

# Harmonizing content technology with standards technology

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## ● Introduction

- The benefits of standards technology
- The necessity of content technology
  - “assembly language” vs.  
“high-level programming language”

## ● My approach

- Theory-awareness and standards-compliance

## ● Study in progress

- Deployment of a theory-aware and standards-compliant authoring system

## ● Conclusion

- Toward sharing and reuse of high-quality learning contents and services

# Outline



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# Introduction

**Sharing and reuse of high-quality learning contents and services**

## **Enabling technology**

- Standards technology
  - Standardization of data format and application interface
    - IEEE LOM, ADL SCORM, IMS Content Packaging (CP), Question and Test Interoperability (QTI), Learner Information Package (LIP), Learning Design (LD), etc.
  - Not standardization of education
    - pedagogically neutral





# IMS Learning Design

## IMS LD is for

- supporting the use of a wide range of learning and instructional activities in online learning and,
- enabling variety of of learning and instructional activities to be expressed.

## IMS LD provides

- a representation in XML which makes of learning and instructional activities machine readable
  - an IMS LD-compliant tool is able to "play" of learning and instructional activities.
- Three levels of description
  - from simple time ordered learning activities to more complex structure for control and automation



# Problems in the use of IMS LD

## Two general problems in the use of standards technology

- Low usability
- No guidelines for high-quality contents or services

## Problems embodied in IMS LD

- Requirement of a kind of “programming” skill
  - XML Coding for machine readability
  - Unfamiliar representation to teachers and instructional designers
- Too much flexibility to describe any learning and instruction
  - Respect for the diversity of learning and instruction
  - No guideline for high quality design



# Content technology for IMS LD

**IMS LD can be viewed as “assembly language” in programming language**

- the cost of big effort to learn how to program
- a high possibility of producing low-quality design

**Sharing and reuse of high-quality learning contents and services**

**“High-level programming language” compared with “assembly language”**

- Easier to use
- More understandable



# Requirement for “High-level programming language” for IMS LD

## The basic requirements

- Not machine-oriented programming
- But human-oriented representation close to the conceptual level of practitioners

## The advanced requirements

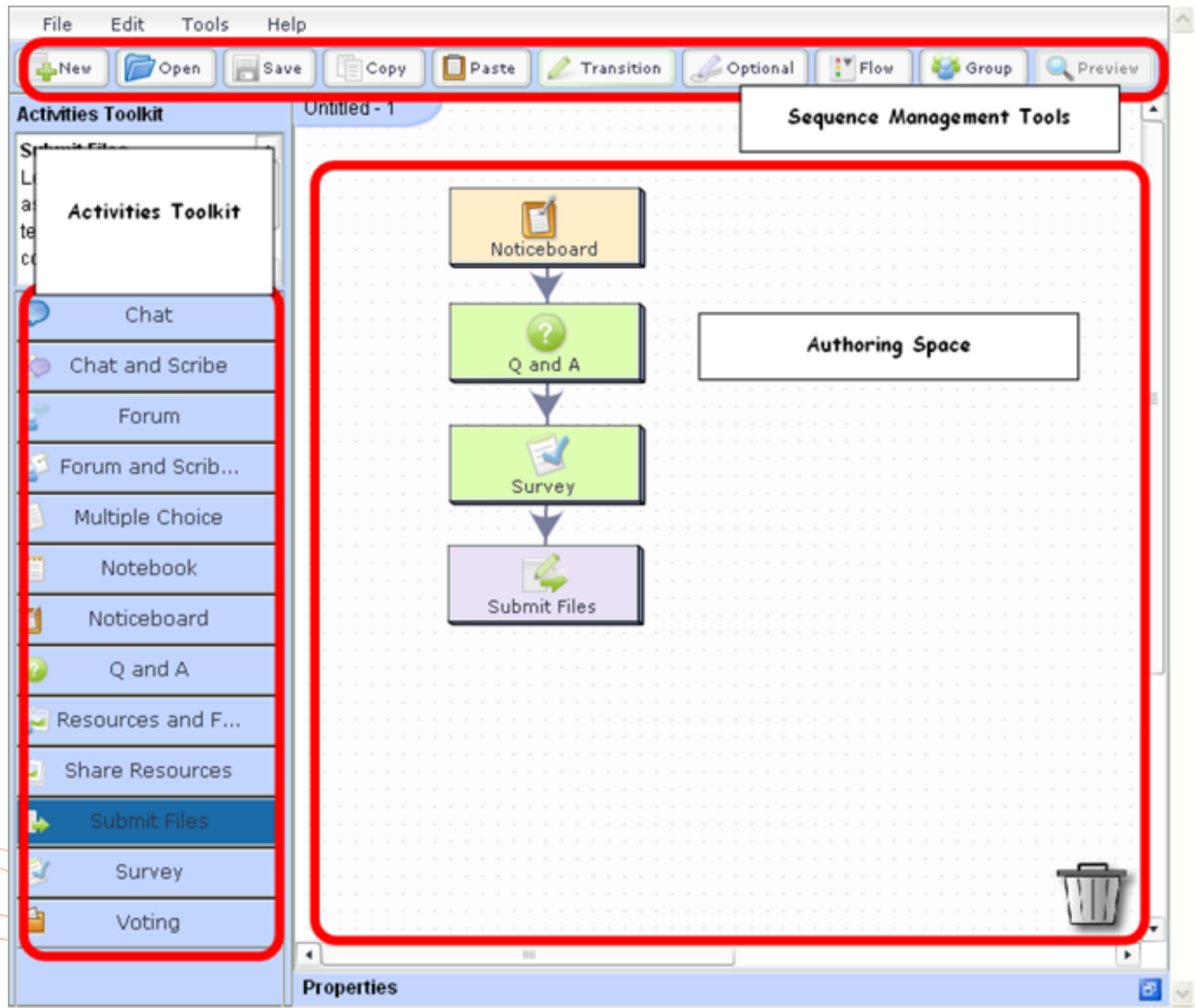
- Preventing producing low-quality design of learning
- Guidelines from
  - Learning and instructional theories
  - Practical experiences, Best practices





# LAMS (Learning Activity Management System)

a visual authoring environment for creating sequence of learning activities



# Collaborative Learning Flow Patterns (CLFPs)

[Hernández-Leo et al. 2005]

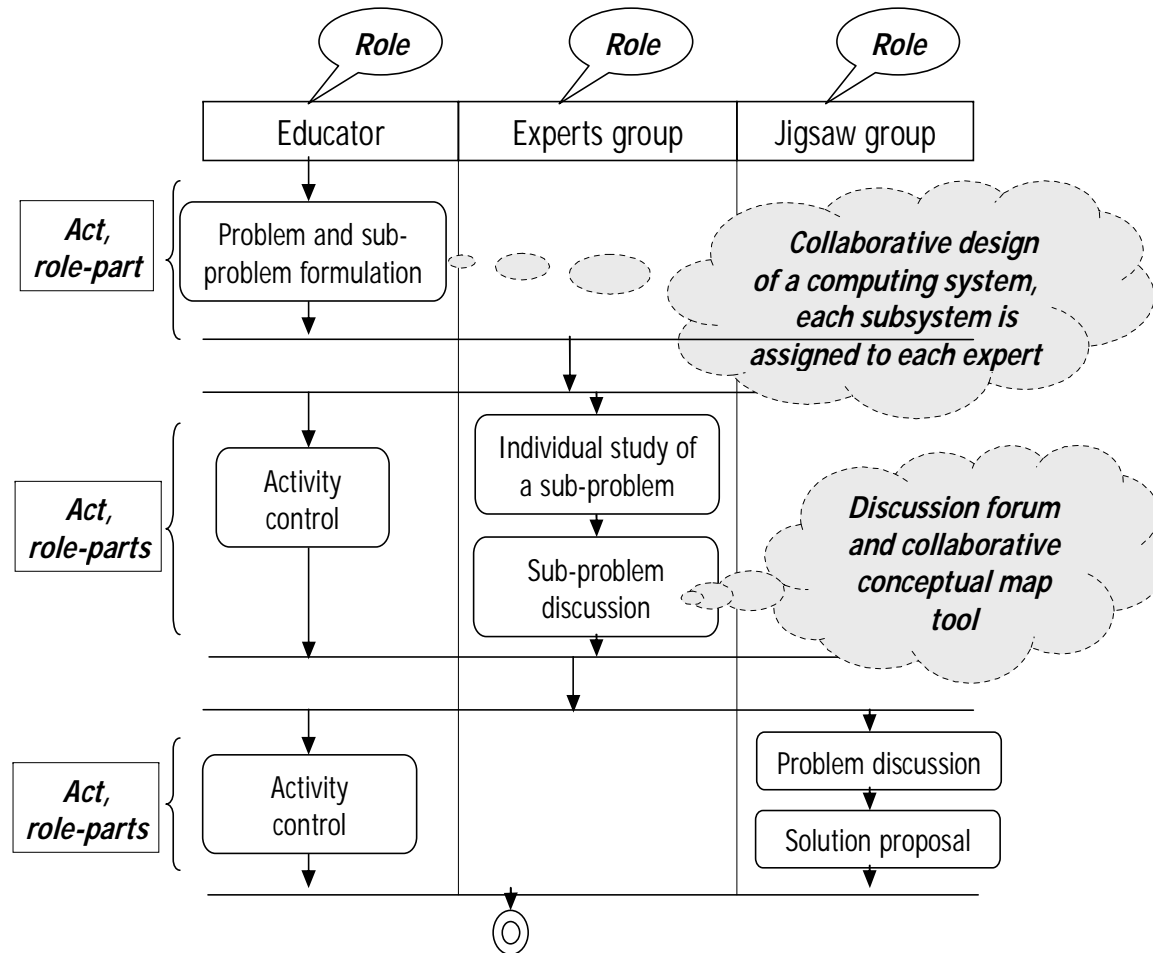


Figure 5. IMS-LD description and customization of the Jigsaw CLFP

# Approaches to content technology

## The basic requirement

- human-oriented representation close to the conceptual level of practitioners
- LAMS provides GUI and components for representing flows of learning activities

## The advanced requirement

- knowledgeable guidelines from Learning and instructional theories and Best practices
- CLFPs provides description of best practices in IMS LD

## My approach

- Theory-awareness: capability of authoring systems knows theoretical and empirical knowledge
  - A framework to organize theoretical and empirical knowledge for guidelines
  - a mechanism to apply them to a particular scenario.



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# OMNIBUS project

## **OMNIBUS: an ontology for theoretical and empirical knowledge for learning instruction**

- Definitions of concepts for representing flows of learning activities with the design rationale
- Foundation for modeling
  - Teachers' and instructional designers' own ideas, and
  - Learning and instructional theories, practical experiences and best practices

## **SMARTIES: a theory-aware and standards compliant authoring system**

- An environment for representing flows of learning activities with the design rationale
- provision of models of learning and instructional theories convertible into IMS LD, and environments to organize them
- Output of flows of learning activities in the IMS LD format



# How SMARTIES works

OMNIBUS: an ontology for organizing learning and instructional knowledge

- Definitions of concepts for representing flows of learning activities with the design rationale
- Foundation for modeling
  - Teachers' and instructional designers' own ideas, and
  - Learning and instructional theories

**SMARTIES: a theory-aware and standards compliant authoring system**

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# SMARTIES provides theory-based guidelines (1/2)

The goal of a scenario

SMARTIES

File Edit View WayKnowledge

100%

Overview Detailed

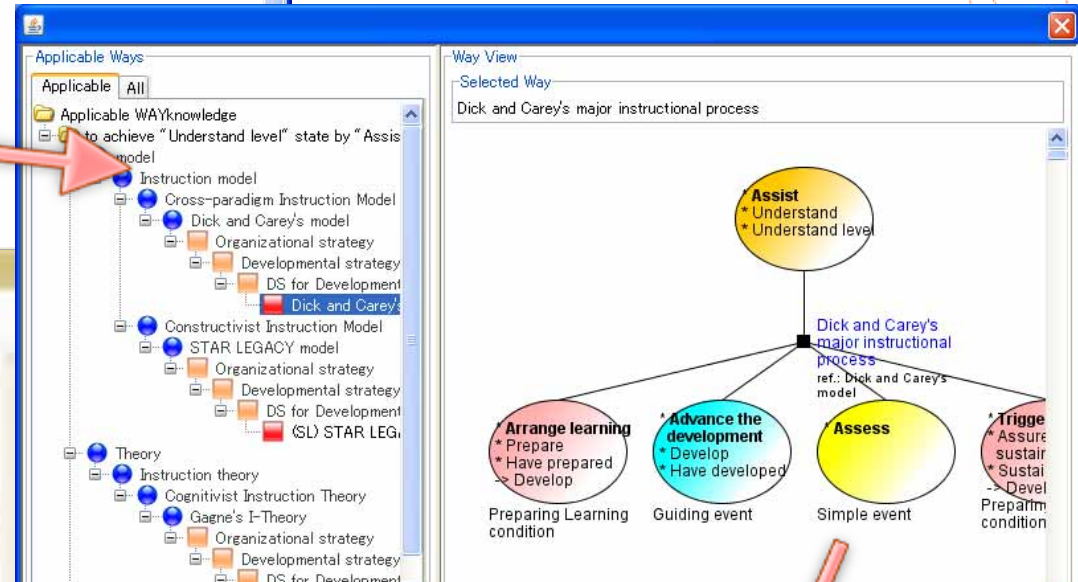
Assist/Understand/Understand

Explanation Note

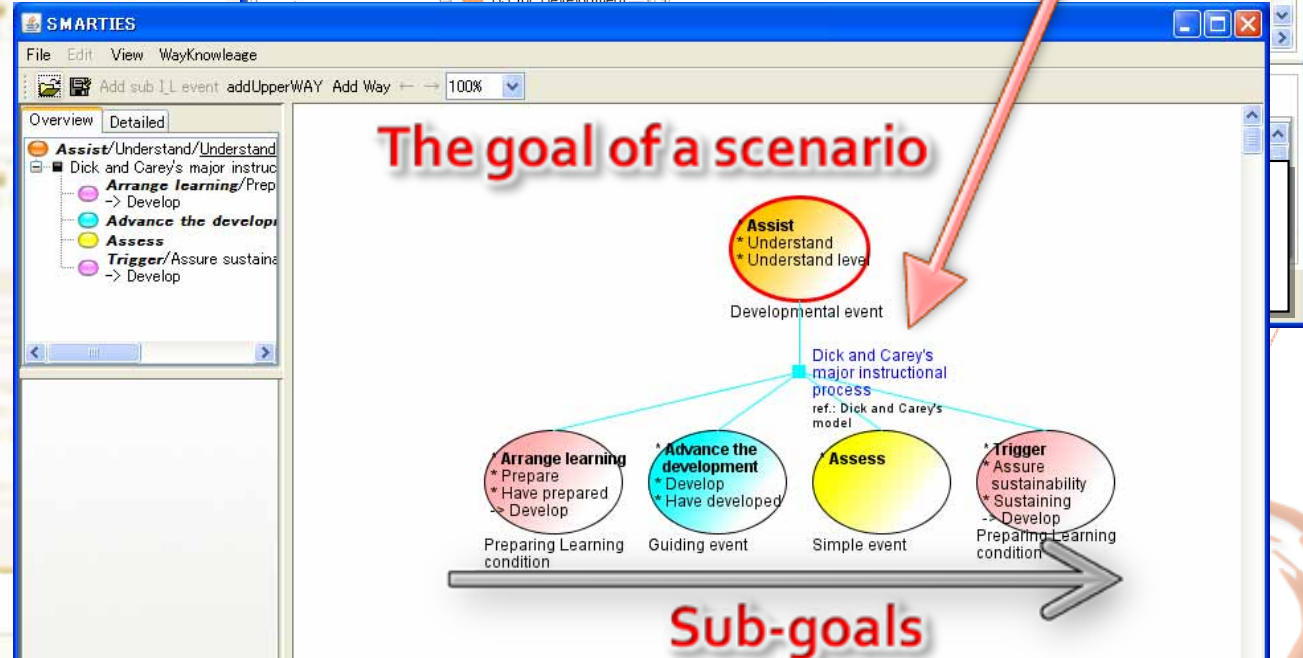
The instructor's action "Assist" influences the learner's action "Understand", which makes the learner be in the "Understand" state.

Detailed view of instructional models and strategies:

- Instruction model
  - Cross-paradigm Instruction Model
    - Dick and Carey's model
      - Organizational strategy
        - Developmental strategy
          - DS for Development
            - Dick and Carey's model
  - Constructivist Instruction Model
    - STAR LEGACY model
      - Organizational strategy
        - Developmental strategy
          - DS for Development
            - (SL) STAR LEGACY model
- Theory
  - Instruction theory
    - Cognitivist Instruction Theory
      - Gagne's I-Theory
        - Organizational strategy
          - Developmental strategy
            - DS for Development



The goal of a scenario

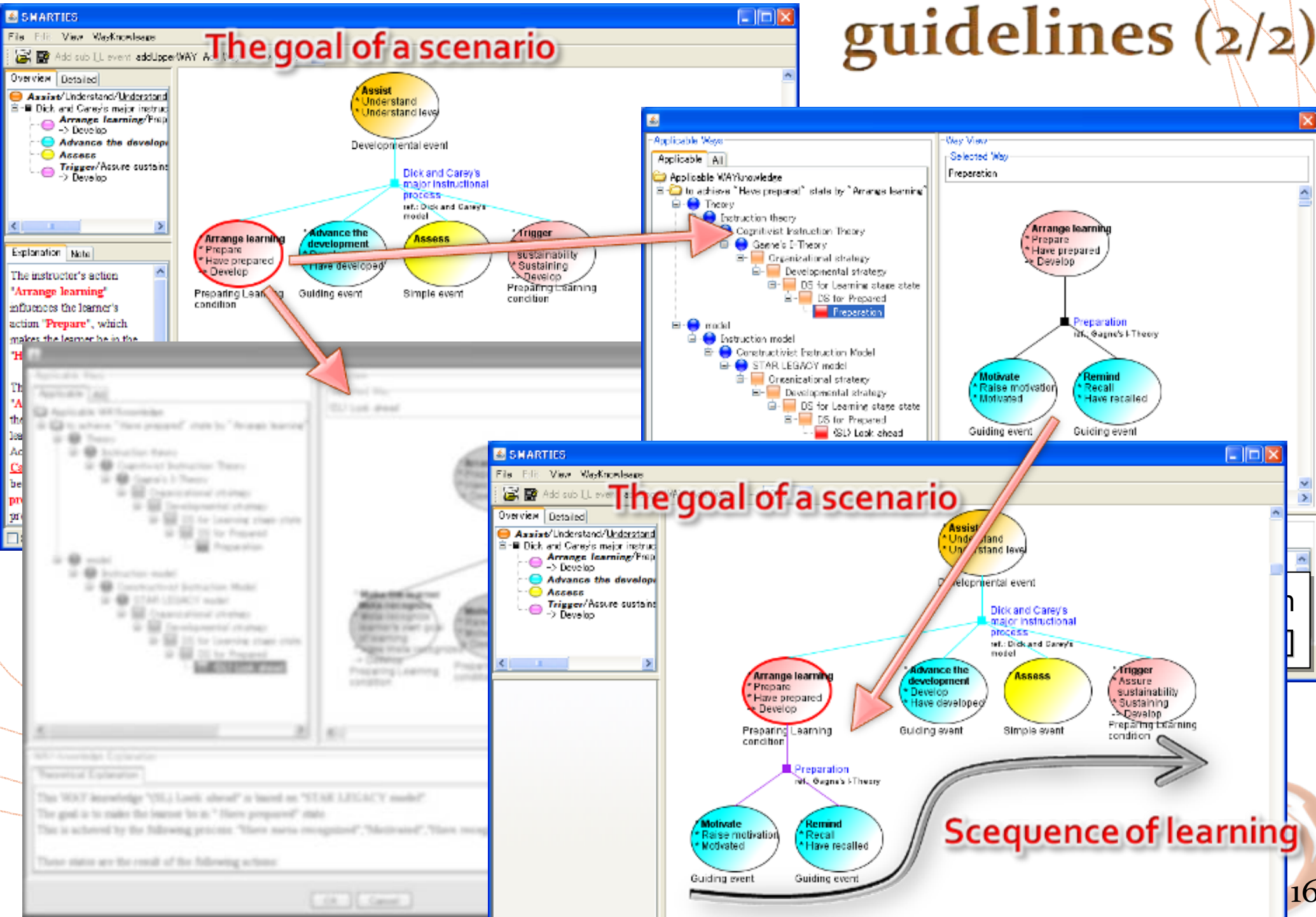




# SMARTIES provides theory-based guidelines (2/2)

The goal of a scenario

guidelines (2/2)





# Learning Object (LO) linked with learning activities

## Object Brokered Exchange) Federated search service

UD Virtual Compound Microscope - Mozilla Firefox

ファイル(F) 編集(E) 表示(V) 履歴(S) ブックマーク(B) GMarks ツール(T) ヘルプ(H)

http://www.ude.edu/biology/ketcham/microscope/scope.html

Google 検索

You are Looking at the microscope

switch views

checklist



Getting Started

If this is your first time using this simulation, please take a moment to familiarize yourself with the controls and options.

start tour

volume: [slider]

www.ude.edu からデータを転送しています...

Object Brokered Exchange)  
Federated search service

0.006 seconds

4 5 6 7 8 9 10 →

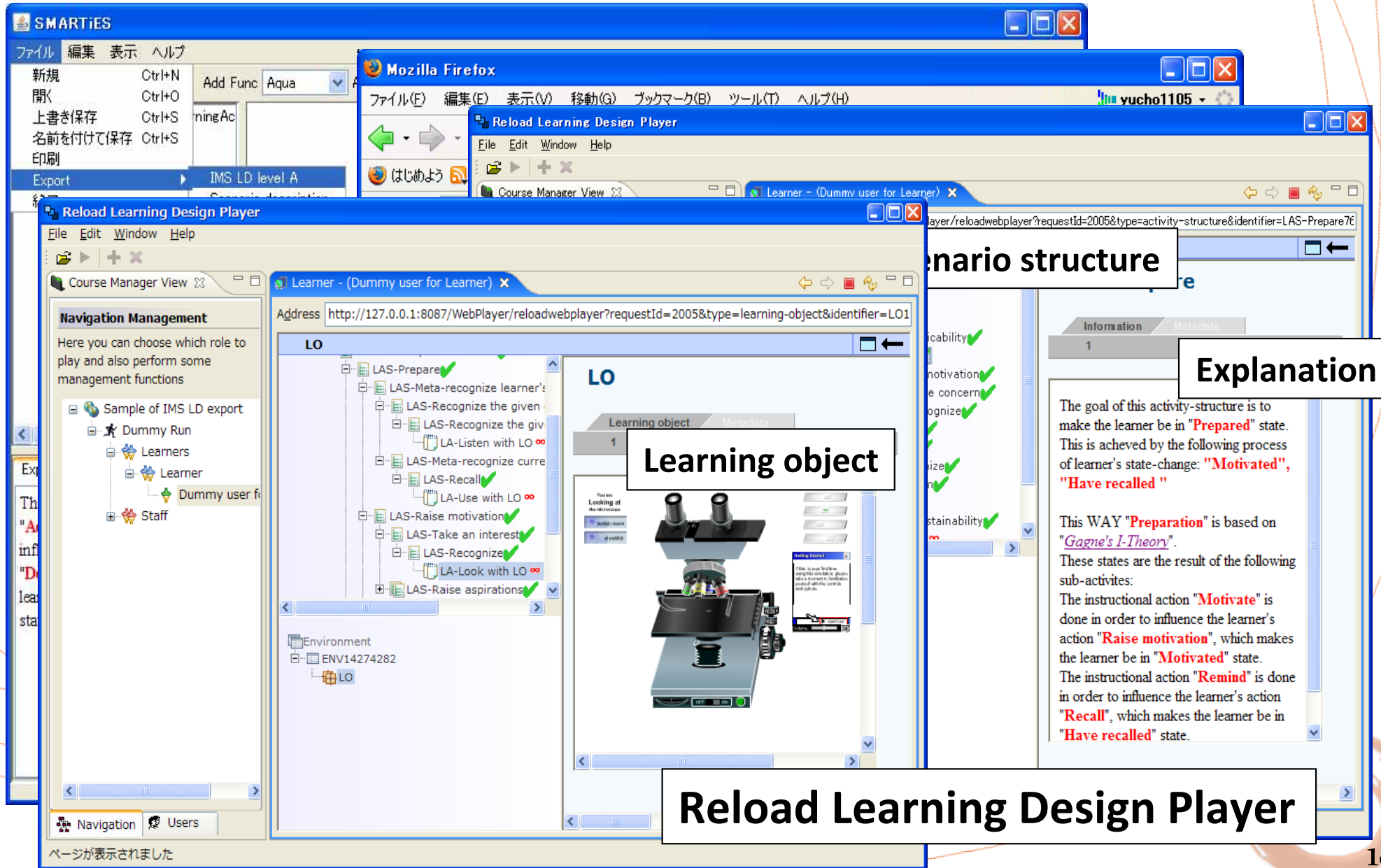
External sources

- ☐ Merlot
- ☐ Europeana
- ☐ Slideshare
- ☐ Wikipedia
- ☐ Google books
- ☐ Scribd

- ARIADNE (EU)
- ESPOL (Ecuador)
- Keris (Korea)
- LORNET (Canada)
- LRE (Europe)
- OER-Africa (South Africa)
- OERcommons (USA)
- OU-Japan (Japan)

re they will describe what they see through  
different qualities such as cell structure,  
different types of algae.  
ne microbiology microscopy principles

## Output in the form of IMS LD



# An overview of OMNIBUS

## **OMNIBUS: an ontology for organizing learning and instructional knowledge**

- Definitions of concepts for representing flows of learning activities with the design rationale
- Foundation for modeling
  - Teachers' and instructional designers' own ideas, and
  - Learning and instructional theories

## **SMARTIES: a theory-aware and standards compliant authoring system**

- An environment for representing flows of learning activities with the design rationale
- provision of coded learning and instructional theories, and environments to make coded principles
- Output of flows of learning activities in IMS LD format



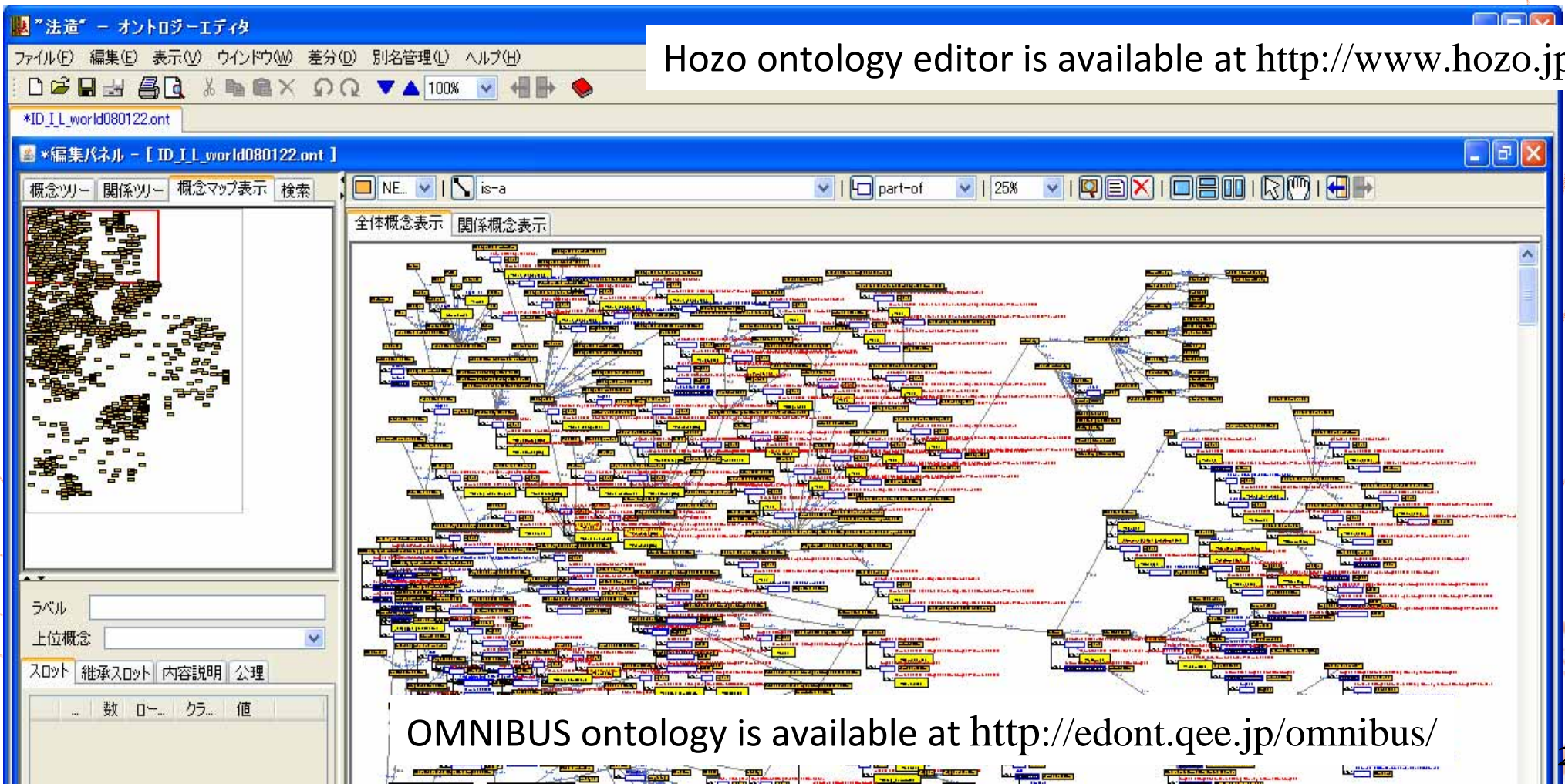


# OMNIBUS ontology

## Conceptual basis for structuring theoretical and empirical knowledge

- Basic structure for modeling learning and instructional activities
- Types of actions and states of the stakeholders in learning and instruction
- 1189 whole concept, 249 relational concepts, 3965 slots (part-of, attribute of)

Hozo ontology editor is available at <http://www.hozo.jp/>



OMNIBUS ontology is available at <http://edont.tee.jp/omnibus/>



# The core concepts of OMNIBUS

Learning is modeled as state-change of a learner

- I\_L event: what to achieve
- WAY: How to achieve

## Definition of I\_L event

- \* Instructional action
  - \* Learning action
  - \* State-change (a state as the goal)
- influence  
cause

**Macro-I\_L event**

- \* Make the learner recognize
- \* Recognize
- \* Have recognized the context of learning

OR

WAY1

is-achieved by

AND

**Micro-I\_L events**

- \* Make the learner recognize
- \* Recognize
- \* Have recognized what to learn

- \* Make the learner recognize
- \* Recognize
- \* Have recognized how to learn

- \* Make the learner recognize
- \* Recognize
- \* Have recognized the examples

WAY2

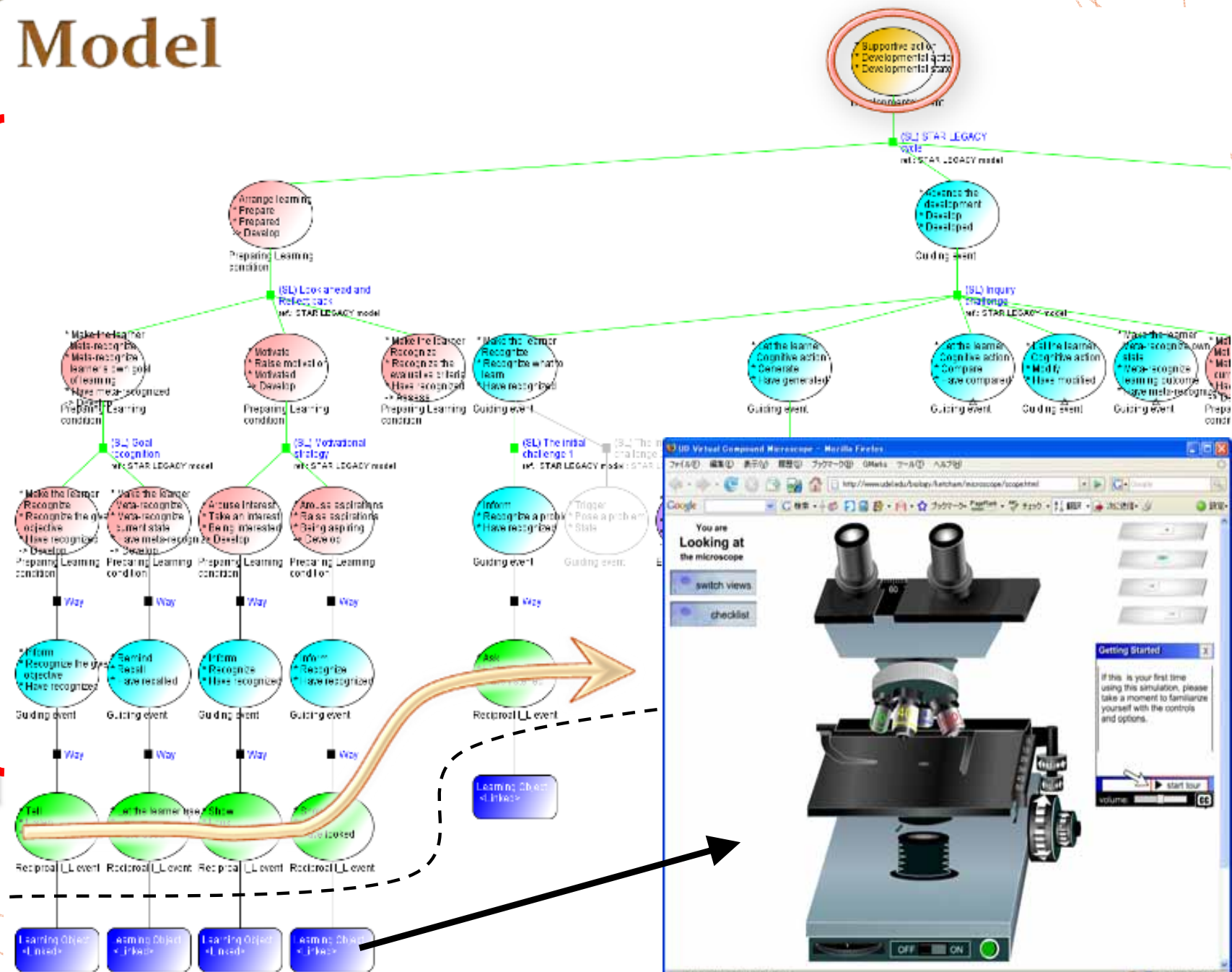
is-achieved by

# Learning and Instructional Scenario Model

The goal of the whole course

Design rationale

Flow of actual learning and instructional activities



Learning objects





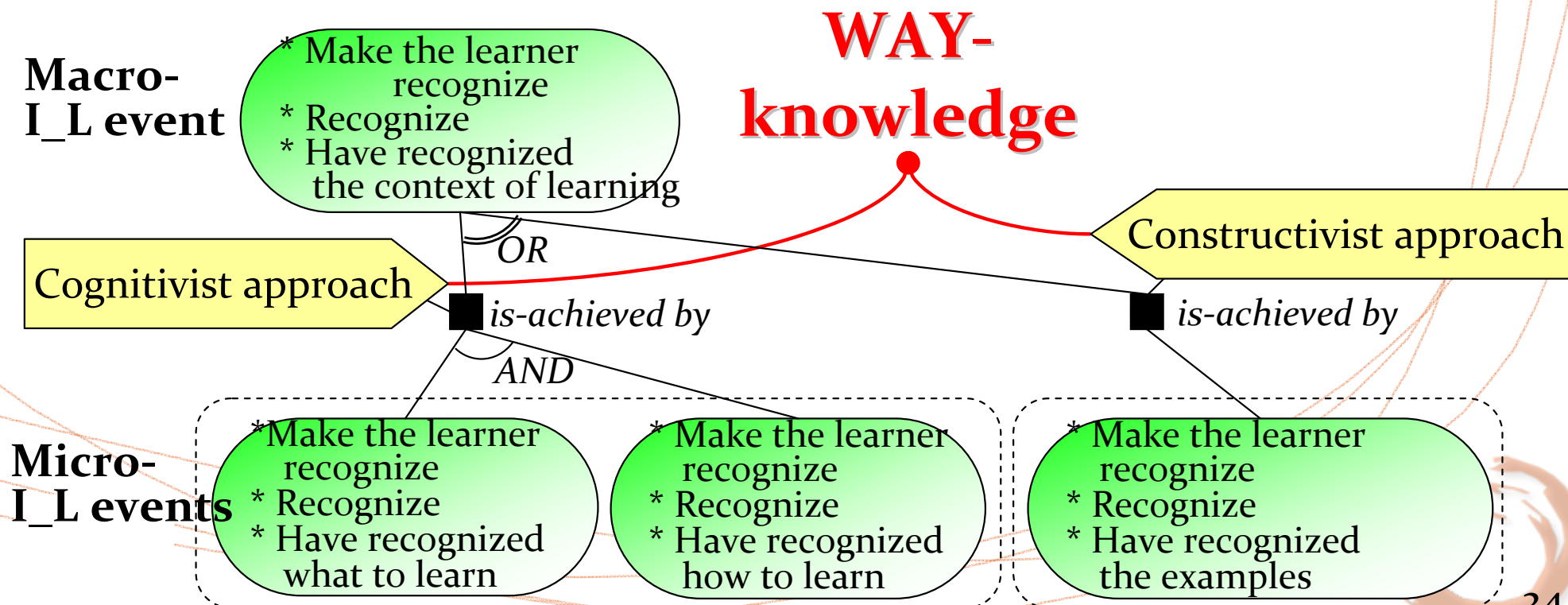
# Another point of WAY

**Learning is modeled as state-change of a learner.**

- I\_L event: what to achieve
- WAY: How to achieve
- **Principle: theoretical and empirical knowledge**

## Definition of I\_L event

- \* Instructional action
  - \* Learning action
  - \* State-change (a state as the goal)
- influence  
cause





# Modeling learning/instructional theories

	Cross-paradigm Theory		Cognitivist Theory		Constructivist Theory		Instruction management theory	
<b>Num. of theories</b>	<b>1</b>		<b>3</b>		<b>6</b>		<b>1</b>	
<b>Num. of WAY-knowledge</b>	<b>2</b>		<b>30</b>		<b>51</b>		<b>16</b>	
<b>Num. of WAY-knowledge of each theories</b>	Dick and Carey's I-model [Dick 2001]	2	Component display theory [Merrill 1983]	21	Jonassen's constructivist learning environment design [Jonassen 1999]	22	Keller's I-Theory [Keller 1987]	16
			Gagne's I-Theory [Gagne 1979]	8	STAR LEGACY model [Schwartz 1999]	19		
			Merrill and Tennyson's I-Theory [Merrill 1977]	1	Scaffolding theory [Hogan 1997] [Hmelo 1996]	3		
					Cognitive apprenticeship [Collins 1989]	8		



# Analysis of learning and instructional theories with WAY-knowledge

	Cross-paradigm theory/model	Cognitivist theory/model	Constructivist theory/model	Instruction management theory/model
Num. of theories	1	2	6	1
Num. of WAY-knowledge	2	30	52	16
Num. of I_L event	7	77	74	39
Learning stage (%)	71.4	4.8	6.5	0.0
Cognitive process state (%)	14.3	61.9	36.7	35.9
Meta-cognitive process state (%)	0.0	15.9	41.4	12.8
Attitudinal state (%)	0.0	9.5	4.7	43.6
Developmental state (%)	14.3	0.0	0.8	0.0
External state (%)	0.0	7.9	10.2	7.7

# The inside of SMARTIES

## OMNIBUS: an ontology for organizing learning and instructional knowledge

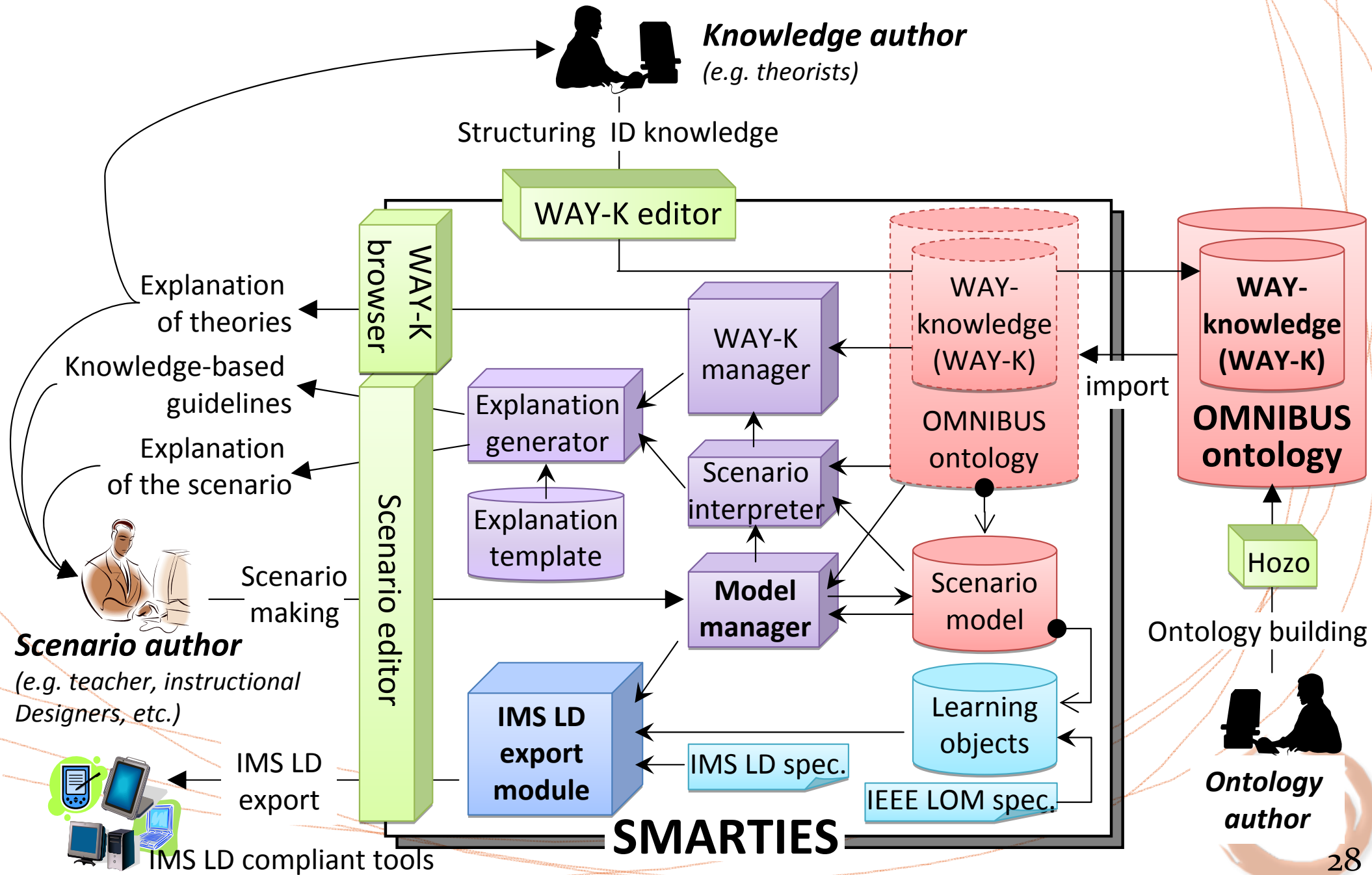
- Definitions of concepts for representing flows of learning activities with the design rationale
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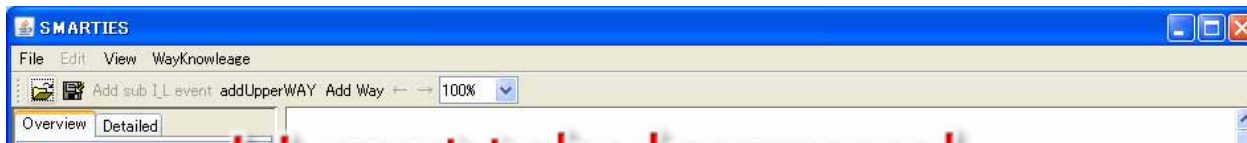


# The system architecture of SMARTIES





# SMARTIES provides knowledgeable guidelines

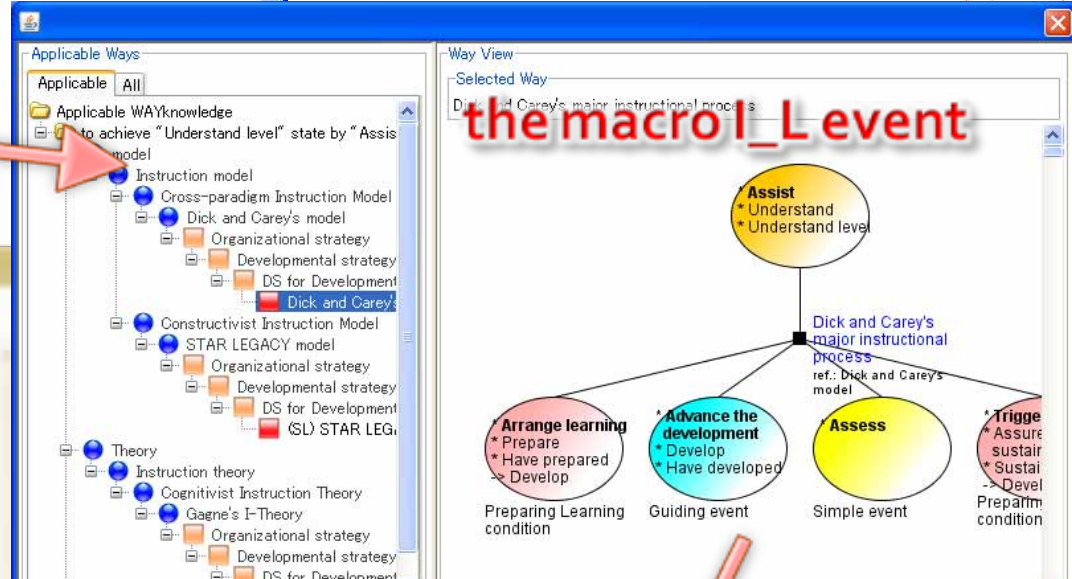


I\_L event to be decomposed

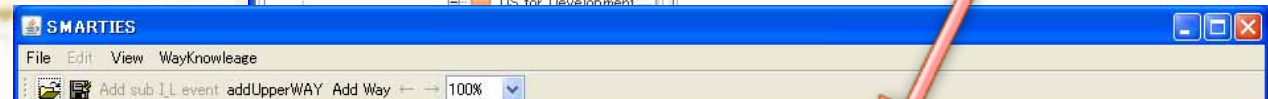
Assist  
\* Understand  
\* Understand level

Developmental event

The instructor's action "Assist" influences the learner's action "Understand", which makes the learner be in the "Understand" state.



the macro I\_L event



I\_L event to be decomposed

Assist  
\* Understand  
\* Understand level

Developmental event

Arrange learning  
\* Prepare  
\* Have prepared  
-> Develop

Preparing Learning condition

Advance the development  
\* Develop  
\* Have developed  
-> Develop

Guiding event

Assess  
\* Assess  
\* Have assessed  
-> Develop

Simple event

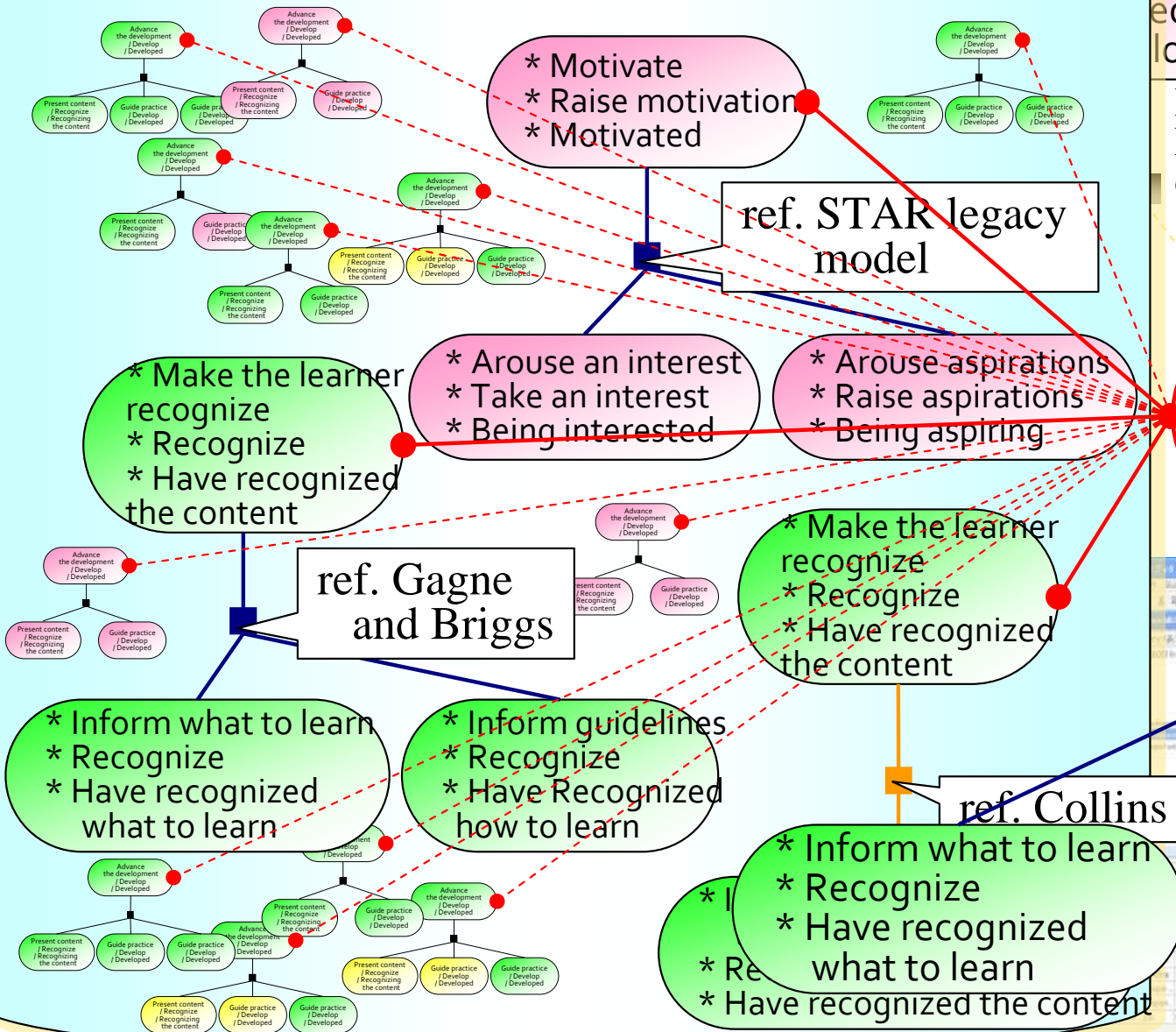
Trigger  
\* Assure sustainability  
\* Sustaining  
-> Develop

Preparing Learning condition

Sub-goals

# Utilization of WAY-knowledge

## Way-knowledge base



the learning  
e  
ed  
oped

Preparing  
Learning  
condition

\* Advance  
the development  
\* Develop  
\* Developed

Coached  
exe

ref. Dic

\* Make the learner  
recognize  
\* Recognize  
\* Have recognized  
the content

\* Guide pra  
\* Develop  
\* Developed

ref. Gagne  
and Briggs

ref. Collins

\* Inform what to learn  
\* Recognize  
\* Have recognized  
what to learn

\* Inform guidelines  
\* Recognize  
\* Have Recognized  
how to learn

tology



# Output in the form of IMS LD

The screenshot displays the Reload Learning Design Player interface, which is a web-based application for managing and playing learning scenarios. The interface is divided into several sections:

- Navigation Management:** This section allows users to choose which role to play and perform management functions. It includes a tree view showing the scenario structure, such as "Sample of IMS LD export", "Learners", "Learner", "Staff", "Instructor", and "Dummy user for Learner".
- Scenario Structure:** This section displays the scenario structure, showing a sequence of activities and sub-activities. The structure is as follows:
  - act ∞
    - LAS-Develop applicability ✓
      - LAS-Prepare ✓
        - LAS-Raise motivation ✓
        - LAS-Have concern ✓
        - LAS-Recall ✓
        - LAS-Develop ✓
        - LAS-Recognize ✓
        - LAS-Perform ✓
        - LA-action ∞
          - LAS-Assure sustainability ✓
          - LAS-Perform m ✓

- Explanation:** This section provides a detailed explanation of the scenario structure. It states: "The goal of this activity-structure is to make the learner be in 'Prepared' state. This is achieved by the following process of learner's state-change: 'Motivated', 'Have recalled'." It also mentions that "Preparation" is based on "Gagne's I-Theory" and lists the sub-activities: "Motivate", "Raise motivation", "Remind", and "Recall".

The interface also includes a menu bar with options like "File", "Edit", "Window", and "Help", and a status bar at the bottom showing "Navigation" and "Users".

**The scenario structure**

**Explanation**

The goal of this activity-structure is to make the learner be in "Prepared" state. This is achieved by the following process of learner's state-change: "Motivated", "Have recalled".

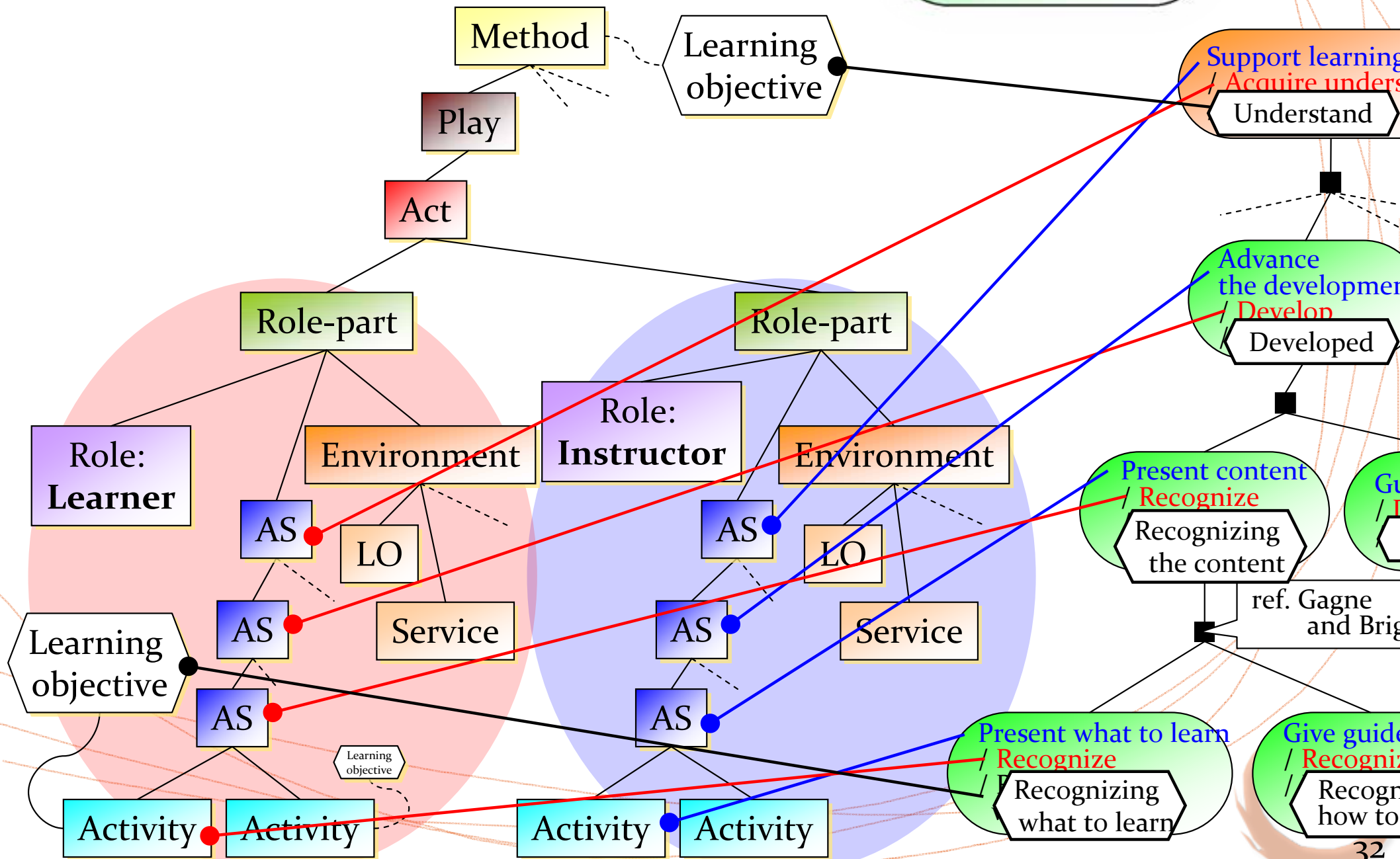
This WAY "Preparation" is based on "Gagne's I-Theory". These states are the result of the following sub-activities:

The instructional action "Motivate" is done in order to influence the learner's action "Raise motivation", which makes the learner be in "Motivated" state. The instructional action "Remind" is done in order to influence the learner's action "Recall", which makes the learner be in "Have recalled" state.

**Reload Learning Design Player**



# Relation between IMS LD and OMNIBUS



# Relation between IMS LD and OMNIBUS

```
<imscp:organizations>
  <imsld:learning-design identifier="sample"... (Snip)...
    <imsld:title>Sample of IMS LD export</imsld:title>
    ... (Snip)...
  <imsld:components>
    <imsld:roles>
      <imsld:learner identifier="R-learner"/>
      ... (Snip)...
```

**Role**

**I\_L event**

Instructional action  
/ Learning action  
/ State change

Support learning  
/ Acquire under  
/ Understand

HTML  
file

This structure is based on  
"Gagne and Briggs's theory".  
The goal "Developed" is  
achieved by ...

Present c  
/ Recogn  
/ Recogn  
the con

Guide pr  
/ Develop  
/ Develop

ref. Gagne  
and Briggs

Present what to learn  
/ Recognize  
/ Recognizing  
what to learn

Give guidelines  
/ Recognize  
/ Recognizing  
how to learn

**Activity-structure for Instructor Activities**

```
<imsld:activity-structure
  Identifier="IAS-Present content836231168"
  structure-type="sequence">
  <imsld:title>IAS-Present content</imsld:title>
  - <imsld:information
    <imsld:item identifier="IASI-Present content857600000"
      identifierref="RES-i857600000" isvisible="true" />
    </imsld:information>
    <imsld:activity-structure-ref
      ref="LAS-Present what to learn85705938" />
    <imsld:activity-structure-ref
      ref="LAS-Give guidelines858066941" />
  </imsld:activity-structure>
```

```
<imsld:activity-structure
  identifier="LAS-Recognize836231168"
  structure-type="sequence">
  <imsld:title>LAS-Recognize</imsld:title>
  <imsld:activity-structure-ref
    ... (Snip)...
  </imsld:activity-structure>
```

**Activity-structure for Learner**

```
<imsld:environments>
  (Snip)...
```

**Environment**

**XML description of IMS LD**

# Harmonization of content technology and standards technology in SMARTIES

## Theory-awareness + standards compliance

### Theory-awareness: knowledgeable guide

- Pieces of theoretical and empirical WAY-knowledge
- Helpful for producing high-quality designs based on theories

### standards compliance: Scenario export to IMS LD

- Conversion from a scenario model in SMARTIES to the form of activity structure in IMS LD
- With explanation based on theoretical and empirical WAY-knowledge





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# Lesson planning with SMARTIES by Japanese schoolteachers

**A research group of social studies teachers at junior high schools in Tokyo (To-Chu-Sha)**

- Members
  - From novice teachers to experienced teachers
  - Only active teachers, not including researchers
- The main branch of research groups of social studies at junior high schools in Japan

## **Achievement to date**

- Improvement of plans of lesson
  - 2 lesson plans went through some cycles of modeling and improvement
  - Received high praise from authorized commenters in a conference
- A basic model for lesson design
  - Abstract model of curriculum design for geography in junior high schools in Japan
  - Adopted by To-chu-Sha as a reference model



# SMARTIES in Korean classroom

by Prof. LEE JaeMu in Busan National University of Education





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# Conclusion

## Sharing and reuse of high-quality learning contents and services

### Standards technology

- Standardization of data format and application interface
- No guidelines to produce high-quality scenario

### Content technology

- Easier to use and more expressive description
- knowledgeable guidelines

### Harmonization of standards technology and content technology

- Standards technology for sharing and reuse
- Content technology for high-quality



# **My collaborators**

**Prof. Riichio Mizoguchi  
(Osaka university, Japan)**

**Prof. Jacqueline Bourdeau  
(LICEF UQAM, Canada)**

## **Acknowledgements**





**Thank you  
for your attention**

