Platforms for self-expression

## Security & Copyright Protection

- Privacy information protection
- Creative Commons



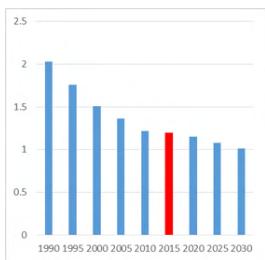
# Distance Learning System (遠隔教育システム工学)

*Advanced Topic*

Koichi Ota  
ota@jaist.ac.jp

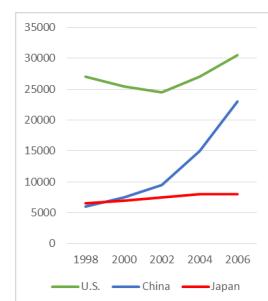
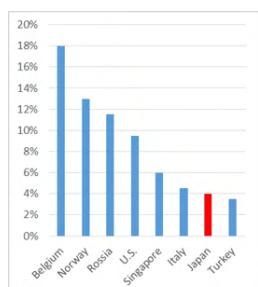


## Current Situation for Graduate Education in Japan



- The population of age 18 in Japan is decreased year by year.

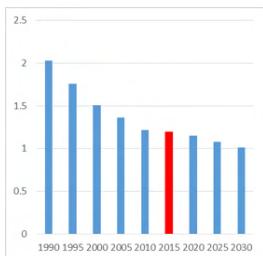
- The number of Ph.D. in Science/Technology fields seems to reach limit in these years.



- The number of Ph.D. researchers in laboratory of company is low.

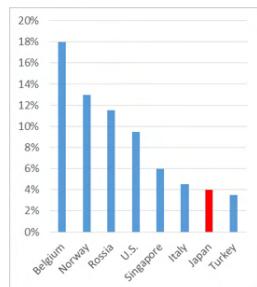
*Central Council for Education, MEXT (1. 2011)*

# Keywords in Graduate Education for Japan



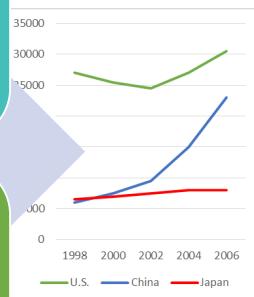
Globalization

Innovation



Systematic Education

Visualization of Education



*Central Council for Education, MEXT (1. 2011)*

## 21st Century Skills

### Definitions

- Learning Cognitive Skills to Collaborate with Others and to Connect through Technology
- Ways of Thinking
  - Creativity, Innovation, **Critical Thinking**, Problem Solving, Decision Making, & Learning to Learn
- Ways of Working
  - Communication & **Collaboration** (Teamwork)
- Tools for Working
  - Information Literacy & **ICT Literacy**
- Living in the World
  - Citizenship, **Personal & Social Responsibility**

*ATC21s: Draft White Papers (2010), The Assessment and Teaching of 21st Century Skills Project*

# Issues Addressed

Education	Learner	Acquisition	Assessment
Traditional		Knowledge	Testing
Leaner-centered		Skills	?

How should we deal with  
**“Quality Assurance of Skills”**  
in New Education Era with ICT?

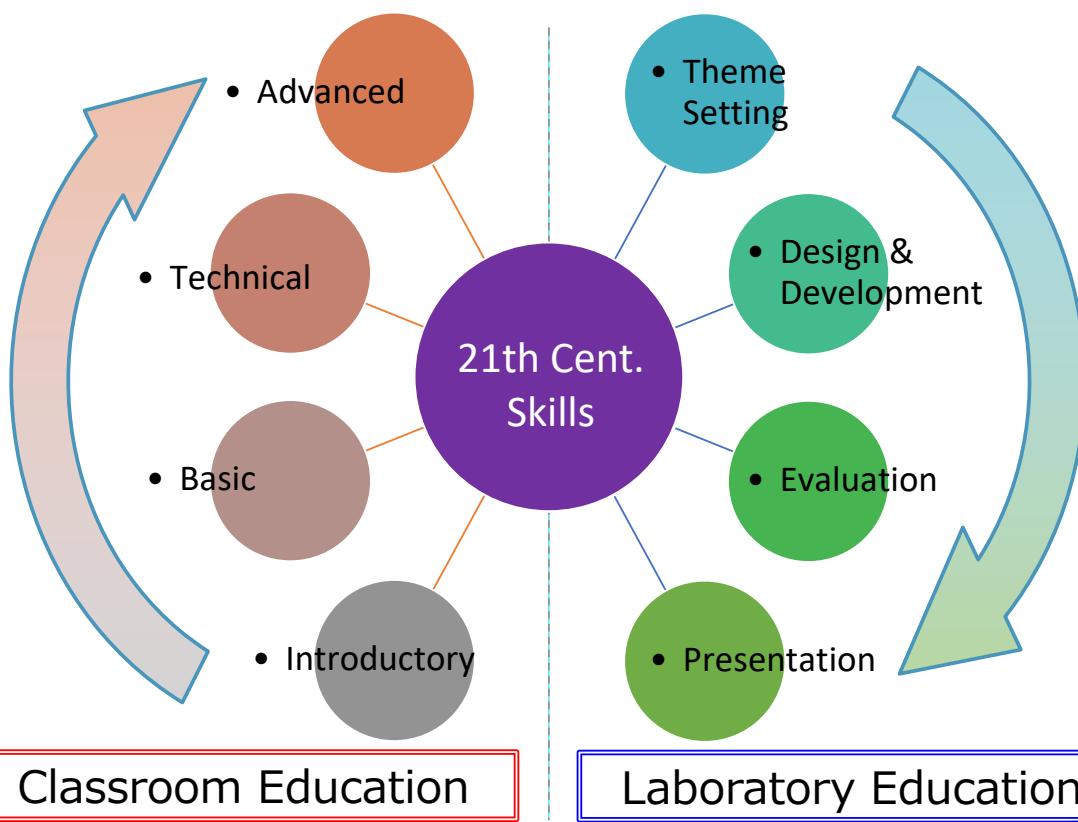


# Issues Addressed

## Difficulties in Unified Criteria

- **Social demands**
  - General valuation does not reflect on education
  - Objective evidence by big data with ICT
- **Different goals among students**
  - Background, process, level
  - Not only education but also research
- **Comparative vs Absolute**
  - Comparative: Easy but not objective
  - Absolute: Objective but difficult

# Skill Development Model



## Quality Assurance in Graduate Education

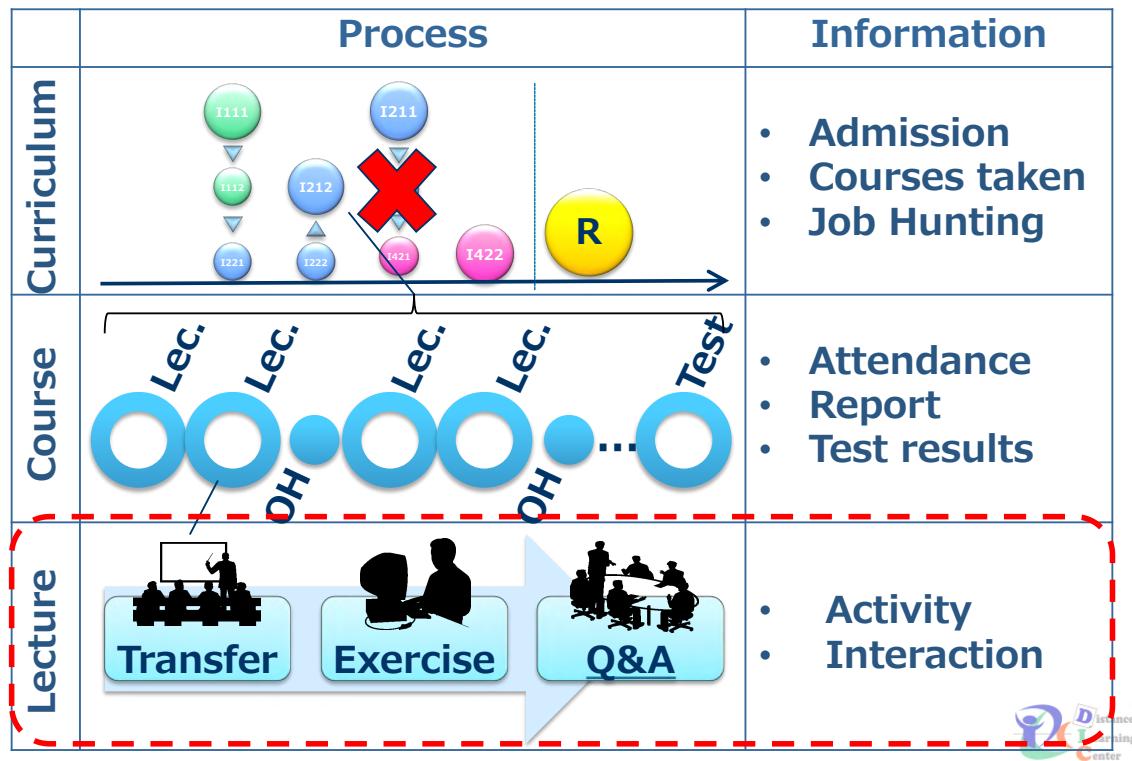
### Quality Assurance by Process Data

- **Process:** “Series of activity”
- **How do we collect process data from education and research activities?**
  - Depending on grain size of process
  - Composing of formal & informal activities
  - Including temporal features

### Role of ICT in Quality Assurance

- Facilitating learning process
- Collecting cross-sections data
- Analyzing data collected

# Examples for Process in Education



## Research Question

What do you think about  
How to deal with process  
in lecture time with ICT?

# Lecture Archiving System

## Features

- Enabling students to search & watch education scenes recorded.
  - Asynchronous learning for preparation & reflection
  - Supplemental material for f2f lecture
  - From 2006 (Around 2,000 per year in IS)

## Process info. By System

- Lecture segments (on lecture)
  - Division by whiteboard/slide
- Comments by students (after lecture)
  - Video Forum: Forum linking timeline



# Video Forum

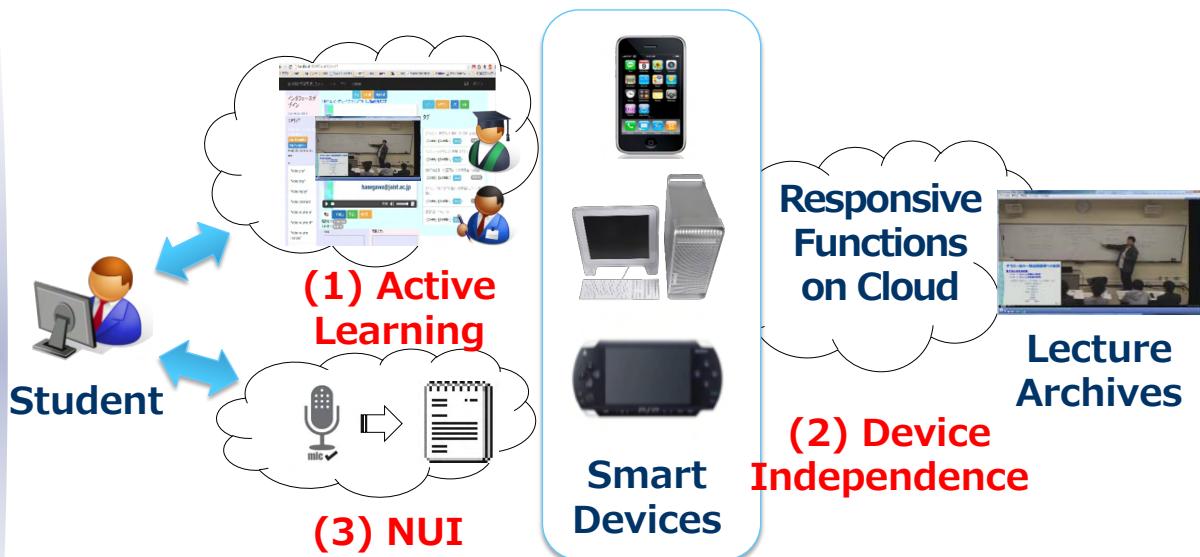
The screenshot shows a Windows Internet Explorer window displaying a lecture archive. The interface includes:

- Lecture Archive:** A video player showing a professor at a whiteboard.
- Comment Form:** A text input field for students to type comments.
- Slide Segmentation:** A vertical list of slide thumbnails on the right side of the video player.
- Video Forum:** A separate panel on the right containing a list of comments with timestamps and user names.

The Video Forum panel lists the following comments:

コメント	日付
Tatsunokuchi Joubou	2010/03/11 13:41
[00:07:12]#3	
[00:10:00]#4	
[00:12:05]#5	
[00:17:16]#6	
[00:20:00]#7	
[00:21:15]#8	
[00:24:17]#9	
[00:27:22]#10	
[00:28:46]#11	
[00:30:00]#12	
[00:35:03]#13	
[00:40:00]#14	
[00:43:12]#15	
[00:44:34]#16	
[00:50:03]#17	
[00:51:49]#18	

# Purpose of Research

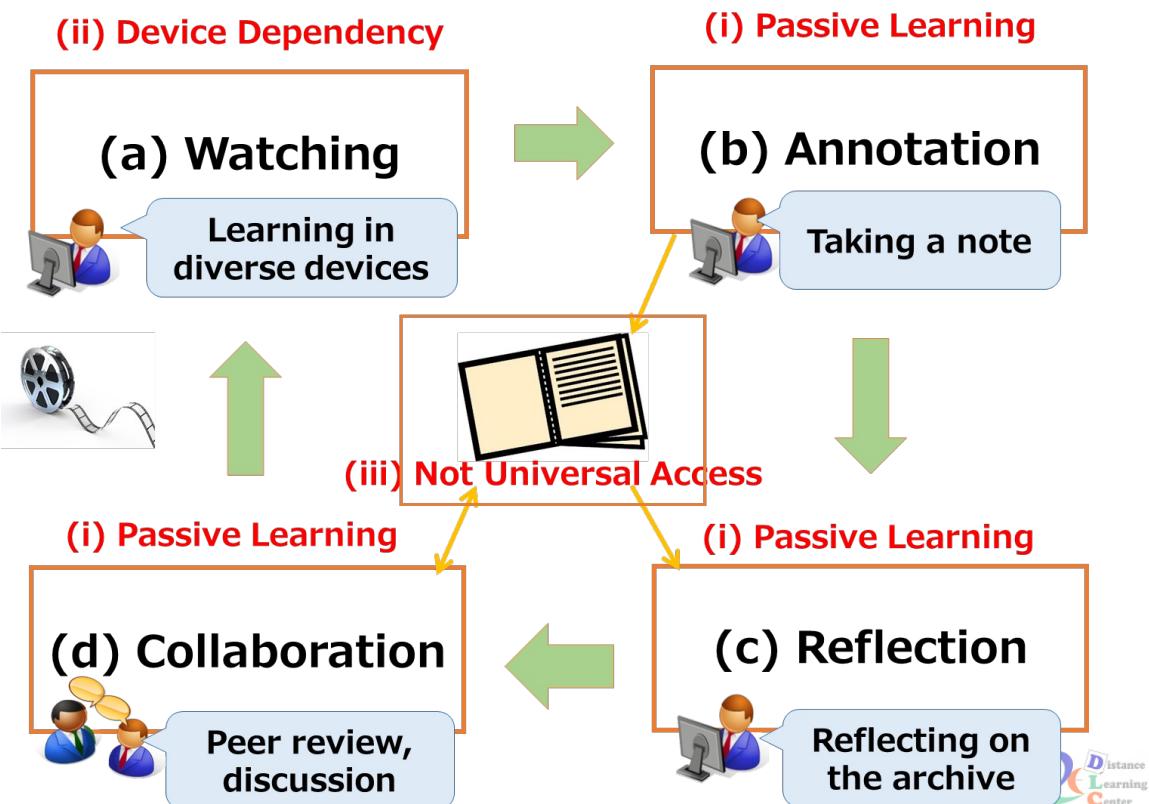


## To Develop cloud-based U-VOD learning platform

1. Note-centered approach
2. Responsive function approach
3. NUI (Natural User Interface) approach



# Learning Process Model





# Archive Note Function

The screenshot shows a web application interface. On the left, there's a sidebar titled "インタフェースデザイン" (Interface Design) containing a list of commands like "video play", "video stop", etc. In the center, a video player displays a video titled "遠隔教育システム工学" (Distance Education System Engineering) by "長谷川 忍" (Toshi Hasegawa) with the email "hasegawa@jaist.ac.jp". The video player has controls for play, pause, volume, and seek. On the right, there's a sidebar titled "タグ" (Tags) listing several entries with delete and play buttons, and a timestamp. At the bottom right is a logo for "Distance Learning Center".



# Simple Demo

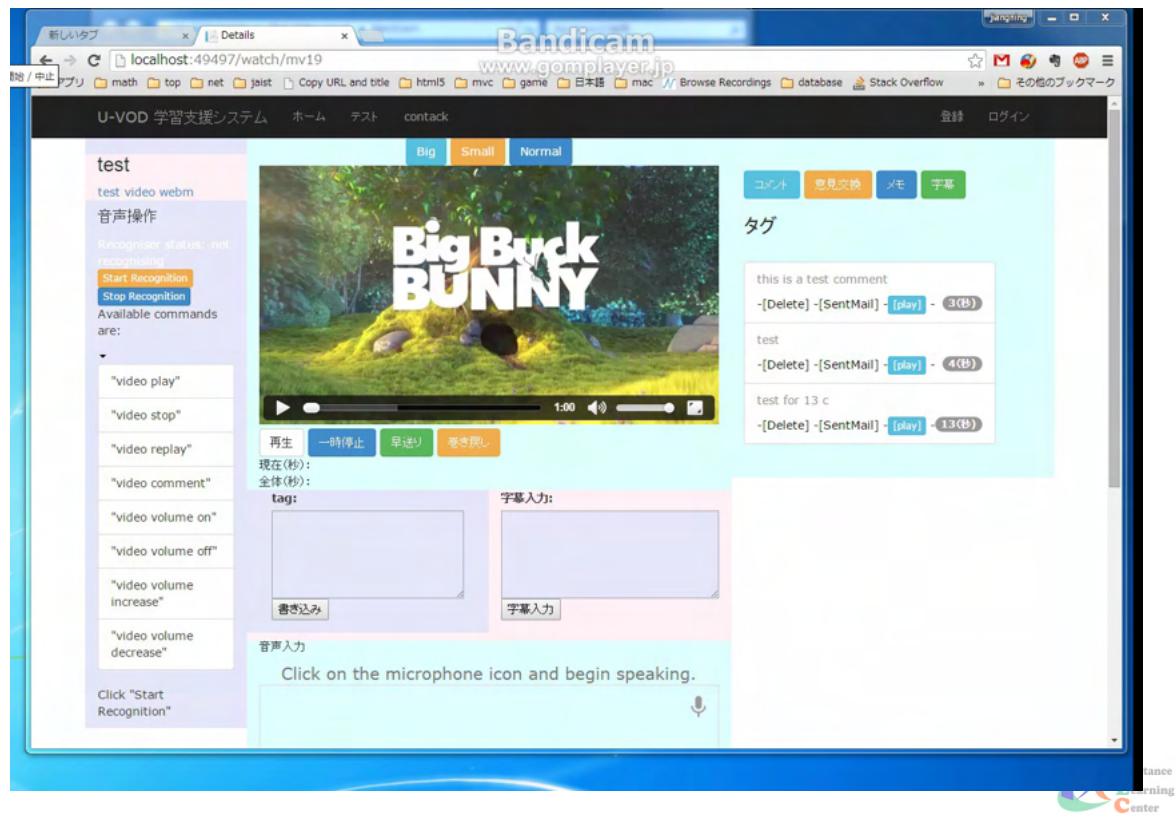
The screenshot shows a "Video List" page. It features a search bar at the top and a table below it displaying five video entries. The table columns are Title, Description, CreatedAt, and UpdatedAt. Each entry includes links for Edit, Details, and Delete. At the bottom of the page is a copyright notice.

	Title	Description	CreatedAt	UpdatedAt
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	speaking English	There are easy ways to learn English	2015/01/21 0:11	2015/01/21 0:11
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	cueplot	test video	2015/01/21 0:32	2015/01/21 0:32
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	インターフェースデザイン	test video (firefox)	2015/01/25 17:37	2015/01/25 17:42
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	インターフェースデザイン	test video webm	2015/01/25 18:41	2015/01/25 18:41
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	test for 審査	test video webm	2015/02/14 4:55	2015/02/15 17:17

© 2015 - マイ ASP.NET アプリケーション

Distance Learning Center

# NUI Demo



## Case Study

### Purpose

- To evaluate effect of note-centered function.

### Participants

- 8 graduate students (4 = female, 4 = male)
- 11 inch laptop PCs
- Counter-balancing for conditions

### Prepared lecture archives

- Recorded PowerPoint slides and lecture's voice
  - System evaluation design (16:10)
  - Interface design (13:58)

### Conditions

- Within-participants-design
  - Experiment condition: With-note
  - Control condition: Without-note

# Test Results

(N=8, Full marks = 100)

Conditions	With-note		Without-note	
	Pre-test	Post-test	Pre-test	Post-test
Average	91.3	93.4	73.8	61.3
SD	10.6	11.9	15.1	29.5
p-Value	0.711		0.208	
Significance	n.s.		n.s.	

## N.S. between pre-/post-tests

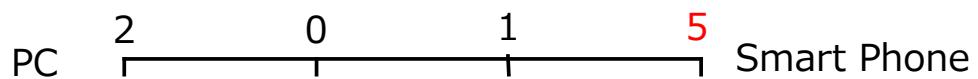
- Pre-/Post-tests might be too easy.



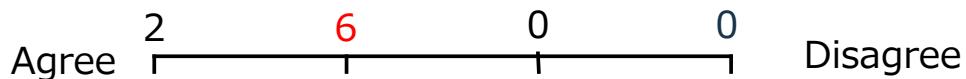
# Questionnaire Results

(N=8)

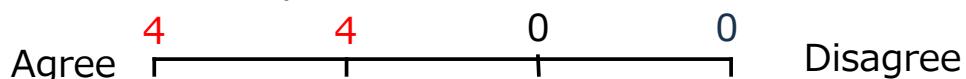
Q1: Frequency of use for Watching video.



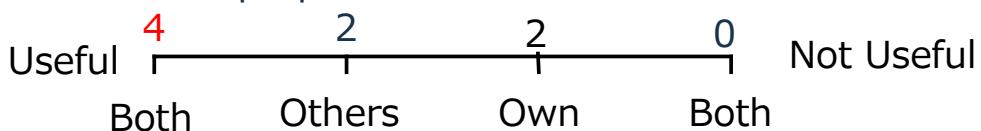
Q2: Effectiveness of others comments.



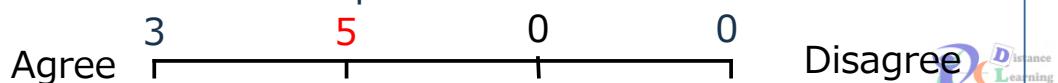
Q3: Effectiveness of your own memos/comments.



Q4: Usefulness of proposed “archive note” function.



Q5: Usefulness of voice operation.



# Quality Assurance in Lecture

## Facilitation

- Note-taking to archive
- Discussion with archive timeline
- Flipped Classroom

## Collection

- Lecturer's Activity Extraction
- Access / Comment Log

## Analysis

- Frequently commented segments
- Self/peer assessment based on activity

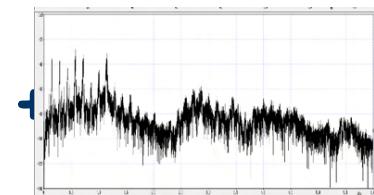
# Activity Extraction



Facial Recognition



Optical Flow



Silent Detection



Important Activity in Lecture

# Quality Assurance in Lecture

## Facilitation

- Note-taking to archive
- Discussion with archive timeline
- Flipped Classroom

## Collection

- Lecturer's Activity Extraction
- Access / Comment Log

## Analysis

- Tendency of learning style
  - Frequently commented segments
- ⇒ These processes are stored into e-Portfolio  
(digital collection of evidence for learning)

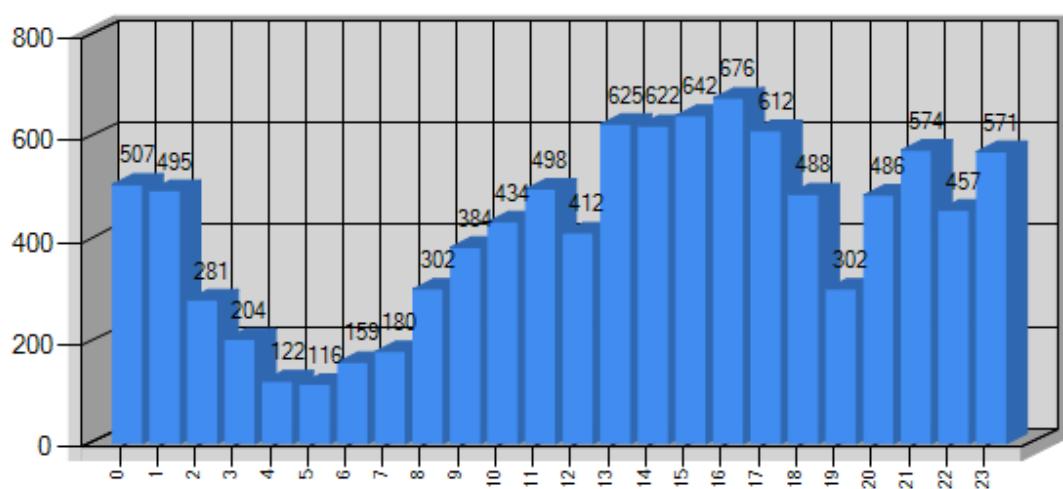
unc  
sing  
ip

# Summary of Access

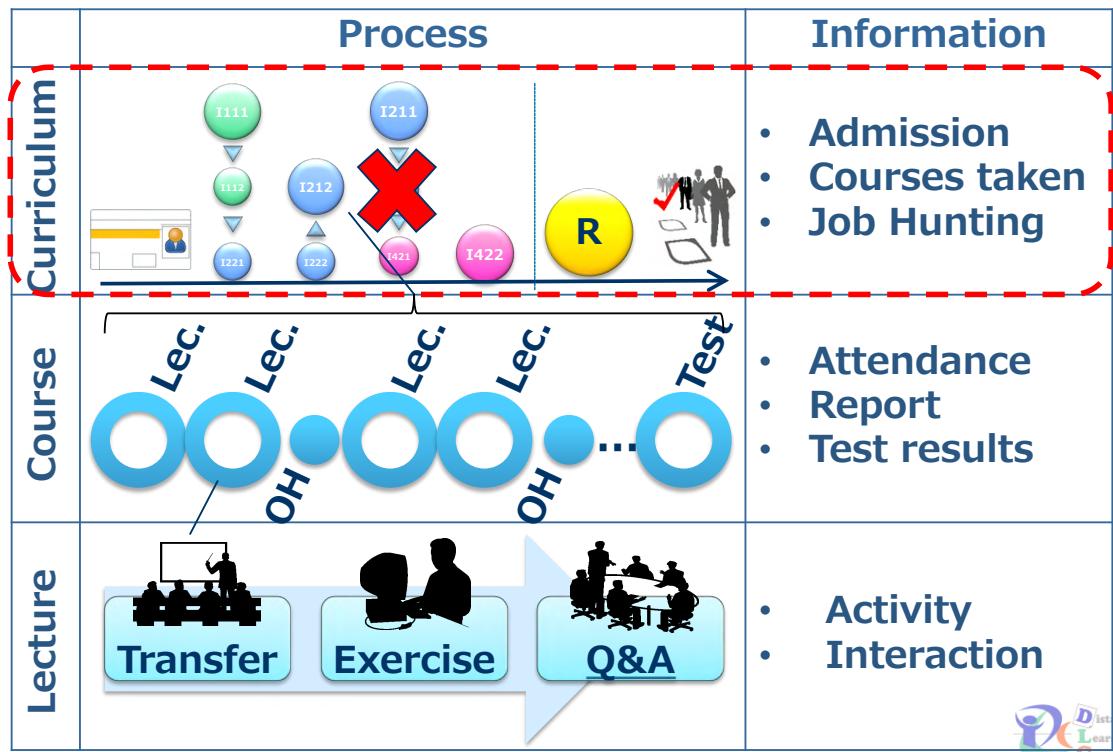
10,149 Accesses/214 days

Display term: 2014 / 4 / 1 - 2014 / 10 / 31 Display

All access count by hour(Sum in selected term:10149)



# Examples for Process in Education



## IR System

### Institutional Research

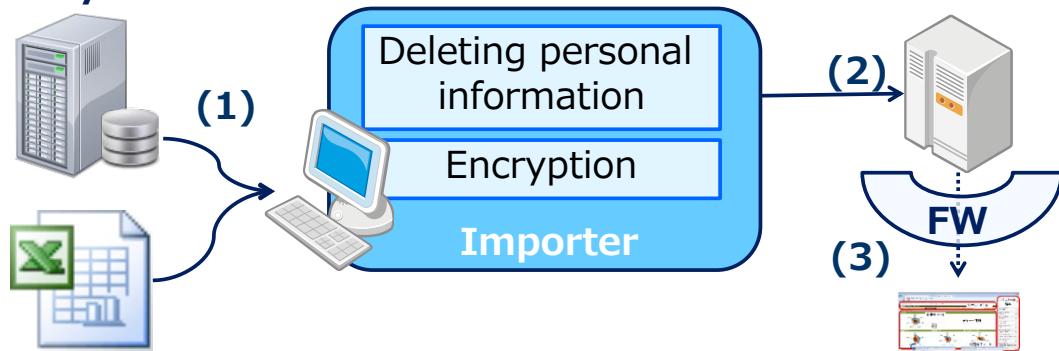
- Objective evaluation for achievement of educational goal
- Combining distributed data to different section (i.e. admission, career dev.)
- **IR in Univ.  $\neq$  BI + CSR in Company**

### Process info. By System

- **Course Record**
  - Period, field, level, grade, etc.
- **Analysis Condition**
  - Admission test, job hunting, research, etc.

# IR System Overview

## Educational DB system



## Flow of System

- (1) Upload data to importer
- (2) Register encrypted data to analyzer
- (3) Report results to authorized user

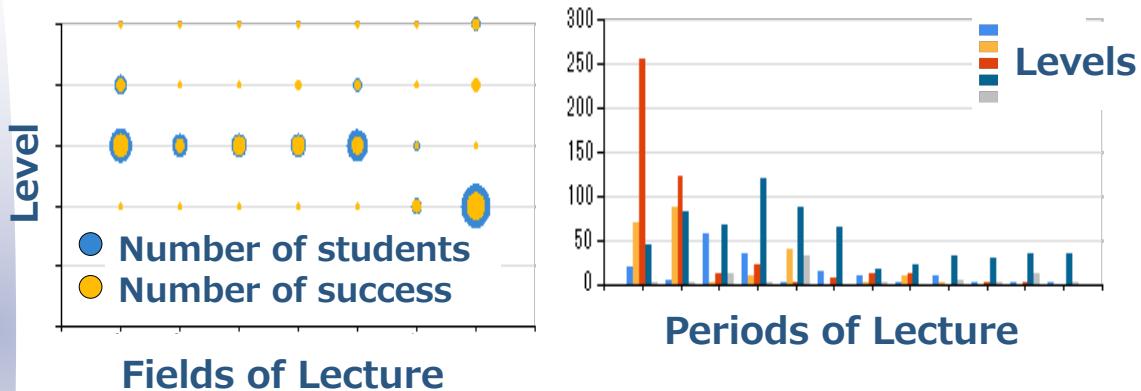


# System UI

The screenshot displays the System UI interface with several analytical components:

- Scenario Menu:** Located at the top left, enclosed in a red box.
- Total Chart:** A large radar chart in the center-left, enclosed in a red box.
- Chart Area:** A smaller chart area to the right of the total chart, enclosed in a red box.
- School Chart:** Three smaller radar charts corresponding to different schools, enclosed in a red box.
- Param. Area:** A sidebar on the right containing various parameters and filters, enclosed in a red box.
- Drilldown (List View):** A detailed list view at the bottom left, enclosed in a blue box.
- Drilldown (Personal View):** A personal view or summary at the bottom right, enclosed in a blue box.

# Examples of Chart



## Analysis/Report/Prediction

- Comparison of difficulty among fields
- Reports of tendency for taking courses
- Prediction of future from past data

⇒ This enables us to extract role model.



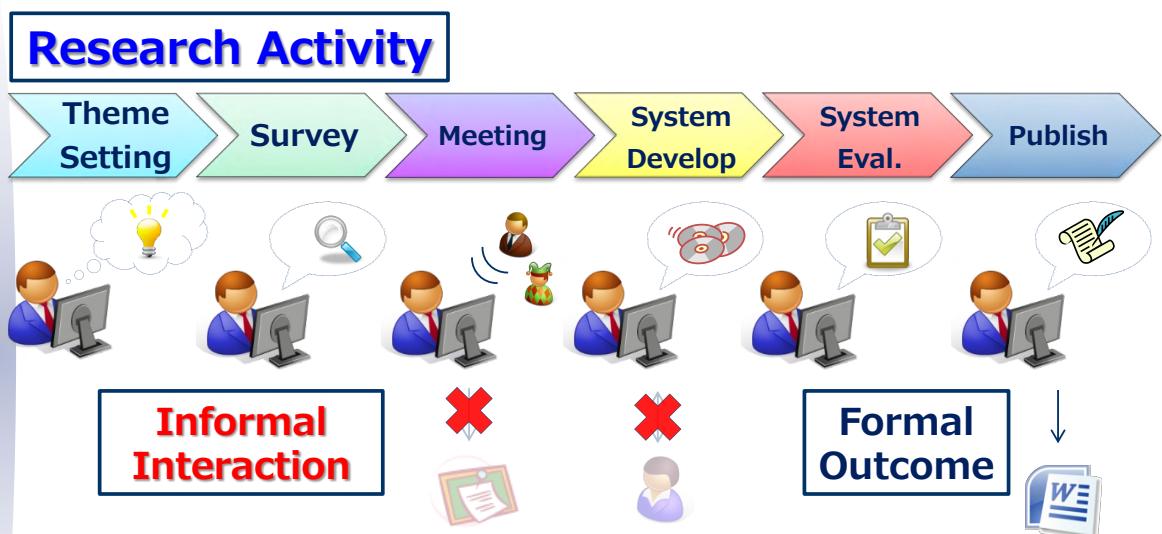
What do you think about  
How to support research process  
with ICT?



# Examples of Process in Research

	Process	Information
Research	<pre> graph LR     A[Theme] --&gt; B[Survey]     B --&gt; C[Meeting]     C --&gt; D[Develop]     D --&gt; E[Eval.]     E --&gt; F[Publish]   </pre>	<ul style="list-style-type: none"> <li>• Research Activity</li> <li>• Interaction</li> </ul>
Present.	<p>A circular flow diagram with three main stages: "Talk" (with a person at a computer), "Q&amp;A" (with a person at a computer and a small plant icon), and "Reflection" (with a person at a computer). Arrows indicate a clockwise cycle between them.</p>	<ul style="list-style-type: none"> <li>• Presentation Activity</li> <li>• Q&amp;A</li> <li>• Reflection</li> </ul>
Writing	<p>A diagram showing a revision process. It starts with a document labeled "Comment". Below it are two versions: "Ver.1" and "Ver.2". Arrows show the progression from Ver.1 to Ver.2.</p>	<ul style="list-style-type: none"> <li>• Revision Process</li> <li>• Revision Intention</li> </ul>

## Research Activity Process

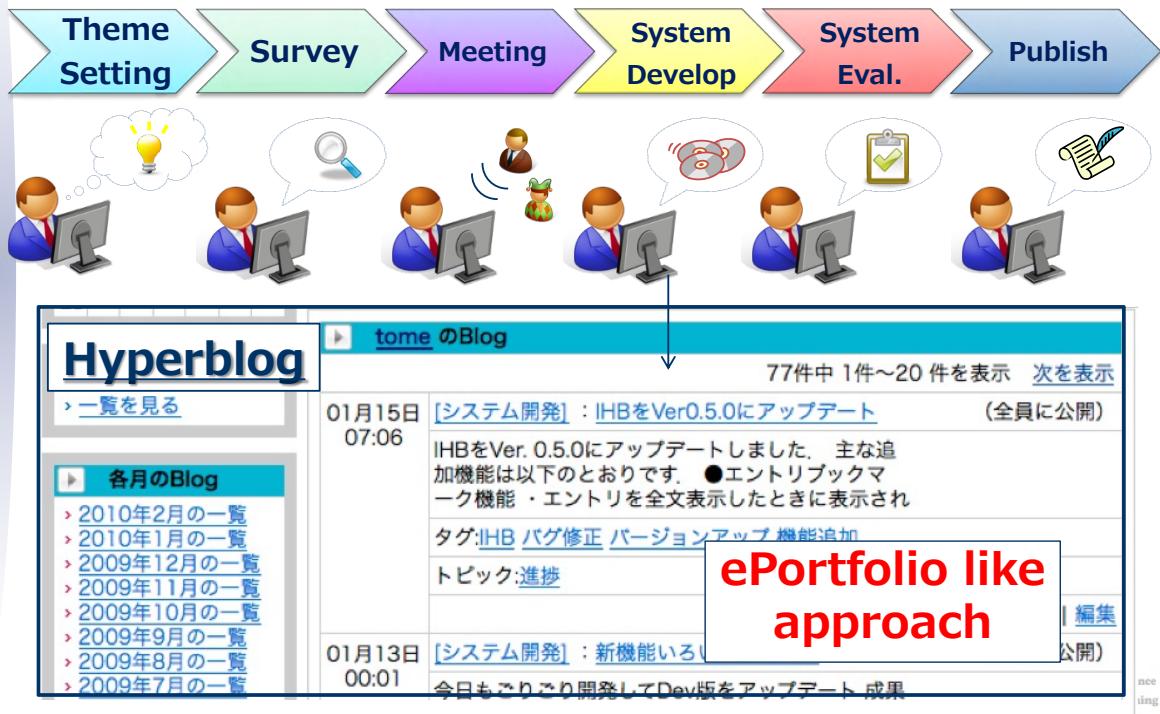


### Research Process in Laboratory

- Community of Practice
- **Informal interactions are existed dispersedly**  
⇒ Difficult to reuse

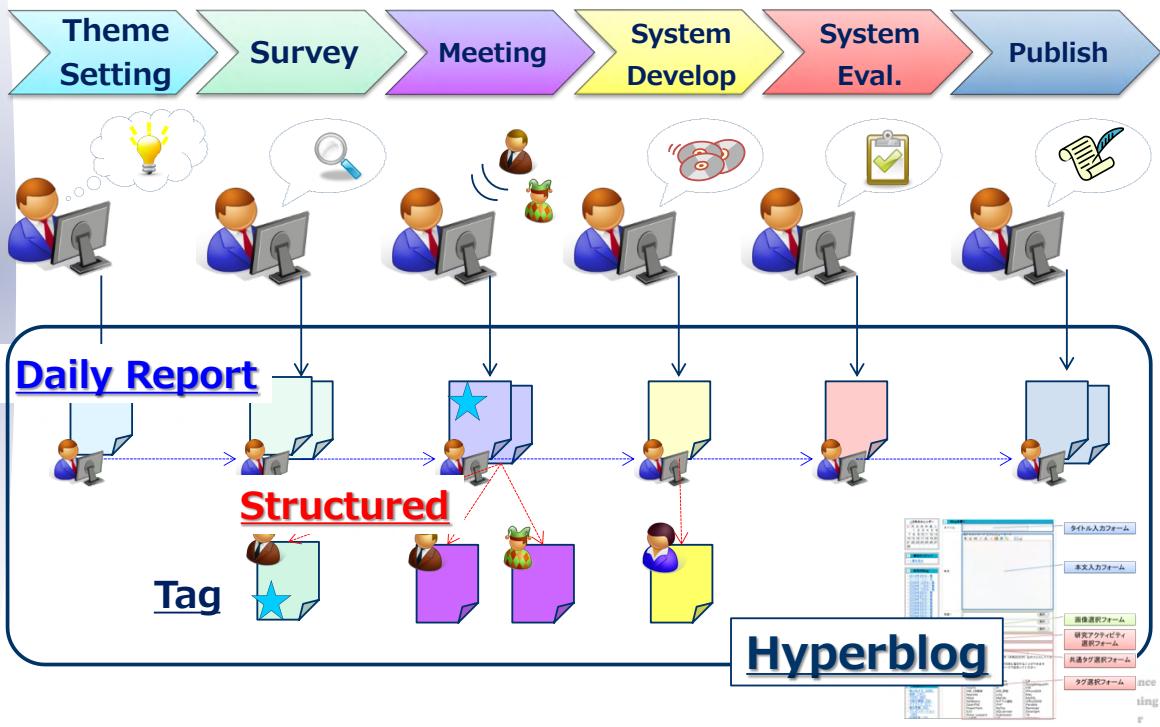
# Support for Structuring

## Research Activity

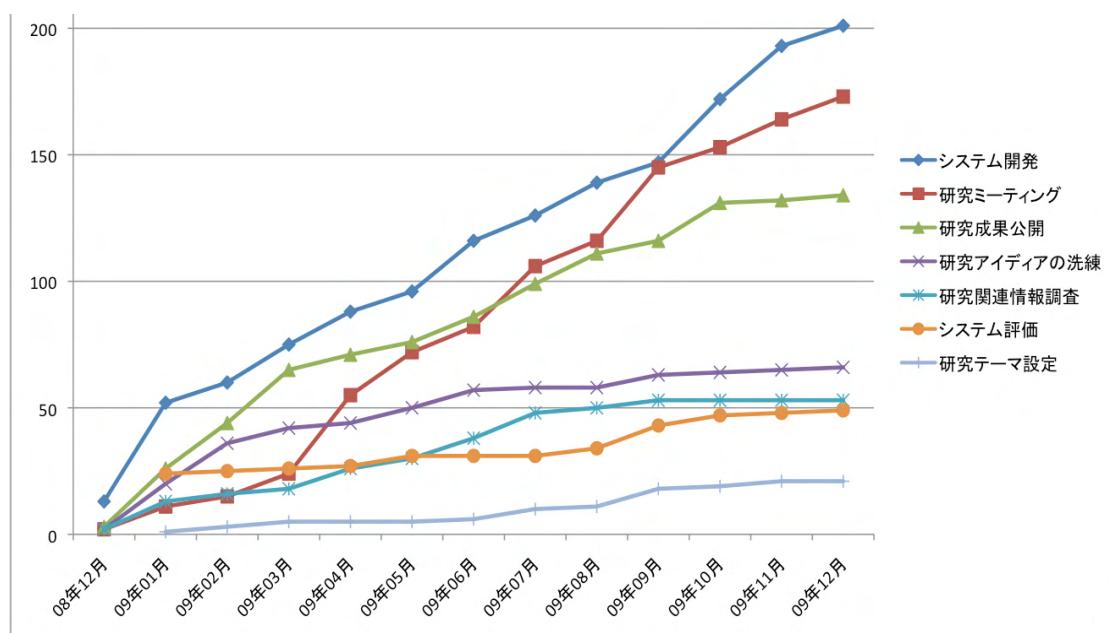


# Support for Structuring

## Research Activity



# Tendency of Process



## Analysis/Report/Prediction

Sharing suitable moment for each activity

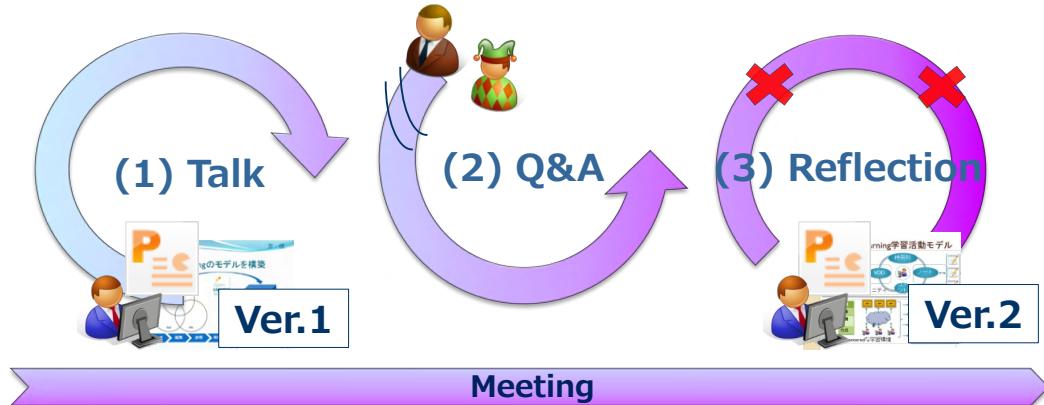


## Examples of Process in Research

	Process	Information
Research	<pre> graph LR     A[Theme] --&gt; B[Survey]     B --&gt; C[Meeting]     C --&gt; D[Develop]     D --&gt; E[Eval.]     E --&gt; F[Publish]   </pre>	<ul style="list-style-type: none"> <li>Research Activity</li> <li>Interaction</li> </ul>
Presen.		<ul style="list-style-type: none"> <li>Presentation Activity</li> <li>Q&amp;A</li> <li>Reflection</li> </ul>
Writing		<ul style="list-style-type: none"> <li>Revision Process</li> <li>Revision Intention</li> </ul>



# Meeting Review Process



## Awareness by Meeting Reflection

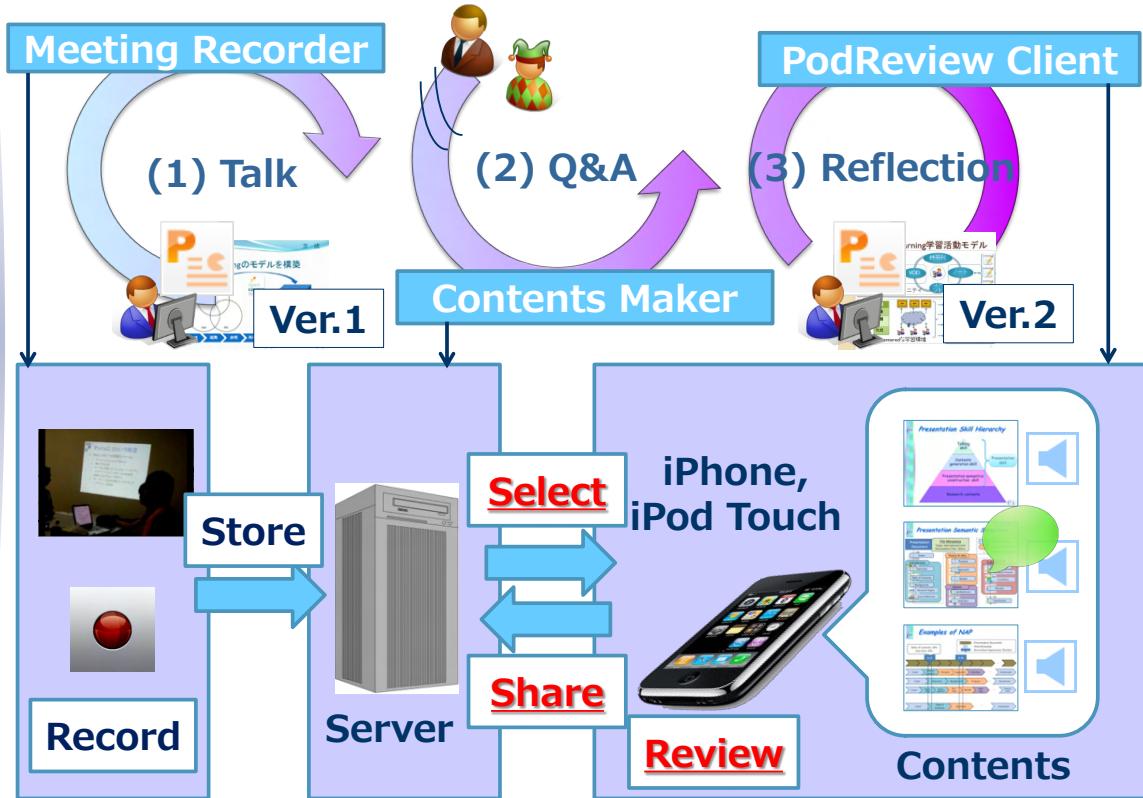
- (1) Students talk their presentation
- (2) Q&A by professor & other students
- (3) Students reflect on meeting (Meeting Review)
  - Difficult to get time for reviewing
  - Hard to remember contents to be reviewed



# Support for Meeting Review



# Support for Meeting Review



## Examples of Review Process

	Number	Average Time	Average Slide
<b>Home</b>	<b>10</b>	<b>28 min.</b>	<b>7.4 seg.</b>
<b>Train</b>	<b>13</b>	<b>13 min.</b>	<b>4.5 seg.</b>
<b>Lab</b>	<b>3</b>	<b>32 min.</b>	<b>8 seg.</b>
<b>University</b>	<b>3</b>	<b>12 min.</b>	<b>2.7 seg.</b>
<b>Road</b>	<b>1</b>	<b>10 min.</b>	<b>3 seg.</b>

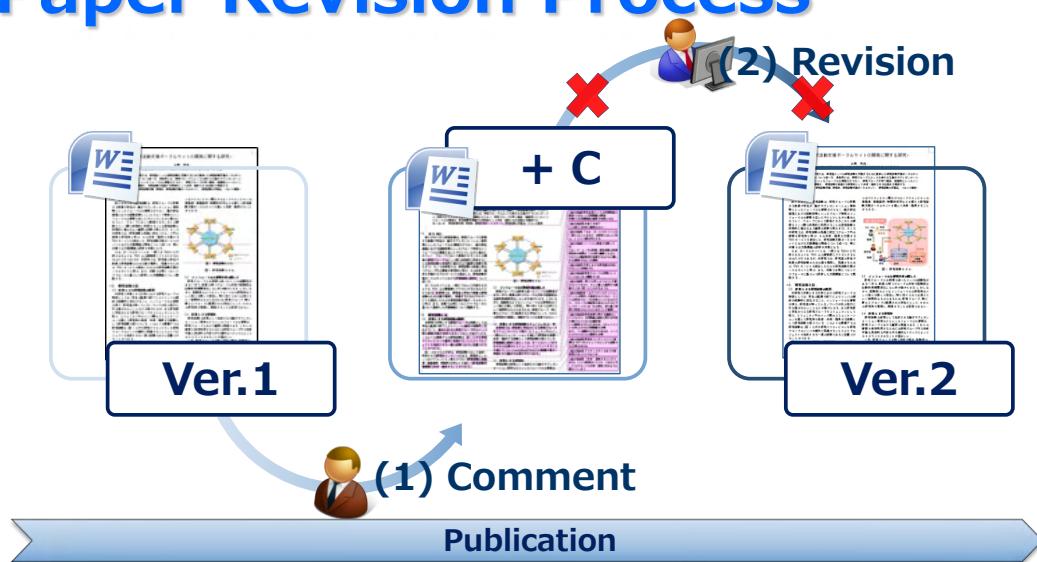
(n = 7/24h)

System provides learning opportunities out of laboratory.

# Examples of Process in Research

	Process	Information
Research	<pre> graph LR     A[Theme] --&gt; B[Survey]     B --&gt; C[Meeting]     C --&gt; D[Develop]     D --&gt; E[Eval.]     E --&gt; F[Publish]   </pre>	<ul style="list-style-type: none"> <li>• Research Activity</li> <li>• Interaction</li> </ul>
Present.	<p>Talk → Q&amp;A → Reflection</p>	<ul style="list-style-type: none"> <li>• Presentation Activity</li> <li>• Q&amp;A</li> <li>• Reflection</li> </ul>
Writing	<p>Ver.1 → Comment → Ver.2</p>	<ul style="list-style-type: none"> <li>• Revision Process</li> <li>• Revision Intention</li> </ul>

## Paper Revision Process

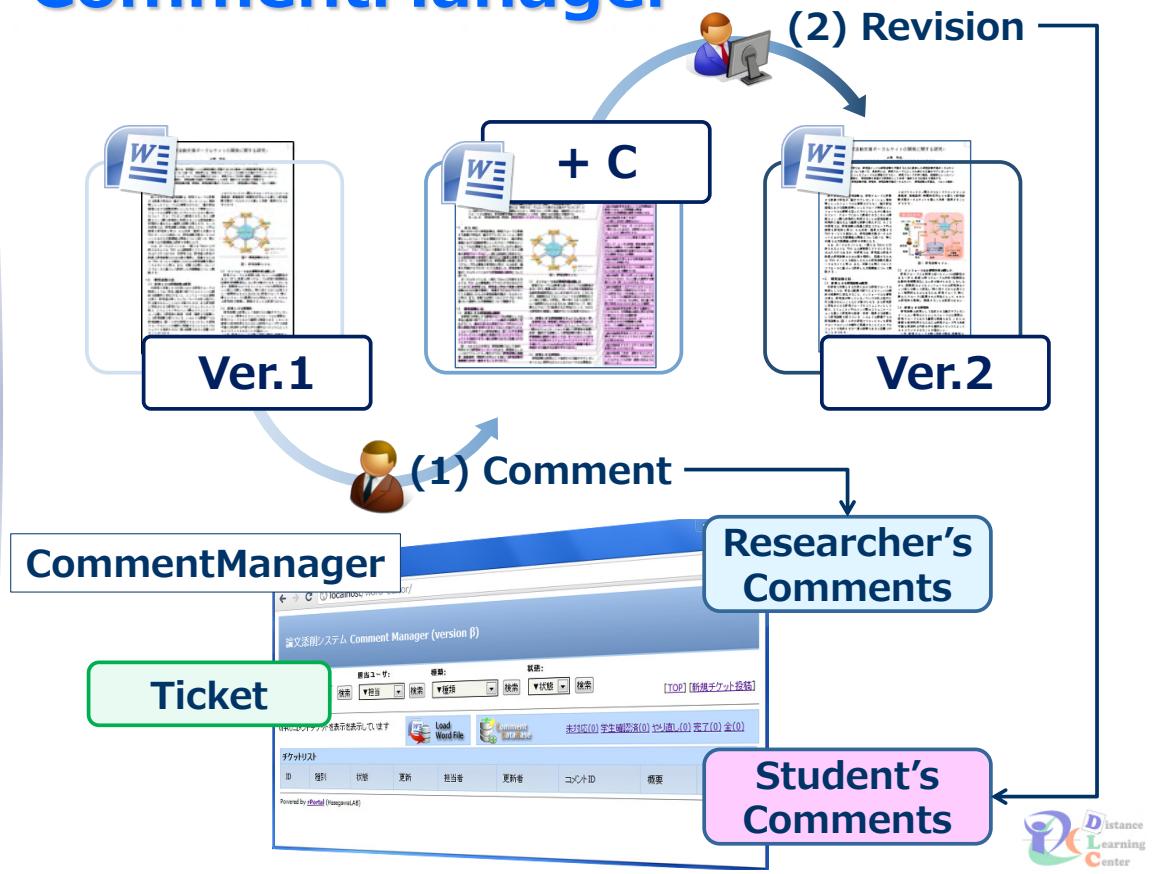


## Revision Process in Publication

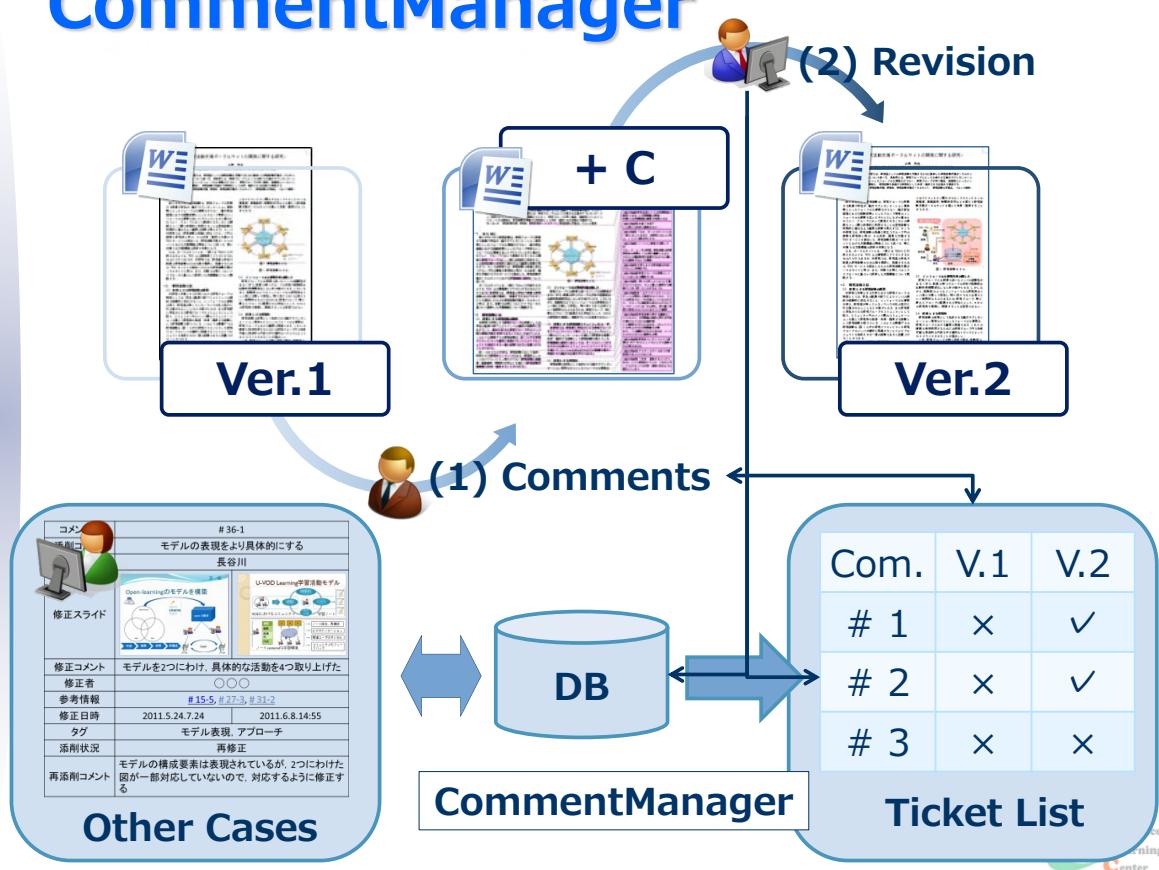
(1) Making comments by researcher  
 (2) Revising paper by student } Repeat

- Hard to reflect on commented intention
- Difficult to know where should pay attention

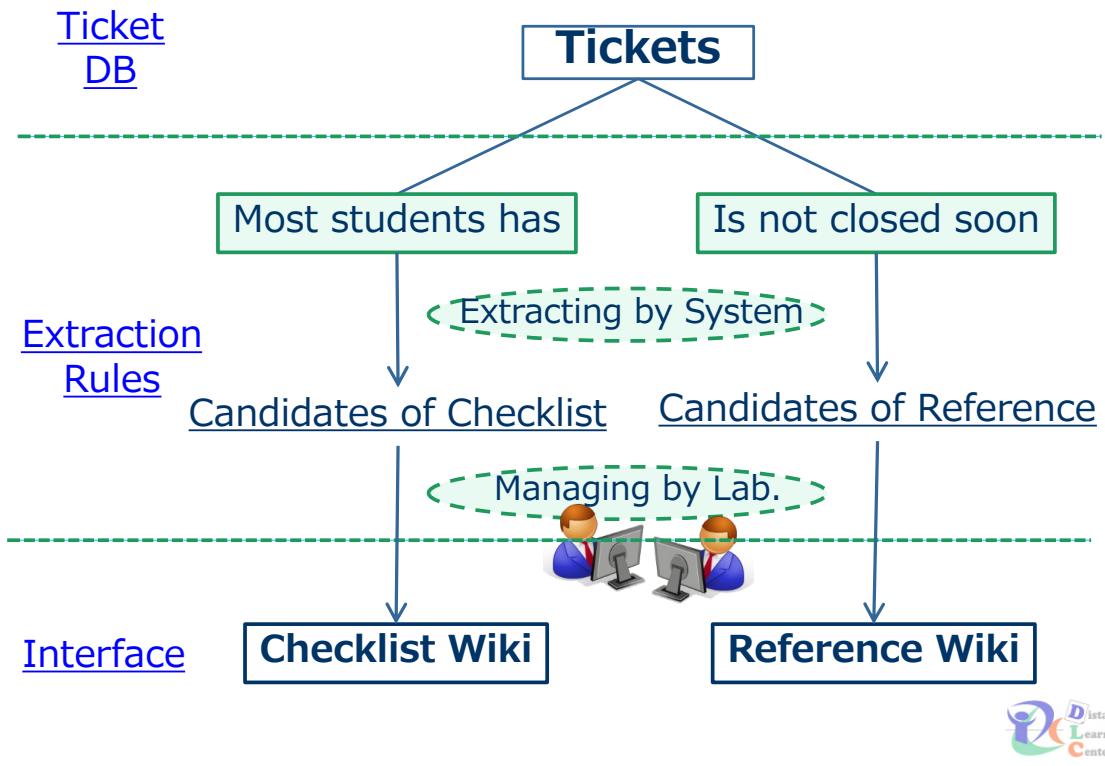
# CommentManager



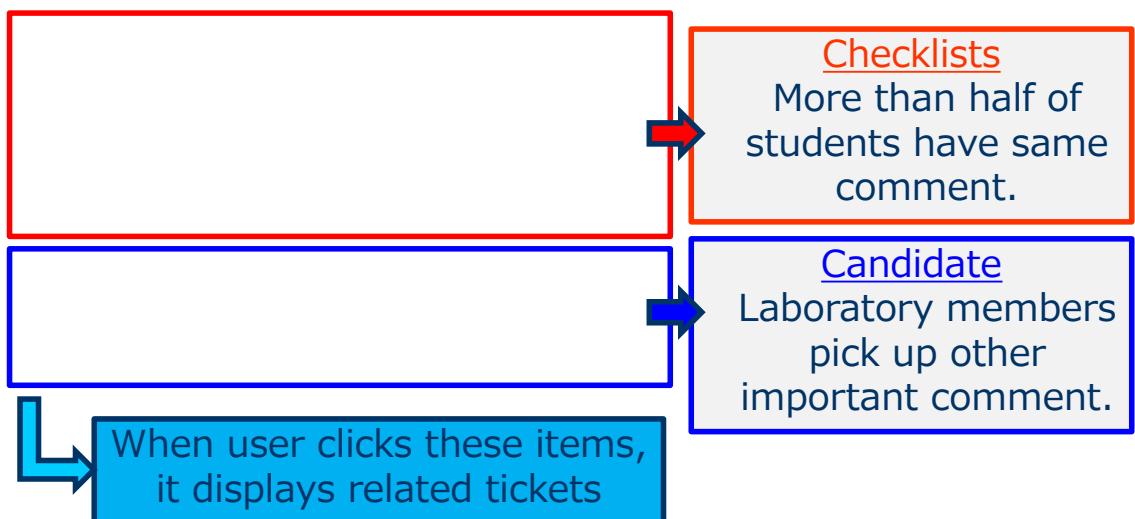
# CommentManager



# Knowledge Transfer Function



## Checklist Wiki



# Conclusion

## ICT can deal with process directly

- **Learning Informatics**
  - Designing & Improving Education & Learning
- **Cognitive Science (Theoretical):**
  - Modelling for Human Learning Process as Target
- **Information Technology (Technological):**
  - By Using ICT and/or AI/Media/Software Tech.
- **Research Target is Changed**
  - From knowledge to Skills

**ICT should not be just replacement of conventional equipment.**



## What's Next for SDL ?

### 1. How to support Open Learning

- Modeling open planning/reflection process
- Developing support functions for OL

### 2. How to support Learning Community

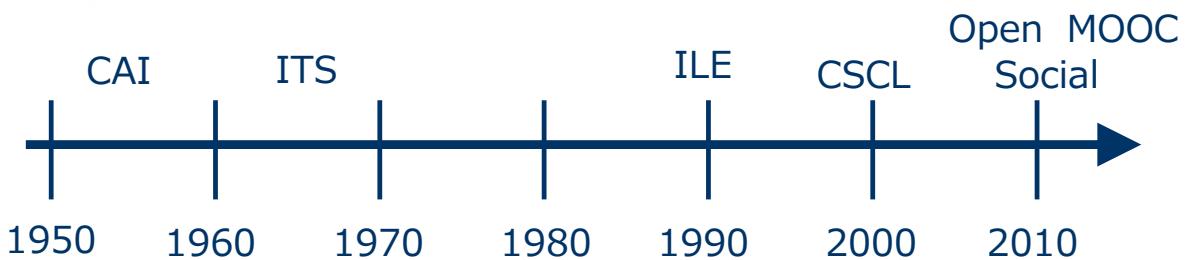
- Modeling learning/communication in community
- Developing support function for LC

### 3. How to support Learner adaptively

- User-modeling and task-modeling
- Adaptive Hypermedia

# Next Trends for DLS

## Open/Social paradigm



- Any resources are delivered on Internet
  - Ex.) “**Flipped Class**” will change lecture

## Cloud/Big data

- Any information through IC is available
  - Some issues may be caused as privacy
- Key Performance Indicator will be founded



# Examples for BigData age

## New Type of Information

- Affective Information:
  - Estimating attitude from input device

## Analysis from whole data

- Role Model:
  - Analyzing ideal learning process
- Comparison:
  - Comparing with similar learning process
- Experimental Knowledge:
  - Gathering common learning process
- Quality Assurance:
  - Using learning process with KPI as evidence

# Goal of This Lecture

To Propose  
“Next” (Distance) Learning

To Improve  
“Current” (Distance) Learning



## Evaluation Criteria

### Report: 40% (10+20+10)

- To design distance learning class for your own topic with presentation.

### Final Exam: 50%

- Use Jaist-Ims.
  - Posting of question papers
  - Upload answers using a camera, etc.

### Discussion: 10%

- To participate in course constructively.



# Distance Learning System (遠隔教育システム工学)

## 3W. Teaching/Learning Theory

Shinobu Hasegawa  
hasegawa@jaist.ac.jp



## Instructional Design

### Definitions (Merrill etc. 1996)

- Creating “instructional experiences which make the acquisition of knowledge and skill more efficient, effective, & appealing.

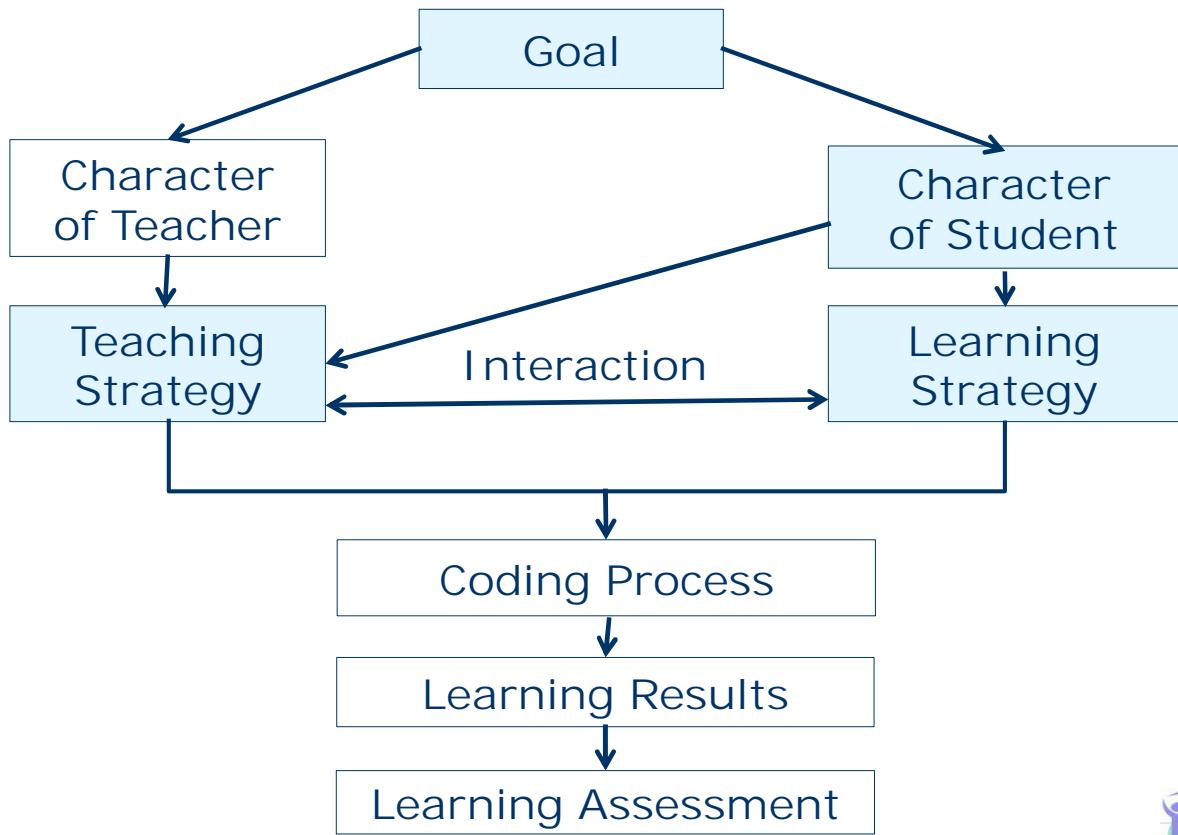
### ADDIE Model

- 5 Phases
- Scientific
- Follow-able



# Education/Learning Process

(Weinstein & Mayer, 1986)



## Learning Style

### Definition

- Learning style is a learner's natural or habitual pattern of acquiring and processing information in learning.

### Kolb's model

- Designed to help learners identify the way they learn from experience (Kolb, 1984)
- Accommodator: Concrete & Active
- Converger: Abstract & Active
- Diverger: Concrete & Reflective
- Assimilator: Abstract & Reflective

# Perceptual Modalities

(Messick, 1994)

## Definition

- Perceptual modalities represent the way we most efficiently adopt data.

## Typical type

- Visual Learners: Learning through seeing
  - They need to see teacher's body language
- Auditory Learners: Learning through listening
  - They learn best through verbal lectures
- Kinesthetic Learners: Learning by doing
  - They learn best through hands-on approach



# Paradigms of L-Theories

## Basis for Teaching/Learning Strategy

- Behaviorism (-1950s)
  - All behavior caused by external stimuli.
- Cognitivism (1960s)
  - Opening "black box" of human mind.
  - Learner is viewed as information processor.
- Constructivism (1970s-1980s)
  - Learning is active, constructive process.
  - Learner is viewed as information constructor.
- Humanism (1990s-)
  - Focusing on human freedom, dignity, potential.
  - Learning is viewed as a personal act.
- Design-based (1990s-)
  - A blend of empirical educational research with theory-driven design of learning environment.

# Teaching Strategy in Class

## Explanation Approach

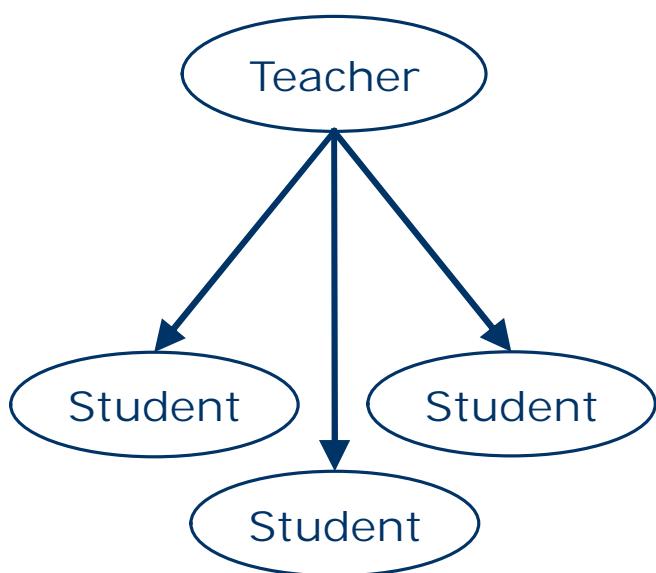
- One way information provision from teacher
  - Classroom lecture, Meaningful reception learning, Programmed learning
  - 9 steps of instruction

## Exploration Approach

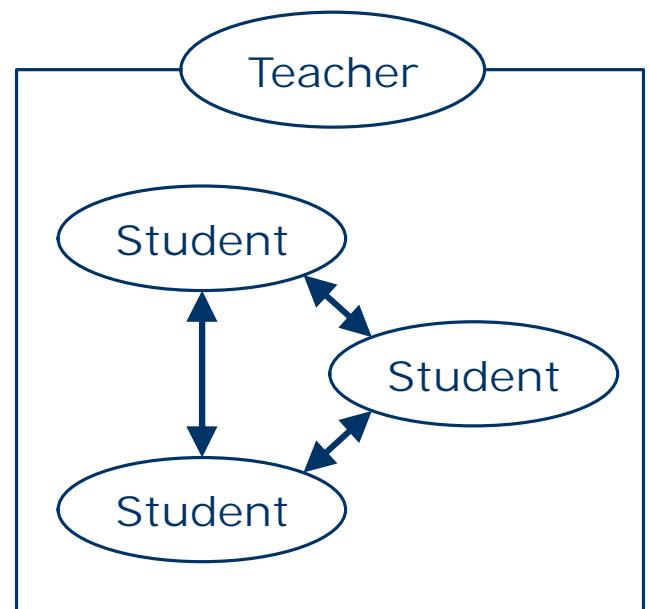
- Self-directed activity by interaction
  - Discovery learning, Problem based learning, Jigsaw learning, Flipped learning



## Explanation vs Exploration



Explanation  
Approach



Exploration  
Approach

# Classroom Lecture

## Feature

- Fixed lecture environment
- Same material & lecture to all students
- One-way transformation from teacher
- Efficient & economical way of transformation

## Disadvantage

- [Empty box]
- [Empty box]
- [Empty box]
- [Empty box]



# 9 Steps of Instruction

(Gagne et al. 1974)

## Supporting learning process in class

### Introduction

1. Gaining attention
2. Informing learners of objectives
3. Stimulating recall of prior learning

### Body

4. Presenting the stimulus
5. Providing learning guidance
6. Eliciting performance
7. Providing feedback

### Conclusion

8. Assessing performance
9. Enhancing retention and transfer



# Meaningful Reception Learning

(Ausubel & Fitzgerald, 1961)

## Main Concept

- Advance Organizer

- Helping to link new learning material with existing related ideas (different from overviews)

## Process of meaningful learning

1. Derivative subsumption
2. Correlative subsumption
3. Superordinate learning
  - Learning concept itself
4. Combinatorial learning
  - Learning by analogy



# Programmed Learning

(Skinner, 1954)

## Main Concept

- Managing learning under controlled conditions

## Basic Approach

- Small step principle
  - Increasing motivation by success.
- Self-paced learning
  - Getting positive response from students.
  - Fading in accordance with progress.
- Immediate feedback
  - Preventing misunderstanding.



# Authentic Learning

(Maina, 2004)

## Main Concept

- Solving problems with real-world significance.
- Learning in wild ⇔ Schoolized learning.

## Process of Authentic Learning

- Authentic Context
  - Learning Contents with actual context.
- Authentic Assignment
  - Acquiring implicit knowledge of Specialist.
- Authentic Activity
  - Providing environment to practice.
- Authentic Assessment
  - Assessing results as social practice.



# Teaching Strategy in Class

## Explanation Approach

- One way information provision from teacher
  - Classroom lecture, Meaningful reception learning, Programmed learning
  - 9 steps of instruction

## Exploration Approach

- Self-directed activity by interaction
  - Discovery learning, Problem based learning, Jigsaw learning, Flipped learning

# Discovery Learning

(Bruner, 1967)

## Main Concept

- Inquiry-based instruction to take tailored experience of discovering facts or concepts.
- Mainly applied science in secondary/high school in Japan.

## Process of Discovery Learning

1. Understanding of assignment
2. Setup & improving inquiry
  - Diverse approaches for teacher's participation
3. Verifying inquiry
4. Conclusion



# Problem-based Learning

(Barrows & Tamblyn, 1980)

## Main Concept

- Hands-on learning centered on investigation and resolution of real-world problems.

## Characteristics

- Stating open-ended problems with no "right" answer.
- Problems are context specific.
- Problem solving in small collaborative groups.
- Teachers adopt role as facilitators of learning.
- PBL makes students to apply knowledge to new situations.



# Jigsaw Classroom

(Aronson, Blaney, Sikes, Stephan, & Snapp, 1975)

## Main Concept

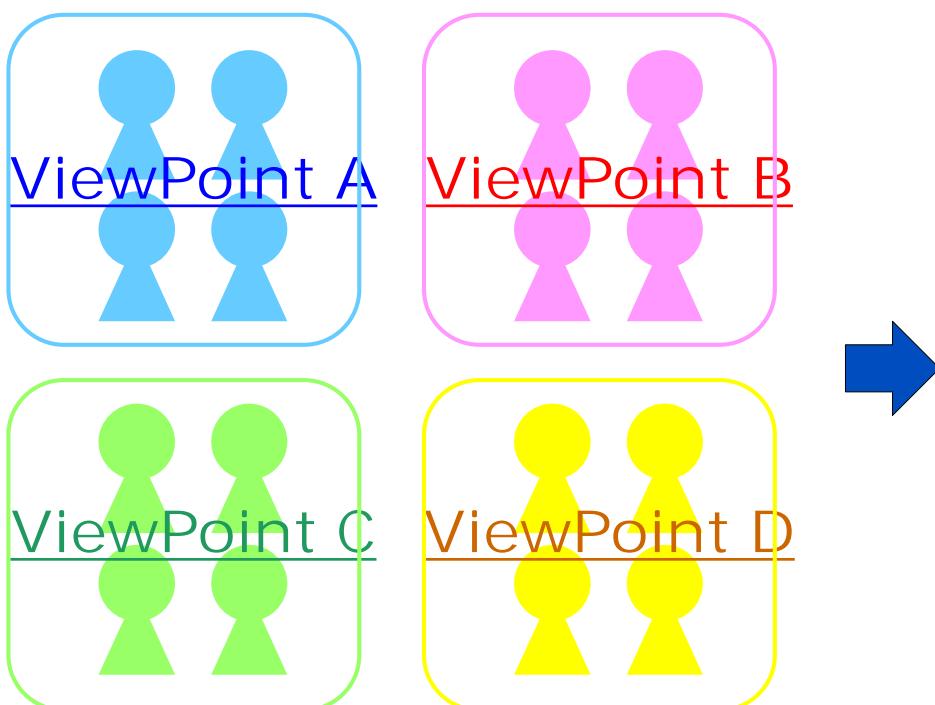
- Cooperative learning strategy that enables each student of “home” group to specialize in one aspect of learning unit.

## Process of Jigsaw Classroom

1. Each student receives materials.
2. Students leave their “home” groups & meet in “expert” groups.
3. Expert groups discuss materials.
4. Experts return to their “home” groups to teach results of “expert” groups.

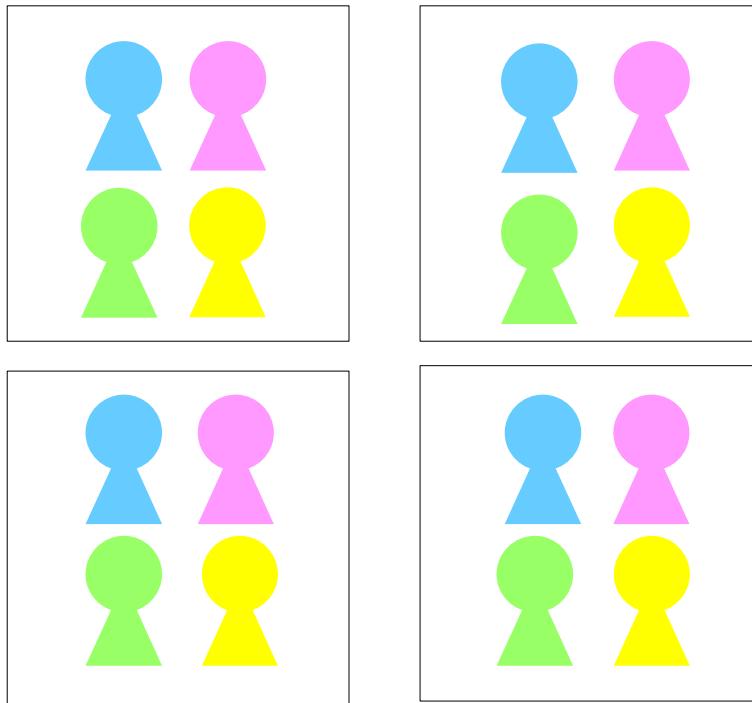


## Jigsaw Group work (1)



<Group work 1>

# Jigsaw Group work (2)



<Group work 2>



# Flipped Learning

(Zappe et al., 2009)

## Main Concept

- Students gain first exposure to new material outside of class, and then class time is used to do the harder work for assimilating.

## Process of Flipped Learning

1. Concept Exploration
  - Video/audio recordings (by teacher)
2. Meaning making
  - Reflective podcast, quizzes (by students)
3. Demonstration/Application
  - PBL, Experiments, Role plays (in class)

<https://www.youtube.com/watch?v=iQWvc6qhTds>



# Advantage & Disadvantage?

What are  
advantages & disadvantages  
for each teaching methodology?



## Motivation

### Intrinsic Motivation

- Driven by interests or enjoyment in the task.
- Existing within the individual.
- Sense of achievement, development, self-efficacy, etc.
- Risk without questioning.

### Extrinsic Motivation

- Attaining outcomes or rewards.
- Money, grades, competition, cheering, etc.
- Overjustification, subsequent reduction & threat of punishment.

# Motivation Design

## Definition

- Process of arranging resources and procedures to bring about changes in motivation in systematic way.

## ARCS Model (J. Keller, 1983)

- Attention
  - Perceptual & inquiry arousal, variability
- Relevance
  - Goal orientation, motive matching, familiarity
- Confidence
  - Requirements, success, personal control
- Satisfaction
  - Intrinsic reinforcement, extrinsic rewards



# Process of Motivation Design

## Procedure

- A) Analyzing learner characteristics
  - Identifying problems for motivation
- B) Selecting appropriate motivation tactics
  - Unnecessary tactics may discourage
- C) Assessing & Improving tactics

## How do you do motivation design?

- A:
- R:
- C:
- S:

# Gamification

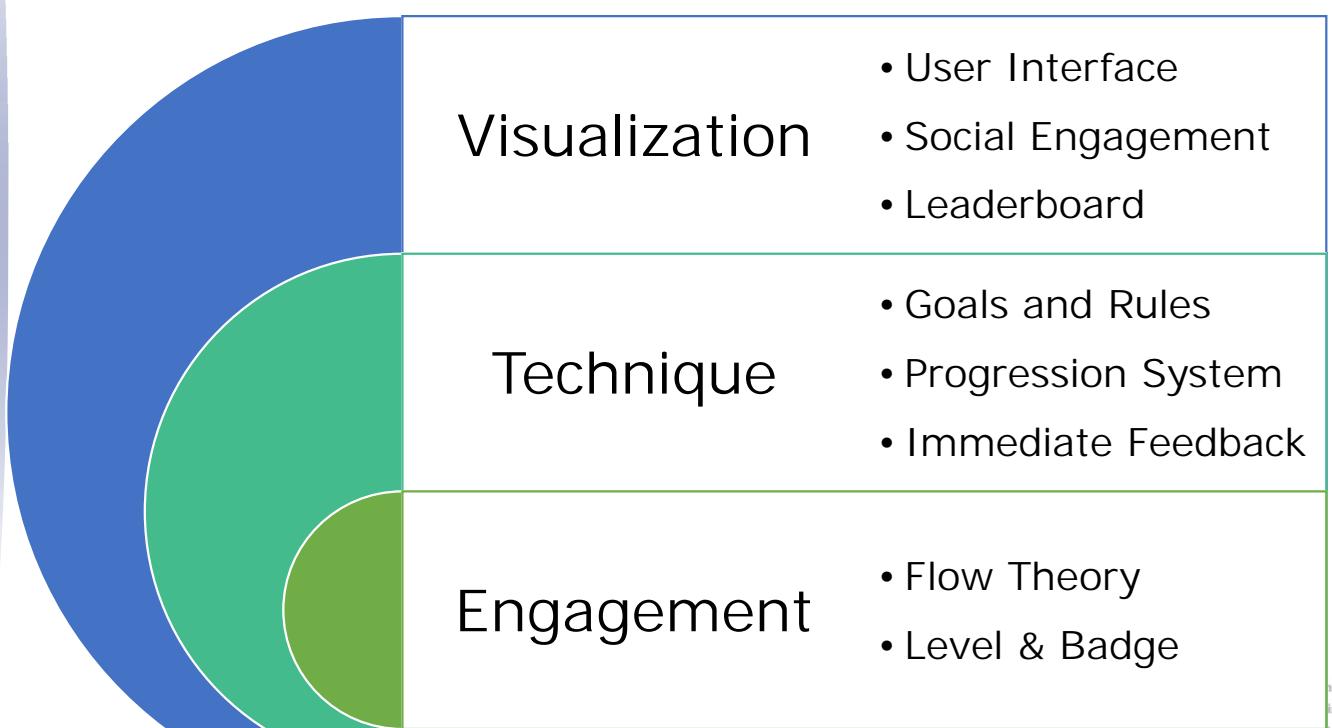
## Use Mechanism of Game to Solve Problem

- Improvement of motivation in learning
  - Ranking: Need for approval, competition principle
  - Leveling: Self-realization
  - Badge : Extrinsic motivation, completion
  - Borderline of difficulty: Challenge to next time
- ⇒ Should lead to intrinsic motivation for learners
- Improvement of cognitive skills in learning
  - Mission: Embedded challenges
  - Adaptation: Tasks according to learner's level
  - Instant feedback : Fixing of understanding
  - Visualization : Reflection of learning process
- ⇒ Should provide how to make good learning



## What is Gamification?

### Gamification: Using Game Mechanism to Solve Problem in Non-game Context



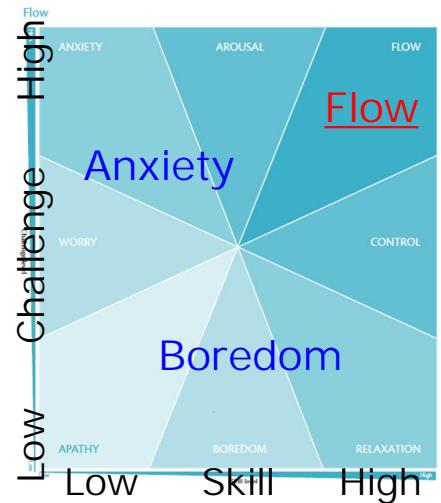
# Elements of Gamification (1)

## Engagement:



### Flow Theory

- Balance between challenge and skill so that player can neither be bored nor anxious. (Csikszentmihalyi et.al. 2005)



### Level-up & Badge

- Self-efficacy and trigger of motivation with completion



# Elements of Gamification (2)

## Technique:



### Goals & Rules

- Goal-oriented & rule-based context to focus on specific activity



### Progression System

- Incremental challenges and accessibility to keep players' motivation (i.e. Quests)



### Immediate Feedback

- Giving players guidance at the right moment



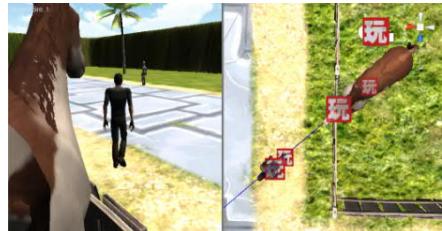
# Elements of Gamification (3)

## Visualization:



### User Interface

- Part of appeal to allow to adopt new role or to make meaningful play



### Social Engagement

- Teamwork and cooperation for collective responsibility



### Leaderboard

- Showing where player's rank in a gamified system (Competition)



# Why Gamification?

## Affinity between Education and Gamification

### ➤ First principles of instruction

Item	Education	Gamification
Task-centered	Authentic task-driven	Goals & Rules
Activation	Advanced organizer Motivation design	Flow Theory Level-up & Badge Leaderboard
Demonstration	Modeling topic Using Media	User Interface (Tutorials)
Application	Practice opportunity Feedback & coaching Fading support	Progressive system Immediate Feedback (Free to failures)
Integration	Exploration	Social Engagement

# Learning Strategy (1)

(Weinstein & Mayer, 1986)

## Main Concept

- Special thoughts or behaviors for learning new information.

## Five major groups

- Rehearsal strategies
  - Identifying & repeating important segments of given materials.
  - Loud-reading, highlighting, underlining etc.
- Elaboration strategies
  - Going beyond the given content and extends it with additional information.
  - Paraphrasing, summarizing, applying analogies



# Learning Strategy (2)

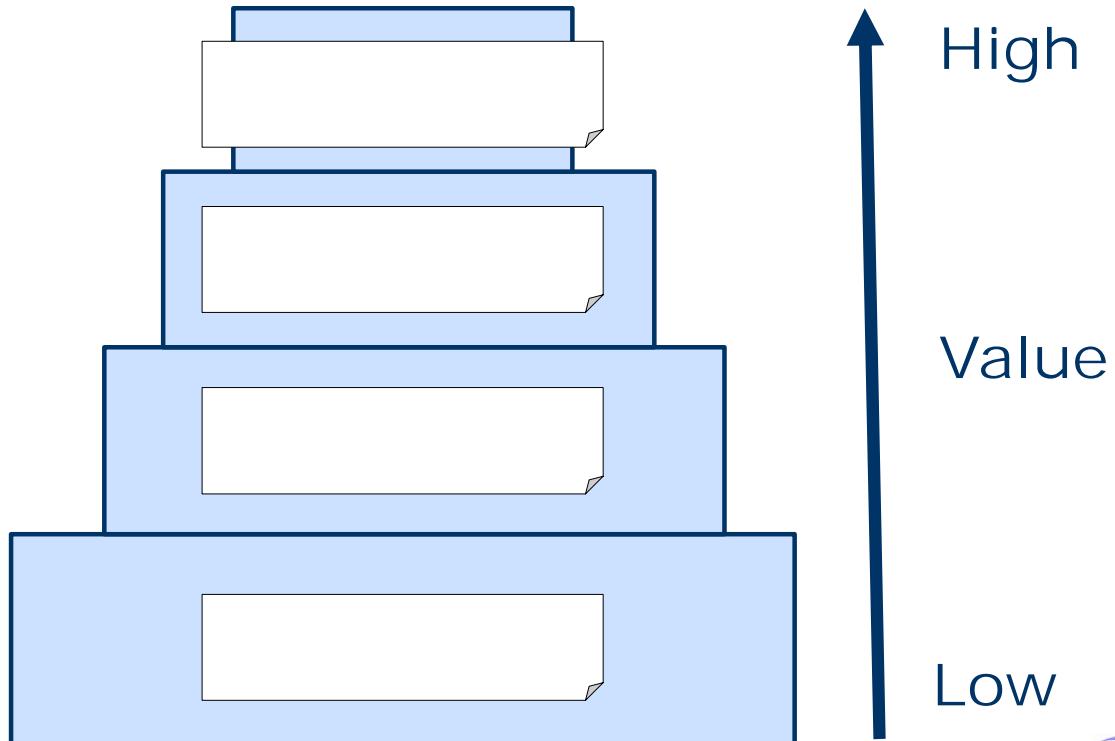
(Weinstein & Mayer, 1986)

## Five major groups

- Organization strategies
  - Reviewing & restructuring the presented material.
  - Outlining, creating tables, classifying etc.
- Metacognition strategies
  - Dealing with self-awareness of student.
  - Self-critique, reflection, monitoring
- Motivational strategies
  - Containing student's perception & conscious efforts to perform & feel better.
  - Attention focusing, reducing stress, etc.



# What is “Knowledge”?



## Value of Knowledge

### Characteristics of Knowledge Society

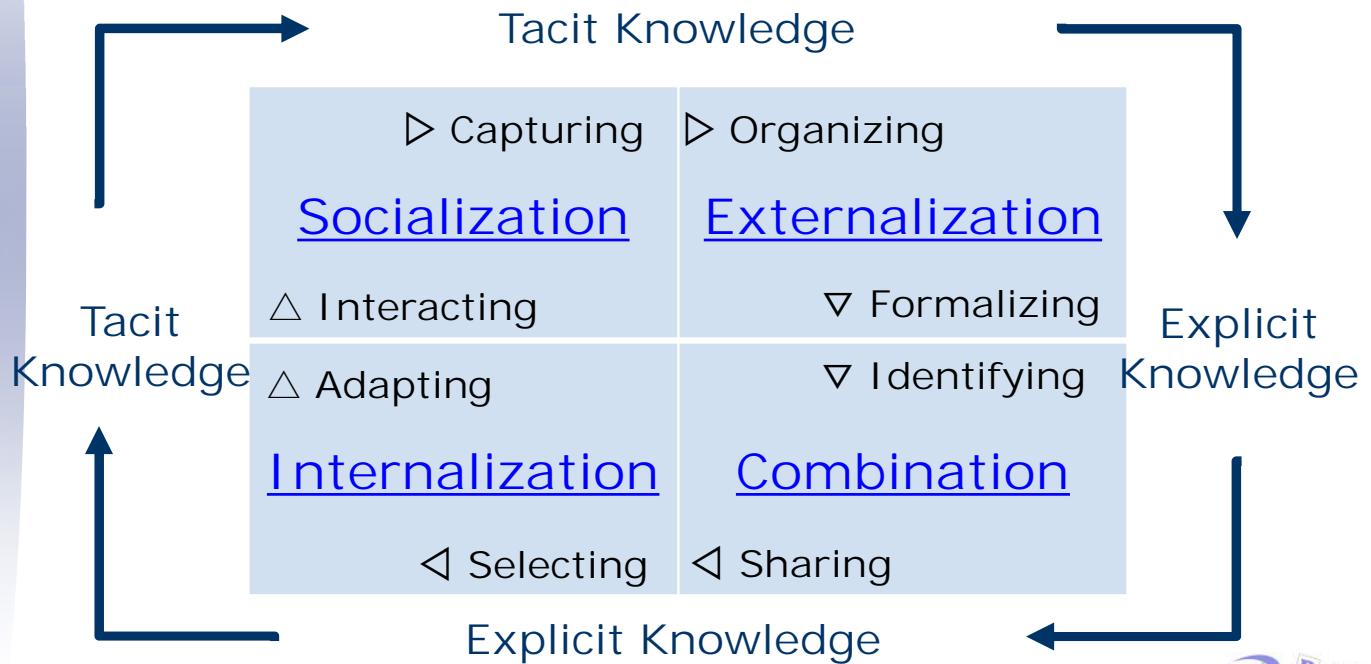
- Change of value by/without using.
  - Growing in value by using.
  - Falling in value without using.
- Non-linear value of knowledge.
  - 1 idea + 1 idea  $\neq$  2 ideas.
  - Change of value by combination.
- Easy moving/storing.
- Creator may be consumer.
  - Knowledge creation by interaction.

Learning should be connected to social practice.

# SECI Model

(Nonaka, 1990)

- **Tacit Knowledge** : Non-verbalized
- **Explicit Knowledge** : Verbalized



# Social Development Theory

(Vygotsky, 1962)

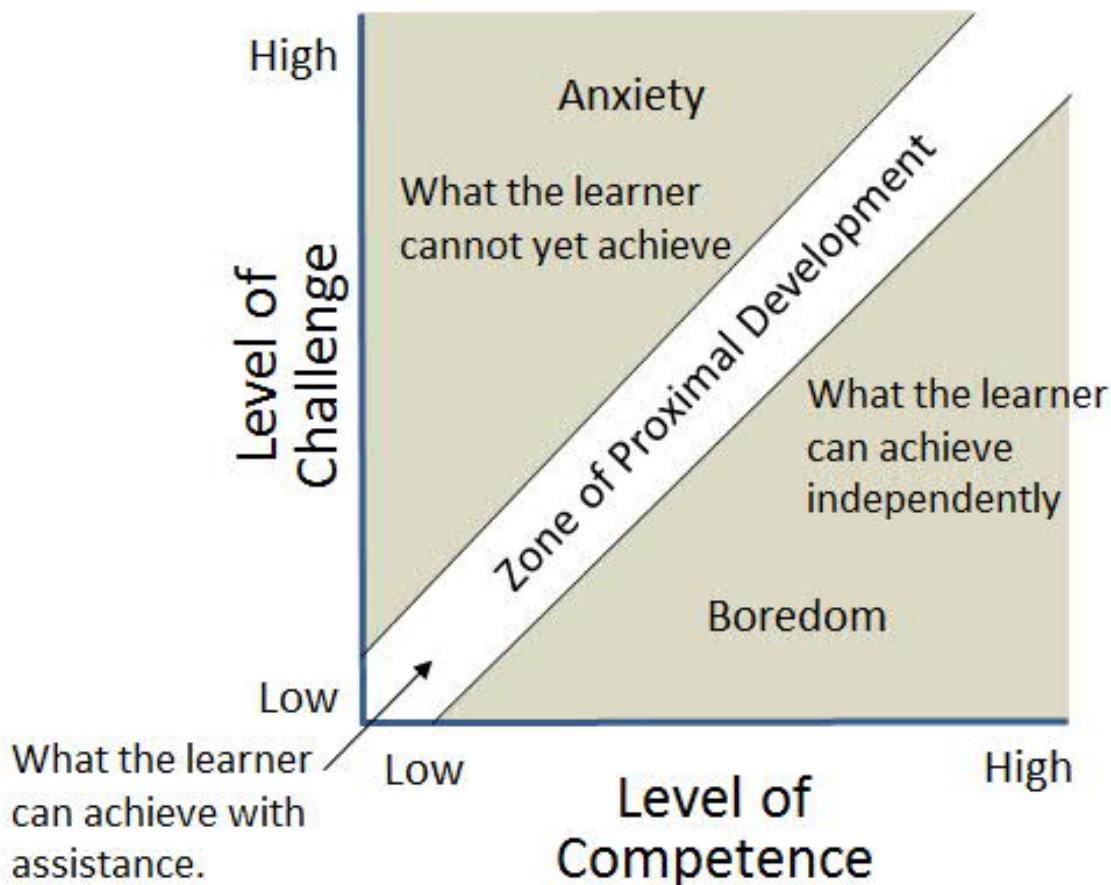
## Main Concept

- Social interaction plays fundamental role in process of cognitive development.

## Keywords

- More Knowledgeable Other (MKO)
  - Anyone who has better understanding than learner.
- Zone of Proximal Development (ZPD)
  - Distance between student's ability to perform task under guidance of MKO and his/her ability solving problem independently.





## Communities of Practice

(Lave & Wenger, 1991)

### Main Concept

- Groups of people who share concern or passion for something they do and learn how to do it better as interact regularly.

### Required Components of CoPs

- Domain
  - Membership implies a commitment to domain.
- Community
  - Members interact and engage in shared activities.
- Practice
  - Members are practitioners.

# Legitimate Peripheral Participation

(Lave & Wenger, 1991)

## Main Concept

- How newcomers become experienced members of CoP.

## Process of LPP

- 1<sup>st</sup> step
  - Participating in simple & low-risk tasks.
- 2<sup>nd</sup> step (Through peripheral activities)
  - Organizing principles of community.
- 3<sup>rd</sup> step (Becoming old timer)
  - More & more central to functioning of CoP.



# Distributed Cognition

(Hutchins, 1995)

## Main Concept

- Mind is in the world (not world is in the mind).
- Knowledge & cognition is distributed across objects, individuals, artefacts & tools.

## Goal of D-Cog

- How distributed units are coordinated by analyzing interaction between individual, media, & environment.
- Effect **with vs. of** technology.
- Affordance



# Collaborative Learning

(Resta, 1995)

## Main Concept

- Groups work together for common purpose.

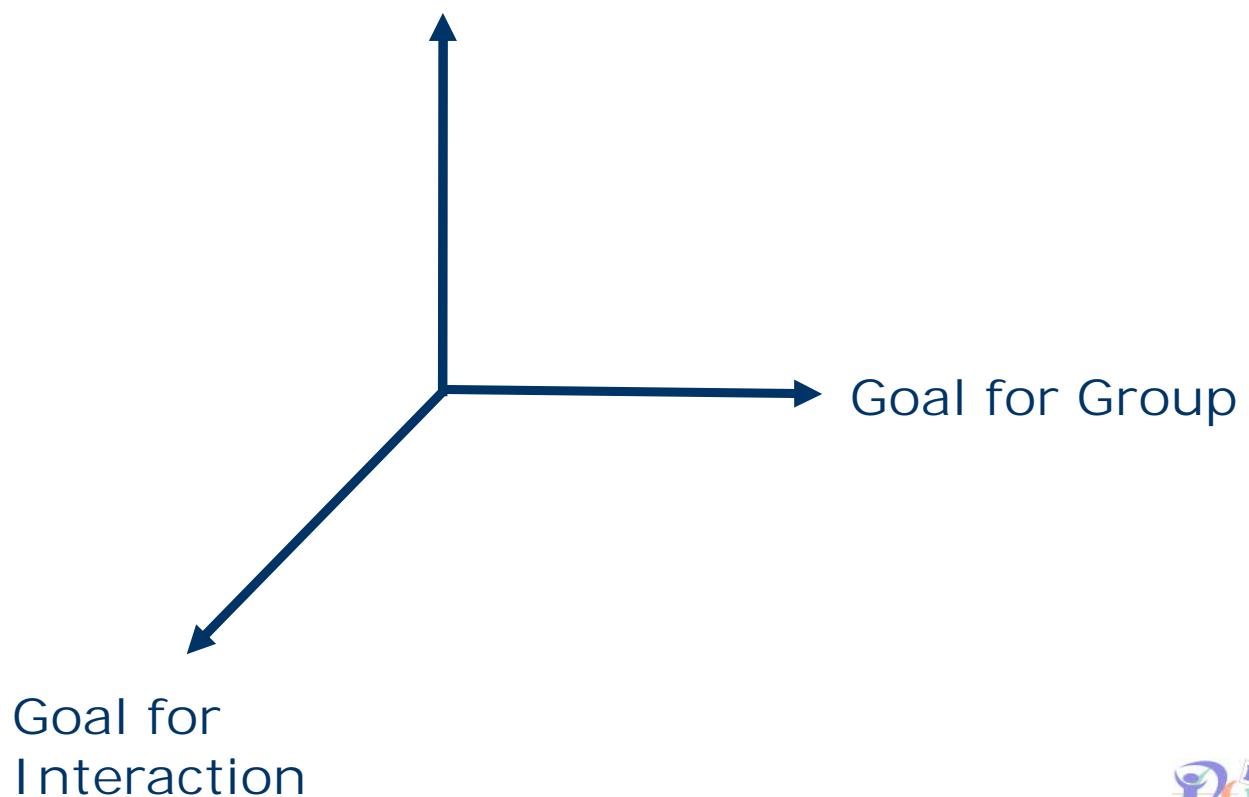
## Computer Supported

- CSCW (Ellis 1991)
  - Computer Supported Collaborative Work
  - Groups work in common task using shared interface & system.
  - Facilitating communication & productivity
- CSCL
  - Computer supported Collaborative Learning
  - Learning take place via interaction using computer.
  - Supporting students in learning together effectively.



## Goal of CL

Goal for Individual



# Principles of CL (CoREF, 2009)

1. Students can have a unified goal.
  2. They can have different answer.
  3. They can exchange their own ideas.
  4. They can develop their thinking by ideas' integration.
  5. They can share knowledge by presentation.
  6. They can find what they want to know.
- Teacher should maximize the difference of understanding process of students.  
→ Students expand their understanding by collaborative activity.



## Typical Types of CL

(Inaba & Toyoda, 1998)

Learning by ...	Description
Observation	Indirect learning by observing others' learning process.
Self-explanation	Learning by explaining one's own thinking process to others.
Teaching	Deeply learning by teaching to others.
Doing	Deeply learning by actual activity
Participation	Learning by participating to better group.
Discussion	Deeply learning by discussing to others.

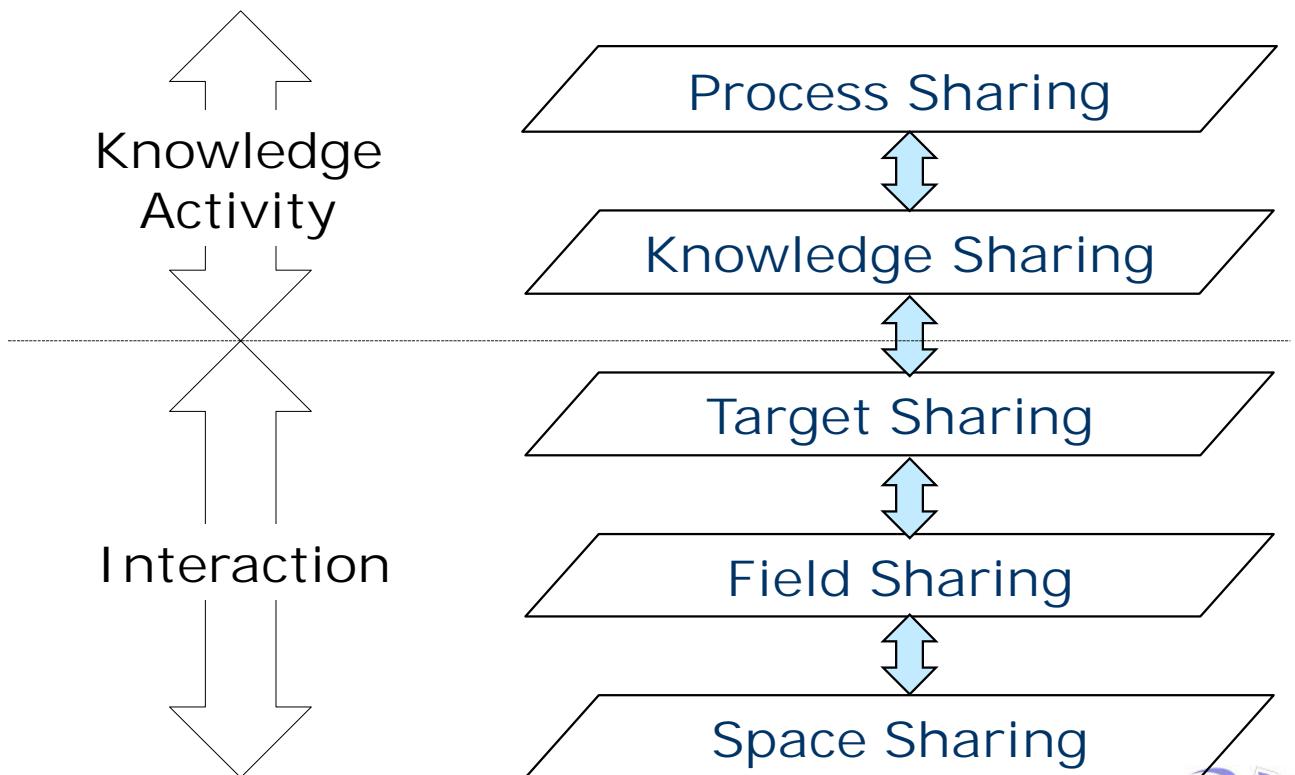
- Teacher should consider about suitable grouping to facilitate students' interaction.

# How to Make Group

Goal	Member	Type of Interaction
Personalized Learning		Opinion, Question, Agreement
Group Thinking		Responsibility, Coordination, Arrangement
Supplementation of Lecture		Assignment, Competition, Cooperation
Training for Interaction		Discussion, Debate, Agreement

## Classification of CL

(Watanabe, 2008)



# Observational Learning

(Bandura, 1986)

## Main Concept

- Learning occurs through observing behavior of others.

## 4 Stages of Observational Learning

- Attention
  - Paying attention to what's happening.
- Retention/Memory
  - Not only recognizing but also remember it.
- Initiation/Motor
  - Physically & intellectually capable of producing act.
- Motivation
  - Coaches should encourage students.



# Peer Tutoring

(Goodlad, 1989)

## Main Concept

- Learners help each other and learn by teaching.
- "Peer" means same or nearly status as person being tutored (not teacher).

## Golden Rules for Organization

- Defining aims & roles.
- Training & supporting tutors & mentors.
- Structuring contents.
- Keeping logistics as simple as possible.
- Evaluating the scheme



# How to develop skills?

What do you think about  
"Good way for developing  
Cognitive skills"  
for novices?



## Metacognition

(Flavell, 1976)

### Main Concept

- Metacognition refers to higher order thinking which involves active control over cognitive processes engaged in learning.

### Difficulties in Metacognitive Skill

- For Learning
  - Input & output for skill are invisible.
  - Unclear when a person uses skill, trigger, result.
- For Executing
  - Capacity of working memory.
  - Multi processing in mind.
  - To be aware when they should use it.

# Situational Leadership

(Hersey & Blanchard, 1972)

## Main Concept

- Successful leaders should change their leadership styles based on maturity level.

## Leadership Style

Maturity Level	Leadership Style
M1: Low Maturity	S1: Telling/Directing
M2: Limited Skills	S2: Coaching
M3: Higher Skills	S3: Participating/ Supporting
M4: High Maturity	S4: Delegating



# Cognitive Apprenticeship (1)

(Collins, Brown & Newman 1987)

## Main Concept

- Process for mastering skill as apprentice.

## Teaching Methods

### 1. Modeling

- Expert demonstrates task so that novice can build conceptual model.

### 2. Coaching

- Expert observes novice's performance and offers feedback & hints.

### 3. Scaffolding

- Expert puts into place strategies and methods to support novice's learning.



# Cognitive Apprenticeship (2)

(Collins, Brown & Newman 1987)

## Main Concept

- Process for mastering skill as apprentice.

## Teaching Methods

### 4. Articulation

- Learner articulates own process.

### 5. Reflection

- Learner compares own process with expert, others, & internal model.

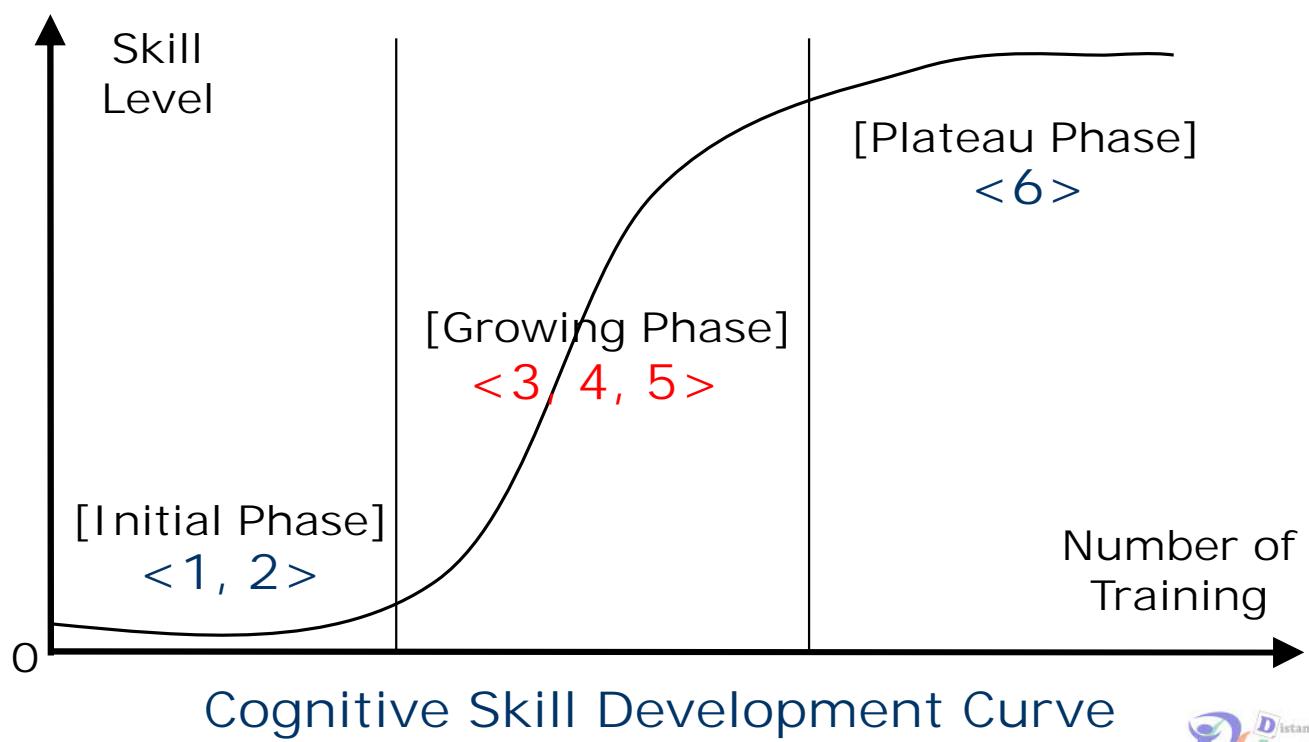
### 6. Exploration

- Expert provides learner with problem solving environments.

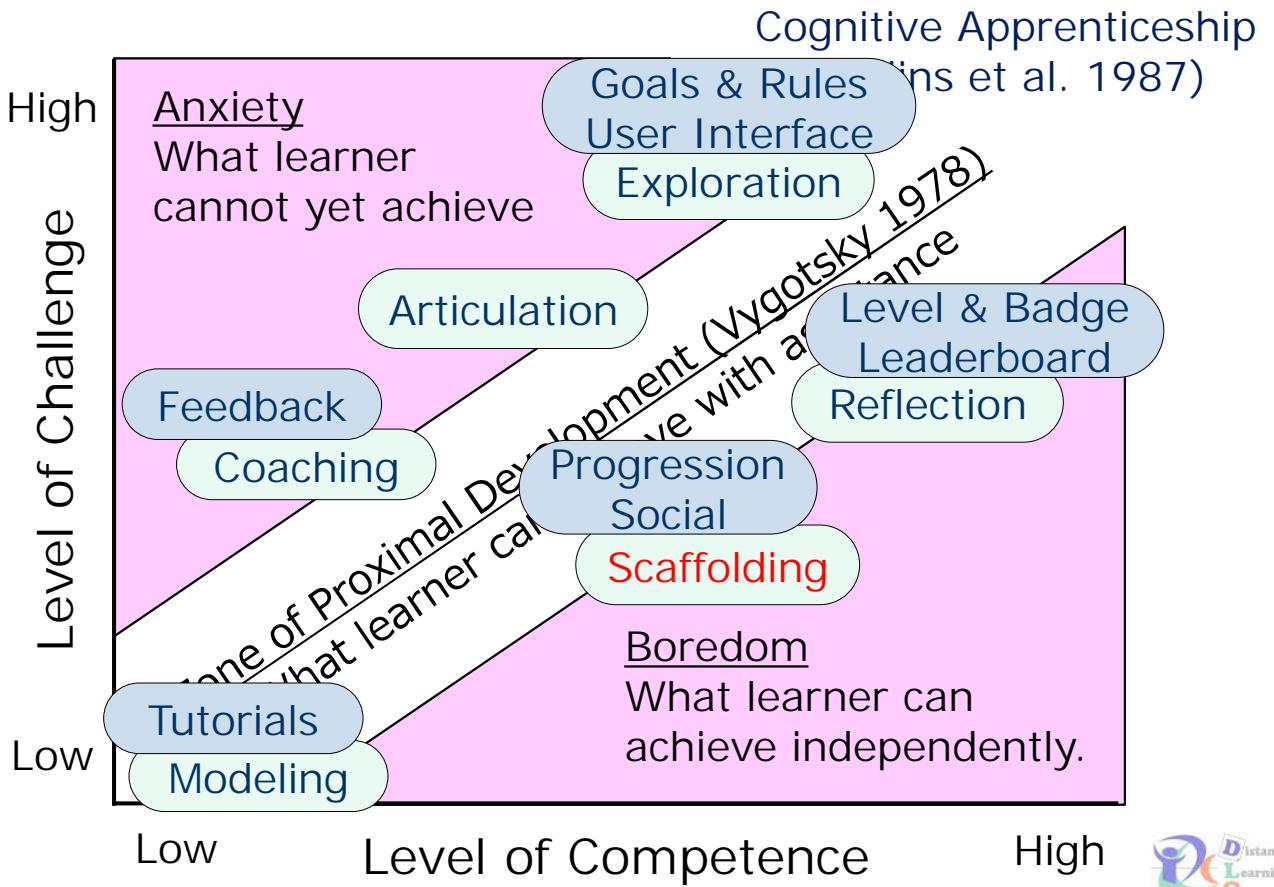


## How to train?

### How to improve “Cognitive Skill”

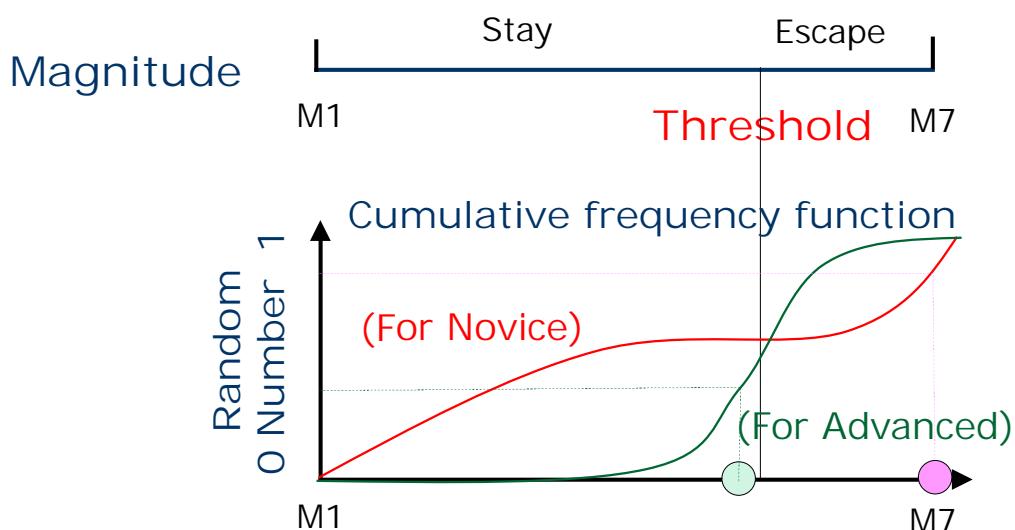


# Skill Cultivation Model



## Adaptive Task Creation

Ex. How do you act at earthquake Mx?



High Potential: Almost parameters are set near to threshold  
 Low Potential: Almost parameters are set far to threshold

$$\text{Param} = \text{Rand}(0,1) * F^{-1}$$

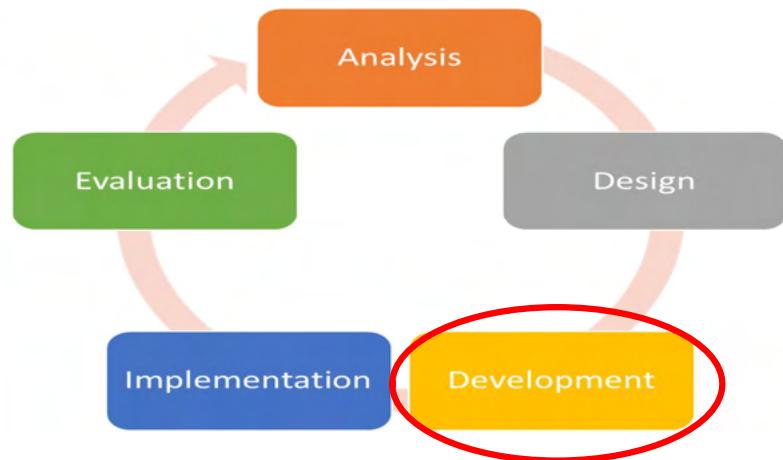
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- **Scientific**
- **Follow-able**



Merrill, M. D., Drake, L., Lacy, M. J., Pratt, J., & ID2\_Research\_Group. (1996). Reclaiming instructional design. Educational Technology, 36(5), 5-7.

## Acceptability of Contents



# Definition of Usability

(Nielsen, 2012)

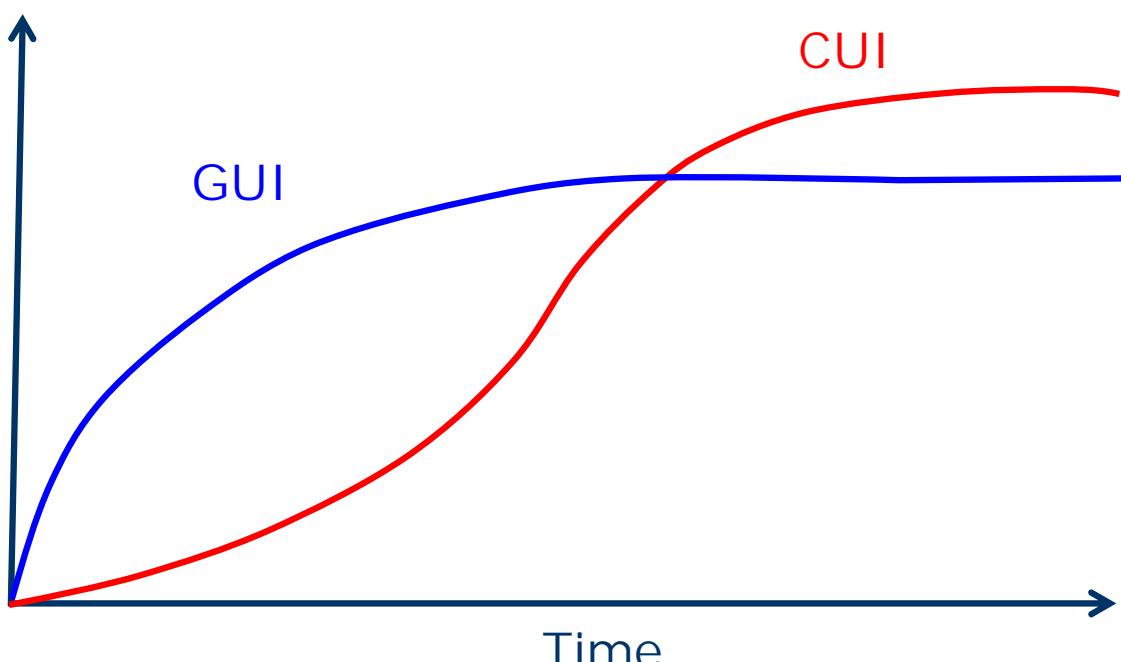
## Method for Improving Ease-of-use

- Learnability
  - How easy do users accomplish tasks?
- Efficiency
  - How quickly can users perform tasks?
- Memorability
  - How easily can users reestablish proficiency?
- Error
  - How many errors do users make?
- Satisfaction
  - How pleasant is it to use?



## Learning Curve

Efficiency



# Usability Trade-offs

## Trade-offs

- For novices
  - GUI is easy to learn, but not so efficient
- For experts
  - CUI is efficient, though initially hard to learn
- Multiple interaction styles are better
- If impossible, violating some principles

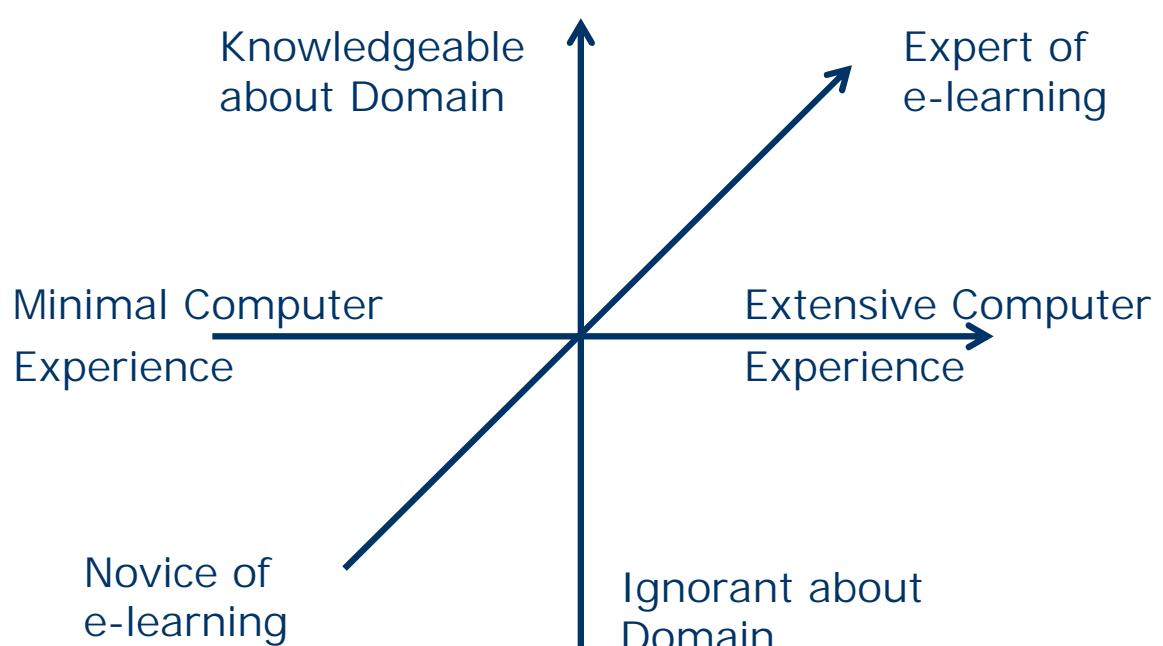
## Accelerators

- User interface elements
  - Allowing user perform frequent task quickly
  - Such as shortcut



# Individual User Differences

## User Cube



# Usability Slogans

- Your best guess is not good enough.
- Users are always right.
- Users are not always right.
- Users are not designers
- Designers are not users.
- Less is more.
- Details matter.



## Mistakes in Web Design in 1996

1. Using Frames
2. Gratuitous use of bleeding-edge technology
3. Scrolling text, marquees, & constantly running animation
4. Complex URLs
5. Orphan pages
6. Long scrolling pages
7. Lack of navigation support
8. Non-standard link colors
9. Outdated information
10. Overly long download times

# Mistakes in Web Design in 2011

1. Bad search
2. PDF files for online reading
3. Not changing color of visited links
4. Non-scannable text
5. Fixed font size
6. Page titles with low search engine visibility
7. Anything that looks like advertisement  
selective attention
8. Violating design conventions
9. Opening new browser windows
10. Not answering users' questions



## What is User Interface?

### Definition

- Part of computer & software that people can see, hear, touch, talk to, & understand.
  - GUI is easy to learn, but not so efficient

### Essential Components

- Input
  - How person communicates their needs to computer
  - Keyboard, Mouse, Trackball, fingers ...
- Output
  - How computer conveys results of computations & requirements to user
  - Display, Screen, Speaker ...



# Design Approach

Approach	Focus	User	Design
User-centered Design	User's needs & goals	Design principle	Interpretation of needs/goal
Task-centered Design	Tasks to be achieved	Task player	Function for task execution
System Design	System components	Goal setting	Organization for system
Talented Design	Designer's talent	Confirmation for Validation	Inspiration

## User-Centered Design

### Focusing User's Needs & Goals

#### Concept

- Design approach centered on usability and availability

#### Feature

- To increase user satisfaction
- To improve productivity and efficiency
- To reduce training cost
- To keep competitiveness

# Principles of UCD

1. Target Setting
  - Starting with definition of market & users.
2. User Understanding
  - Understanding target users' characteristic.
3. Team from Different Areas
  - Designing totally by experts from different areas.
4. For All Experience
  - Purchase, usage, support, & next selection.
5. User Evaluation
  - Making feedback based on usage of prototype.
6. Continual User Observation
  - Big data acquisition & analysis.



# Design Principles of IBM (1)

1. Concepts from the product's subject domain (for example, systems management) should be central and apparent in the software design.
2. Keep it simple.
3. Optimize the design for the most frequent or important tasks.
4. Make the interface accessible and visible to users.
5. Use proper default values when supporting complex tasks.
6. Be flexible.
7. Keep your users informed and in control by providing informative and timely feedback tailored to the current situation.
8. Things that look the same should behave in the same way, and an action should always produce the same result.
9. Provide the ability to undo and redo actions.



# Design Principles of IBM (2)

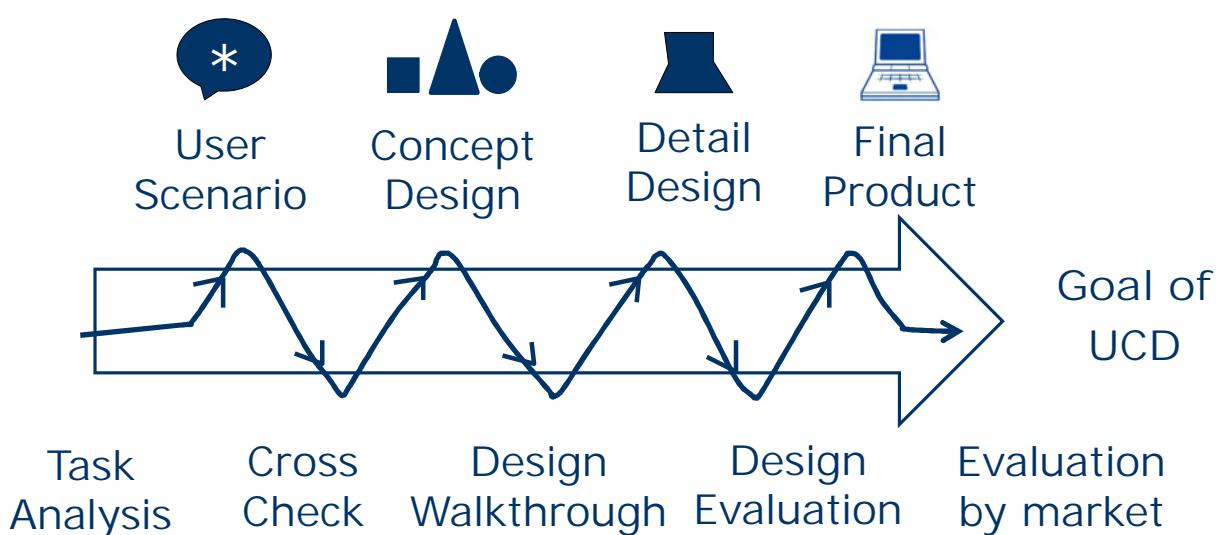
10. Make your application predictable by using industry standard user interface conventions wherever possible.
11. Always keep your target users in mind as the product is designed.
12. Avoid adding features just so they can be ticked off a list.
13. Design your user interface so that it can be localized for other geographies without redesigning the interface.
14. Consider persons with disabilities when designing your applications.
15. Design the application so that contextual help is available to users when they need it.
16. Bring objects to life through good visual design.
17. Create user interfaces that promote clarity and visual simplicity.

(<https://www-01.ibm.com/software/ucd/designconcepts/designbasics.html>)



## Process for UCD

### Design by Expert Team



### Feedback from Users



# Comparison with Traditional

Traditional Approach	UCD Approach
Technology-driven	User-centered
Quality of component	Quality of total solution
Limited collaboration	Cross-section team
Internal specification	External specification
Absence of user analysis	Participation of user analysis
Lack of attention to competitor	Attention to competitor
Production without user test	Production after user test
Quality control by defects	Quality control by experience
Lack of attention to user feedback	User feedback first
Focus to existing user	Not only existing user but also untapped user

## Topics of UCD

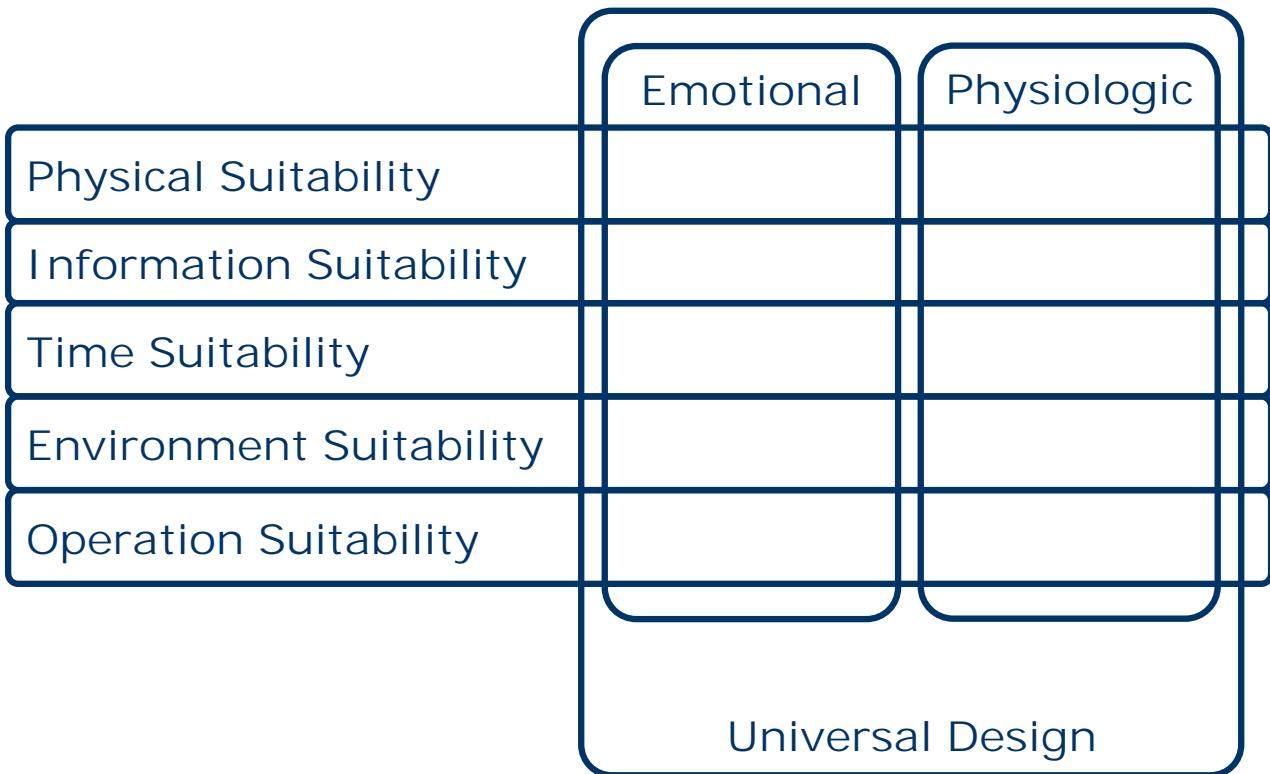
### Standards

- ISO13407: Human-centered design processes for interactive systems
- JIS Z8530 インタラクティブシステムの人間中心設計プロセス
  - Translation of ISO13407
  - <http://kikakurui.com/z8/Z8530-2000-01.html>

### Challenges for UCD

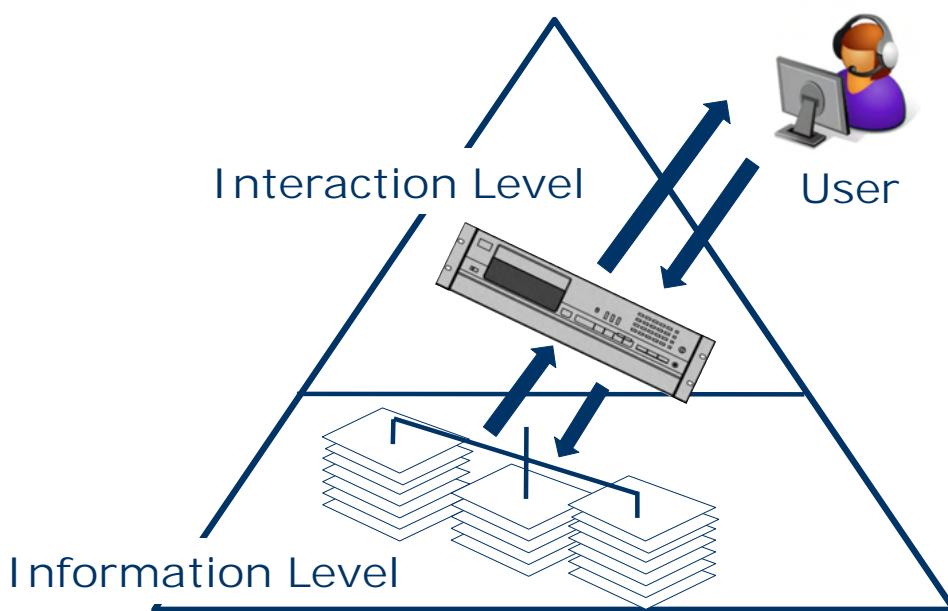
- Different terminology between designer & user
- Diversification of user performance
- Evolutionary change by user habituation

# Aspect of UI



## Level of UI

- Interaction Level
  - Ease to watch, use, understand
- Information Level
  - Systematic structure

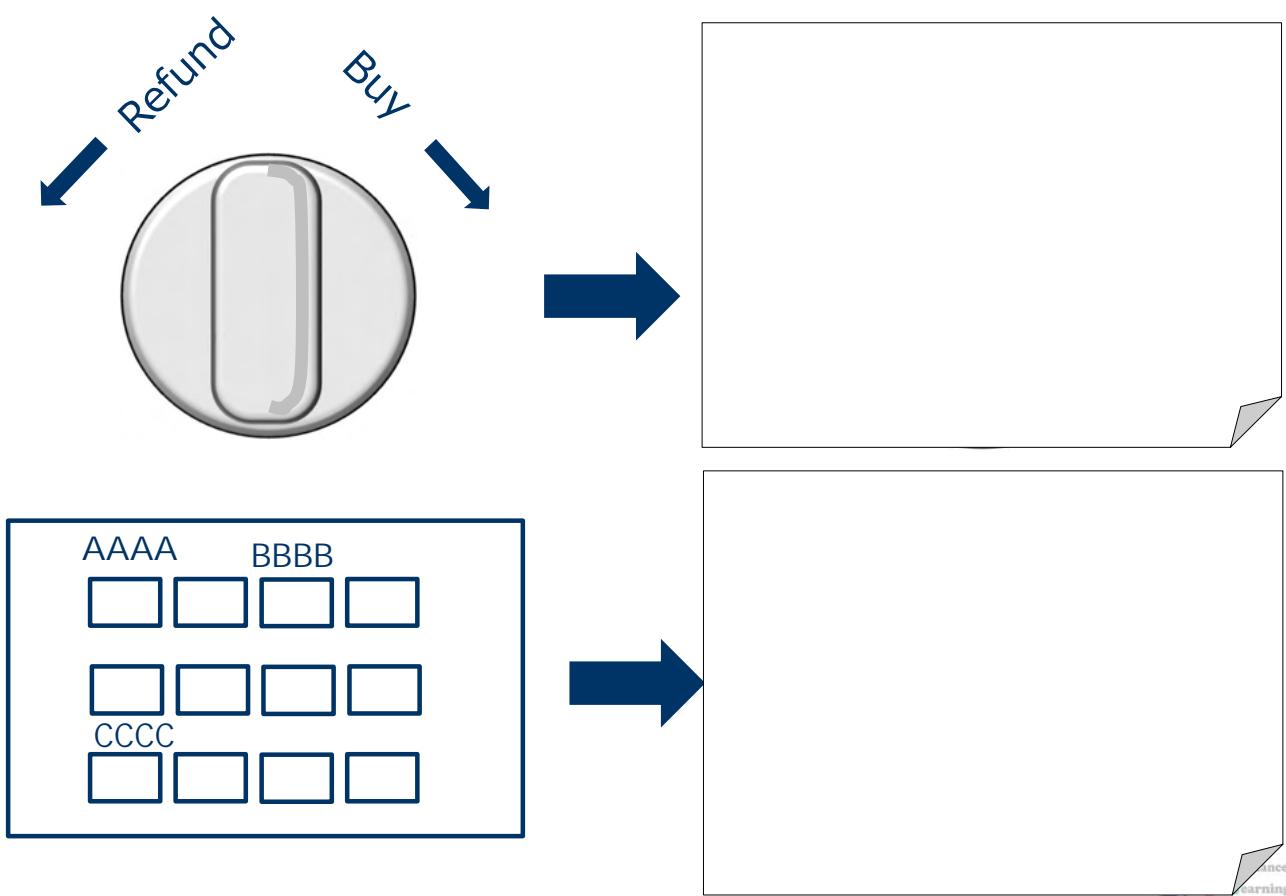


# Principles of Interaction

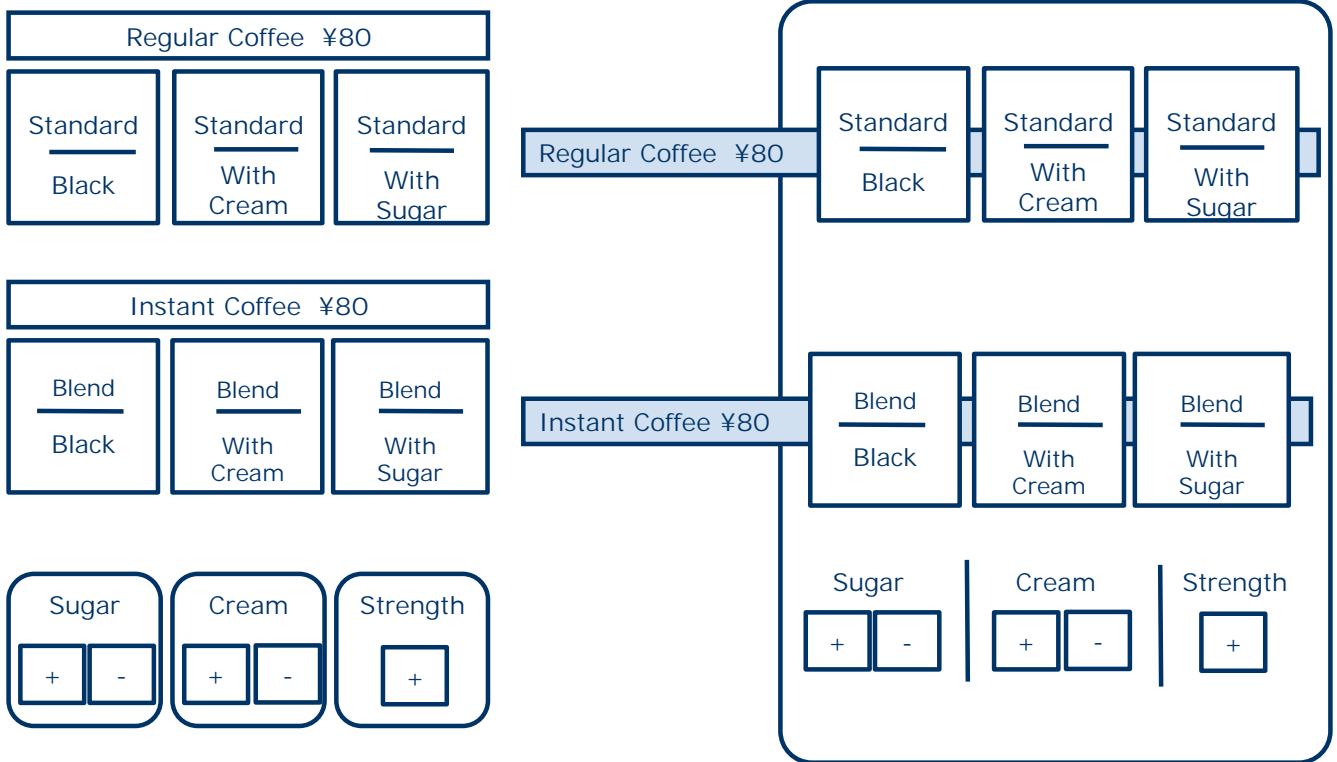
1. Visual clues
  - Providing operating guide, current situation, etc.
2. One word one meaning
3. Mapping
  - Clarification of relationship among elements
4. Consistency
  - Operational method, layout, reaction, etc.
5. Feedback
  - Visual & sound feedback to user operation
6. Operating principle
  - Constructing mental model of UI structure



## Examples of Interaction (1)



# Examples of Interaction (2)



# Information Classification

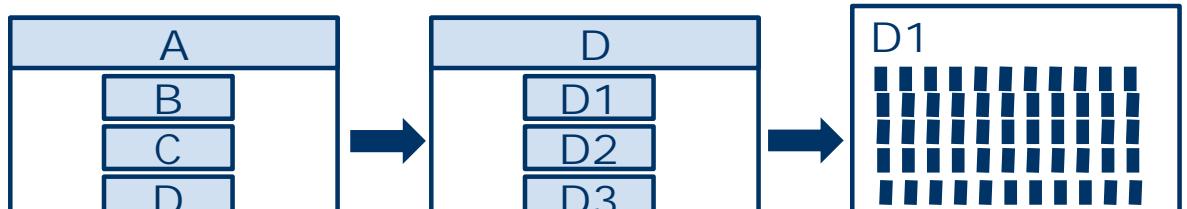
## Definition

- Understandable criteria for users
- Consistency classification

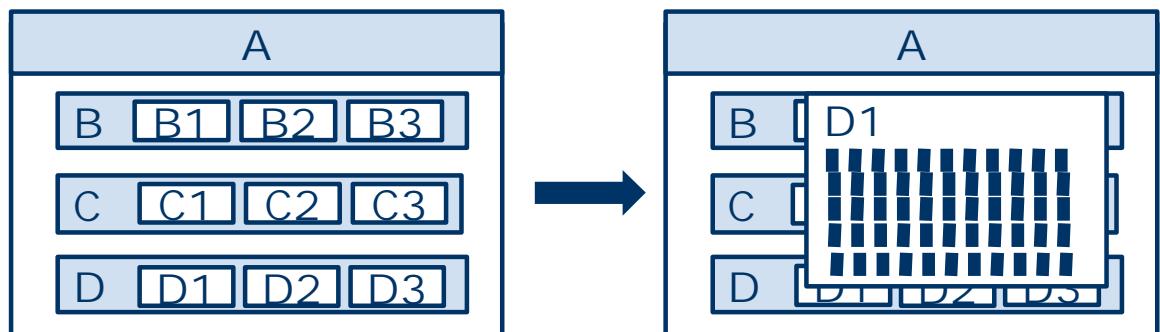
## Example of Classification Axis

- Position: Country, region
- Phonology: Japanese syllabary, Alphabetical order
- Timeline:
- Degree: Importance, size, weight
- Domain: Topic, purpose, function, attribute

# Information Structuring



Sequential Information Display



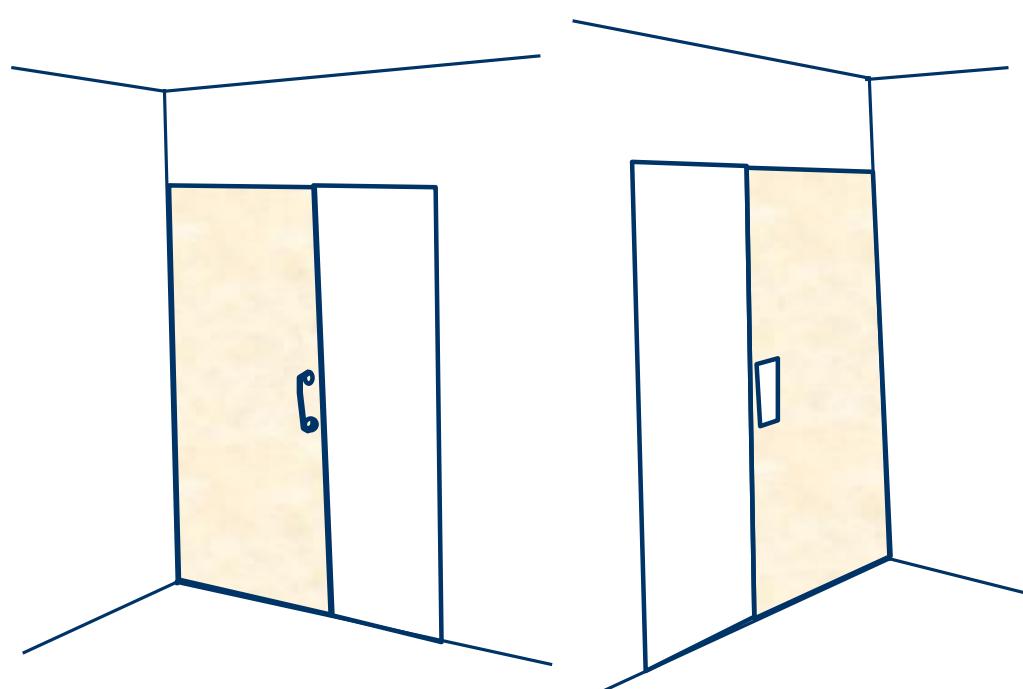
Parallel Information Display



## Affordance

(Gibson, 1979)

- Relation between object/environment & organism.



# Principles of Web Navigation

## Navigation Principle

- Where am I?
- Where do I come from?
- Where can I go to?

## How to Provide Good Navigation

- Common navigation in all pages
- 1 click access to main contents
- Based on typical contents structure
  - Linear, Hierarchical, Hyperlink, Grid



# Role of Media in Learning

- Motivation
  - Increasing learner's interest by media presentation.
- Information Acquisition
  - Media is suitable presentation for complex information.
- Information Structuring
  - Learners construct & transmit information by themselves.
- Indirect Experience
  - Media supports learners' conceptualization by virtual experiment without constraint.

# Principles of Multimedia Contents (1)

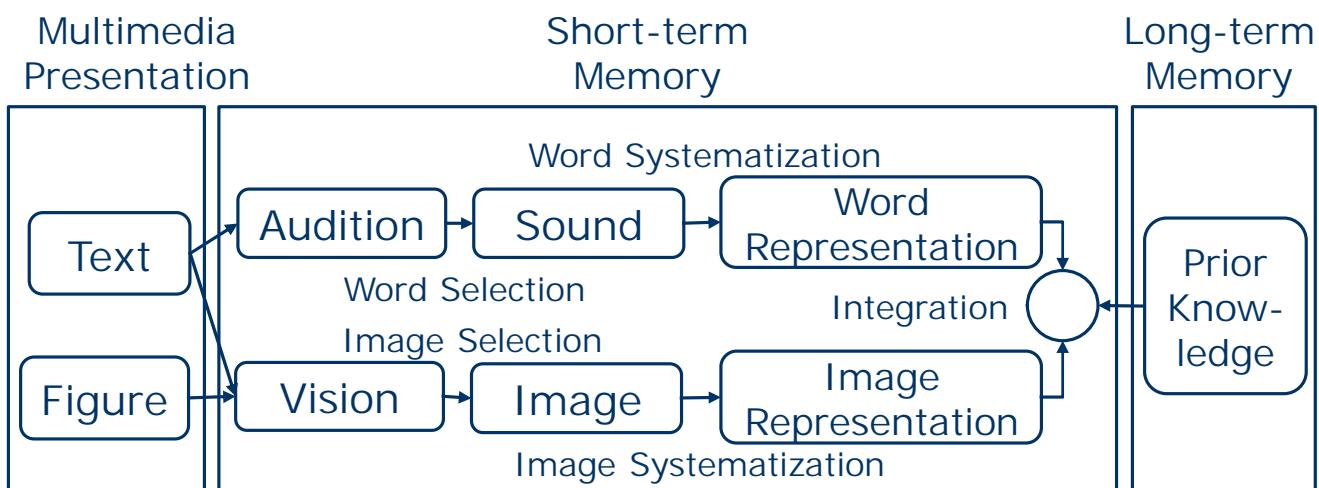
## Facilitation for Understanding

- Multimedia Principle
  - by text with figures, animation with sounds.
- Spatial Proximity
  - by placing text near to related figures.
- Temporal Proximity
  - by presenting text & related figures at the same time.
- Consistency Principle
  - If without non-related contents.



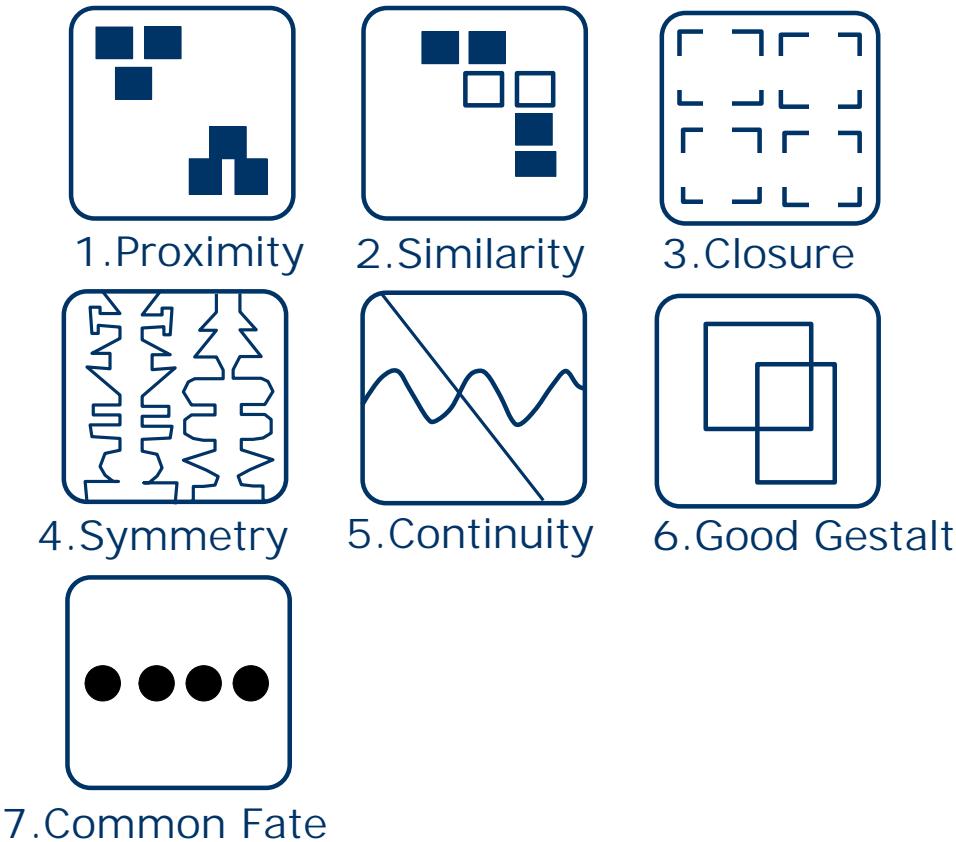
## Dual-coding Theory

(Mayer, 1998)



	Audition	Vision	A + V
Cognition Rate	11%	83%	94%
Information Quantity	$10^4 \sim 10^5$ bps	$10^6 \sim 10^8$ bps	—
Regeneration Rate(3days after)	10%	20%	65%

# Principles of Gestalt Systems



# Principles of Gestalt Systems

## 1. Law of Proximity

- When individuals perceive assortment of objects, they perceive objects that are close to each other as forming group.

## 2. Law of Similarity

- Elements within assortment of objects are perceptually grouped together if they are similar to each other.

## 3. Law of Closure

- Individuals perceive objects such as shapes, letters, pictures, etc., as being whole when they are not complete.

## 4. Law of Symmetry

- Mind perceives objects as being symmetrical and forming around a center point.

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# Principles of Multimedia Contents (2)

## Be Better / Be effective

- Representation Media
  - by figure/video & narration than by figure/video & text.
- Diffuseness
  - By video, text & narration than by video & narration.
- Individual Differences
  - for novices than for experts

# Contents Time & Pointer

## Contents Time

- Learner's interest decrease after around 15 minutes.
- Interactive mechanism (for practice, discussion) is important.

## Usage of Pointer

Advantages of pointer are to be able

- To control learner's viewpoint
- To reduce cognitive load for search
- To grow understanding by resource allocation



→ Test score of contents with pointer is better than one without pointer.



# Font Colors

## Degree of Attention

- Red > Blue > Green > Black > Purple > Orange > Yellow > Brown
  - RGB three primary colors are great deal of attention.

## Time of Attention

- Blue > Green > Red > Purple > Orange > Yellow > Brown > Black
  - Time of attentions for Red & Black are lower than degree of attention for them.

# Basic Principles for Charting

## Visualizing subsets on whole set

- Elemental Symbol
- Relational Symbol
- Relation between Subset

## Approaches

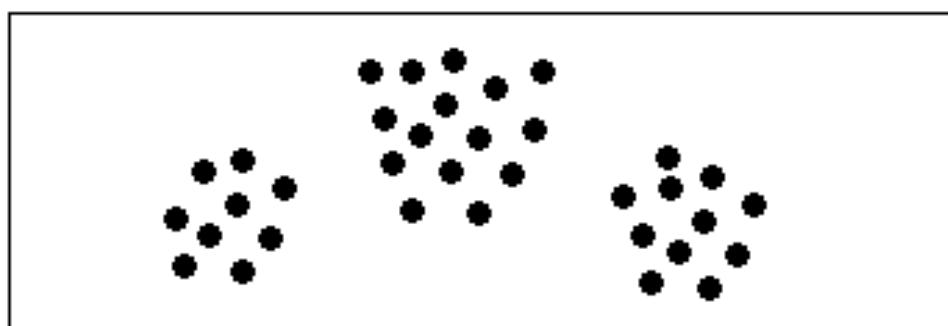
- Relationship by Placement
- Relationship by Indication Function
- Relationship by Representation of Elements



# Relationship by Layout (1)

## Perspective Layout :

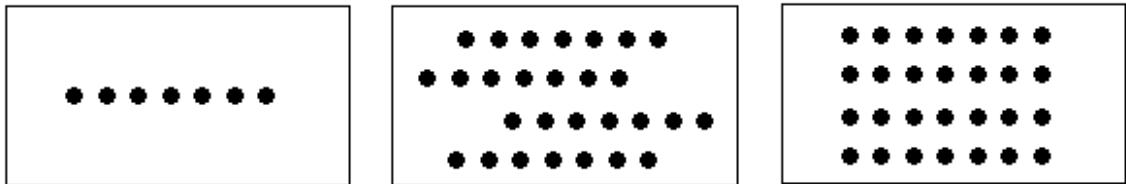
- Making subsets by collecting related elements
  - For simple classification
  - Relation: perspective of elements
  - Set, distribution, concentration, fusion, etc.



# Relationship by Layout (2)

## Array Layout :

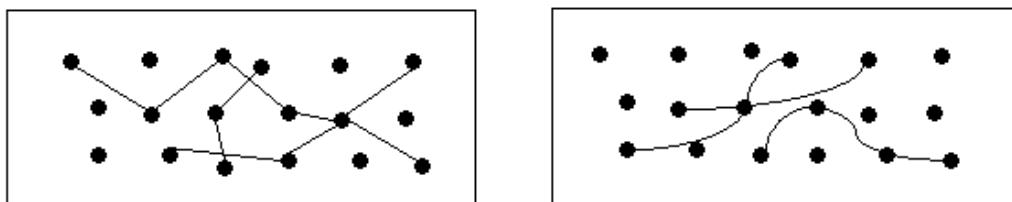
- Making arrays by allocating related elements
- Gestalt Systems
- Geometric array: Ex.) 2-dimensional matrix
- Relation: Regularity of layout
- Comparison, match, transition, order, etc.



# Relationship by Indicator(1)

## Connected Figures :

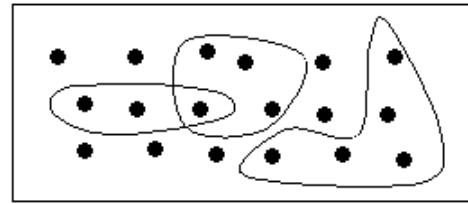
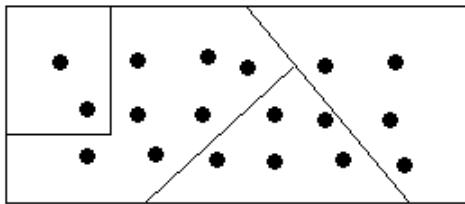
- Making subsets by connecting related elements directly with line
- Depending on linkage function of line
- Causality, order, system, process, etc.



# Relation by Indicator(2)

## Area Figures :

- Making subsets by dividing areas occupied by related elements
- Depending on division function of line
- Complicated areas by arrangement of elements
- Inclusion, duplication, boundary, etc.



# Relation by Elements

## Features

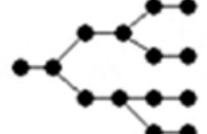
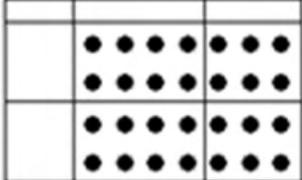
- Representing subsets by providing surface differences to elements
- Same surfaces are same groups regardless position of elements

## Method

- Representation by shape
  - Including direction
- Representation by size
- Representation by surface

Shape	Direction
○ △	↕
△ ○	↗ ↖
Size	Surface
○ ○	●
○ ○	● ●

# Combination

		Relation by Indicator	
		Connection	Area
			
Relation by Layout	Position	 	 
	Array		 

# Distance Learning System (遠隔教育システム工学)

*4W. Evaluation &  
Math in DLS*

Shinobu Hasegawa  
hasegawa@jaist.ac.jp



1

## Instructional Design

Definitions (Merrill etc. 1996)

- Creating “instructional experiences which make the acquisition of knowledge and skill more efficient, effective, & appealing.

ADDIE Model

- 5 Phases
- Scientific
- Follow-able



Merrill, M. D., Drake, L., Lacy, M. J., Pratt, J., & ID2\_Research\_Group. (1996). Reclaiming instructional design. *Educational Technology*, 36(5), 5-7.

2

# What do you imagine?

What do you think  
“Why Evaluation is important”?

What do you imagine as  
“Evaluation” in Classroom?



3

## Learning Goal vs. Scoring Goal

	Learning Goal	Scoring Goal
Purpose	How can I do that?	Whether can I do that?
Focus	Process	Result
Mistake	Valuable	Failure
uncertainty	Motivation	Danger
Best task	Task for maximizing outcome	Task for feeling clever
Desire	Correct info. about ability	Positive comments
Evaluation criteria	Subjective, long-term, flexible	Comparison to others, short-term, fixed
Expectation	Planning with my efforts	Planning with my ability
Teacher	Resource, guide	Judge, boss
Value of goal	Intrinsic: making value to acquiring skill & activity	Extrinsic: making value to others evaluation



4

## Summative vs. Formative Eval.

### Summative Evaluation

総括的評価

- Summarizing development of students at particular time.
- Results are often recorded as scores.
  - Midterm exam
  - Assigning grade to final exam

### Formative Evaluation

形成的評価

- Monitoring students learning to provide ongoing feedback.
- Identifying their strengths and weakness.
  - Mini test
  - Draw concept map
  - Research proposal



## Summative vs. Formative Eval.

### Summative Evaluation

▶ Viewpoint ◀

Summary in learning	← Meaning →	Clue for learning
Long-term	← Unit Size →	Short-term
End of period	← Timing →	Ongoing (End of unit)
Whole achievement	← Information →	Unit achievement
Final results	← Meaning for Information →	Intermediate status
Score or grade	← How to use →	Feedback

### Formative Evaluation



## Summative Evaluation for Class

### Kirkpatrick's 4 levels of evaluation model

Level	Timing	Target	Methods
1 Reaction	Immediately after class	Satisfaction	Questionnaire, interview, feedback system
2 Learning	Immediately after class	Achievement	Exam, practice, simulation
3 Behavior	2 months later	Improvement of behavior	Observation of work, interview to boss, record of OJT
4 Results	2 months later	Effects on business	Sales, cost, production, quality



7

## Formative Evaluation of Class

### Definition

- Conducting it to redevelop materials before completing educational course.

### Typical approach

- One-to-one Evaluation
  - Acquiring information for improving teaching method or material to one learner who should be selected according to ability.
- Mini-Group Evaluation
  - Judging effectiveness of class or materials to 8 – 20 learners who should be selected randomly.
- Field Evaluation
  - Confirming effectiveness of class or materials in actual lecture which consists of around 30 learners.



8

## Absolute vs. Relative Eval.

	Absolute Evaluation	Relative Evaluation
Viewpoint	<ul style="list-style-type: none"> <li>Degree of achievement</li> <li>Accreditation criterion</li> </ul>	<ul style="list-style-type: none"> <li>Measurement of learner's position in group</li> </ul>
Feature	<ul style="list-style-type: none"> <li>Consistent with learning goals (Directly)</li> <li>Depending on evaluator's subjective view</li> <li>How do we validate evaluation criteria???</li> </ul>	<ul style="list-style-type: none"> <li>Easy to judge (Indirectly)</li> <li>Depending on level of learners group (Objective)</li> <li>Does it use improvement for learning???</li> </ul>
Example	<ul style="list-style-type: none"> <li>TOEIC/TOEFL</li> <li>Grade (in University)</li> </ul>	<ul style="list-style-type: none"> <li>Deviation</li> <li>Low examination</li> <li>Admission test</li> </ul>



9

## How do we evaluate skill?

Learner	Skill Gotten	Time	Trial	Score
		1h	2	?
		3h	5	?

What do you think about  
**“How to evaluate skill”**  
by learning on DLS?



10

# Rubric

## Criteria for Skill Evaluation

- Learner can do something regarding to skills.
  - Basis on quality assurance for skills

Criteria	Managing class with ICT
Excellent	• To resolve ICT's troubles & recover class
Good	• To support students' operation
Average	• To operate ICT by themselves in class
Neutral	• Just To show e-materials in class
Poor	• Not to use any ICT in class

**Usual 5-grade evaluation like Likert scale  
may be different by each evaluator.**

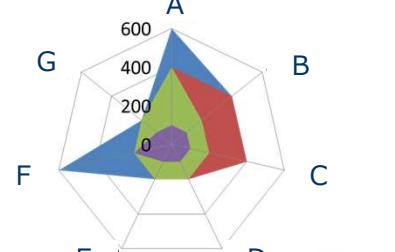
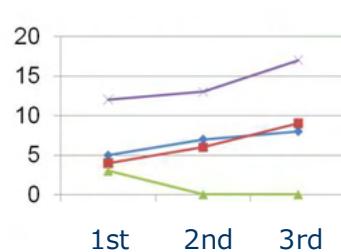


11

# Process Assessment

## Feedback by Learning Process

- Comparison:
  - To assess change with time
  - To compare with their past
- Achievement:
  - To visualize relationship among skills



12

# Peer Assessment

## Definition

- Assessment of student work by other students.

## Advantages

- Increasing feedback to students
- Reducing marking loads for teacher
- Giving students a sense of ownership of assessment process
- Encouraging critical analysis of student work
- Easy to understand feedback from similar level of students.



13

# Learning Portfolio

## What is portfolio?

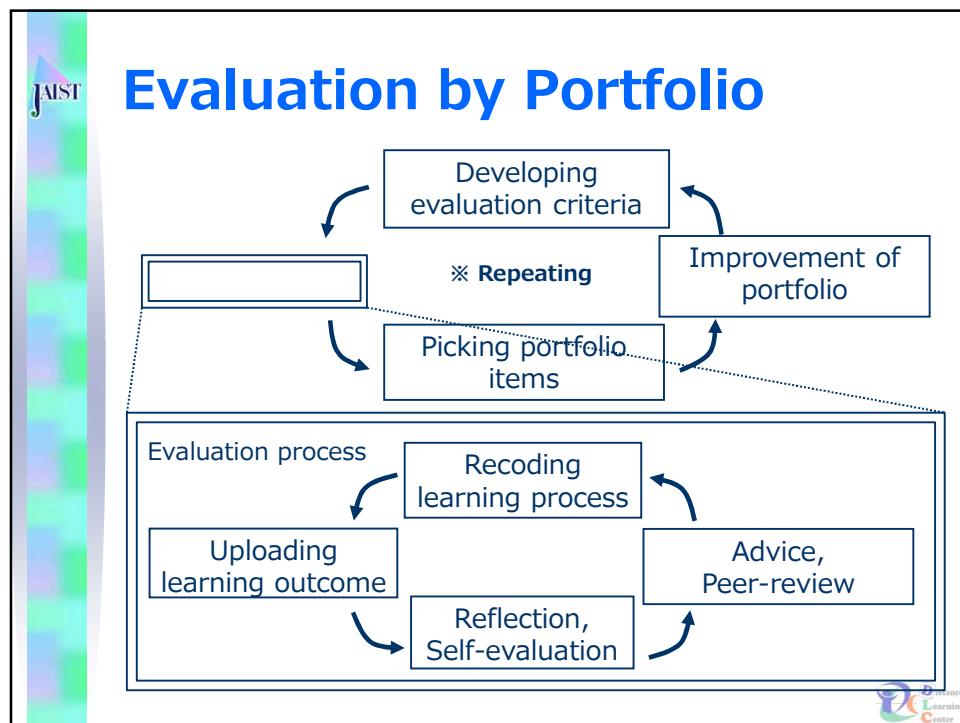
- Collection of evidence that represents achievement & learning within a module/course or program of study.

## Why portfolio?

- Actively reflecting on experiences.
- Integrating learning across experiences.
- Evaluating aspects of experiences as they relate to academic, personal & professional identities.
- Communicating integration of learning to various university audiences.



14



15



Written Exam.	Evaluation based on Performance	
	Performance	Process
<ul style="list-style-type: none"> <li>Subjective           <ul style="list-style-type: none"> <li>- Free description</li> </ul> </li> <li>Objective           <ul style="list-style-type: none"> <li>- Multiple-choice</li> <li>- True or false</li> <li>- Ordering</li> <li>- Pairing</li> <li>- Fill-in-the-blank</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Outcome           <ul style="list-style-type: none"> <li>- Report</li> <li>- Art work</li> <li>- Design</li> <li>- Software</li> </ul> </li> <li>Practical           <ul style="list-style-type: none"> <li>- Presentation</li> <li>- Debate</li> <li>- Physical skill</li> <li>- Operation</li> <li>- Practice</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Observation           <ul style="list-style-type: none"> <li>- Behavior</li> <li>- Activity</li> <li>- Note</li> </ul> </li> <li>Interaction           <ul style="list-style-type: none"> <li>- Q&amp;A</li> <li>- Discussion</li> <li>- Interview</li> <li>- Peer review</li> </ul> </li> </ul>
		Project, groupwork
		Portfolio

16

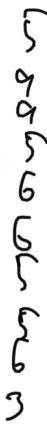




## S-P Table

		Problem ID									
		1	2	3	4	5	6	7	8	9	10
Student ID	1	1	0	0	0	1	0	1	0	1	1
	2	1	1	1	0	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	0	1
	4	1	1	1	1	1	0	0	0	0	0
	5	0	0	0	0	1	1	1	1	1	1
	6	0	0	1	1	1	1	1	1	0	0
	7	1	1	1	1	0	0	0	0	1	0
	8	0	1	0	1	0	1	0	1	0	1
	9	0	1	0	1	0	1	1	1	0	1
	10	0	1	1	0	1	0	0	0	0	0

5 7 6 6 7 6 6 6 4 6
 



17



## Procedure for S-P Table

1. Creating table with vertical list is student ID and horizontal list is problem ID, and filling 1 if it is correct or 0 if it is incorrect.
2. Sorting students in descending order of correct answers
3. Sorting problems in descending order of correct students
4. S curve: Writing delimiter for each student by counting correct answers from left side
5. P curve: Writing delimiter for each problem by counting correct students from upper side



18



## S-P Table

	2	5	3	4	6	7	8	(a)	1	9
2	1	1	1	a	1	1	c	1	c	1
3	r	r	r	1	r	i	1	c	r	a
5	a	r	o	o	1	1	c	a	1	
6	a	1	r	r	r					
7	r	o	a	c						
8	r	a	r	r						
9	r	a	a	a						
(a)	(	(	(	o	a	a	a	a	a	)



19



## Basic Features for S-P Table

- There are many “1 (correct answer)” in the upper left, and “0 (wrong answer)” in the lower right
- The area surrounded by S curve is equal to the area surrounded by P curve
- There may be heterogeneous reactions, “0” above S curve and “1” below S curve
- There may be heterogeneous reactions, “0” above P curve and “1” below P curve
- Homogeneous problems & students make S & P curves coincide
- Heterogeneous problems & students make S & P curves separate



20

# How do you evaluate?

How do you evaluate  
“DLS is effective or not”?



# Basic Format

Basic way of organizing experiment or investigation.

- Purpose
  - Hypothesis of experiment or investigation
- Method
  - Procedure of experiment or investigation
  - Plan, participants, materials, schedule, etc.
- Results
  - Results of experiment or investigation
  - Figure or table
- Discussion
  - Findings from analysis of results
  - Adoption/rejection of hypothesis



## Experiment vs. Investigation

### Experiment:

実験：仮説検証型

- Testing hypothesis derived from specific theory for certain event.

### Investigation:

調査：探索・発見型

- Finding status or behavior for certain event.

	Situation	Name	Interposition of researcher	How to get information
Experiment	Artificial	Subject	Condition setting	Measurement
Investigation	Natural	Participants	Passively observation	Observation



23

## Comparison of Data

- Comparison by setting**
  - Setting 2 or more conditions
  - Ex. Comparing learning outcomes in noisy, music & silent rooms.
- Comparison by sampling**
  - Gathering 2 or more groups of subject
  - Ex. Comparing learning processes of group of elementary, secondary, & high school students.
- Comparison by control**
  - Setting same natures except for condition to be evaluated.
  - Ex. Comparing learning outcomes in different conditions of lighting.  
→ Difficult to compare without control.



24

## Level of Measurement (1)

### Ratio Scale: 比率尺度

- Ratio between magnitude of continuous quantity & unit magnitude of same kind.
  - Physical scale: time, distance, speed, etc.
  - Count value: number of correct number, etc.
  - Percentage: percentage of correct answer, etc.
  - Score: test score, intelligence quotient, etc.

### Interval Scale: 間隔尺度

- Degree of difference between items, but not ratio between them.
  - Temperature: Interval is equal, but 0°C is not basing point.



25

## Level of Measurement (2)

### Ordinal Scale: 順位尺度

- Data can be sorted but doesn't allow for relative degree of difference.
  - Rank order, rating, level, etc.

### Nominal Scale: 名義尺度

- Difference between items or subjects based only on their name (Just qualitative type).
  - Yes or No, gender, nationality, language, etc.

### How about “Likert Scale”?



26

## Type of Data

ID	Age	Gender	Purchase	Impressions
A	23	Female	Health food	Nice in variety.
B	32	Female	Cosmetics	Good since it is cheap.
C	41	Female	Cosmetics	There are few kinds.
D	29	Female	Clothing	Difficult to know size.
E	34	Male	Clothing	Good quality.
F	42	Male	Watch	Slow to arrive.
G	33	Male	Watch	Nice in design.
H	22	Female	Health food	I want to purchase it next.

- Quantitative Data : Age etc.
- Qualitative Data : Gender, Purchase, etc.
- Natural Language Data : Impression, etc.



27

## Level of Measurement (3)

	Nominal Scale	Ordinal Scale	Interval Scale	Ratio Scale
$\times \cdot \div$				
$+\cdot -$				
$> \cdot <$				
$= \cdot \neq$				
Central Tendency	Mode	Median	Average	Geometric Mean

**Mode:** most often in set of data.

**Median:** separating higher half of set of data.

**Average:** sum of data divided by number of data.

**Geometric mean:**  $\sqrt[n]{a_1 a_2 \dots a_n}$



28

## Level of Measurement (3)

	Nominal Scale	Ordinal Scale	Interval Scale	Ratio Scale
$\times \cdot \div$	×	×	×	○
$+ \cdot -$	×	×	○	○
$> \cdot <$	×	○	○	○
$= \cdot \neq$	○	○	○	○
Central Tendency	Mode	Median	Average	Geometric Mean

**Mode:** most often in set of data.

**Median:** separating higher half of set of data.

**Average:** sum of data divided by number of data.

**Geometric mean:**  $\sqrt[n]{a_1 a_2 \dots a_n}$



## Check for Extreme Data(1)

- Outlier: Extreme deviation from average
- Screening : Work that finds outliers and decides them to be removed
- Ex.1: Find outliers from the following test scores of 20 students

65	41	55	38	49	49	93	63	57	47
42	39	46	40	55	46	57	64	62	55

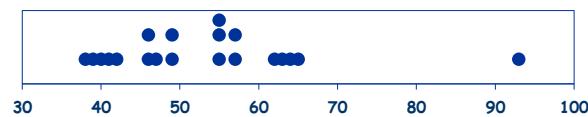
- Ex.2: Find outliers from the following report scores of 20 students

52	75	49	82	38	55	41	62	78	43
87	49	93	69	57	71	67	82	65	60

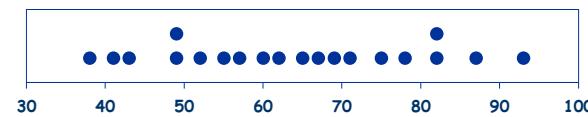


## Check for Extreme Data (2)

- Ex.3: Find outliers from the following test scores of 20 students



- Ex.4: Find outliers from the following report scores of 20 students



→ Objective criteria are necessary for judging



31

## Average & Standard Deviation

- Criteria for outliers : Consider central position of data and magnitude of variation

- Average: Indicator for central position of data

$$\rightarrow \mu = \frac{1}{n} \sum_{i=1}^n x_i$$

平均

- Standard deviation: Indicator for variation of data

$$\rightarrow \sigma = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \mu)^2}$$

標準偏差.

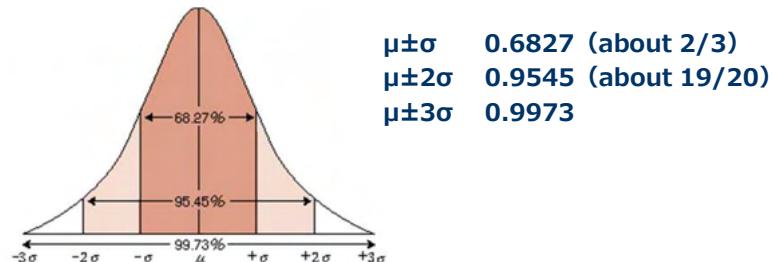
- Indication of outliers :  $\mu \pm 3\sigma$

中央値  $\mu$  の ± 3 倍  
 は 外れ値 (= Outlier)

32



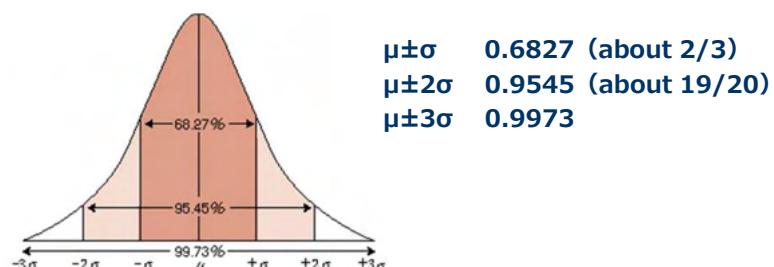
## Meaning of S.D. in Normal Dist.



(出展：富山県統計課編, 経済指標のかんごろ  
[http://www.cap.or.jp/~toukei/kandokoro/html/14/14\\_2migi.htm](http://www.cap.or.jp/~toukei/kandokoro/html/14/14_2migi.htm))

	Average	S.D.
Ex.1	<input type="text"/>	<input type="text"/>
Ex.2	<input type="text"/>	<input type="text"/>

## Meaning of S.D. in Normal Dist.



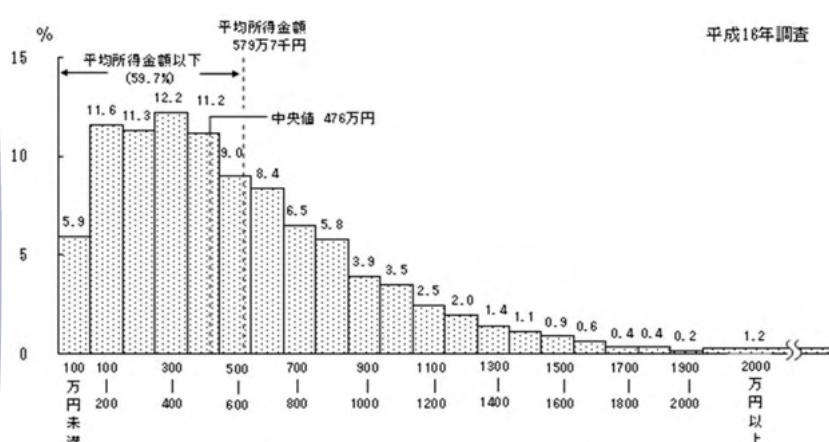
(出展：富山県統計課編, 経済指標のかんごろ  
[http://www.cap.or.jp/~toukei/kandokoro/html/14/14\\_2migi.htm](http://www.cap.or.jp/~toukei/kandokoro/html/14/14_2migi.htm))

	Average	S.D.
Ex.1	<b>53.2</b>	<b>12.8</b>
Ex.2	<b>63.8</b>	<b>15.9</b>

## What is deviation score ?

- Individual position in overall distribution
    - We can't compare our position in Math and English test results if their difficulties are different.
    - Deviation score is common standard for such case.
- $$\rightarrow \text{Deviation Score (T)} = 50 + 10 \times \frac{x_i - \mu}{\sigma}$$
- Average score is 50 in deviation score.
  - Value calculated by  $50 \pm Z \times 10$  to score that average  $\pm Z \times S.D.$

## Is Average always Representative ?



(出展：厚生労働省：平成16年国民生活基礎調査の概況  
<http://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa04/2-1.html>)

# Design of Experiment

## Definition

- Procedure for planning experiments by changing one or more process variables (or factors) to observe effect the changes.

## Keywords

- **Factor:** 要因
  - General type or category of treatment.
  - Something that researcher control to units.
- **Level: (1 factor has 2 or more levels)** 水準
  - Condition of each factor.
  - Man/woman, noisy/music/silent.



37

# Procedure of DoE (1)

1. Determining number of factor
  - Keep number of factor lower than or equal to 3.
2. Determining number of level
  - If 1 factor, keep number of level lower than or equal to 5.
  - If multiple factors, keep number of level lower than or equal to 3 to each factor.  
→ Number of condition = factor × level
3. Determining number of data
  - Make effort to gather over 20 in each treatment
  - Equalize number of data for each treatment essentially.



38

## Procedure of DoE (2)

### 4. Determining number of participants

- Between-subjects design
  - Assigning each subjects in each treatment.
  - 20 data for 1 factor 3 levels: 60 participants
- Within-subjects design
  - Assigning same subject in different levels.
  - 20 data for 1 factor 3 levels: 20 participants

初歩的実験  
~(段階以降  
の実験が変わる。

複数実験

Which design should be used?



## Within-subjects Design (1)

### Advantages

- Control of extraneous variables
  - Same ones conduct different treatments.
  - It is difficult for between-subjects design to keep similar status of participants.
- Efficiency in terms of subjects & time
  - Need less subjects & time than between-subjects design.
- Statistical Efficiency
  - Easier to detect differences across levels of results because subject's behavior under one treatment is compared to other treatments.





## Comparison

被験者間計画 vs. 被験者内計画

Between-subjects Design

Control		Treatment	
S1	60	S6	59
S2	65	S7	74
S3	55	S8	54
S4	50	S9	69
S5	70	S10	65
M=60		M=64.2	

Within-subjects Design

	Cont.	Treat.	Diff.
S1	60	65	5
S2	65	69	4
S3	55	59	4
S4	50	54	4
S5	70	74	4
M	60	64.2	4.2



41

## Within-subject Design (2)

### Disadvantages

- **Carryover effects**
  - When having been tested under one treatment affects how subjects behave in other treatments.
  - Need counterbalancing or randomization.
- **Tiredness effects**
  - Decreasing activity level by long experiment duration.
- **Averaging tendency**
  - Next reaction may be affected by previous reaction.
- **Factitive reaction**
  - Subjects may adjust reaction factitively.



42

# Counterbalancing

## Definition

- Separating groups of subjects so that each group can receive treatments in different order.

	1 <sup>st</sup> test	2 <sup>nd</sup> test	3 <sup>rd</sup> test
Subject 1	N	M	S
Subject 2	N	S	M
Subject 3	M	N	S
Subject 4	M	S	N
Subject 5	S	N	M
Subject 6	S	M	N

N  
M S

1回/2回  
交互法  
完全反復法  
カバーフォルダ

43



# Counterbalancing

## Definition

- Separating groups of subjects so that each group can receive treatments in different order.

	1 <sup>st</sup> test	2 <sup>nd</sup> test	3 <sup>rd</sup> test
Subject 1	Treatment A	Treatment B	Treatment C
Subject 2	Treatment A	Treatment C	Treatment B
Subject 3	Treatment B	Treatment A	Treatment C
Subject 4	Treatment B	Treatment C	Treatment A
Subject 5	Treatment C	Treatment A	Treatment B
Subject 6	Treatment C	Treatment B	Treatment A



44

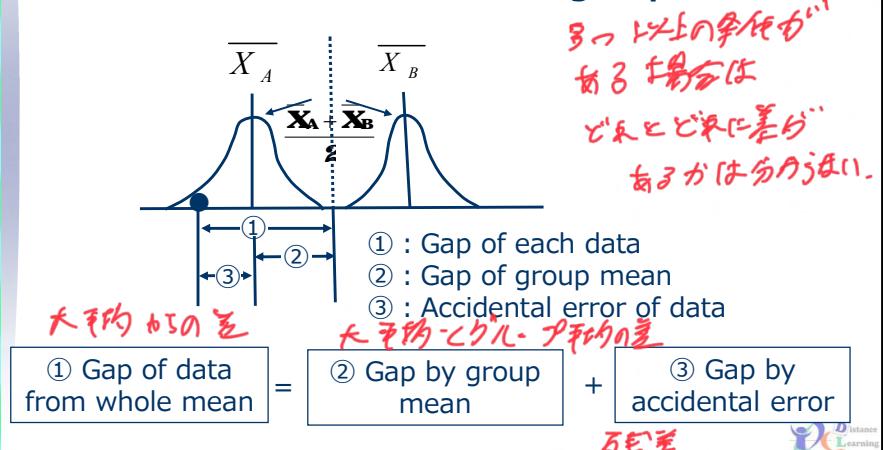
# Type of Significant Test 有意味検定

Parametric Test: normally distributed 正規分布		
For 2 groups	Non-paired	T-test, ANOVA
	Paired	Paired T-test, Paired ANOVA
For 3 or more	Non-paired	ANOVA
	Paired	Paired ANOVA
		Multiple comparison
Nonparametric Test: not normally distributed 一元配置		
For 2 groups	Non-paired	Mann-Whitney U test Wilcoxon rank-sum test
	Paired	Wilcoxon signed-rank test
For 3 or more	Non-paired	Kruskal-Wallis test
	Paired	Friedman test

# ANOVA

## Analysis of Variance

- Analyzing differences among group means.
- ANOVA allows for 3 or more groups.



## Procedure of ANOVA (1)

統計  
C&H

	Control	Treatment	
S1	60	S6	59
S2	65	S7	74
S3	55	S8	54
S4	50	S9	69
S5	70	S10	65
M=60		M=64.2	

統計  
C&H

### Data of Between Subjects Design

- Compute number of data, average, & standard deviation of each treatment.

- Compute whole mean.

$$M = \frac{\overline{X}_A + \overline{X}_B + \dots}{\text{Number of groups}} = 62.1$$



$$SD = \sqrt{\frac{1}{n} \sum (x_i - \bar{x})^2}$$

47

## Procedure of ANOVA (2)

- Compute SS<sub>Total</sub> ①

- Deviations from whole mean.  $SS_{Total} = (60 - 62.1)^2 + (65 - 62.1)^2 + \dots$

$$SS_{Total} = \sum (x_i - M)^2$$

- Compute SS<sub>Treatments</sub> ②

$$SS_{Treatments} = (\overline{X}_A - M)^2 \cdot N_A + (\overline{X}_B - M)^2 \cdot N_B + \dots$$

$$SS_{Treatments} = (60 - 62.1)^2 \times 5$$

- Compute SS<sub>Error</sub> ③

$$SS_{Error} = \sum_A (x_i - \overline{X}_A)^2 + \sum_B (x_i - \overline{X}_B)^2 + \dots$$

$$+ (64.2 - 62.1)^2 \times 5 \dots$$

$$= 44.1$$

$$\dots = 500.8$$

- $SS_{Total} = SS_{Treatments} + SS_{Error}$



48

## Procedure of ANOVA (3)

### 7. Make ANOVA table 分散分析表

(SV)	(SS)	(df)	(MS)	F value
Treatment	44.1	1	= 44.1	0.79
Error	500.8	8	= 62.6	
Total	544.9	9		

手作のページ

- **df (Degree of Freedom):** 自由度 独立に操作する データ数 - 1
- df of Treatment = number of treatment - 1
- df of Error =  $(N_A-1)+(N_B-1)+\dots$
- df of Total = number of whole data - 1



## Procedure of ANOVA (4)

### 7. Make ANOVA table

- **MS (Mean of SS)**
  - $MS_{Treatment} = SS_{Treatment} \div df_{Treatment}$
  - $MS_{Error} = SS_{Error} \div df_{Error}$
- **F-value**
  - $F\text{-value} = MS_{Treatment} \div MS_{Error}$

### 8. Verification of Significance

- F-distribution table: Theoretical distribution of F-value in random situation.



**F-distribution Table**

$\alpha = 0.05$	自由度 $m$	df treatment	2	3	4
自由度 $n$	1 2 3 4 5 6 7 8	161.45 18.513 10.128 7.7086 6.6079 5.9874 5.5914 5.3177	199.50 19.000 9.5521 6.9443 5.7861 5.1433 4.7374 4.4590	215.71 19.164 9.2766 6.5914 5.4095 4.7571 4.3468 4.0662	224.58 19.247 9.1172 6.3882 5.1922 4.5337 4.1203 3.8379

F値が大きいほど有意である。  
F値が小さいほど有意でない。

51



**Significance Level**

Probability of Occurrence	Significance Level	Representation in manuscript	Probability of Occurrence
$P > .10$	-	n.s.	Non-significant 「有意でない」
$.05 < p < .10$	-	†	Marginally significant 「有意傾向である」
$P < .05$	5%	*	Significant 「有意である」
$P < .01$	1%	**	

52



## ANOVA for Within Subjects

$$SS_{\text{Total}} \quad ① = SS_{\text{Treatments}} \quad ② + SS_{\text{Individual}} \quad ④ + SS_{\text{Residual}} \quad ⑤$$

$SS_{\text{Error}} \quad ③$

個人内ばらつき 箱差

- Dividing accidental error into individual difference & residual error.
  - Easy to verify significant because residual error becomes small.



53

## Procedure of ANOVA (1)

	Cont.	Treat.
S1	60	65
S2	65	69
S3	55	59
S4	50	54
S5	70	74
M	60	64.2

Individual sum  
125  
134  
114  
194  
144

### Two Within Students Data

1. Compute number of data, average, & standard deviation of each treatment.
2. Compute whole mean.

$$M = \frac{\overline{X}_A + \overline{X}_B + \dots}{\text{Number of groups}}$$



54

## Procedure of ANOVA (2)

### 3. Compute SS<sub>Total</sub> ①

- Deviations from whole mean.

$$SS_{Total} = \sum (x_i - M)^2$$

### 4. Compute SS<sub>Treatments</sub> ②

$$SS_{Treatments} = (\bar{X}_A - M)^2 \cdot N_A + (\bar{X}_B - M)^2 \cdot N_B + \dots$$

### 5. Compute SS<sub>Error</sub> ③

$$SS_{Error} = \sum_A (x_i - \bar{X}_A)^2 + \sum_B (x_i - \bar{X}_B)^2 + \dots$$

Same  $SS_{Total} = 544.9$

Same  $SS_{TR} = 44.1$

Same  $SS_{ER} = 500.8$



55

## Procedure of ANOVA (3)

### 6. Compute SS<sub>Individual</sub> ④

$$SS_{Individual} = \frac{\sum_n Ind. Sum^2}{Number\ of\ Treatment} - \frac{\left( \sum_n Ind. Sum \right)^2}{Number\ of\ Whole\ Data}$$

= 38584.1  
違うのは何?  
1回ずつ引いて  
 $(125+134+114+104+144)^2$   
 $= 10$   
 $(125)^2 + (134)^2 + (114)^2 + (104)^2 + (144)^2$   
 $= 500.4$

### 7. Compute SS<sub>Residual</sub> ⑤

$$SS_{Residual} = SS_{Error} - SS_{Individual}$$

$$= 500.8 - 500.4 = 0.4$$



56

## Procedure of ANOVA (4)

### 8. Make ANOVA table

(SV)	(SS)	(df)	(MS)	F value
Treatment	44.1	1	44.1	44.1
Individual	500.4	4	125.1	<del>500.4 / 4 = 125.1</del>
Residual	0.4	4	0.1	
Total	544.9	9		

- df (Degree of Freedom):

- df of Treatment = number of treatment - 1
- df of Individual = number of subject - 1
- df of Residual = ~~dfTotal~~ Individual
- df of Total = number of whole data - 1



## Procedure of ANOVA (5)

### 8. Make ANOVA table

- MS (Mean of SS)
  - MS of Treatment =  $SS_{Treatment} \div df_{Treatment}$
  - MS of Individual =  $SS_{Individual} \div df_{Individual}$
  - MS of Residual =  $SS_{Residual} \div df_{Residual}$
- F-value =  $MS_{Treatment} \div MS_{Residual}$

### 9. Verification of Significance

- F-distribution table: Theoretical distribution of F-value in random situation.



3人の場合

## Procedure of ANOVA (1)

Sub.	T <sub>A</sub>	T <sub>B</sub>	T <sub>C</sub>
S1	50	70	70
S2	70	70	80
S3	60	80	90
S4	70	80	100
Ave	62.5	75	85
SD	8.29	5	11.2

Individual sum

190  
220  
230  
250

### Three Within Students Data

- Compute number of data, average, & standard deviation of each treatment.
- Compute whole mean.

$$M = \frac{\bar{X}_A + \bar{X}_B + \dots}{\text{Number of groups}} \approx 74.2$$



$$SS_{TA} = (50 - 74.2)^2 + \dots + (190 - 74.2)^2 = 1892$$

$$SS_{TR} = (62.5 - 74.2)^2 \cdot 4 + \dots + (85 - 74.2)^2 \cdot 4 = 1017$$

$$SS_{Ind} = \underbrace{(90^2 + 220^2 + 230^2 + 250^2)}_3 - \frac{(190 + 220 + 230 + 250)^2}{12} = 625$$

$$SS_R = 1892 - 1017 - 625 = 250$$

## Procedure of ANOVA (2)

- 7. are similar.
- Make ANOVA table

(SV)	(SS)	(df)	(MS)	F value
Treatment	1017	2 <sup>3-1</sup>	509	12.2
Individual	625	3 <sup>4-1</sup>	208	
Residual	250	6	41.7	
Total	1892	11		

5%  
有り

### 9. Verification of Significance

- F-distribution table: Theoretical distribution of F-value in random situation.
- DF = 2



## F-distribution Table

$\alpha = 0.05$	自由度 $m$			
	1	2	3	4
自由度 $n$				
1	161.45	199.50	215.71	224.58
2	18.513	19.000	19.164	19.247
3	10.128	9.5521	9.2766	9.1172
4	7.7086	6.9443	6.5914	6.3882
5	6.6079	5.7861	5.4095	5.1922
6	5.9874	5.1433	4.7571	4.5337
7	5.5914	4.7374	4.3468	4.1203
8	5.3177	4.4590	4.0662	3.8379

## Multiple Comparison 多重比較

### Definition

- Comparing each pair in case there are 3 or more averages.

### LSD Method

- Least Significant Difference
- To compute least value larger than significant level (5%).
- If difference between pair is larger than LSD, the difference is significant.

## Procedure of LSD (1)

1. Obtaining t-value of 5% significant level regarding to DF for residual in ANOVA.  $t = 2.45$

2. Obtaining  $MS_{\text{Residual}}$  from ANOVA table.  $MS_{\text{Residual}} = 41.9$

3. Computing LSD

$$LSD = \underline{t\text{-value}} \cdot \sqrt{\frac{2 MS_{\text{Residual}}}{\text{Number of data by treatment}}} = 2.45 \cdot \sqrt{\frac{2 \cdot 41.9}{4}} = 11.2$$

4. Computing whether each difference between two treatments is larger than LSD.

$$\overline{X}_A \text{ vs } \overline{X}_B, \quad \overline{X}_B \text{ vs } \overline{X}_C, \quad \overline{X}_A \text{ vs } \overline{X}_C$$

$$|62.5 - 75| = 12.5 > LSD$$

$$|75 - 85| = 10 < LSD$$

$$|62.5 - 85| = 22.5 > LSD$$

ACD .. 差が大きい

DCC .. 差が大きい

ACC .. 差が小さい

$$T_A < T_D = T_C$$

63



## T-distribution Table

degrees of freedom $f$	two tails probability $P$				
	0.1	0.05	0.02	0.01	0.001
1	6.313752	12.70620	31.82052	63.65674	636.6192
2	2.919986	4.302653	6.964557	9.924843	31.59905
3	2.353363	3.182446	4.540703	5.840909	12.92398
4	2.131847	2.776445	3.746947	4.604095	8.610302
5	2.015048	2.570582	3.364930	4.032143	6.868827
6	1.943180	2.446912	3.142668	3.707428	5.958816
7	1.894579	2.364624	2.997952	3.499483	5.407883
8	1.859548	2.306004	2.896459	3.355387	5.041305
9	1.833113	2.262157	2.821438	3.249836	4.780913
10	1.812461	2.228139	2.763769	3.169273	4.586894



64

# Reporting Relationships

## Way of Description

- From the results of ANOVA, there are statistical relationships among the treatments.
  - $(F(2,6)=12.12 \text{ p}<.05)$
- By using LSD method, magnitude relationships among treatments are as follows.
  - Treatment A < Treatment B
  - = Treatment C
  - (MSe=0.42 5% Significant Level)



65

# AI in Edu/Learn Tech

## Adaptation

- Providing support based on learner's status

## Ontology

- Representation for model of target world
  - Describing basic concepts and their relationship

## Linked Open Data (LOD)

- Technology for sharing data on Web
  - New approach for knowledge representation in educational system



66

# AI in Edu/Learn Tech

## Data Mining/Machine Learning

- Data Mining : Finding rules and patterns from huge data by human
  - Learning Analytics
- Machine Learning: Making rules and behaviors from huge data by system
  - Learner Modeling

## Other AI Tech

- GA, NN, Deep Learning…
- Item Response Theory (IRT)



67

# Educational Data Mining

- Discovering, summarizing, classifying useful information from big data
- “Learning Analytics” (from 2008)

## Methods

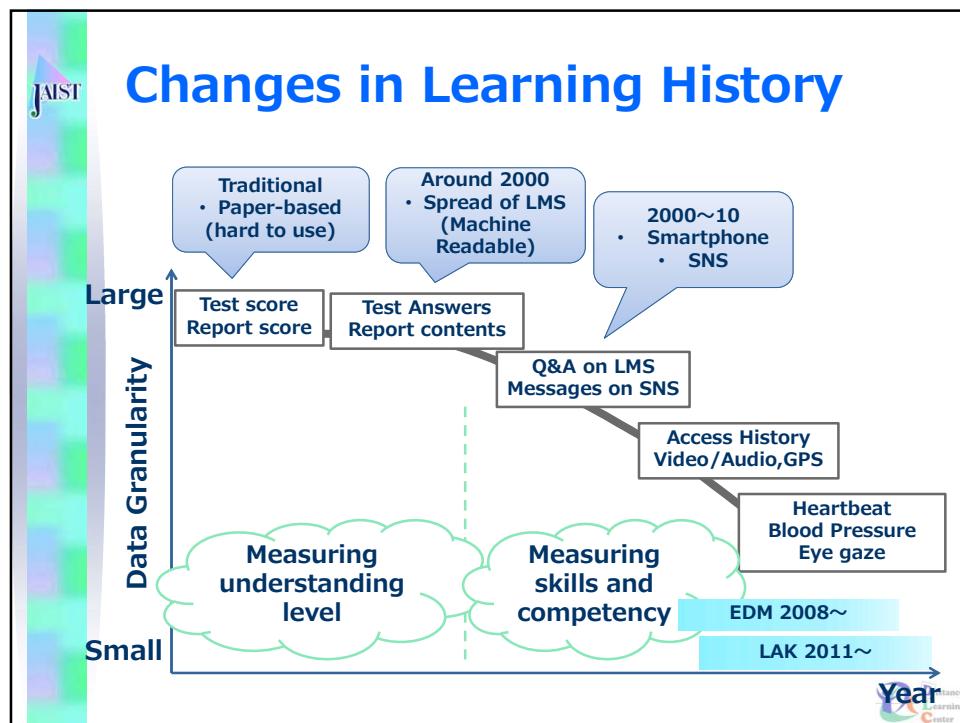
- Association rules, Decision tree, SVM, Naïve Bayes Bayesian Network, Clustering, Text Mining, etc.

## Target Data

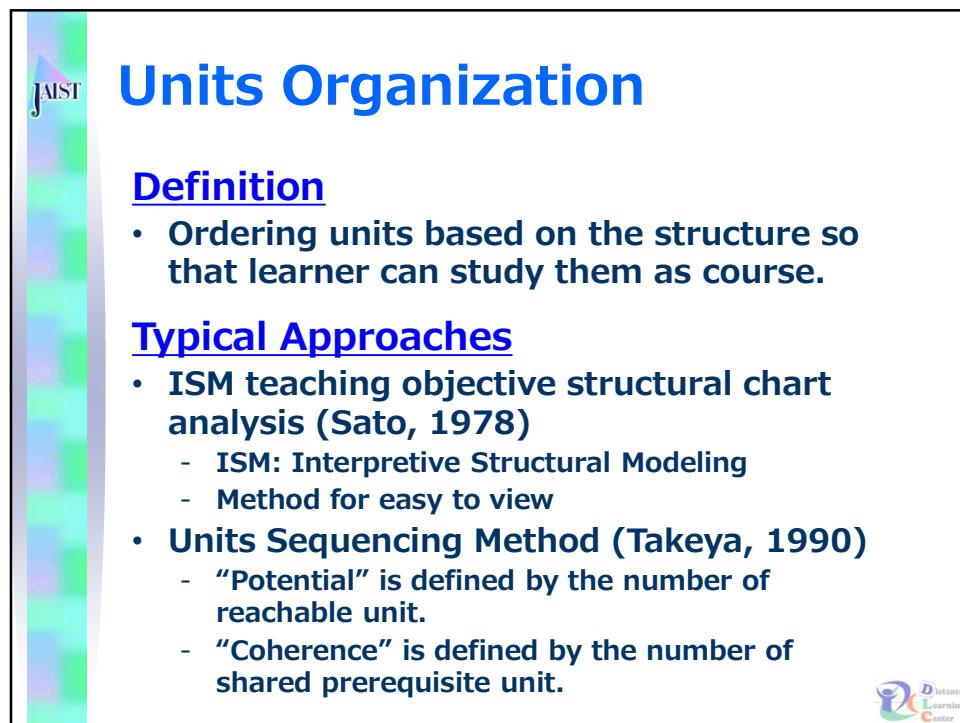
- Small ← Statistical Analytics (Hypothesis validation) … Data Mining(Finding Unknown Rules) → Large



68

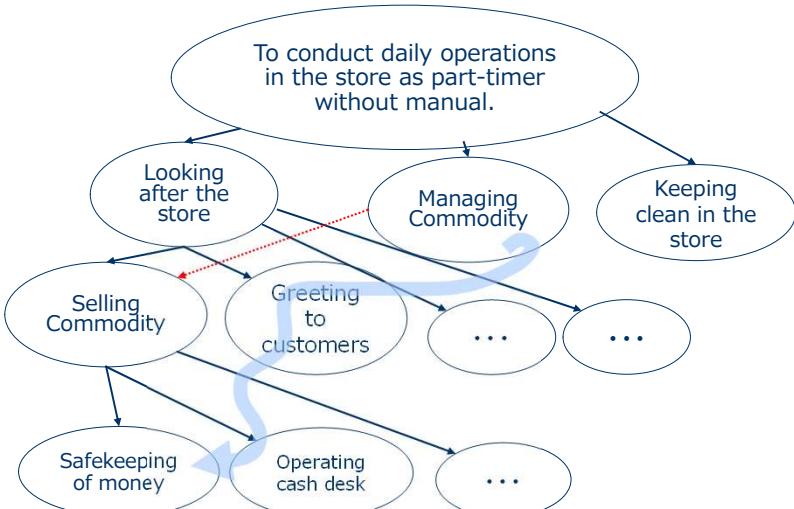


69



70

## Ex. of Units Organization



71

## Process of ISM Method

1. Create adjacency matrix A.
2. Compute Boolean operation to  $A+I$  by  $(A+I)^{r-1} \neq (A+I)^r = (A+I)^{r+1} = T$   
- T: Reach Ability Matrix
3. Find reachable set  $R_i$   
-  $R_i = \{s_j \text{ where } m_{ij} = 1\}$
4. Find advanced set  $A_i$   
-  $A_k = \{s_k \text{ where } m_{ki} = 1\}$
5. Find intersection  $R_i \cap A_i$
6. Make table for each item
7. Describe longest path
8. Add 2<sup>nd</sup> longest path ...



72

① 隣接行列 A

②  $A + I$  — 単位行列 .. 2<sup>nd</sup> 最長経路

$$A = \begin{bmatrix} 00100 \\ 10000 \\ 01001 \\ 01100 \\ 00000 \end{bmatrix}$$

(1)  $A^T$   
(2)  $A^T A$

$$A^T = \begin{bmatrix} 10100 \\ 11000 \\ 01101 \\ 01100 \\ 00001 \end{bmatrix}$$

[左追加]

③  $(A + I)^n$  のグーリー計算

$$(A + I)^n = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{array}{l} r_f = 1 \\ r_f = 1 \\ r_f = 1 \\ r_f = 1 \\ r_f = 0 \end{array} \quad \begin{array}{l} r_s = 1 \\ r_s = 1 \\ r_s = 1 \\ r_s = 0 \\ r_s = 0 \end{array}$$

$$\begin{array}{l} r_a = 0 \\ r_a = 0 \\ r_a = 0 \\ r_a = 0 \\ r_a = 0 \end{array} \quad \begin{array}{l} r_o = 0 \\ r_o = 0 \\ r_o = 0 \\ r_o = 0 \\ r_o = 0 \end{array}$$

## JAIST How do you order that?

$(A^T)^3 (A^T)^2 = \begin{bmatrix} 10100 \\ 11000 \\ 01101 \\ 01100 \\ 00001 \end{bmatrix} \begin{bmatrix} 10100 \\ 11000 \\ 01101 \\ 01100 \\ 00001 \end{bmatrix} = \begin{bmatrix} 10100 \\ 11000 \\ 01101 \\ 01100 \\ 00001 \end{bmatrix}$

$(A^T)^3 = \begin{bmatrix} 11000 \\ 11000 \\ 01101 \\ 01100 \\ 00001 \end{bmatrix}$

$(A^T)^4 = (A^T)^3$

ISM Method:

Legend:  
n : Learning Units  
→ : Prerequisite

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73

## JAIST Association Rule Mining 相関ルール発見

Extracting combinations highly related (パターン) (発見)

支障度

- “90% of customers who buy bread and butter also buy milk.”
- “Customers who buy bread, butter, and milk are 4%.”
- $\{\text{Bread, Butter}\} \Rightarrow \{\text{Milk}\}$  (Support 4%, Confident 90%)  
前件部 → 后件部
- X  $\Rightarrow$  Y : X = Antecedent, Y = Consequent
- Support : The rate which satisfies both antecedent and consequent at the same time  
 $= \frac{\text{(Transactions which satisfy antecedent and consequent)}}{\text{(All transactions)}}$
- Confident : The rate that consequent occurs when antecedent occurs  
 $= \frac{\text{(Transactions which satisfy antecedent and consequent)}}{\text{(Transactions which include antecedent)}}$

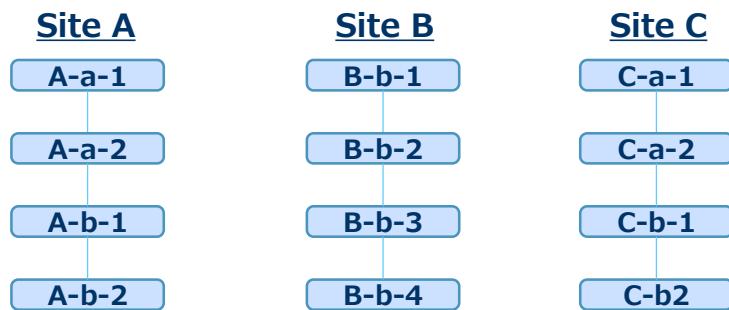
信頼度

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74

## JAIST Examples

Web based learning in different web site



75

## JAIST Rule Extraction (I)

(1) **Transaction Set D** is each student's learning history

The diagram shows four students' learning histories:

Student 1	Student 2	Student 3	Student 4
A-a-1	A-b-1	A-b-1	A-a-2
A-a-2	A-b-2	B-b-1	A-b-1
A-b-1	C-b-2	C-b-1	A-b-2
A-b-2	C-b-1	C-b-2	C-b-2
C-b-2	C-b-2	A-a-1	A-a-1

Handwritten notes on the left side of the slide:

- 2^n - 1 = 15
- 15 件
- 15 分け

A large bracket on the right side groups the four student rows together and is labeled **D**.



76

## Rule Extraction (II)

(2) When local order  $X \Rightarrow Y$  satisfies Antecedent  $X \subseteq I$ , Consequent  $Y \subseteq I$ ,  $X \cap Y = \emptyset$ , extract the rule that satisfies minimum support  $\text{min\_sup}$ , and minimum confident  $\text{min\_conf}$

Sup. >10%, Conf.>50%

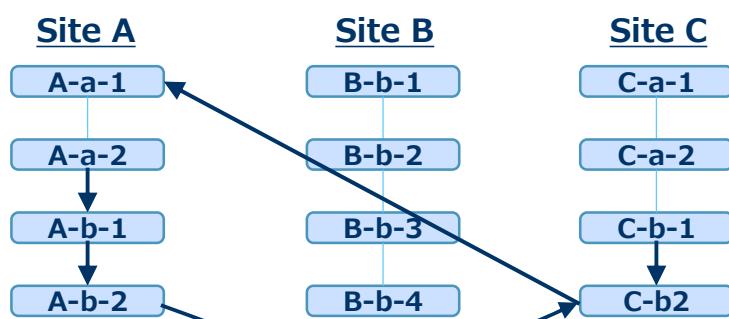
Candidates of rule	Sup.	Conf.
<del>A-a-1 <math>\Rightarrow</math> A-a-2</del>	1/16	1/1
A-a-2 $\Rightarrow$ A-b-1	2/16	2/2
A-b-1 $\Rightarrow$ A-b-2	3/16	3/4
A-b-2 $\Rightarrow$ C-b-2	3/16	3/3
<del>C-b-2 <math>\Rightarrow</math> C-b-1</del>	1/16	1/3
C-b-1 $\Rightarrow$ C-b-2	2/16	2/2
<del>A-b-1 <math>\Rightarrow</math> B-b-1</del>	1/16	1/4
<del>B-b-1 <math>\Rightarrow</math> C-b-1</del>	1/16	1/1
C-b-2 $\Rightarrow$ A-a-1	2/16	2/3



77

## Rule Visualization

Overlay the rules that meet the conditions in the web site structure.



78

# Association Rule Mining

## Advantages

- Clear expression to action  
⇒ Breakthrough for practical data mining

## Disadvantages

- Many common rules are extracted
- Rules show that there is a correlation
- Combination explosion makes calc. impossible

## How to use

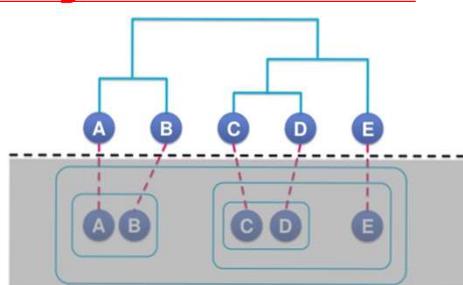
- Contents Recommendation
  - Since a student learn A & B, he/she should learn C.
- Extracting effective learning process
  - Submitting report ⇒ 85% students pass the exam



79

# Clustering

## Dividing target data into subsets

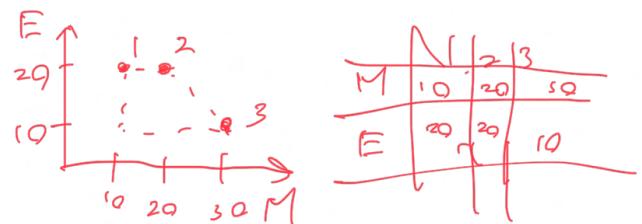


## Hierarchical approach

1. Initial state : N clusters with 1 data
2. Sequential merge : Merging clusters that are close  
→ Repeating until all clusters are merged
3. Determining dividing point from the dendrogram



80



## Examples

### Data

引文資料(2) 2集

ID	1	2	3	4	5	6	7	8	9	10
Score	10	13	20	28	57	60	65	77	80	89

### Distance Matrix: Squared difference

ID	1	2	3	4	5	6	7	8	9	10
1	0	9	100	324	2209	2500	3025	4489	4900	6241
2	9	0	49	225	1936	2209	2704	4096	4489	5776
3	100	49	0	64	1369	1600	2025	3249	3600	4761
4	324	225	64	0	841	1024	1369	2401	2704	3721
5	2209	1936	1369	841	0	9	64	400	529	1024
6	2500	2209	1600	1024	9	0	25	289	400	841
7	3025	2704	2025	1369	64	25	0	144	225	576
8	4489	4096	3249	2401	400	289	144	0	9	144
9	4900	4489	3600	2704	529	400	225	9	0	81
10	6241	5776	4761	3721	1024	841	576	144	81	0



81

## Grouping (1)

### (1) Finding closed pairs

1-2, 5-6, 8-9



ID	1	2	3	4	5	6	7	8	9	10
1	0	9	100	324	2209	2500	3025	4489	4900	6241
2	9	0	49	225	1936	2209	2704	4096	4489	5776
3	100	49	0	64	1369	1600	2025	3249	3600	4761
4	324	225	64	0	841	1024	1369	2401	2704	3721
5	2209	1936	1369	841	0	9	64	400	529	1024
6	2500	2209	1600	1024	9	0	25	289	400	841
7	3025	2704	2025	1369	64	25	0	144	225	576
8	4489	4096	3249	2401	400	289	144	0	9	144
9	4900	4489	3600	2704	529	400	225	9	0	81
10	6241	5776	4761	3721	1024	841	576	144	81	0

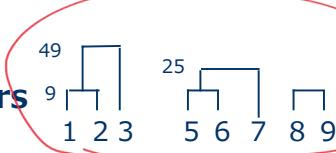


82



## Grouping (2)

(2) Finding next closed pairs  
(1-2)-3, (5-6)-7, 8-9



ID	1	2	3	4	5	6	7	8	9	10
1	0	9	100	324	2209	2500	3025	4489	4900	6241
2	9	0	49	225	1936	2209	2704	4096	4489	5776
3	100	49	0	64	1369	1600	2025	3249	3600	4761
4	324	225	64	0	841	1024	1369	2401	2704	3721
5	2209	1936	1369	841	0	9	64	400	529	1024
6	2500	2209	1600	1024	9	0	25	289	400	841
7	3025	2704	2025	1369	64	25	0	144	225	576
8	4489	4096	3249	2401	400	289	144	0	9	144
9	4900	4489	3600	2704	529	400	225	9	0	81
10	6241	5776	4761	3721	1024	841	576	144	81	0

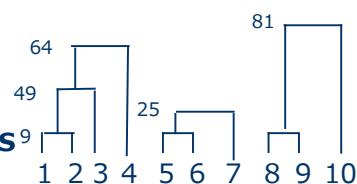


83



## Grouping (3)

(3) Merging next closed pairs  
(1-2-3)-4, (5-6)-7, 8-9



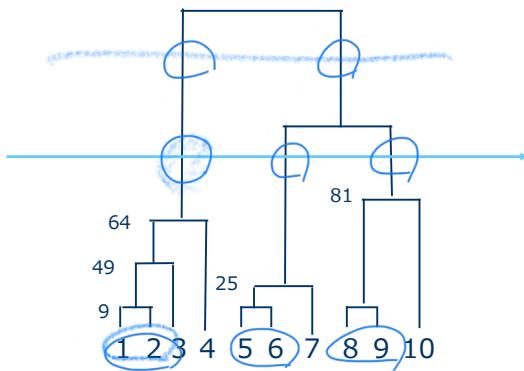
ID	1	2	3	4	5	6	7	8	9	10
1	0	9	100	324	2209	2500	3025	4489	4900	6241
2	9	0	49	225	1936	2209	2704	4096	4489	5776
3	100	49	0	64	1369	1600	2025	3249	3600	4761
4	324	225	64	0	841	1024	1369	2401	2704	3721
5	2209	1936	1369	841	0	9	64	400	529	1024
6	2500	2209	1600	1024	9	0	25	289	400	841
7	3025	2704	2025	1369	64	25	0	144	225	576
8	4489	4096	3249	2401	400	289	144	0	9	144
9	4900	4489	3600	2704	529	400	225	9	0	81
10	6241	5776	4761	3721	1024	841	576	144	81	0



84

## Dendrogram

- Classification Tree Diagram
  - Items with similar scores are placed close
  - The length of vertical line represents distance between clusters
  - Repeating to merge closest items



## Clustering

### Advantages

- The results are easy to understand.
- The method is simple.

### Disadvantages

- Interpretation of the results is subjective.
- Uniform data clustering is difficult
- Missing information by reducing dimension

### Usage

- Learners' grouping
  - Grouping learners based on their performance and arranging support method

# Test Theory

- **Conditions of Good Test**
  - Validity: Adequate measurement of academic achievement
  - Reliability: Stable calculation of scores
- **Classical Test Theory**
  - $X(\text{observed score}) = T(\text{true score}) + E(\text{error})$
  - Reliability: Proportion of T in X

	Test A	Test B
Student A	70	
Student B		90

- Student A < Student B ???



87

# Item Response Theory

- **Goals**
  - Equating: To makes multiple test scores comparable
  - Scaling: To make scores meaningful
- **Item Response Theory**
  - Estimation of statistical properties of test items
    - Group-independent item properties
      - Item difficulty: inverse of percentage of correct responses
      - Item discrimination: correlation between items and total score



88

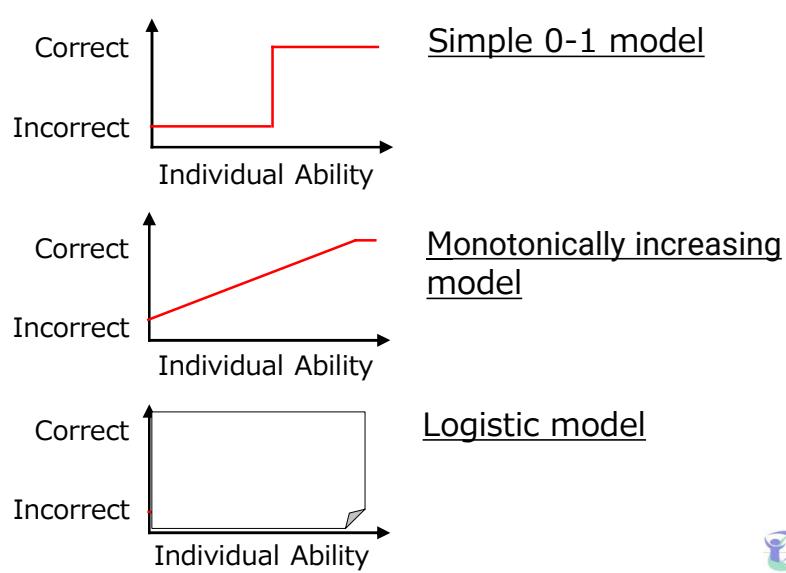
## Examples

	Q1	Q2	Q3	Q4	Q5
S1	○	○	✗	○	○
S2	○	○	✗	○	○
S3	✗	✗	○	○	○
S4	✗	○	○	○	✗
S5	✗	✗	○	○	○
S6	✗	✗	○	✗	○
S7	✗	✗	✗	✗	○



89

## Modeling Ideas



90

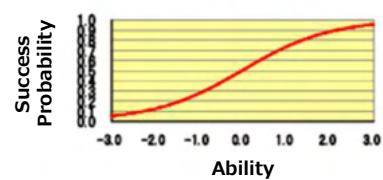
## Rush Model

$$P_j = \frac{1}{1 + e^x}$$

where  $x = b_j - \theta$

Relationship between ability and success

- $b_j$ : Difficulty of test j
- $\theta$ : Student's ability
- $P_j$ : Probability of solving the test j



- Ability is same as difficulty:  $P_j = 0.5$
- Difficulty >> Ability :  $P_j$  becomes smaller



91

## Simple PROX Method

1. Convert to binary(01) data

	Q1	Q2	Q3	Q4	Q5
S1	1	1	0	1	1
S2	1	1	0	1	1
S3	0	0	1	1	1
S4	0	1	1	1	0
S5	0	0	1	1	1
S6	0	0	1	0	1
S7	0	0	0	0	1

※ If a row or column has all 0 or 1, exclude them.



92

**Simple PROX Method**

2. Calculate Logit Incorrect ( $\log_e((1-p)/p)$ )

	Q1	Q2	Q3	Q4	Q5
S1	1	1	0	1	1
S2	1	1	0	1	1
S3	0	0	1	1	1
S4	0	1	1	1	0
S5	0	0	1	1	1
S6	0	0	1	0	1
S7	0	0	0	0	1
Correct Ratio	0.29%	0.43%	0.57%	0.71%	0.86%
Incorrect Ratio	0.71	0.57	0.43	0.29	0.14
LI	0.92	0.29	-0.29	-0.92	-1.79

93



## Simple PROX Method

3. Averaging logit incorrect:  
set the origin of the scale to 0

	Q1	Q2	Q3	Q4	Q5
LI	0.92	0.29	-0.29	-0.92	-1.79
LI Average	-0.36	-0.36	-0.36	-0.36	-0.36
Initial Difficulty	1.27	0.65	0.07	-0.56	-1.43

初期困難度

易

普通

難



94

## Simple PROX Method

4. Calculate logit correct ( $\log_e(p/(1-p))$ )

	Q1	Q2	Q3	Q4	Q5	p	1-p	LC
S1	1	1	0	1	1	0.8	0.2	1.39
S2	1	1	0	1	1	0.8	0.2	1.39
S3	0	0	1	1	1	0.6	0.4	0.41
S4	0	1	1	1	0	0.6	0.4	0.41
S5	0	0	1	1	1	0.6	0.4	0.41
S6	0	0	1	0	1	0.4	0.6	-0.41
S7	0	0	0	0	1	0.2	0.8	-1.39



95

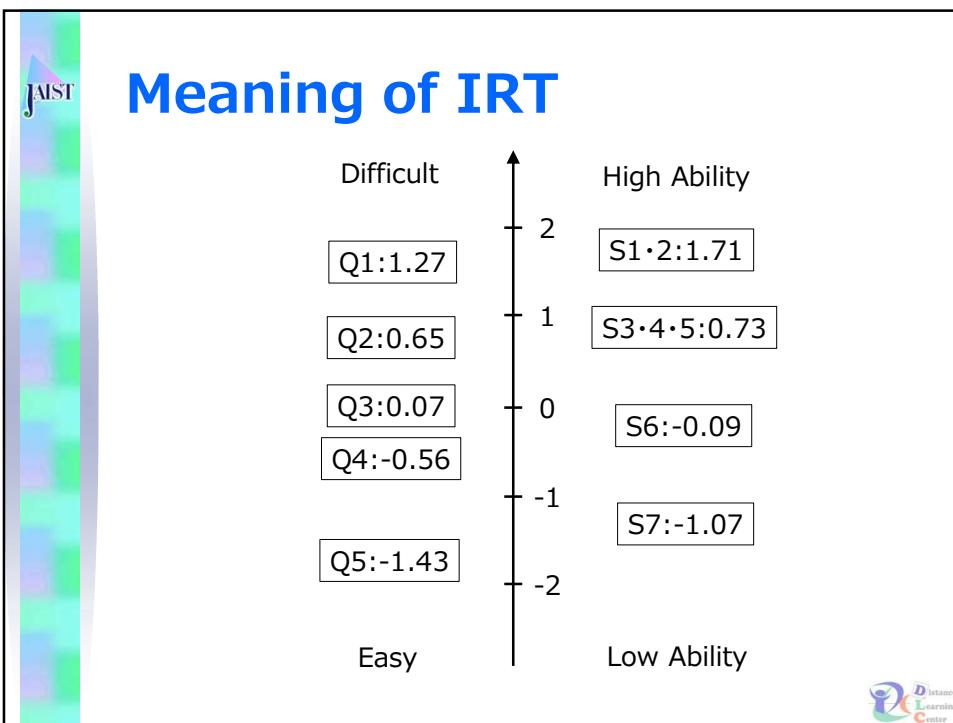
## Simple PROX Method

5. Averaging logit incorrect:  
set the origin of the scale to 0

	LC	LC Average	能力値
S1	1.39	0.32	1.71
S2	1.39	0.32	1.71
S3	0.41	0.32	0.73
S4	0.41	0.32	0.73
S5	0.41	0.32	0.73
S6	-0.41	0.32	-0.09
S7	-1.39	0.32	-1.07



96



97



**Probability of Correct**

		Q1	Q2	Q3	Q4	Q5
		1.27	0.65	0.07	-0.56	-1.43
S1	1.71	61%	74%	84%	91%	96%
S2	1.71	61%	74%	84%	91%	96%
S3	0.73	37%	52%	66%	78%	90%
S4	0.73	37%	52%	66%	78%	90%
S5	0.73	37%	52%	66%	78%	90%
S6	-0.09	20%	32%	46%	62%	79%
S7	-1.07	9%	15%	24%	38%	59%

Substitute into  $P_j = \frac{1}{1 + e^{(bj-\theta)}}$

98



## Assumptions

- Assumptions of IRT

- Local independence : No effect on the correct probability for other items
- Unidimensionality: all questions measure one area of ability

- 局所独立

- Assumptions of Rasch model

- Discrimination of questions are same: all logistic curve are same
  - Some models with more parameters
- Minimal guesswork : less skill students don't answer correctly by chance
- Large number of students : Over 1000 are needed

- 問題の識別力

- 猜測

- 計算

- Assumption of PROX method

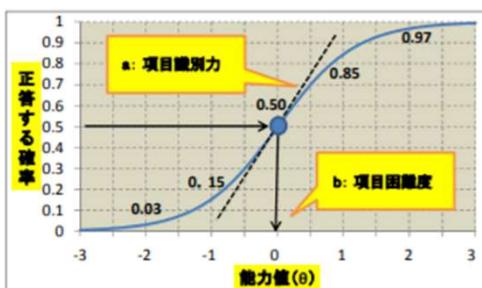
- Problem difficulties are normally distributed
- Students ability are normally distributed



99

## How to make scores comparable

- Creating anchor test: equating and scaling
- Mixing new questions and anchor tests in the main test
  - Equating and scaling the results of the main test to the anchor test
- Updating anchor test (adding new questions)



100

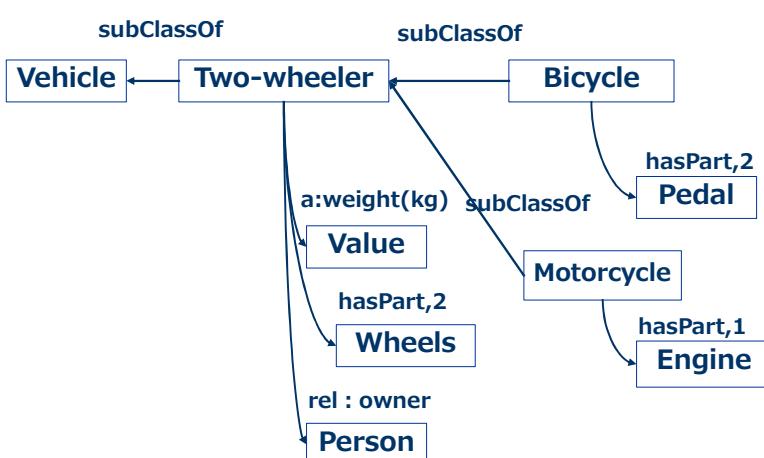
# What is Ontology?

- Concept explicitization
    - Identifying classes (concepts) that have objects & relations appearing in the target world as instances.
    - Organizing them based on hierarchical (is-a) relationship
- Declarative description: expressing fundamental understanding in a system
- A set of concepts as a results of extracting basic ones from the target world



101

# Examples of Ontology



102

# Class Definition

Consistent, easy to understand and process,  
Reflecting properties of objects

- Identity of classification criteria: C2, C3, ... which are subclasses on C1 should be classified on the same level.
- Partitionality of instance set: Instance sets for C2, C3,... are MECE.
- Essential attributes: Constructing attributes to determine identity of objects
  - Fixed attribute: Does not change due to differences in time or interpretation
  - Non-exterior dependence: Can be defined only by the instance itself (including its parts)
- Hierarchy of classification: Should be classified according to its dependency in classification



103

# is-a Relationship

SuperClass(Upper Class) : Parent concept  
SubClass(Lower Class) : Child concept

- All instances of class B are instances of class A if class A is the super class of class B
- A concept represented by a subclass is a concept of a superclass
- is-a relation is a transitive
- Avoid circulation of is-a relation
- Unify granularity of sibling classes
- Pay attention to the number of subclasses (around 2~12)



104

# Attribute Definition

## Intrinsic Attribute:

- Nature of objects

## Extrinsic Attribute:

- Externally attached properties to objects

## hasPart:

- Part-whole relation

## Relation/subClassOf:

- relation: A specific relation with other objects
- subClassOf: Relation with a special object that inherited the parent's properties (is-a)



105

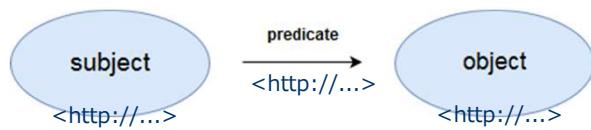
# What is LOD?

Structured information in a format meant for machines.

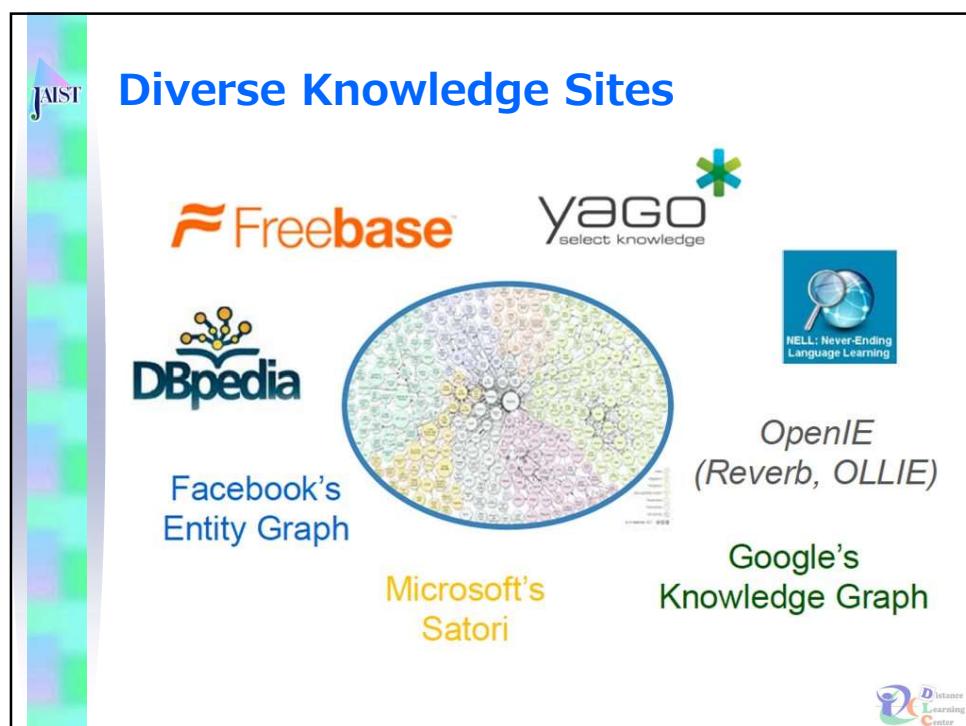
## Principles:

- Use a recognized LOD standard format
  - RDF, Ontologies
- Refer to an entity the same way other people do
  - URI: Uniform Resource Identifier
- Publish your data openly
  - Creative Commons

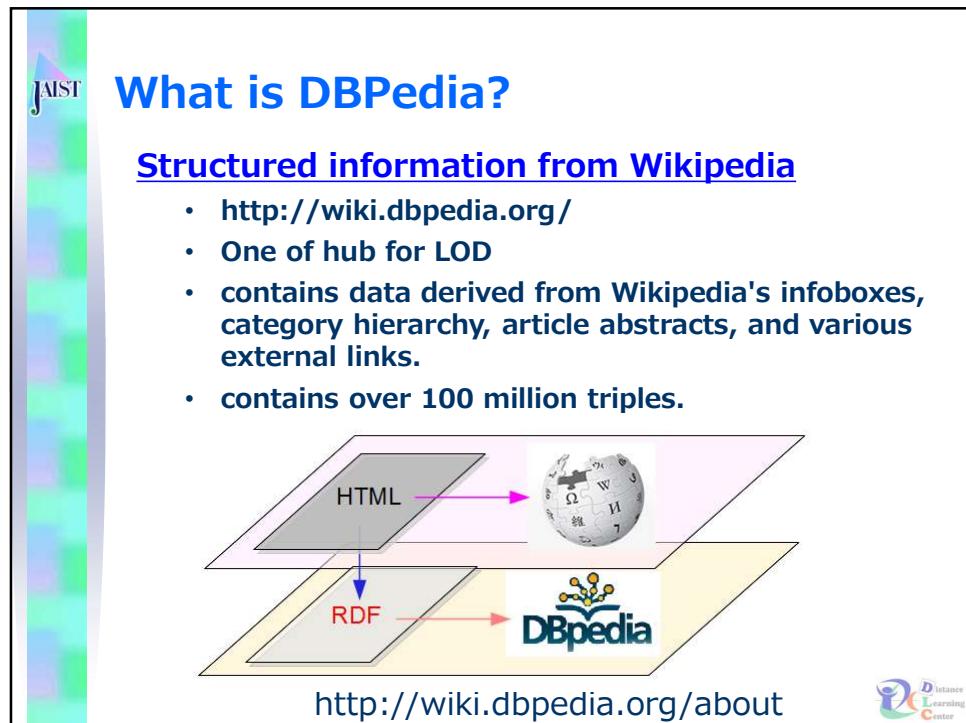
## RDF: Subject, predicate and object



106



107



108

## Entity Type in DBpedia?

### Category

- Attached to pages including similar contents to improve browsability.
- SKOS: Vocabulary for describing concept hierarchy
  - broader, related: Non-strict hierarchy
- [http://dbpedia.org/page/Category:Computer\\_security](http://dbpedia.org/page/Category:Computer_security)

### Thing

- 272 classes are organized in hierarchy with "owl:Thing" representing top level.
  - Each content has multiple classes.
- Including abstracts and external links
- [http://dbpedia.org/page/Computer\\_security](http://dbpedia.org/page/Computer_security)



109

## What is SPARQL?



### Query language for LOD

- Pull values from (semi-) structured data
- Explore data by querying unknown relationships
- Perform complex joins of disparate DB
- Transform RDF data from one vocabulary to another
- Standard API for Open Data!

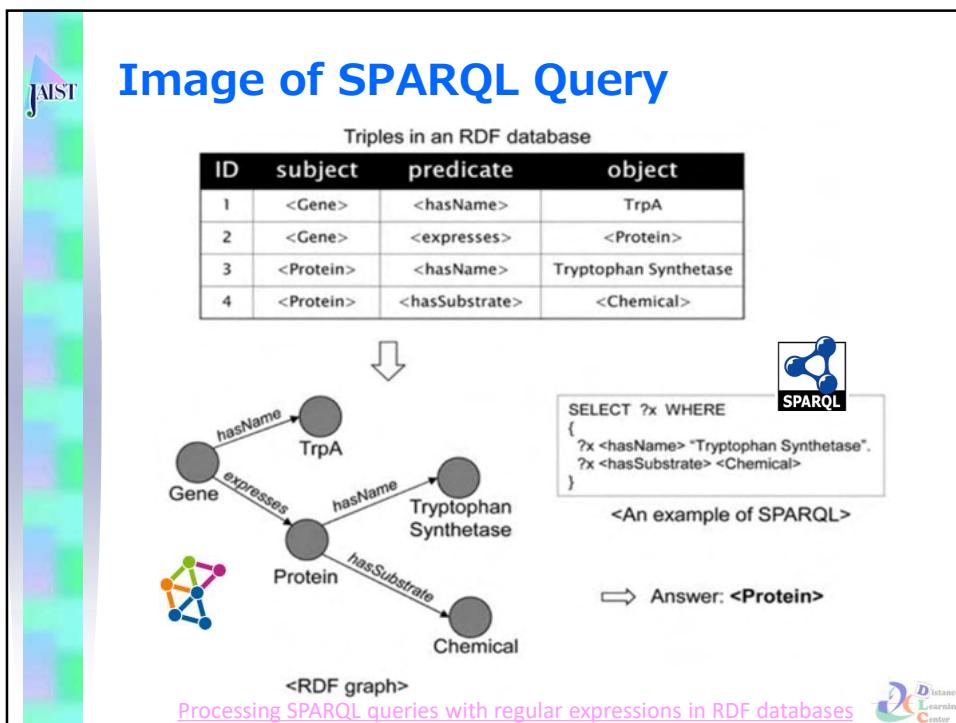
### Architecture

- SPARQL queries are executed against RDF dataset
- SPARQL endpoint accept queries and returns results
- <http://dbpedia.org/sparql/> (for DBpedia)

<https://www.w3.org/2009/Talks/0615-qbe>



110



111

**JAIST**

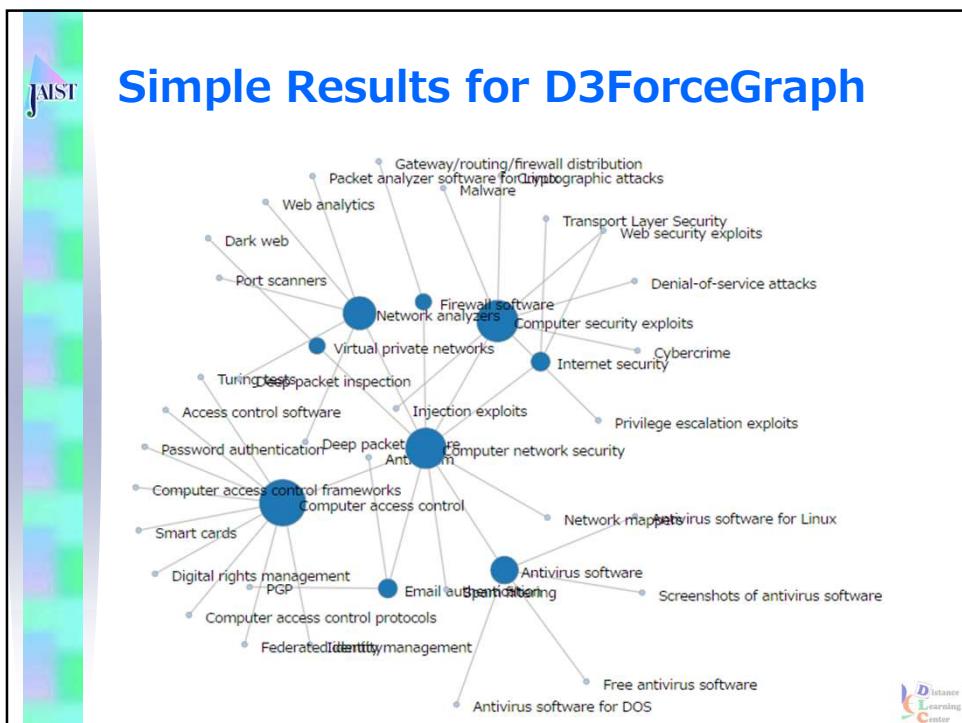
## For Visualization

**Sgvizler 0.6:**

- JavaScript library which renders SPARQL results
  - Using Google Visualization API
  - <http://mgskjaeveland.github.io/sgvizler/>
  - Similar to d3sparql.js
- D3ForceGraph(2–4 columns)
  - Source ID, Target ID, Size, Color
- DraculaGraph(4–7 columns)
  - Source ID, Source Label, Target ID, Target Label, Edge Label, Source Color, Target Color
- formDraw
  - Describe form in HTML

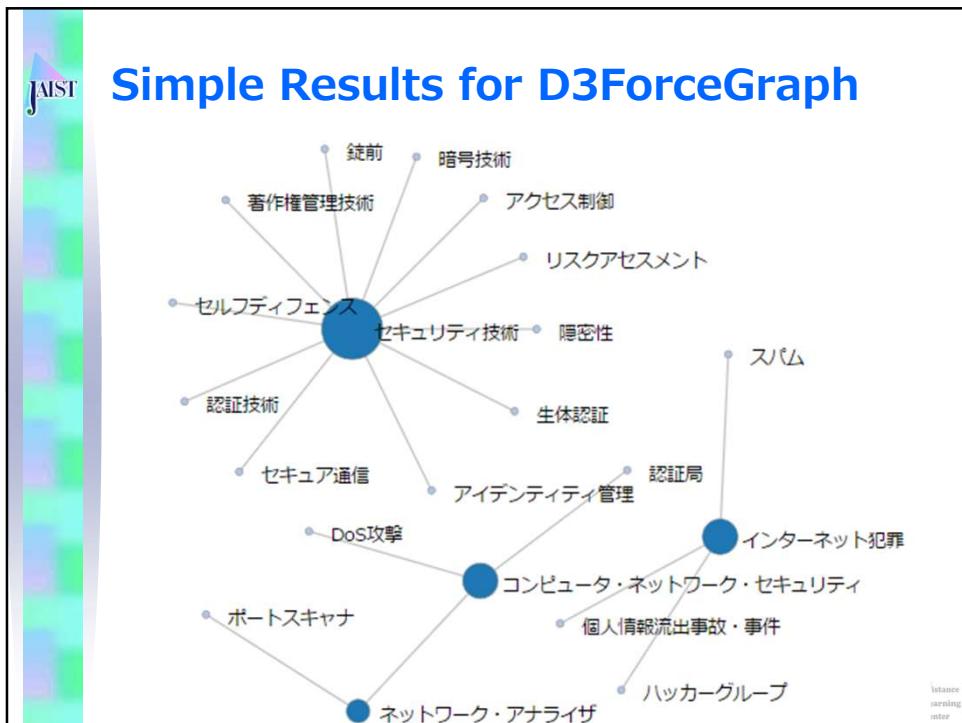
112

# Simple Results for D3ForceGraph



113

# Simple Results for D3ForceGraph



114



## Discussions

### DBPedia vs Ja.DBPedia:

- Category: [DBPedia](#) > [Ja.DBPedia](#)
- Thing: [dct:subject \(en\)](#) vs. [owl:wikiPageWikiLink \(jp\)](#)
- DBPedia supports multi-languages by owl:sameAs
- DBPedia stops update from 2016/04?

### SPARQL Query:

- Powerful but Difficult to make query & debug
  - Not suitable for data processing
- Specific topic should be retrieved by "dct:subject"

### Visualization:

- Sgvizler: Google chart API base
- D3sparql: D3.js base
- Ease of Use/Stability/Documents: Sgvizler > D3sparql
- Flexibility/Graph-Tree: Sgvizler < D3sparql



# Distance Learning System (遠隔教育システム工学)

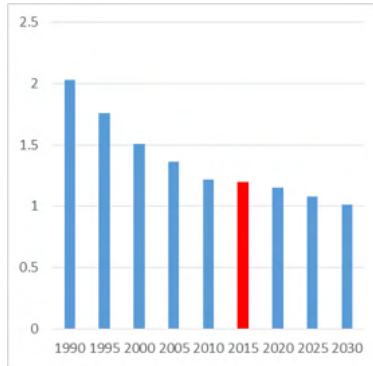
*Advanced Topic+*

Koichi Ota  
[ota@jaist.ac.jp](mailto:ota@jaist.ac.jp)

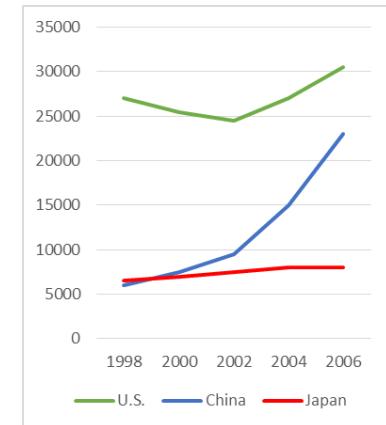
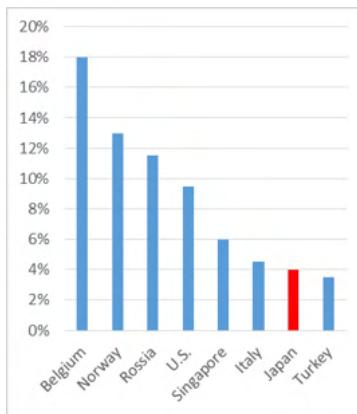
- TA2人とPeer reviewの相関

	観点 1		観点 2		観点 3	
	T1	P1	T2	P2	T3	P3
Ave	4.5	4.15	4.8	4.3	4.7	4.35
		T1-P1		T2-P2		T3-P3
			0		0.46	-0.67
	T1-T2	P1-P2	T2-T3	P2-P3	T1-T3	P1-P3
	0	-0.56	-1	0.91	0	-0.41

# Current Situation for Graduate Education in Japan

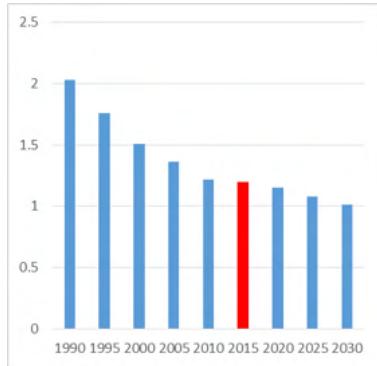


- The population of age 18 in Japan is decreased year by year.
- The number of Ph.D. in Science/Technology fields seems to reach limit in these years.

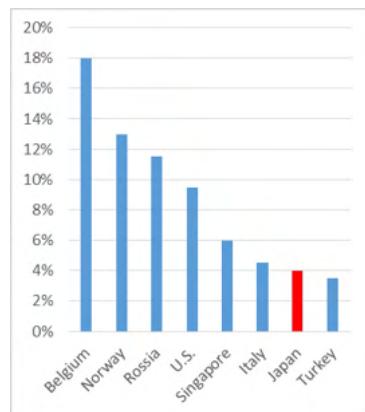


- The number of Ph.D. researchers in laboratory of company is low.

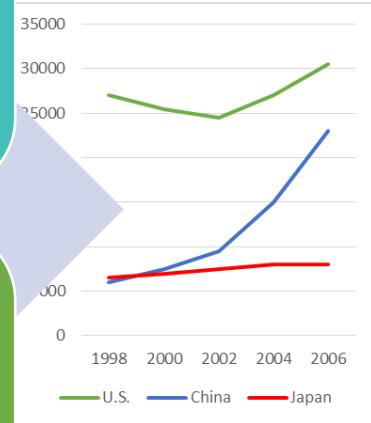
# Keywords in Graduate Education for Japan



Globalization



Systematic  
Education



Visualization  
of Education

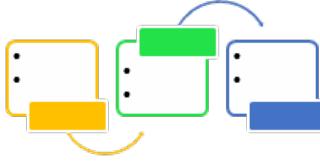
# 21st Century Skills

## Definitions

- Learning Cognitive Skills to Collaborate with Others and to Connect through Technology
- Ways of Thinking
  - Creativity, Innovation, **Critical Thinking**, Problem Solving, Decision Making, & Learning to Learn
- Ways of Working
  - Communication & **Collaboration** (Teamwork)
- Tools for Working
  - Information Literacy & **ICT Literacy**
- Living in the World
  - Citizenship, **Personal & Social Responsibility**

*ATC21s: Draft White Papers (2010), The Assessment and Teaching of 21st Century Skills Project*

# Issues Addressed

Education	Learner	Acquisition	Assessment
Traditional		 Knowledge	 Testing
Leaner-centered		 Skills	?

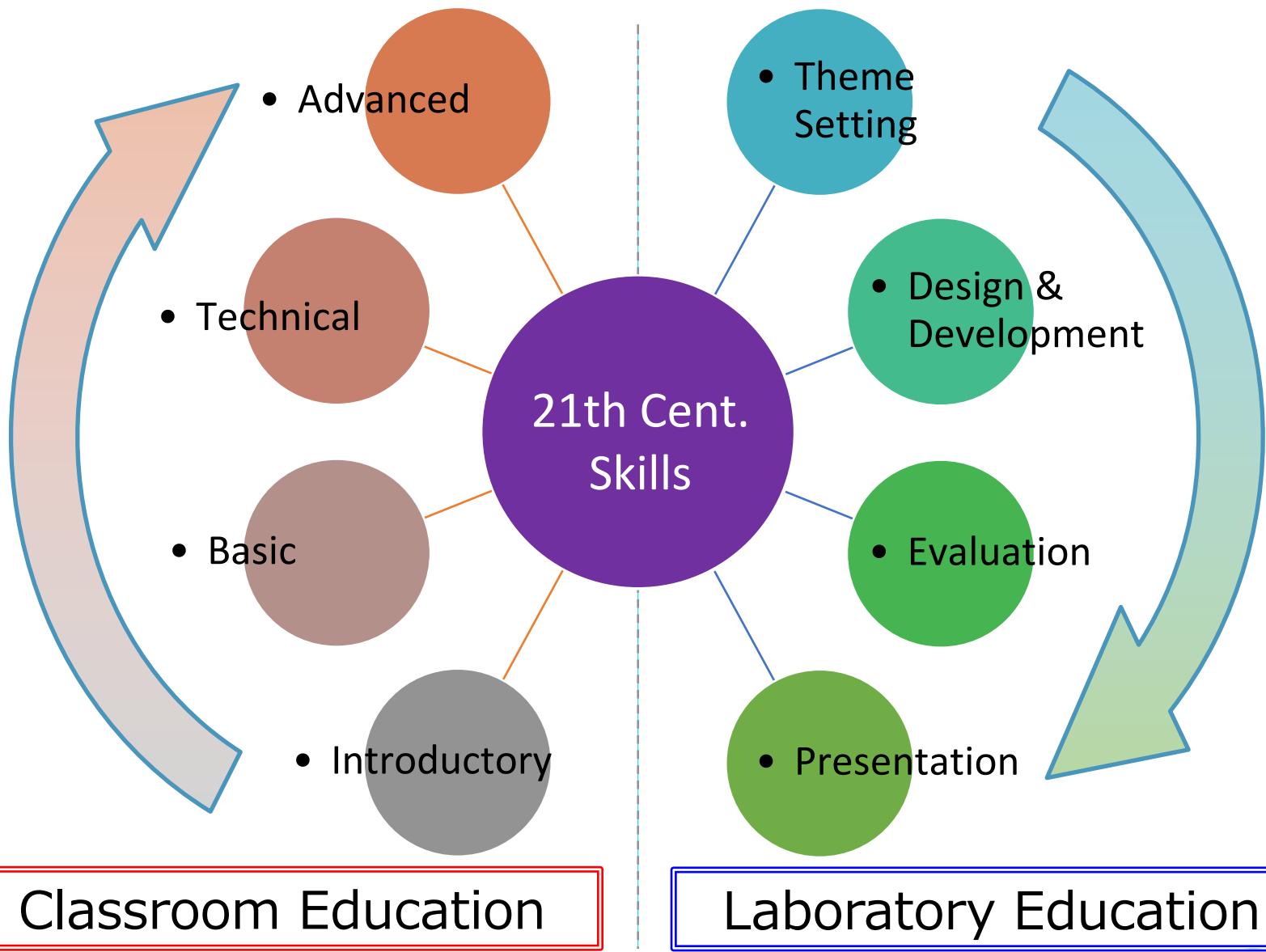
How should we deal with  
“Quality Assurance of Skills”  
in New Education Era with ICT?

# Issues Addressed

## Difficulties in Unified Criteria

- **Social demands**
  - General valuation does not reflect on education
  - Objective evidence by big data with ICT
- **Different goals among students**
  - Background, process, level
  - Not only education but also research
- **Comparative vs Absolute**
  - Comparative: Easy but not objective
  - Absolute: Objective but difficult

# Skill Development Model



Classroom Education

Laboratory Education

# Quality Assurance in Graduate Education

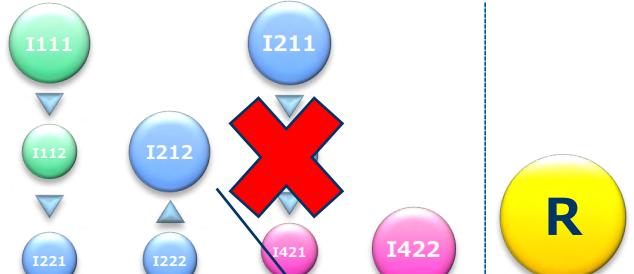
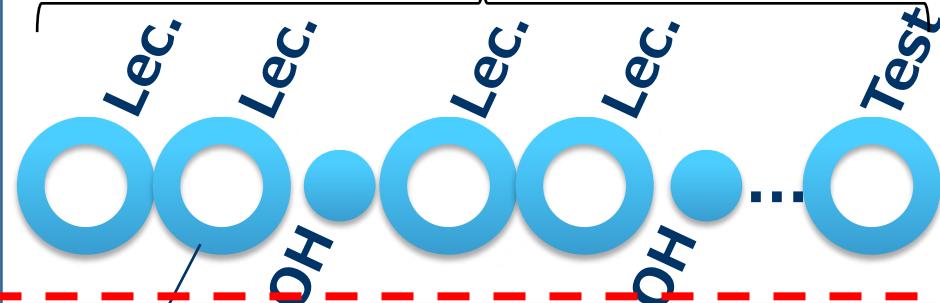
## Quality Assurance by Process Data

- **Process:** “Series of activity”
- **How do we collect process data from education and research activities?**
  - Depending on grain size of process
  - Composing of formal & informal activities
  - Including temporal features

## Role of ICT in Quality Assurance

- **Facilitating learning process**
- **Collecting cross-sections data**
- **Analyzing data collected**

# Examples for Process in Education

	Process	Information
Curriculum		<ul style="list-style-type: none"><li>Admission</li><li>Courses taken</li><li>Job Hunting</li></ul>
Course		<ul style="list-style-type: none"><li>Attendance</li><li>Report</li><li>Test results</li></ul>
Lecture		<ul style="list-style-type: none"><li>Activity</li><li>Interaction</li></ul>

# Research Question

**What do you think about  
How to deal with process  
in lecture time with ICT?**

# Lecture Archiving System

## Features

- Enabling students to search & watch education scenes recorded.
  - Asynchronous learning for preparation & reflection
  - Supplemental material for f2f lecture
  - From 2006 (Around 2,000 per year in IS)

## Process info. By System

- Lecture segments (on lecture)
  - Division by whiteboard/slide
- Comments by students (after lecture)
  - Video Forum: Forum linking timeline

# Video Forum

The screenshot displays a web-based video forum interface. On the left, a video player shows a lecture in progress with a professor at a whiteboard. A 'Comment Form' is overlaid on the bottom left of the video frame. On the right, a list of video segments is shown, each with a timestamp and a thumbnail. A large blue box labeled 'Video Forum' covers the top right corner. Another blue box labeled 'Lecture Archive' covers the middle left area. A third blue box labeled 'Slide Segmentation' covers the bottom right area. The bottom right corner features the 'Distance Learning Center' logo.

遠隔教育システム工学 - MO/Board - Windows Internet Explorer  
http://150.65.144.144/sk/display\_board/?code=70lTEltOpKc14x8JvnEhX94TCZMWEI4vCWO2KD1GR45vLpx5S1zUA5D92%2B

遠隔教育システム工学

#6

遠隔教育システム工学

コメント自動スクロール コメント表示:シーンのみ | コメントタイトルのみ | 全て表示

Video Forum

何回目?  
Tatsunokuchi Jouhou 2010/03/11 13:41

この講義何回目?  
Tatsunokuchi Jouhou 2010/03/11 13:42

10回目

再生リスト

00:07:12#3

00:10:00#4

00:12:05#5

00:17:16#6

00:20:00#7

00:21:15#8

00:24:17#9

00:27:22#10

00:28:46#11

00:30:00#12

00:35:03#13

00:40:00#14

00:43:12#15

00:44:34#16

00:50:03#17

00:51:49#18

書き込み

コメント

添付ファイル

参照 リセット

Slide Segmentation

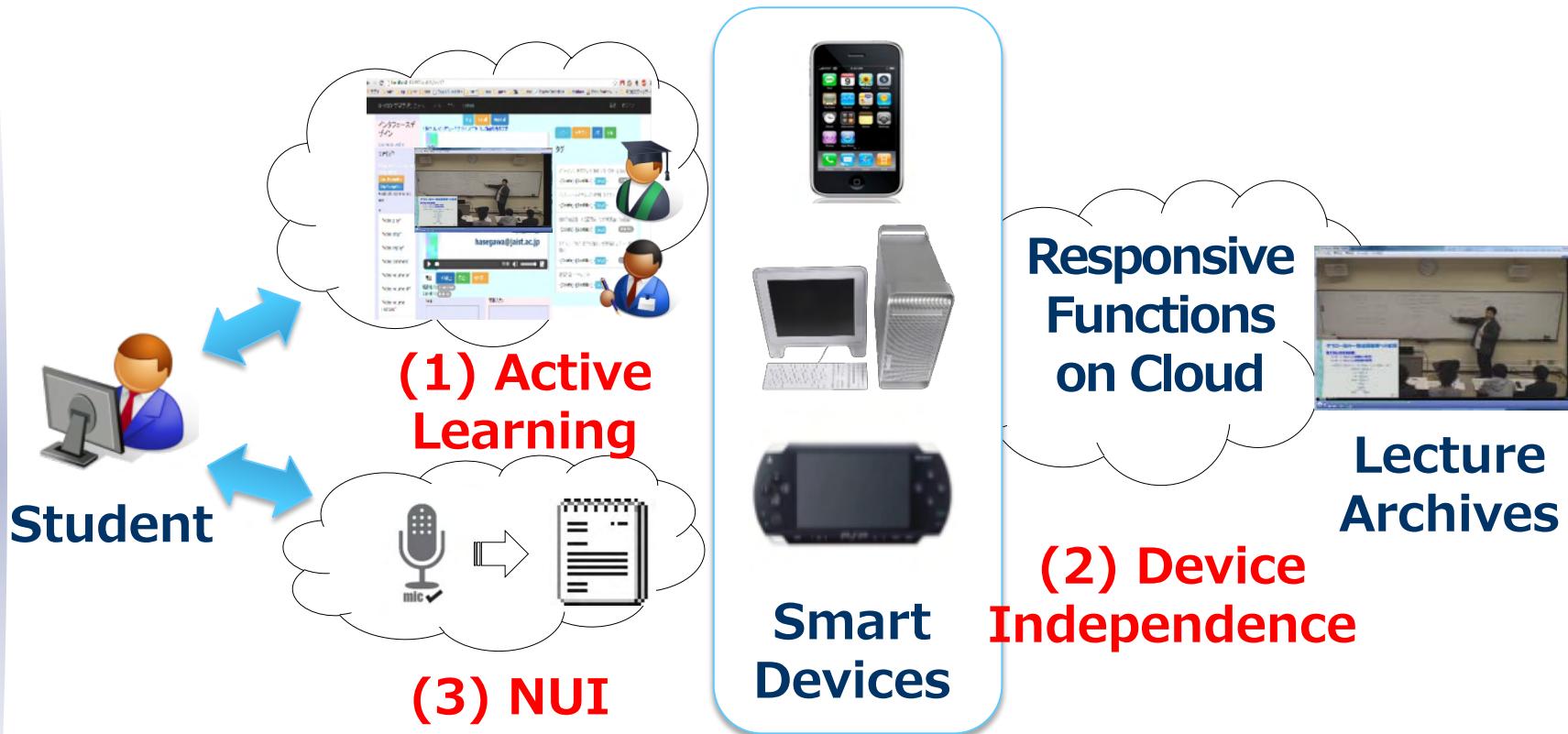
Distance Learning Center

ページが表示されました

インターネット | 保護モード: 有効

100%

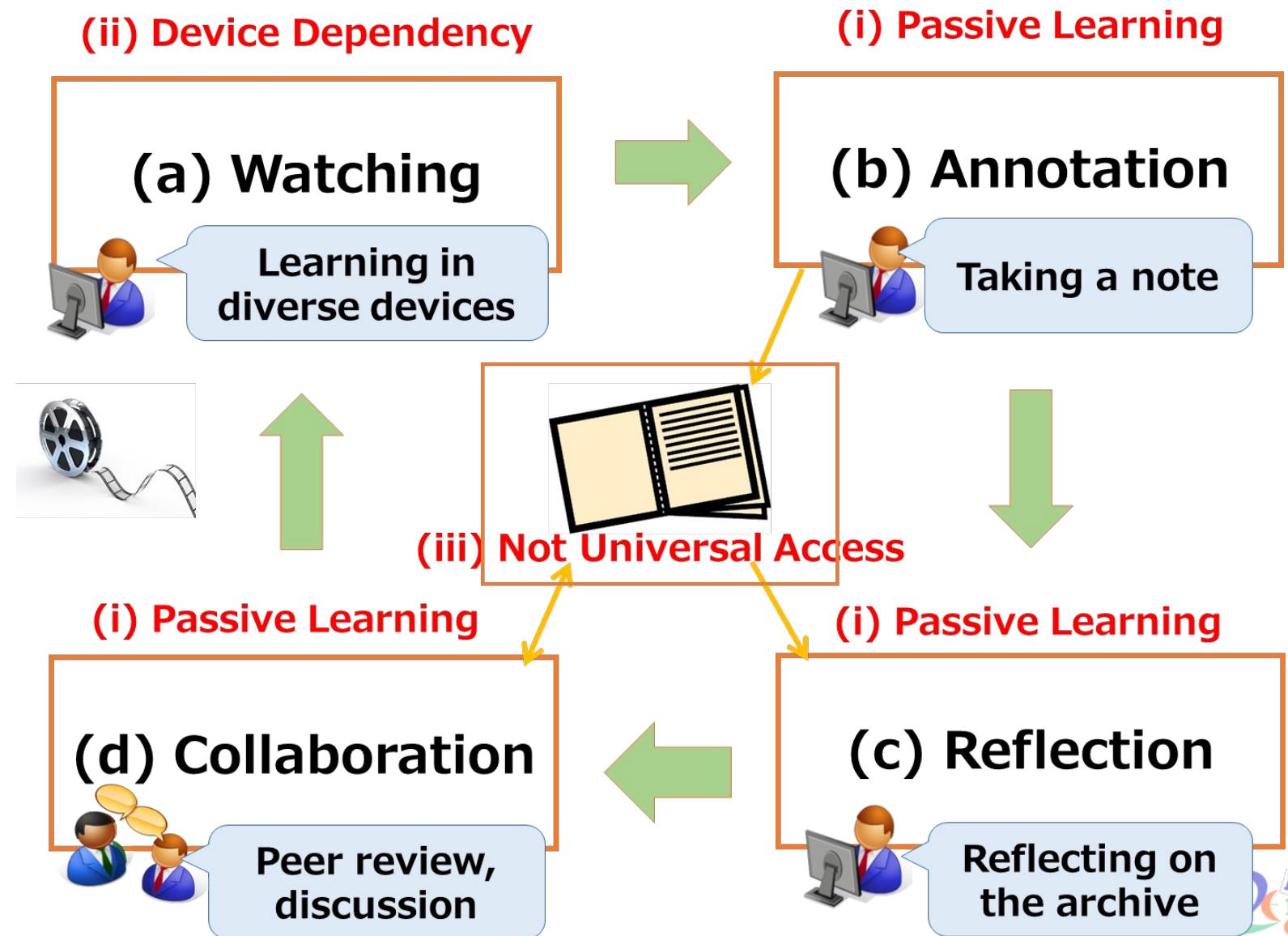
# Purpose of Research



To Develop cloud-based U-VOD learning platform

1. Note-centered approach
2. Responsive function approach
3. NUI (Natural User Interface) approach

# Learning Process Model



# Archive Note Function

localhost:49497/watch/mv17

アメブロ math top net jaist Copy URL and title html5 mvc game 日語 mac Browse Recordings database Stack Overflow その他のブックマーク

U-VOD 学習支援システム ホーム テスト contact 登録 ログイン

Big Small Normal

コメント 意見交換 メモ 字幕

タグ

アフォダンス 環境がヒトに提供する「価値」(gibson)  
-[Delete] -[SentMail] - [play] - 724(秒)

インターフェースデザインの6原則 手がかり  
-[Delete] -[SentMail] - [play] - 405(秒)

身体的適合性—1位置関係 2力学的側面 3接触面  
-[Delete] -[SentMail] - [play] - 266(秒)

デザインプロセス 目的明確化, 仕様明確化, ユーザ明確化  
-[Delete] -[SentMail] - [play] - 152(秒)

遠隔教育システム工学  
インターフェースデザイン  
長谷川 忍  
hasegawa@jaist.ac.jp

再生 一時停止 早送り 巻き戻し

現在(秒): 2.641164 全体(秒): 838.52

tag: 字幕入力:

# Simple Demo

The screenshot shows a web browser window titled "Index" with the URL "localhost:49497". The page is titled "Video List" and displays a list of videos with columns for Title, Description, CreatedAt, and UpdatedAt. Each video entry includes links for Edit, Details, and Delete. The browser's address bar shows "localhost:49497" and the title "Index". The top navigation bar includes links for "U-VOD 学習支援システム", "ホーム", "テスト", "contact", "登録", and "ログイン". The bottom of the page has a copyright notice: "© 2015 - マイ ASP.NET アプリケーション".

	Title	Description	CreatedAt	UpdatedAt
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	speaking English	There are easy ways to learn English	2015/01/21 0:11	2015/01/21 0:11
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	cuepoint	test video	2015/01/21 0:32	2015/01/21 0:32
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	インターフェースデザイン	test video (firefox)	2015/01/25 17:37	2015/01/25 17:42
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	インターフェースデザイン	test video webm	2015/01/25 18:41	2015/01/25 18:41
<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>	test for 審査	test video webm	2015/02/14 4:55	2015/02/15 17:17

# NUI Demo

新しいタブ × Details × localhost:49497/watch/mv19 Bandicam www.gomplayer.jp jiangning

始 / 中止 アプリ math top net jaist Copy URL and title html5 mvc game 日本語 mac Browse Recordings database Stack Overflow その他 の ブックマーク

U-VOD 学習支援システム ホーム テスト contact 登録 ログイン

test

test video webm 音声操作

Recogniser status: not recognising

Start Recognition Stop Recognition Available commands are:

- "video play"
- "video stop"
- "video replay"
- "video comment"
- "video volume on"
- "video volume off"
- "video volume increase"
- "video volume decrease"

Click "Start Recognition"

Big Small Normal

Big Buck BUNNY

1:00

再生 一時停止 早送り 巻き戻し

現在(秒): 全体(秒):

tag:  書込み

字幕入力:  字幕入力

音声入力 Click on the microphone icon and begin speaking.

コメント 意見交換 メモ 字幕

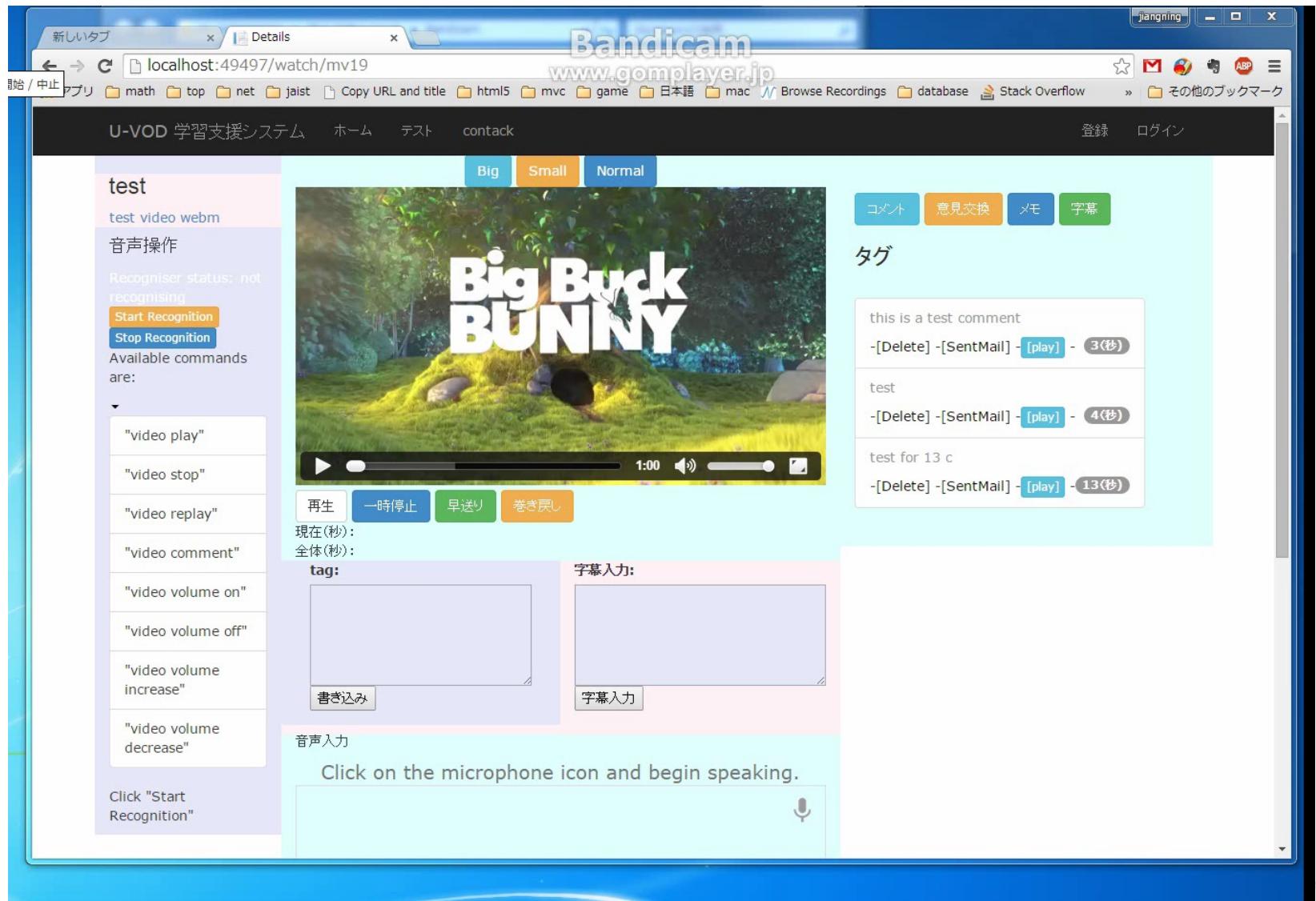
タグ

this is a test comment  
-[Delete] -[SentMail] - [play] - 3(秒)

test  
-[Delete] -[SentMail] - [play] - 4(秒)

test for 13 c  
-[Delete] -[SentMail] - [play] - 13(秒)

ANCE Learning Center



# Case Study

## Purpose

- To evaluate effect of note-centered function.

## Participants

- 8 graduate students (4 = female, 4 = male)
- 11 inch laptop PCs
- Counter-balancing for conditions

## Prepared lecture archives

- Recorded PowerPoint slides and lecture's voice
  - System evaluation design (16:10)
  - Interface design (13:58)

## Conditions

- Within-participants-design
  - Experiment condition: With-note
  - Control condition: Without-note

# Test Results

(N=8, Full marks = 100)

Conditions	With-note		Without-note	
	Pre-test	Post-test	Pre-test	Post-test
Average	91.3	93.4	73.8	61.3
SD	10.6	11.9	15.1	29.5
p-Value	0.711		0.208	
Significance	n.s.		n.s.	

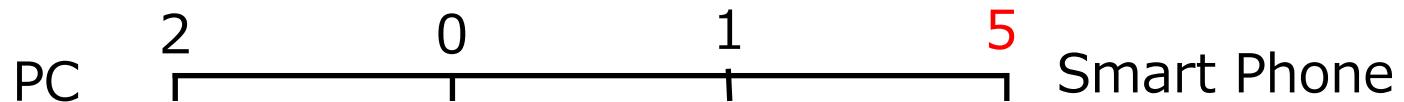
## N.S. between pre-/post-tests

- Pre-/Post-tests might be too easy.

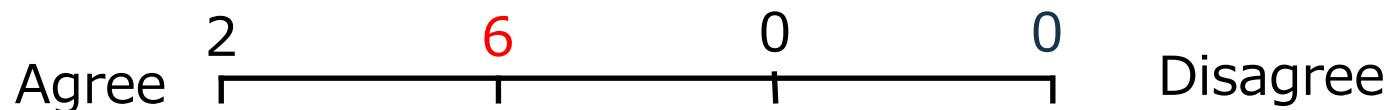
# Questionnaire Results

(N=8)

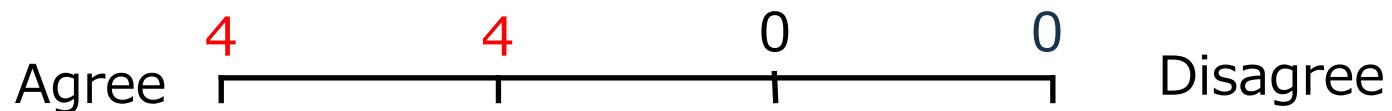
Q1: Frequency of use for Watching video.



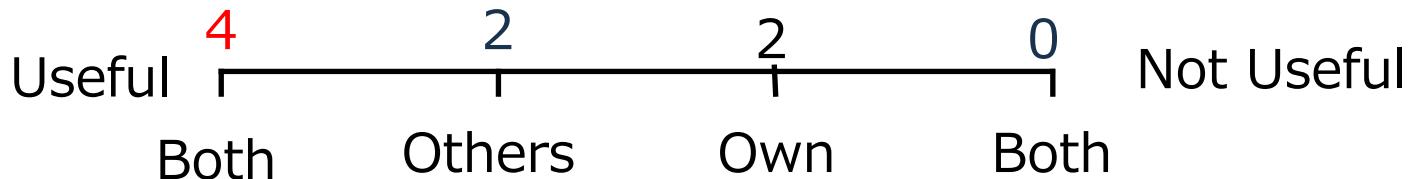
Q2: Effectiveness of others comments.



Q3: Effectiveness of your own memos/comments.



Q4: Usefulness of proposed “archive note” function.



Q5: Usefulness of voice operation.



# Quality Assurance in Lecture

## Facilitation

- Note-taking to archive
- Discussion with archive timeline
- Flipped Classroom

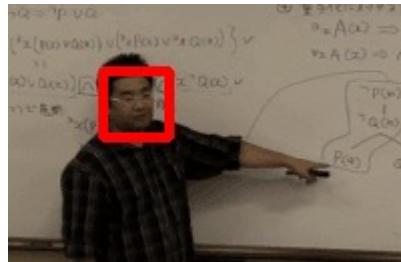
## Collection

- Lecturer's Activity Extraction
- Access / Comment Log

## Analysis

- Frequently commented segments
- Self/peer assessment based on activity

# Activity Extraction

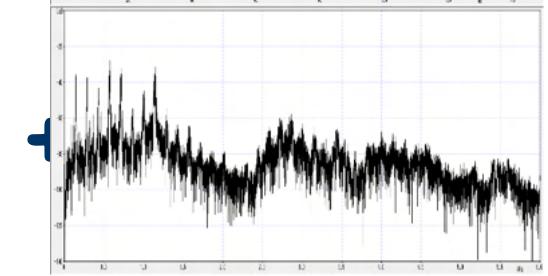


Facial Recognition

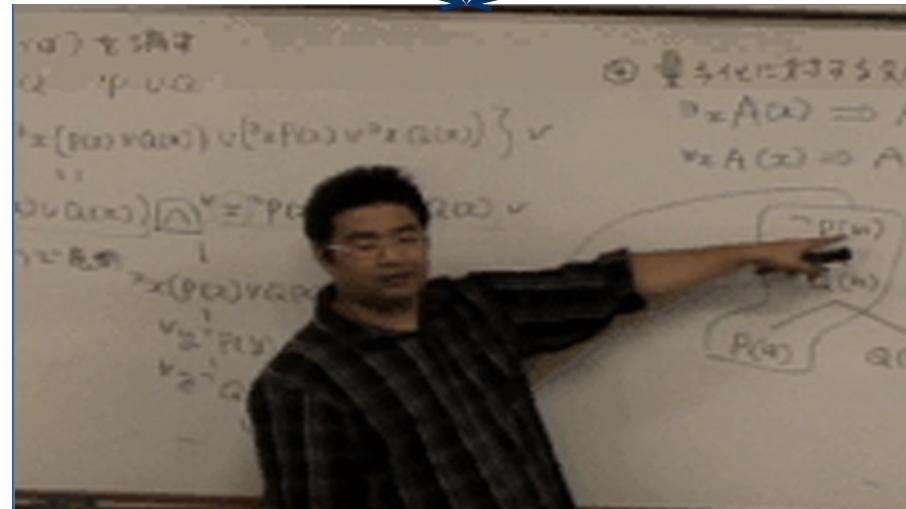
+



Optical Flow



Silent Detection



Important Activity in Lecture

# Quality Assurance in Lecture

## Facilitation

- Note-taking to archive
- Discussion with archive timeline
- Flipped Classroom

## Collection

- Lecturer's Activity Extraction
- Access / Comment Log

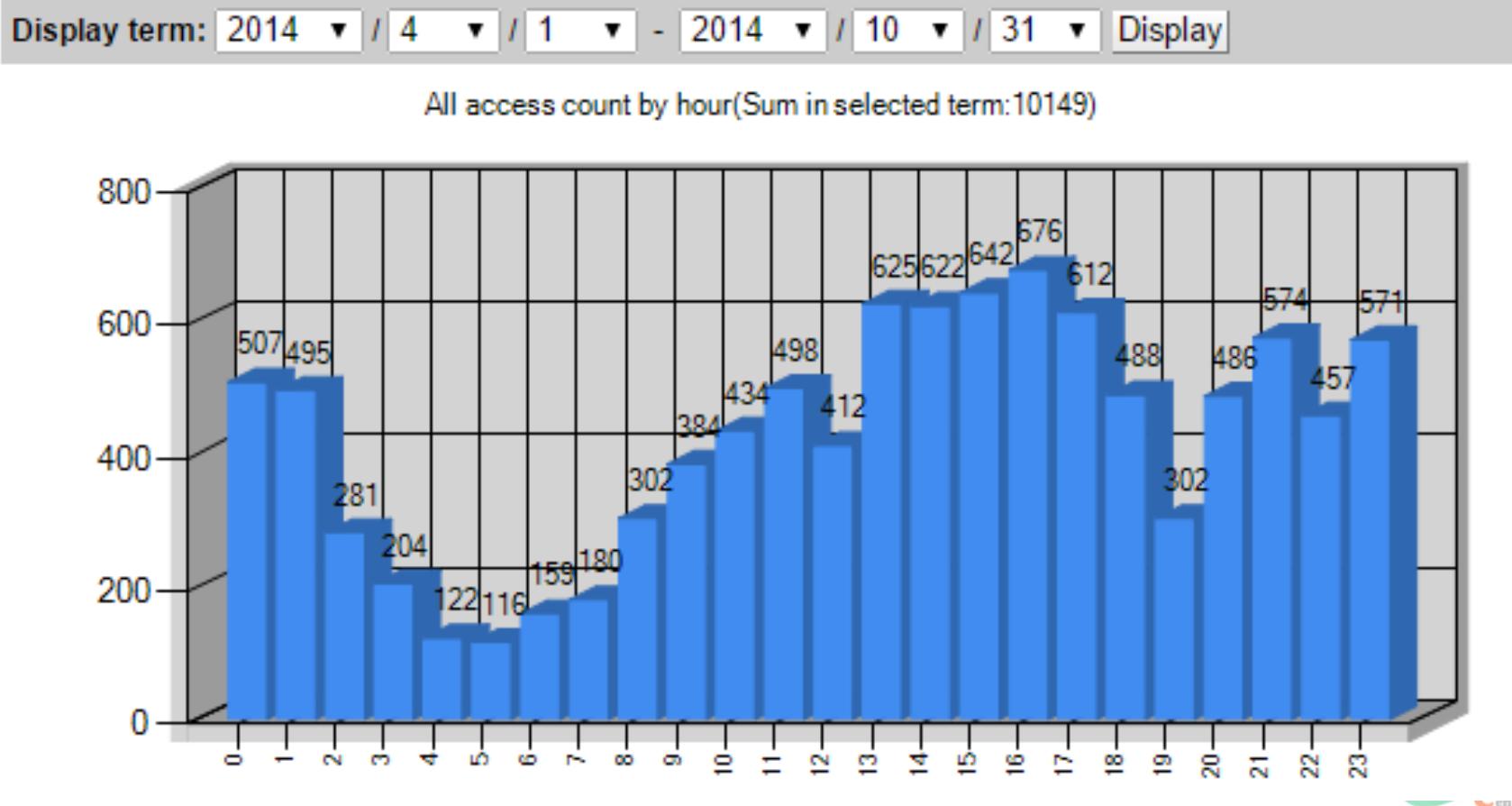
## Analysis

- Tendency of learning style
- Frequently commented segments

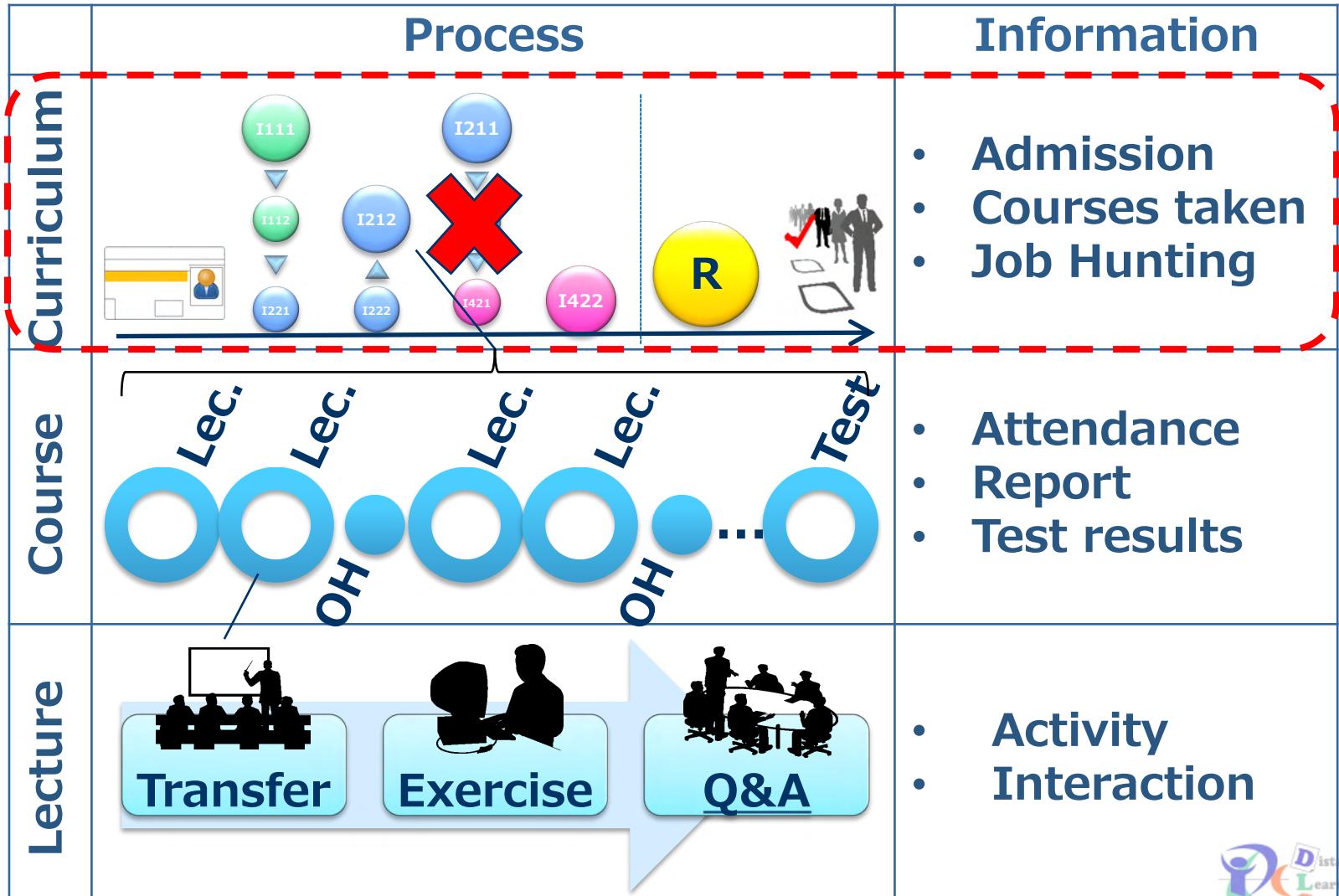
⇒ These processes are stored into e-Portfolio  
(digital collection of evidence for learning)

# Summary of Access

10,149 Accesses/214 days



# Examples for Process in Education



# IR System

## Institutional Research

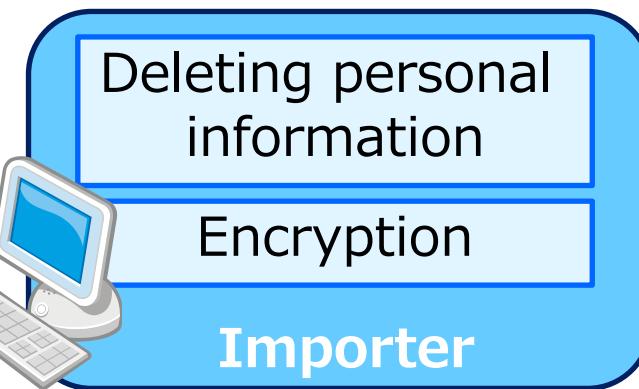
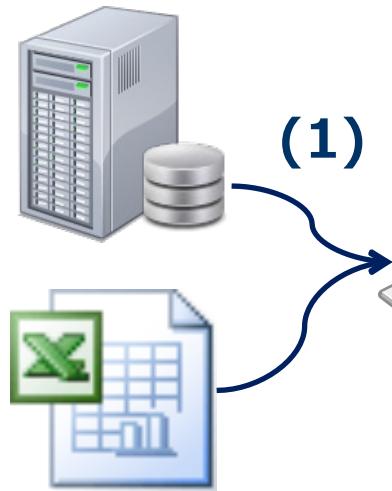
- Objective evaluation for achievement of educational goal
- Combining distributed data to different section (i.e. admission, career dev.)
- **IR in Univ.  $\neq$  BI + CSR in Company**

## Process info. By System

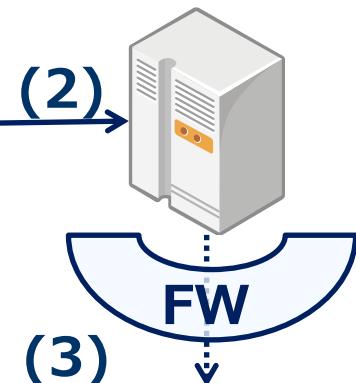
- **Course Record**
  - Period, field, level, grade, etc.
- **Analysis Condition**
  - Admission test, job hunting, research, etc.

# IR System Overview

## Educational DB system



## Analysis Server



## Flow of System

- (1) Upload data to importer
- (2) Register encrypted data to analyzer
- (3) Report results to authorized user

# System UI

**Param. Area**

**Scenario Menu**

**Total Chart**

**Chart Area**

**School Chart**

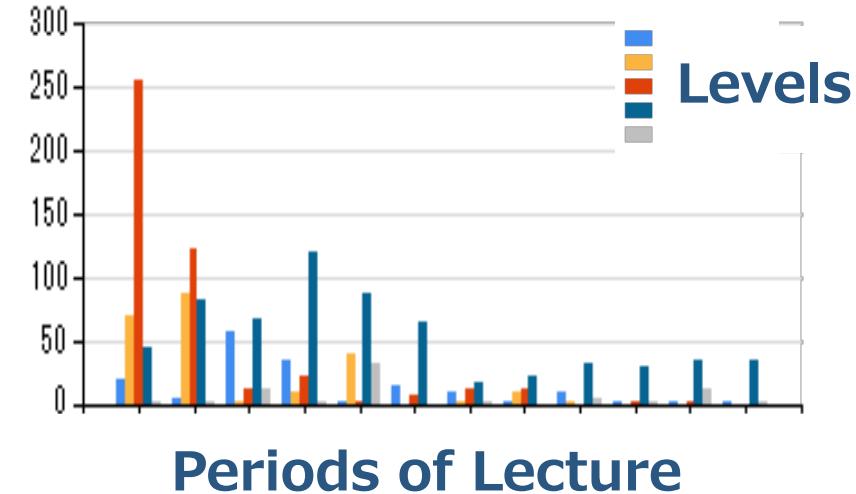
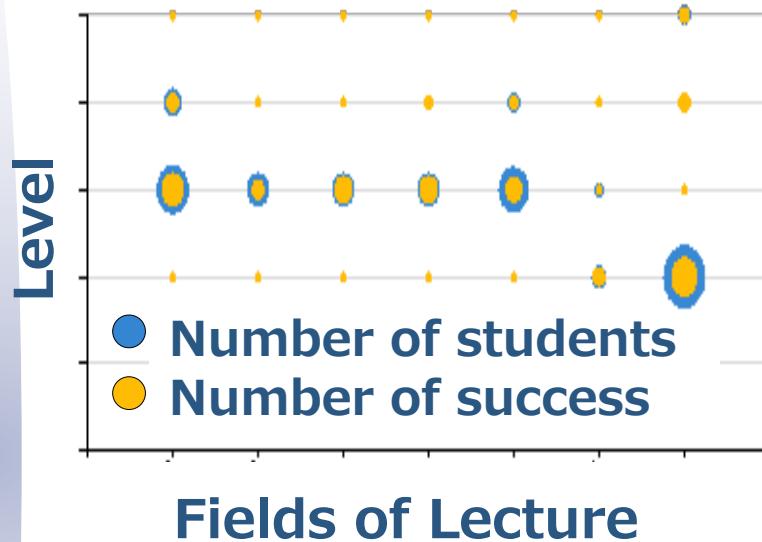
**Drilldown (List View)**

**Drilldown (Personal View)**

The image shows a complex reporting interface with several components:

- Scenario Menu:** Located at the top left, above the main content area.
- Total Chart:** A large sunburst chart in the center of the main area, divided into six segments labeled '分野:ア' through '分野:ヒ'.
- Chart Area:** The main area containing the Total Chart and three smaller charts for different schools: 全研究科, 知識科学研究科, and 情報科学研究科.
- School Chart:** A chart specifically for the Material Sciences Research Institute (マテリアルサイエンス研究科).
- Drilldown (List View):** A detailed table view showing individual records, with one row highlighted.
- Drilldown (Personal View):** A chart showing personal data over time, with a line graph and a table of data points.
- Param. Area:** A vertical sidebar on the right containing various selection parameters for filtering the data.

# Examples of Chart



## Analysis/Report/Prediction

- Comparison of difficulty among fields
  - Reports of tendency for taking courses
  - Prediction of future from past data
- ⇒ This enables us to extract role model.

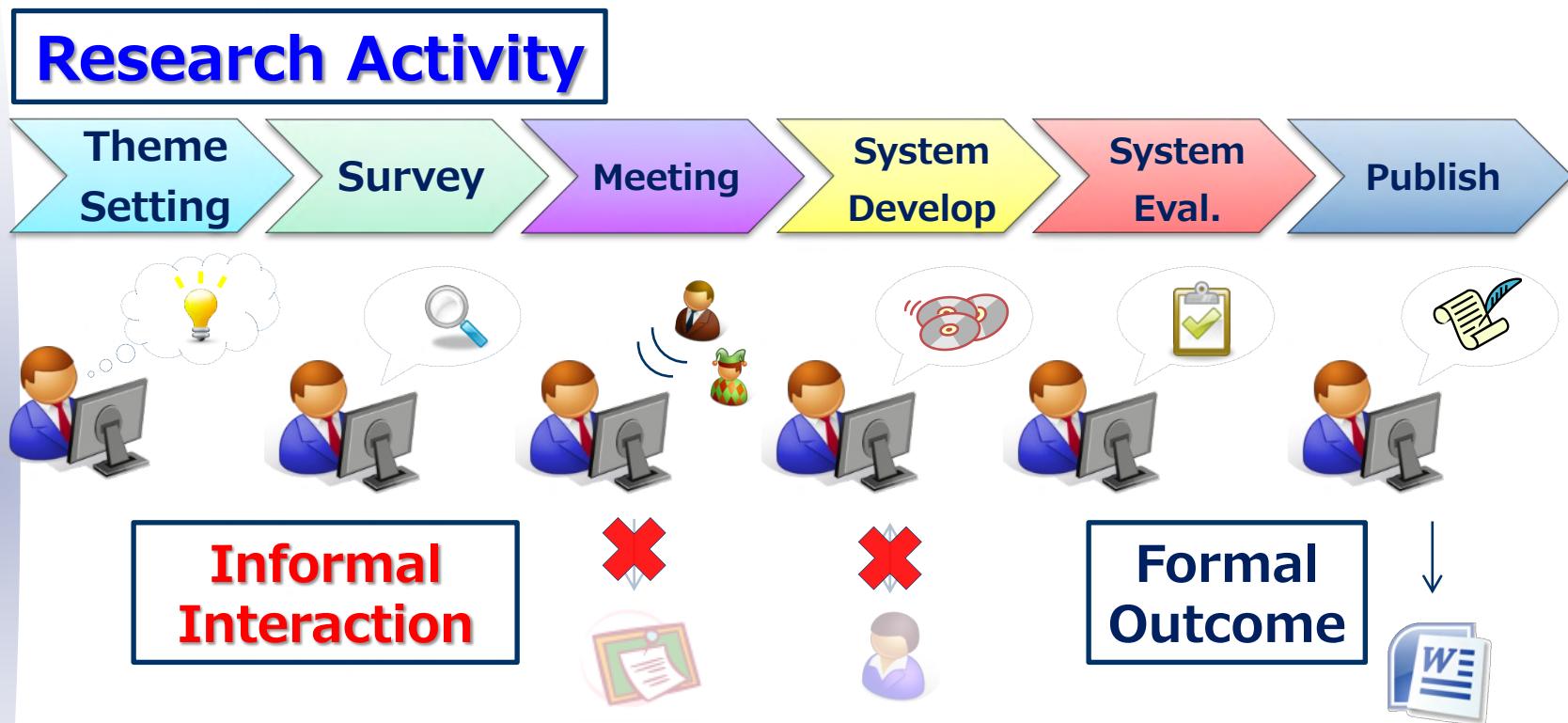
# Research Question

**What do you think about  
How to support research process  
with ICT?**

# Examples of Process in Research

	Process	Information
Research		<ul style="list-style-type: none"> <li>• Research Activity</li> <li>• Interaction</li> </ul>
Presen.		<ul style="list-style-type: none"> <li>• Presentation Activity</li> <li>• Q&amp;A</li> <li>• Reflection</li> </ul>
Writing		<ul style="list-style-type: none"> <li>• Revision Process</li> <li>• Revision Intention</li> </ul>

# Research Activity Process



## Research Process in Laboratory

- Community of Practice
- **Informal interactions are existed dispersedly  
⇒ Difficult to reuse**

# Support for Structuring

## Research Activity



**Hyperblog**

tome のBlog

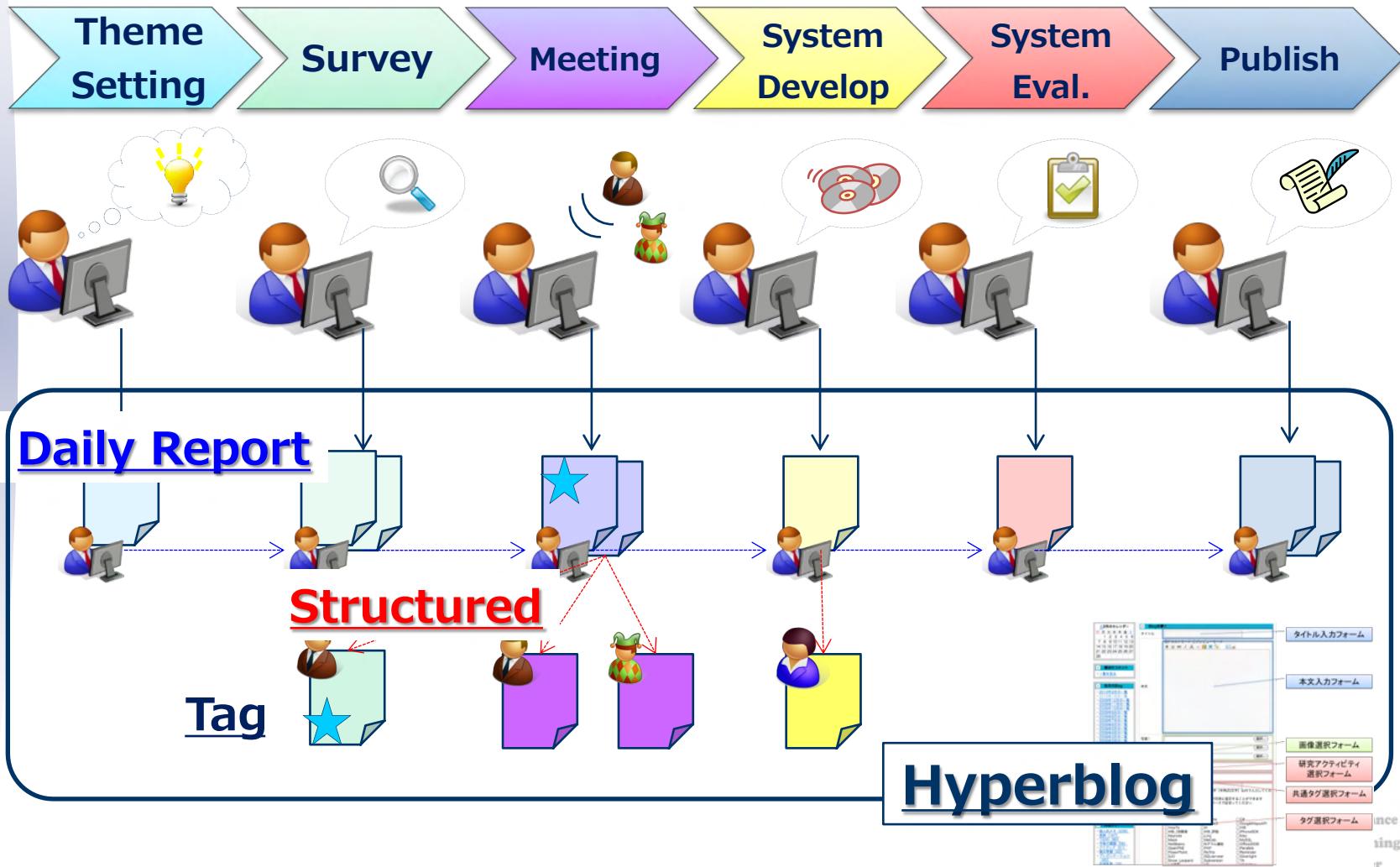
77件中 1件～20件を表示 次を表示

各月のBlog	01月15日 07:06	<a href="#">[システム開発] : IHBをVer0.5.0にアップデート</a> IHBをVer. 0.5.0にアップデートしました。主な追加機能は以下のとおりです。●エントリブックマーク機能・エントリを全文表示したときに表示され タグ: <a href="#">IHB</a> <a href="#">バグ修正</a> <a href="#">バージョンアップ</a> <a href="#">機能追加</a> トピック: <a href="#">進捗</a>
	01月13日 00:01	<a href="#">[システム開発] : 新機能いろいろ</a> 今日もごりごり開発してDev版をアップデート 成果

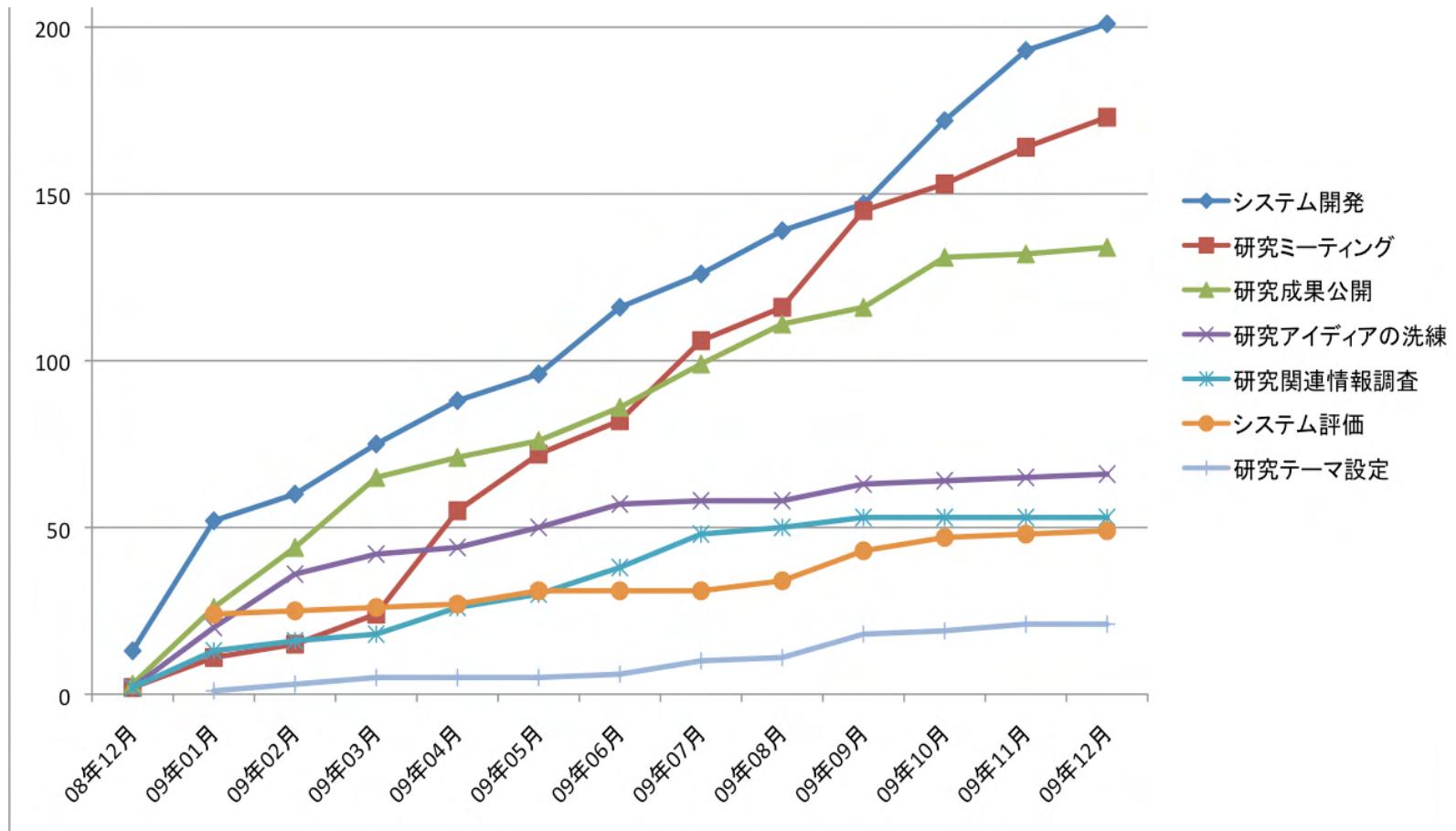
**ePortfolio like approach**

# Support for Structuring

## Research Activity



# Tendency of Process



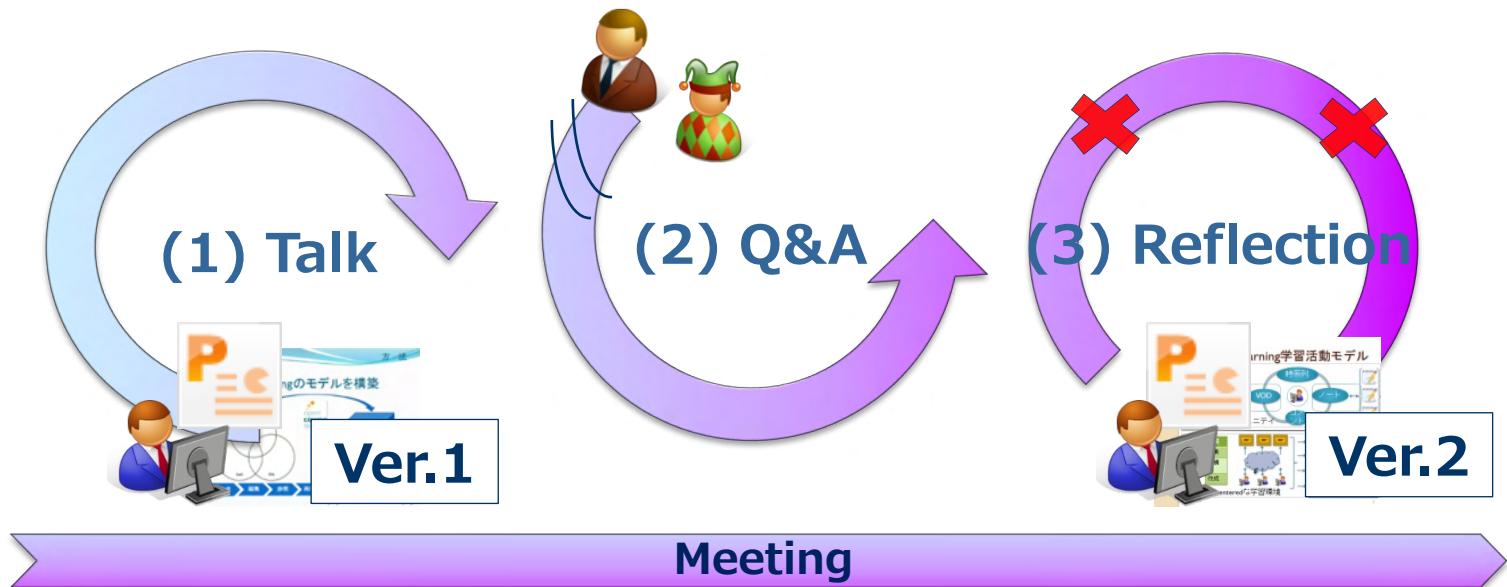
## Analysis/Report/Prediction

Sharing suitable moment for each activity

# Examples of Process in Research

	Process	Information
Research	<pre> graph LR     A[Theme] --&gt; B[Survey]     B --&gt; C[Meeting]     D[Develop] --&gt; E[Eval.]     E --&gt; F[Publish]   </pre>	<ul style="list-style-type: none"> <li>• Research Activity</li> <li>• Interaction</li> </ul>
Presen.	<p>A circular flow diagram showing three interconnected components: <b>Talk</b> (represented by a person at a computer), <b>Q&amp;A</b> (represented by two people talking), and <b>Reflection</b> (represented by a person at a computer). Arrows indicate a clockwise cycle between them.</p>	<ul style="list-style-type: none"> <li>• Presentation Activity</li> <li>• Q&amp;A</li> <li>• Reflection</li> </ul>
Writing	<p>A diagram showing a person at a computer interacting with two versions of a document, labeled <b>Ver.1</b> and <b>Ver.2</b>. The word <b>Comment</b> is prominently displayed in the center, indicating the iterative nature of the writing process.</p>	<ul style="list-style-type: none"> <li>• Revision Process</li> <li>• Revision Intention</li> </ul>

# Meeting Review Process



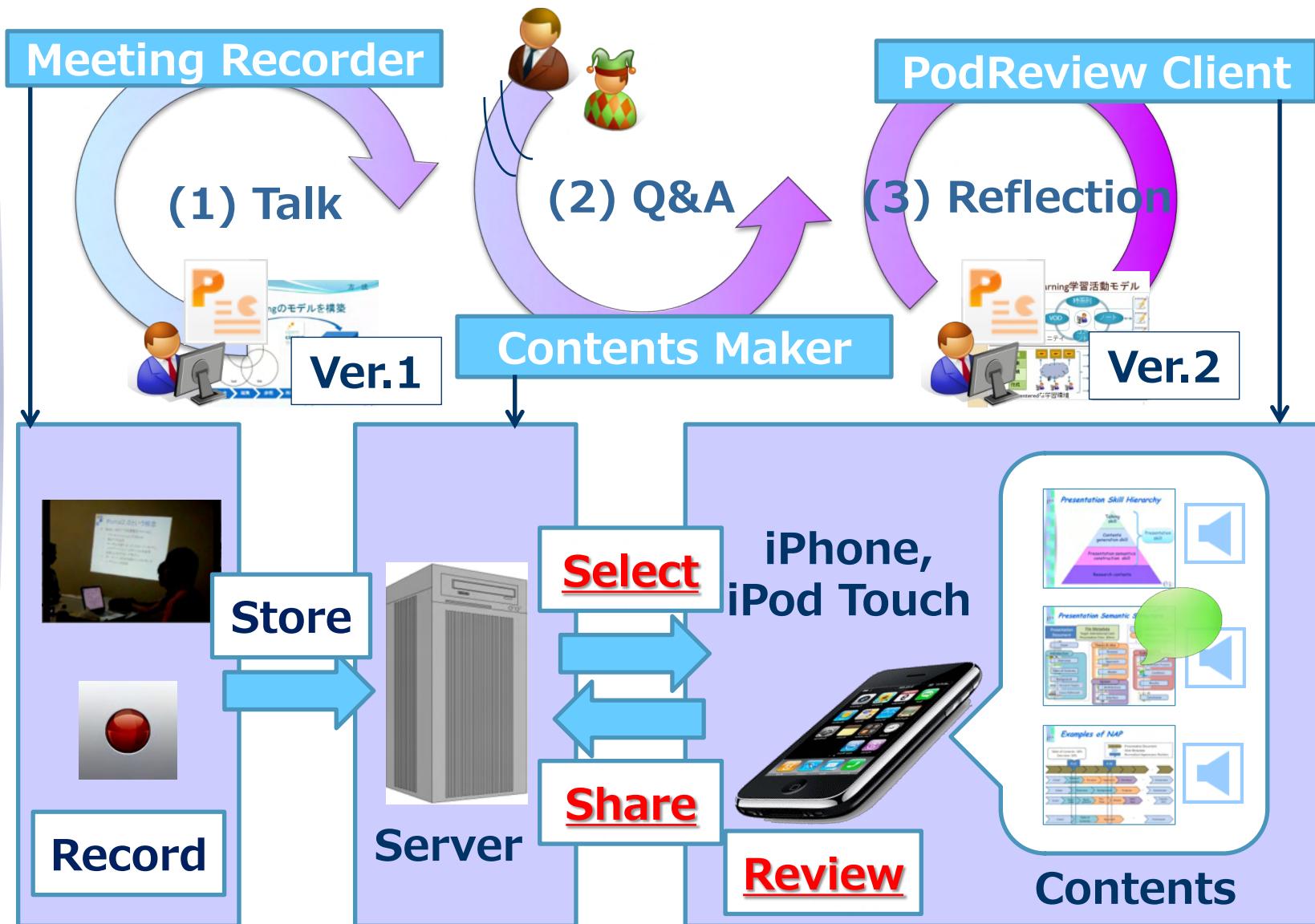
## Awareness by Meeting Reflection

- (1) Students talk their presentation
- (2) Q&A by professor & other students
- (3) Students reflect on meeting (Meeting Review)
  - Difficult to get time for reviewing
  - Hard to remember contents to be reviewed

# Support for Meeting Review



# Support for Meeting Review



# Examples of Review Process

	Number	Average Time	Average Slide
Home	10	28 min.	7.4 seg.
Train	13	13 min.	4.5 seg.
Lab	3	32 min.	8 seg.
University	3	12 min.	2.7 seg.
Road	1	10 min.	3 seg.

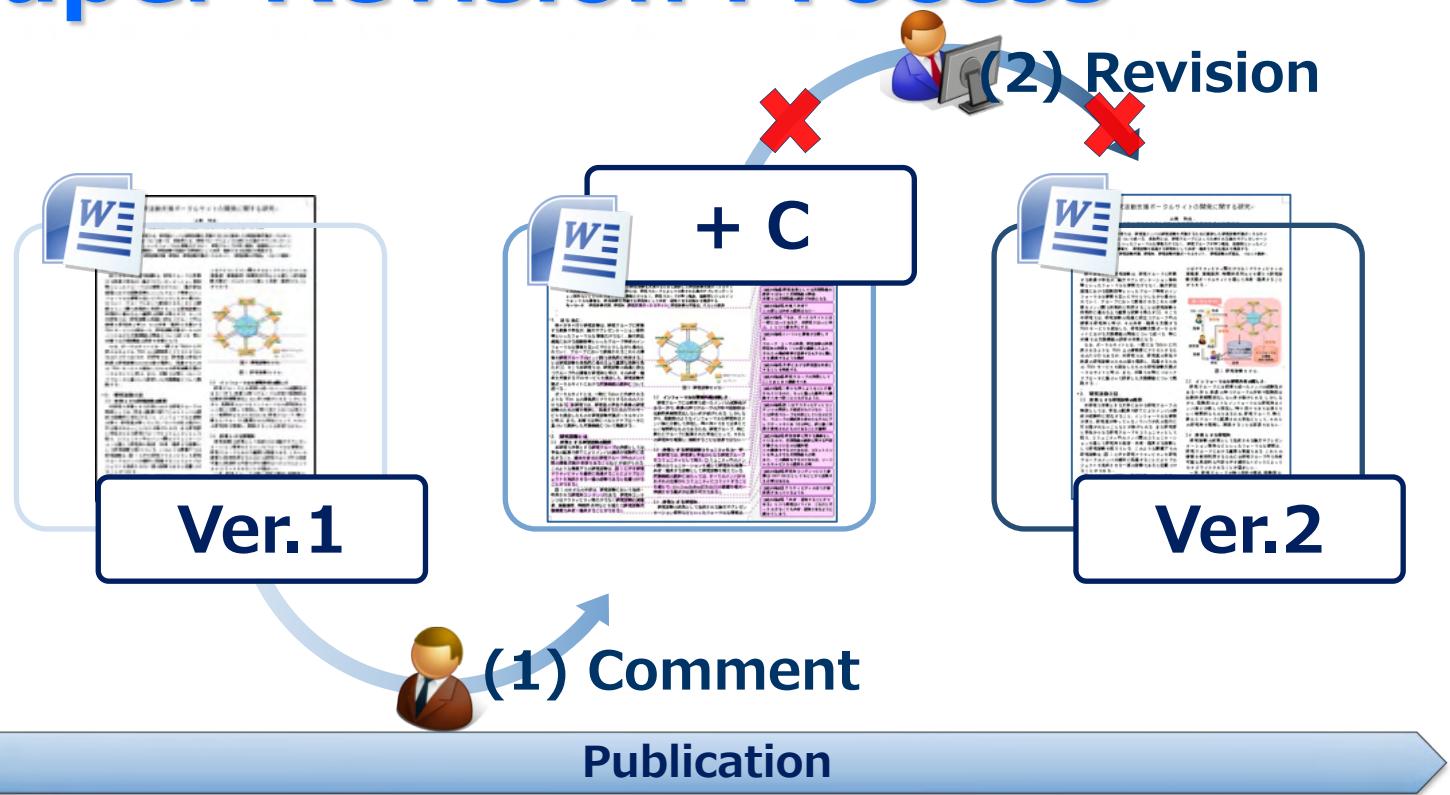
(n = 7/24h)

System provides learning opportunities out of laboratory.

# Examples of Process in Research

	Process	Information
Research		<ul style="list-style-type: none"> <li>• Research Activity</li> <li>• Interaction</li> </ul>
Presen.		<ul style="list-style-type: none"> <li>• Presentation Activity</li> <li>• Q&amp;A</li> <li>• Reflection</li> </ul>
Writing		<ul style="list-style-type: none"> <li>• Revision Process</li> <li>• Revision Intention</li> </ul>

# Paper Revision Process

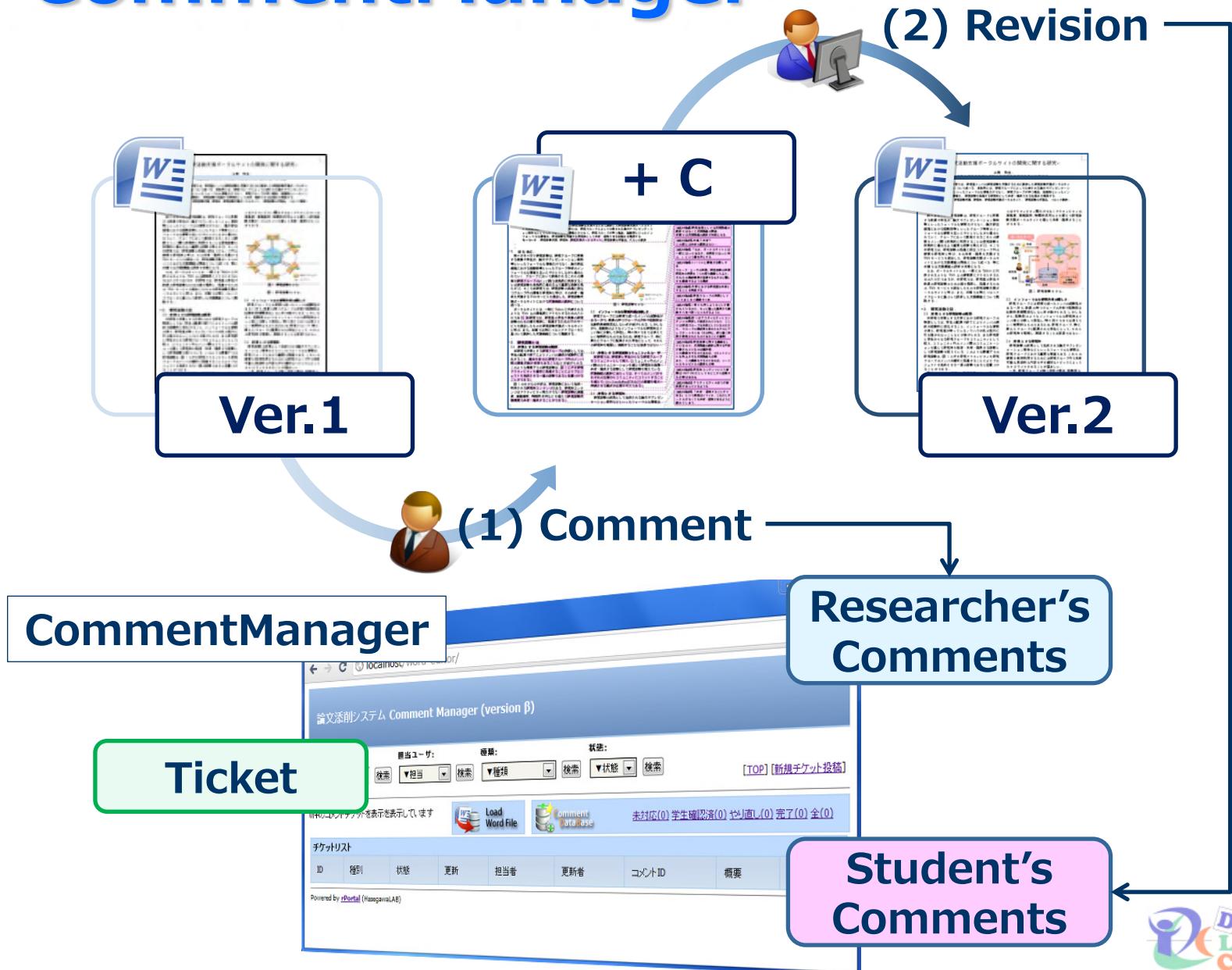


## Revision Process in Publication

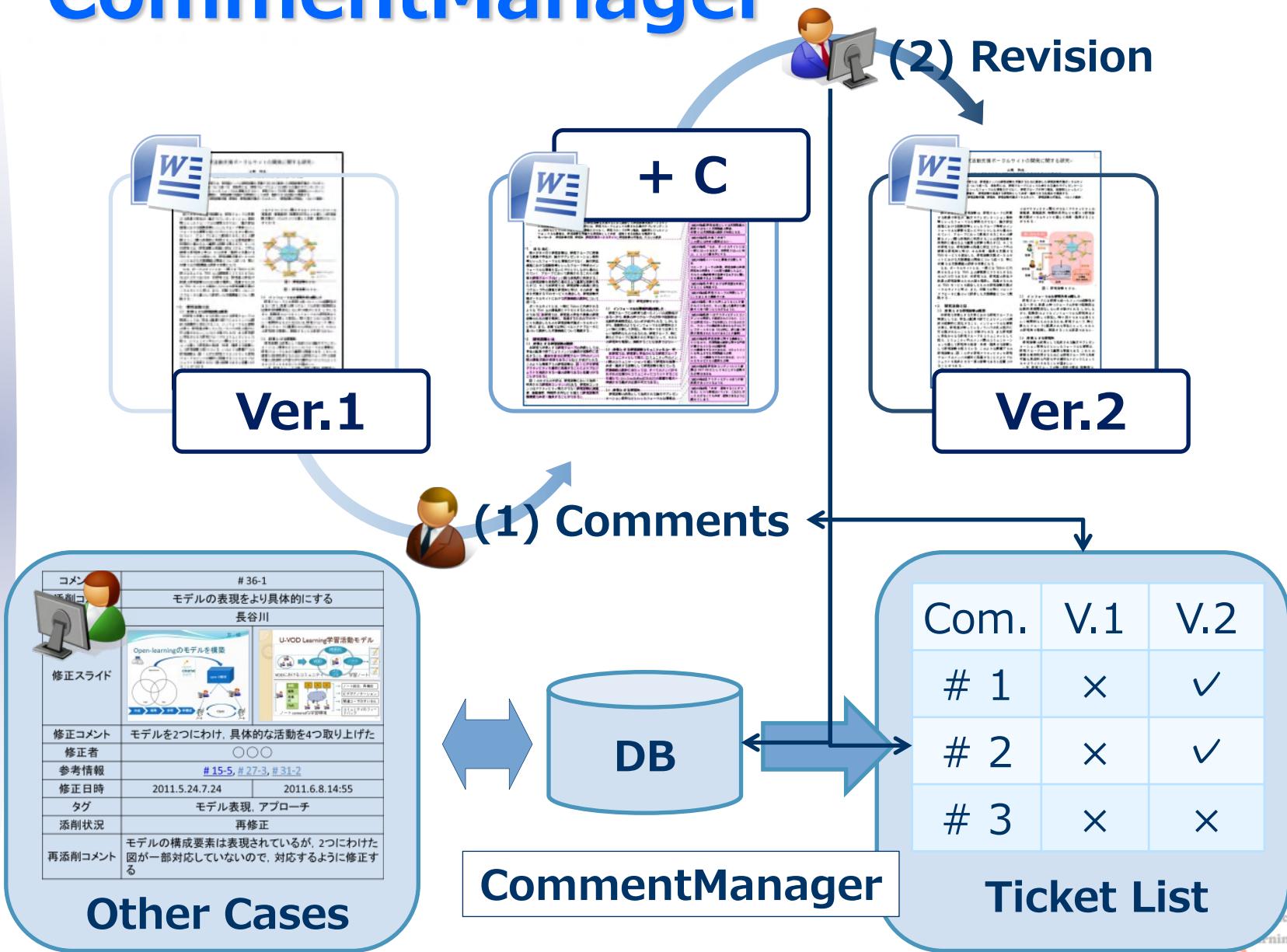
(1) Making comments by researcher      (2) Revising paper by student } Repeat

- Hard to reflect on commented intention
- Difficult to know where should pay attention

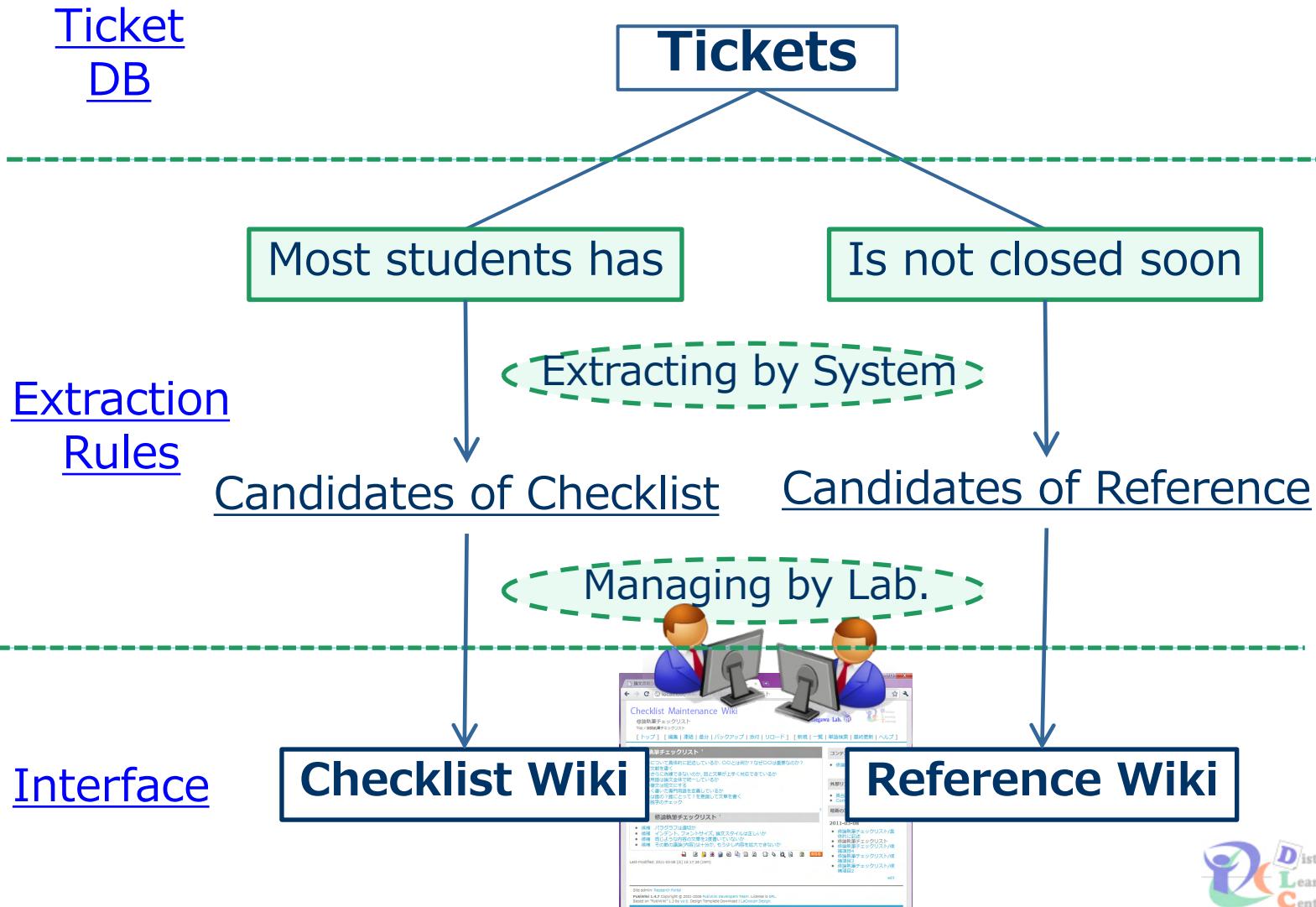
# CommentManager



# CommentManager



# Knowledge Transfer Function



# Checklist Wiki

The screenshot shows a web browser window displaying the 'Checklist Maintenance Wiki' at [localhost/wiki-cm/?修論執筆チェックリスト](http://localhost/wiki-cm/?修論執筆チェックリスト). The page contains two main checklist sections:

- 修論執筆チェックリスト**
  - について具体的に記述しているか、○○とは何か？なぜ○○は重要なのか？
  - 参考文献を書く
  - 図はさらに洗練できないのか、図と文章が上手く対応できているか
  - 専門用語は論文全体で統一しているか
  - 長い複文は短文にする
  - 新しく書いた専門用語を定義しているか
  - それは誰の？誰にとって？を意識して文章を書く
  - 誤字脱字のチェック
- 候補 修論執筆チェックリスト**
  - 候補 パラグラフは適切か
  - 候補 インデント、フォントサイズ、論文スタイルは正しいか
  - 候補 同じような内容の文章を2度書いていないか
  - 候補 その節の議論(内容)は十分か、もう少し内容を拡大できないか

A blue arrow points from the bottom-left of the slide to the ticket display area, which contains the text: "When user clicks these items, it displays related tickets". A red arrow points from the first checklist section to a box containing the text: "Checklists More than half of students have same comment.". A blue arrow points from the second checklist section to another box containing the text: "Candidate Laboratory members pick up other important comment.". The ticket display area also includes a list of ticket titles.

**Checklists**  
More than half of students have same comment.

**Candidate**  
Laboratory members pick up other important comment.

When user clicks these items, it displays related tickets

PukiWiki 1.4.7 Copyright © 2001-2006 PukiWiki Developers Team. License is [GPL](#).  
Based on "PukiWiki" 1.3 by [yu-jl](#). Design Template Download | LaCoocan Design.

Hasegawa Lab. Distance Learning Technology

# Conclusion

**ICT can deal with process directly**

- **Learning Informatics**
  - Designing & Improving Education & Learning
- **Cognitive Science (Theoretical):**
  - Modelling for Human Learning Process as Target
- **Information Technology (Technological):**
  - By Using ICT and/or AI/Media/Software Tech.
- **Research Target is Changed**
  - From knowledge to Skills

**ICT should not be just replacement of conventional equipment.**

# What's Next for SDL ?

## 1. How to support Open Learning

- Modeling open planning/reflection process
- Developing support functions for OL

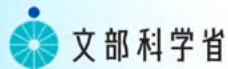
## 2. How to support Learning Community

- Modeling learning/communication in community
- Developing support function for LC

## 3. How to support Learner adaptively

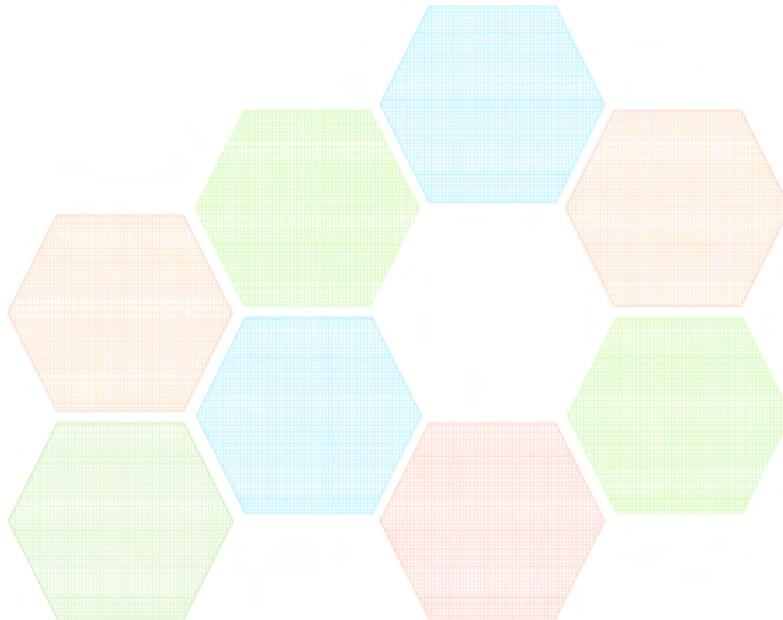
- User-modeling and task-modeling
- Adaptive Hypermedia

# 教育とDX



## 文部科学省におけるデジタル化推進プラン

文部科学省デジタル化推進本部  
令和2年12月23日



# 教育とDX

## 目次

I 来るべきデジタル社会に向けたMEXTのビジョン	… 2頁
II 教育におけるデジタル化の推進	… 4頁
II - 1 GIGAスクール構想による一人一台端末の活用をはじめとした学校教育の充実	
II - 2 大学におけるデジタル活用の推進	
II - 3 生涯学習・社会教育におけるデジタル化の推進	
II - 4 教育データの利活用による、個人の学び、教師の指導・支援の充実、EBPM等の推進 (別紙) 「GIGA StuDX推進チーム」の体制について	
III デジタル社会の早期実現に向けた研究開発	… 13頁
III - 1 デジタル社会への最先端技術・研究基盤の活用	
III - 2 将来のデジタル社会に向けた基幹技術の研究開発	
III - 3 研究環境のデジタル化の推進 (別紙) デジタル化に高まる機会-科学技術WGアンケートに寄せられた声から-	
IV 「新たな日常」における文化芸術・スポーツ、行政DX	… 19頁
IV - 1 文化芸術DX（デジタルトランスフォーメーション）戦略	
IV - 2 デジタル社会におけるスポーツの新たな展開	
IV - 3 行政情報システムの刷新	
IV - 4 DX人材の育成・確保	

# 教育とDX

## I 来るべきデジタル社会に向けたMEXTのビジョン

新型コロナウイルス感染症という未曾有の危機に見舞われた本年、我が国をはじめとする世界中の人々の生活様式は一変した。人ととの接触機会の低減や地域間の往来の制限は、テレワークやオンライン会議といったデジタルツールの活用が社会に急速に浸透する契機となるなど、「フィジカル」の空間から「サイバー」の空間への移行が劇的に進展し、“個々人の生活様式”を変えるほどの大きなパラダイムシフトが発生した。

このパラダイムシフトは、同時に我が国のデジタル化の遅れを露呈させる契機ともなった。事実、新型コロナウイルス感染症の拡大に伴い、急激に進展したデジタル化やオンライン化に、我が国の社会構造が追い付いてゆけず、あらゆる場面・各種活動に影響があつたことは記憶に新しい。

「新たな日常」としての現下の状況は勿論、ポスト・コロナ、更にはその先の未来社会においても、デジタル化促進の重要性は日に日に増してゆくと想定される。こうした中、「未来省」である文部科学省が担う教育や科学技術イノベーション、文化芸術、スポーツの各分野において、高まる新たなニーズや期待に隨時機動的に応えつつ、ポスト・コロナ期のニューノーマルに的確に対応していくために必要なDXに係る取組を早急かつ一体的に推進していかなければならない局面を迎えている。

デジタル化やDXの促進が、国民一人一人の幸福（well-being）を高めるものでなければならぬことを心に留めつつ、今こそ、ソフト・ハードの両面から文部科学省の強みを最大限に活かし、各分野におけるデジタル化に向けた取組を相乗的に加速させるとともに、中長期的視野から競争力の源泉となる新たな成長基盤の構築を推進していかなければならない。

# 教育とDX

## 教育ワーキング・グループ：まとめ

- 国全体でデジタル化の取組が進む中、教育分野においても全般にわたりデジタルの効果的活用を図ることで、これまでにない可能性を新たに生涯を通じた学びにもたらすことが期待される。
- 教育ワーキング・グループにおいては、GIGAスクール構想を始め教育分野において急速なデジタル化への対応が進むことを見据えて、デジタルの活用により一人一人の多様な状況やニーズに対応した取組が進展するなど、その良さを誰もが実感していただくことができるようになることを目指して、現段階における施策や今後の検討の方向性についてとりまとめた。
- さらに、現在政府として取組が進められている個人情報保護制度の見直しを踏まえた在り方やマイナンバーカード等の活用の検討、デジタルを活用した生徒の学習活動の情報等の利活用の在り方、民間における学習履歴の電子化の取組など、進化を続けるデジタル技術や国際的な動向等も踏まえて、今後、更なる効果的な活用の在り方について文部科学省として検討を深めていく。

# 教育とDX

## 【II-1】GIGAスクール構想による一人一台端末の活用をはじめとした学校教育の充実①

概要	GIGAスクール構想による義務教育段階の一人一台端末環境が今年度末までに実現することを踏まえて、ハード・ソフト・人材が一体となった取組を教育再生実行会議等の議論も踏まえつつ、一層加速することにより、子供たち一人一人の多様な実情を踏まえ誰一人取り残すことのない学びの実現に向けた取組を推進。			
事項	取組			
GIGAスクール構想等による一人一台環境の整備	<ul style="list-style-type: none"> <li>▶ 全国的小・中学校において令和2年度中の配備完了に向けて、国として、自治体への支援や事業者への働きかけなどを通じて取組を加速させ、令和3年度からの本格運用開始を目指す。また、新JIS規格の教室用机の整備について地方財政措置を要望。</li> <li>▶ 高等学校段階の低所得世帯等の生徒が使用するICT端末の整備を支援する。</li> <li>▶ 高等専修学校や日本人学校において、一人一台端末などICT環境の整備・活用による個別最適な学びと協働的な学びが実現されるよう支援する。</li> </ul>			
ICT端末の安全・安心な活用の促進	<ul style="list-style-type: none"> <li>▶ GIGAスクール構想により整備されたICT端末が家庭への持ち帰りも含め全国の学校現場で円滑かつ効果的に活用できるよう、情報モラルを含む情報活用能力の育成とともに、児童生徒が安全・安心に端末を取り扱う方法等に関するガイドラインの作成を行う。また、今後的情報モラル教育を含む情報教育の推進に向け、児童生徒の情報モラルを含む情報活用能力を適切に把握する。</li> </ul>			
通信ネットワーク環境の整備・円滑化	<ul style="list-style-type: none"> <li>▶ GIGAスクール構想における児童生徒一人一台端末環境にふさわしい高速大容量の通信ネットワークとの一体的な整備を進め、様々な学習場面でのICTの活用を促進する。</li> </ul>			
幼稚園におけるICT環境の整備	<ul style="list-style-type: none"> <li>▶ 幼稚園においては、コロナ禍における園での取組事例を踏まえ、オンラインによる教員研修や保育参観、ICTを活用した家庭との連絡等に活用できるよう、ICT環境の整備を推進する。</li> </ul>			
学校のデジタル化・クラウド化の推進	<ul style="list-style-type: none"> <li>▶ 教職員による学校・学級運営に必要な情報や児童生徒の状況の一元管理・共有を可能とする統合型校務支援システムについて、令和4年度の100%整備を目指して地方財政措置を講じるとともに、各自治体における導入を引き続き促進する。</li> <li>▶ 個人情報を適切に保護することを前提に、クラウドを円滑に活用できるようにするなど学校におけるICT利活用を促進する。</li> </ul>			

# 教育とDX

## 【II-1】GIGAスクール構想による一人一台端末の活用をはじめとした学校教育の充実②

事項	取組
遠隔・オンライン教育の推進	<ul style="list-style-type: none"><li>➢ 児童生徒一人一台端末と高速大容量の通信ネットワークとの一体的な整備により、遠隔授業やオンデマンドの動画教材等を取り入れ、<u>発達段階に応じて対面指導と遠隔・オンライン教育とを使いこなす（ハイブリッド化）</u>ことで、多様な子供たちに対して教育の質を高め、個別最適な学びと協働的な学びの実現を目指す。</li><li>➢ 誰も取り残すことのないよう、学校で学びたくても学べない児童生徒（病気療養、不登校など）に対する遠隔・オンライン教育の活用を促進する。</li></ul>
学習者用デジタル教科書の普及促進	<ul style="list-style-type: none"><li>➢ 学習者用デジタル教科書について、令和6年度の本格的な導入を目指し、今後の在り方について有識者会議で検討を行い、令和2年度中に中間まとめ、来年夏頃に最終まとめを行う。デジタル教科書の使用を各教科等授業時数の2分の1未満とする基準の見直しについては、令和2年内に一定の方向性を示す。</li><li>➢ デジタル教科書の普及促進に係る実証事業やクラウド配信に関するフィージビリティ検証、効果・影響等に関する実証研究について令和3年度予算（案）において計上。</li></ul>
CBTの活用の推進	<ul style="list-style-type: none"><li>➢ <u>学校・家庭において学習・アセスメントができるオンライン学習システム（CBTシステム）</u>を、希望する全国の小・中・高等学校等が活用できるよう、システムの機能の改善・拡充や解答履歴の分析・フィードバック等を行う。</li><li>➢ あわせて、全国学力・学習状況調査のCBT化について、令和3年度より小規模からの試行・検証に取り組み、課題の解決を図りつつ、段階的にフィージビリティを高めていく。</li></ul>
先端技術の効果的な利活用	<ul style="list-style-type: none"><li>➢ <u>学校教育において先端技術を効果的に利活用できるよう、令和2年度内を目途にガイドブックを作成するとともに、実証研究を実施。</u></li></ul>

# 教育とDX

## 【II-1】GIGAスクール構想による一人一台端末の活用をはじめとした学校教育の充実③

事項	取組
一人一台端末の効果的な利活用促進のための支援体制の構築	<ul style="list-style-type: none"><li>➢ 一人一台端末の効果的な利活用の促進に向けて、省内関係課で構成する「GIGA StuDX推進チーム」を設置し、全国の教育委員会・学校に対する支援活動を展開する。(p.12別紙参照)</li></ul>
学校におけるICT活用等による学びを具体的・専門的に助言できる支援人材	<ul style="list-style-type: none"><li>➢ 各教育委員会等に対してICT環境整備や活用方法等の教育の情報化に関する全般的な助言・支援を行うICT活用教育アドバイザー、</li><li>➢ GIGAスクール構想による各学校における環境整備の初期対応を行うGIGAスクールサポートー、</li><li>➢ 学校における日常的な教師のICT活用をサポートするICT支援員、などの配置を促進し、ICT活用のための環境整備や教師が円滑かつ効果的にICTを活用した授業を行うための支援を行う。</li></ul>
教師のICT活用指導力の向上、ICT活用方法等の支援	<ul style="list-style-type: none"><li>➢ 教師のICT活用指導力の向上のため、独立行政法人教職員支援機構において実施する各地域でのICT活用に関する指導者の養成研修の充実を図る。</li><li>➢ あわせて、文部科学省においては、各教科等の指導におけるICTの効果的な活用に関する参考資料や解説動画の作成・公表を行うとともに、ICT活用に関する助言や研修支援などを行う「ICT活用教育アドバイザー」事業などを実施。</li></ul>
教職課程におけるICTの活用に関する内容の修得促進	<ul style="list-style-type: none"><li>➢ 教職課程において、ICTを活用した効果的な授業方法や、子供たちの情報モラル含む情報活用能力を育成するための指導方法等を修得できるよう、令和3年度中を目途に制度改正（省令等）を行えるよう中央教育審議会教員養成部会にて検討を行い、令和4年4月から学ぶ学生がICTの活用に関する内容を修得できるよう大学の科目の開設を目指す。</li></ul>

# 教育とDX

## 【II-2】大学におけるデジタル活用の推進

### 概要

高等教育へのデジタル技術の大胆な取り入れにより、ポスト・コロナ時代の教育手法の具体化・普及を図る。地理的条件を問わず、国際的な教育機会を享受できる機会を拡大するとともに、海外の学生・教員とのネットワークの継続的な確保を可能にし、国際競争力のあるハイブリッド教育環境を実現する。また、デジタル化の担い手となる人材を育成するための取組や、大学入学者選抜におけるデジタル活用等に向けた検討等を進める。

### 事項

### 取組

#### デジタル技術を活用した高等教育の高度化・成果の普及

- 大学・高等専門学校において、デジタル技術を大胆に取り入れたポスト・コロナ時代の教育手法の具体化・成果の普及を図るための環境整備を推進。デジタル技術を活用し、高い学習成果の達成や、自発的な学び・気づきの効果的な誘導、現場実習・実験に近い経験の機会確保など授業の価値を最大化する機運を醸成し、全国への浸透を促進するための取組を実施。
- 対面とオンラインのハイブリッドによる質の高い教育の推進に向け、教育再生実行会議等における議論を踏まえ、検討を進める。

#### 国立大学法人等におけるハイブリッド教育研究環境の整備

- 対面教育と併せて、オンライン教育を効果的に実施できるよう、キャンパス内の基幹回線や電源の強化、教室等における換気空調の整備などハイブリッド教育の提供のために必要な環境整備を推進する。

#### 数理・データサイエンス・AI教育の推進

- デジタル時代の「読み・書き・そろばん」である「数理・データサイエンス・AI」の基礎などの必要な力を全ての国民が育み、あらゆる分野で人材が活躍する環境を構築するために必要な取組を引き続き推進。

#### 大学入学者選抜におけるデジタル活用等に向けた検討

- 大学入学者選抜におけるC B Tの活用に向けた研究・開発等を進めるほか、「情報I」の出題を含む令和6年度以降の大学入学共通テストの出題教科・科目について、様々な関係者からの意見や「大学入試のあり方に関する検討会議」での取りまとめ等を踏まえて、来年夏頃を目途に決定・公表。

# 教育とDX

## 【II-3】生涯学習・社会教育におけるデジタル化の推進

### 概要

生涯を通じて誰もがいつでもどこでも学ぶことができるよう、インターネット等を活用して、生涯学習・社会教育の学びの機会などのデジタル化を推進する。

### 事項

### 取組

#### 高卒認定・中卒認定の受験申請・証明のデジタル化

- ▶ 高等学校及び中学校卒業程度認定試験の受験申請及び証明について、受験者がインターネットを通じ、自宅や身近な場所から簡単に受験申請が可能となり、また、合格証明書等各種証明書がいつでも入手できるよう、令和5年3月の運用開始を目指して電子化に取り組む。

#### 専修学校におけるオンライン・先端技術利活用の推進と支援のための環境整備

- ▶ 専修学校が遠隔授業を実施するために必要な環境整備に加え、先端技術を活用した教育手法、コンテンツ、カリキュラムの開発・実証を行い、成果の横展開に取り組む。

#### 生涯学習・社会教育分野のICTを活用した取組の推進

- ▶ 地方自治体や社会教育施設におけるICTを活用した取組を推進するため、オンライン研修会の開催による公民館関係者等との意見交換や、各種会議や研修会（社会教育主事講習等）を通じて、既存の財源の更なる活用の促進やICT活用事例の収集・周知に取り組む。

# 教育とDX

## 【II-4】教育データの利活用による、個人の学び、教師の指導・支援の充実、EBPM等の推進

### 概要

学習者・教師・学校・行政機関等が、それぞれの立場から教育データを効果的に利活用することにより、個人の活用による学習等のサポート、教師による個に応じた指導や支援、新たな知見の創出、政策への反映等を目指す。

### 事項

#### 教育データの効果的な利活用の推進

### 取組

- 初等中等教育における教育データについて、個人の活用による学習等のサポート、教師による個に応じた指導や支援、蓄積されたビックデータを分析することによる新たな知見の創出や政策への反映等を実現するための環境の構築に向けた将来的なイメージを今後描き、教育再生実行会議デジタル化タスクフォース等の議論も踏まえ、教育データの利活用に関する有識者会議において令和2年度中に一定の論点整理を行い、文部科学省としての取組を加速する。

#### 教育データの標準化の推進

- 教育データの枠組みの提示と学習データの起点としての「学習指導要領コード」を、文部科学省「教育データ標準」（第1版）として公表したことにより、これまで制度等に基づき学校で普遍的に活用されてきたデータ（統計で活用できるデータや学校健診情報などに関するデータ）等について、令和3年春を目途に「第2版」として公表を目指す。
- 初等中等教育段階における標準化の進展や、大学を始め生涯を通じた学びにおけるデジタル化の進展の状況を踏まえて、標準化の範囲の拡大等について今後検討を深める。

#### 調査やPHRなどにおける教育データの多面的な利活用の推進

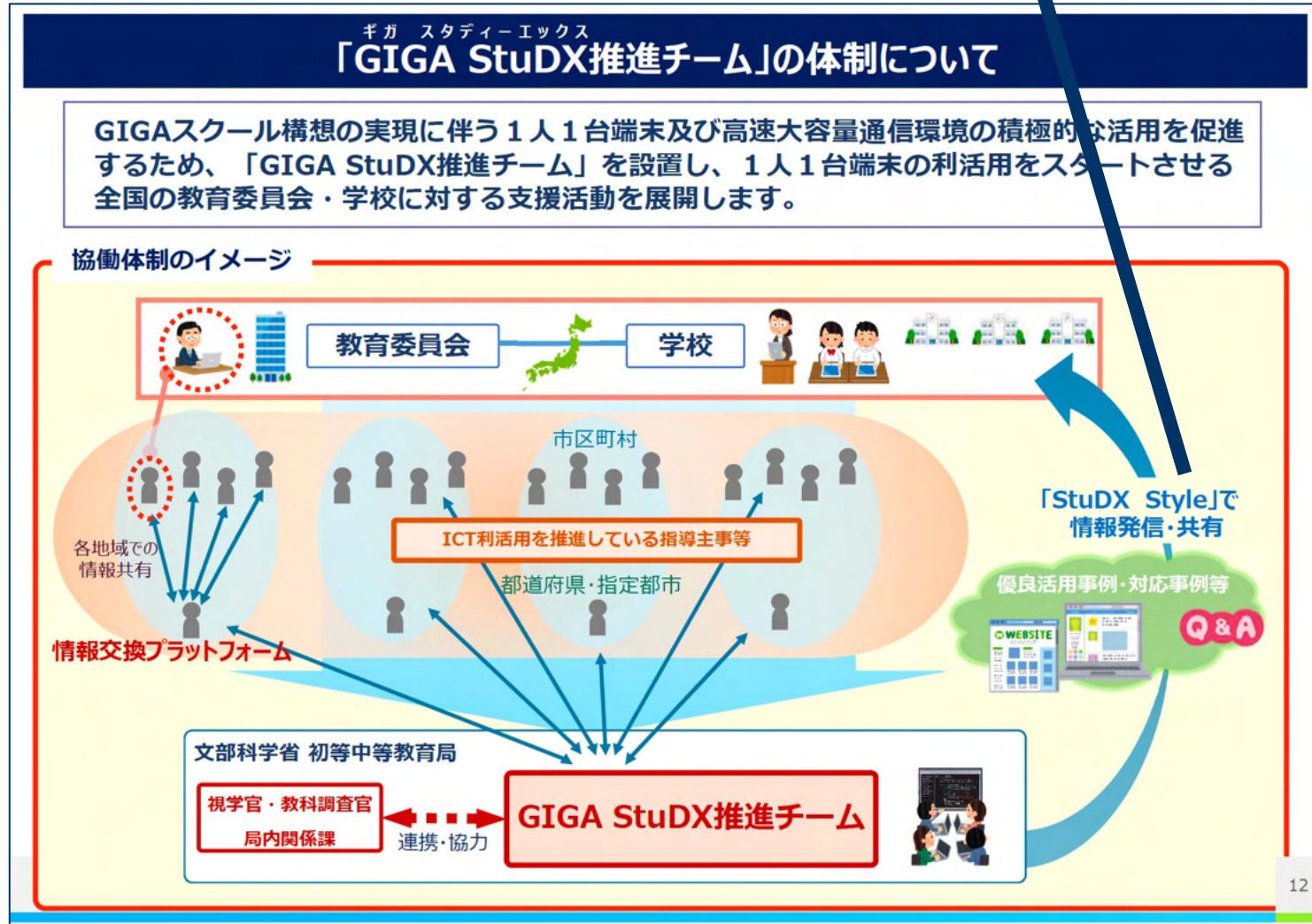
- 統合型校務支援システム等に入力されたデータを活用して、統計への回答や各種の報告等をデジタルで効率的に実現できるよう、教育データ標準における関連データ項目の整備などを段階的に進める。特に、児童生徒の健康診断結果情報について、本人や保護者がマイナポータルを用いて閲覧でき、医療機関受診時の医療者との正確なコミュニケーションに活用したり、本人の行動変容のために活用できる環境について令和4年度中の実現を目指す。また、健康診断票など、転校・進学先への引継ぎを要する情報のデータ連携の在り方についても検討を行う。

#### 教育データの国における分析・研究体制とEBPMの推進

- 令和3年度を目指して国立教育政策研究所に「教育データサイエンスセンター」を設置し、教育分野の様々な調査・研究データの横断的・縦断的研究を可能とするオープンデータ化の支援を行うなど、教育データの分析・研究に関する国としての機能の段階的な構築を図るとともに、教育データについて研究機関や地方自治体等と連携した分析や利活用を進め、教育データの活用によるEBPMの推進を図る。

# 教育とDX

<https://www.mext.go.jp/studxstyle/>



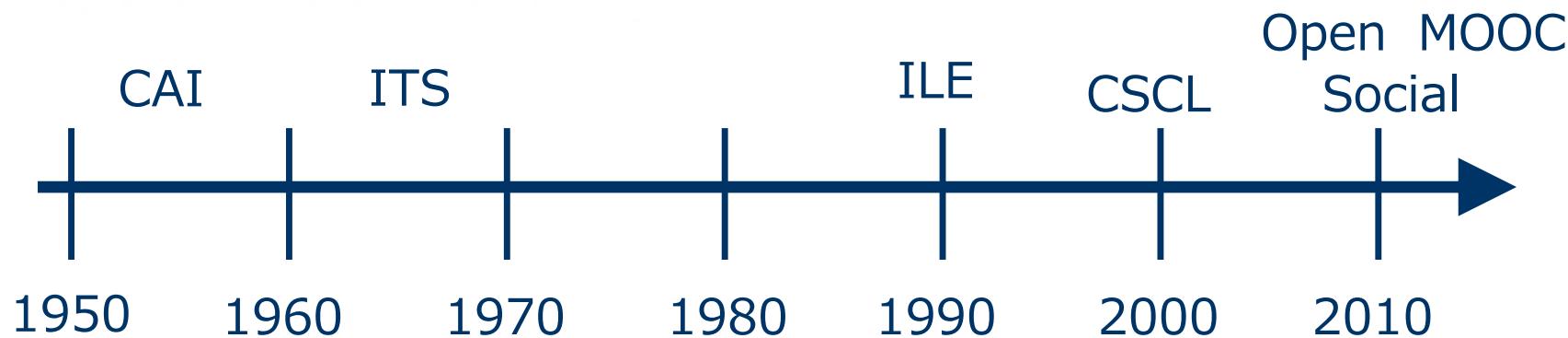
[https://www.mext.go.jp/content/20210412-mxt\\_jyohoka01-000014099\\_13.pdf](https://www.mext.go.jp/content/20210412-mxt_jyohoka01-000014099_13.pdf)

# 教育とDXにおける課題

- ・ 「GIGAスクール構想に関する各種調査の結果」
- ・ 令和3年8月, 文科省
- ・ [https://www.mext.go.jp/content/20210827-mxt\\_jogai01-000017383\\_10.pdf](https://www.mext.go.jp/content/20210827-mxt_jogai01-000017383_10.pdf)

# Next Trends for DLS

## Open/Social paradigm



- Any resources are delivered on Internet
  - Ex.) “**Flipped Class**” will change lecture

## Cloud/Big data

- Any information through IC is available
  - Some issues may be caused as privacy
- Key Performance Indicator will be founded

# Examples for BigData age

## New Type of Information

- Affective Information:
  - Estimating attitude from input device

## Analysis from whole data

- Role Model:
  - Analyzing ideal learning process
- Comparison:
  - Comparing with similar learning process
- Experimental Knowledge:
  - Gathering common learning process
- Quality Assurance:
  - Using learning process with KPI as evidence

# Goal of This Lecture

To Propose  
“Next” (Distance) Learning

To Improve  
“Current” (Distance) Learning

# 期末試験について

LMSに詳細を載せてます

追記として、2問選択して解いてもらう形なのですが  
それ以上解いた場合、上限20点として加点します

例：1問目 6点

2問目 6点

3問目 10点

合計 20点（上限）