Harmonizing content technology with standards technology

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Outline

- **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

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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

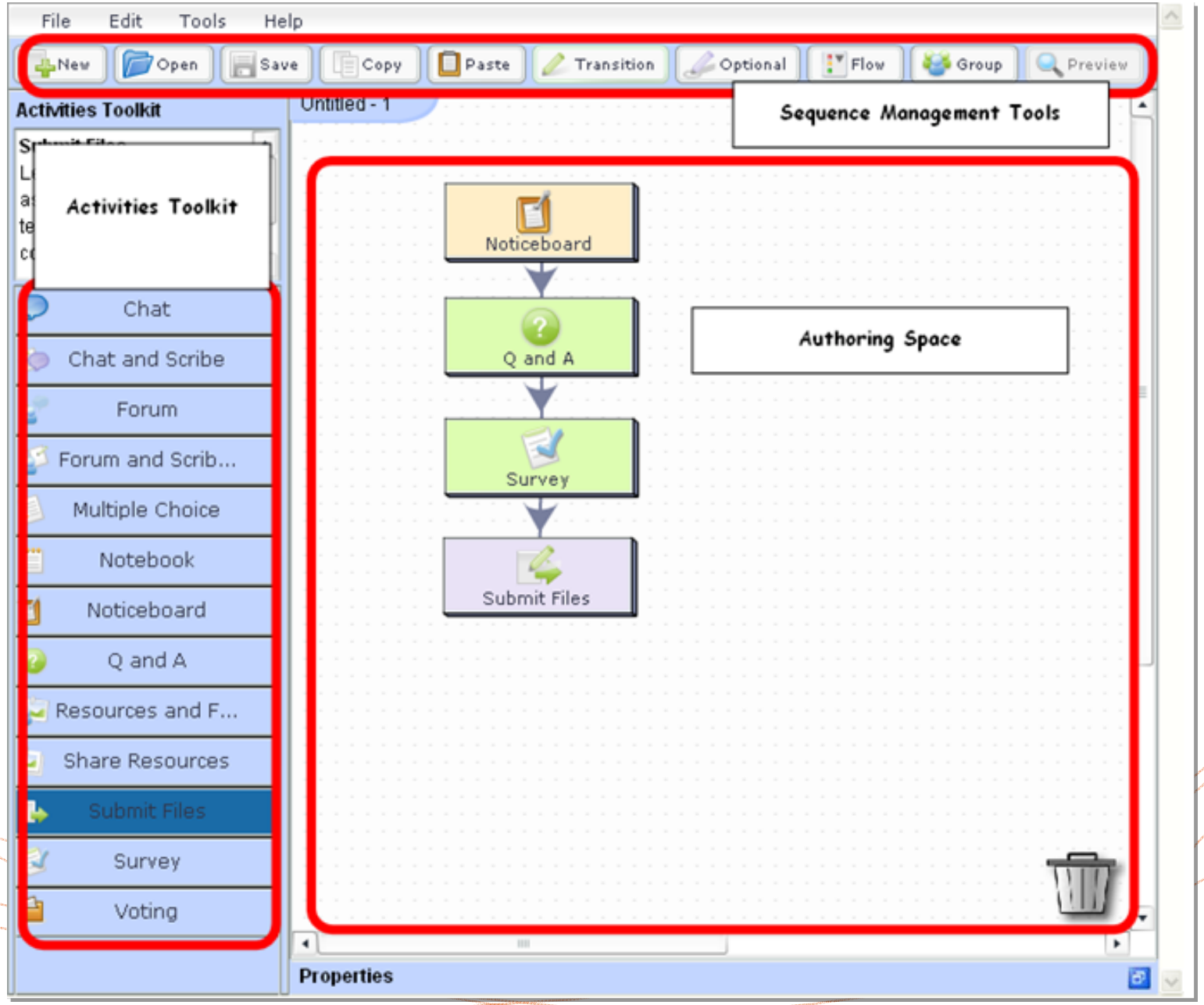
- Not machine-oriented programming
- But human-oriented representation close to the conceptual level of practitioners

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]

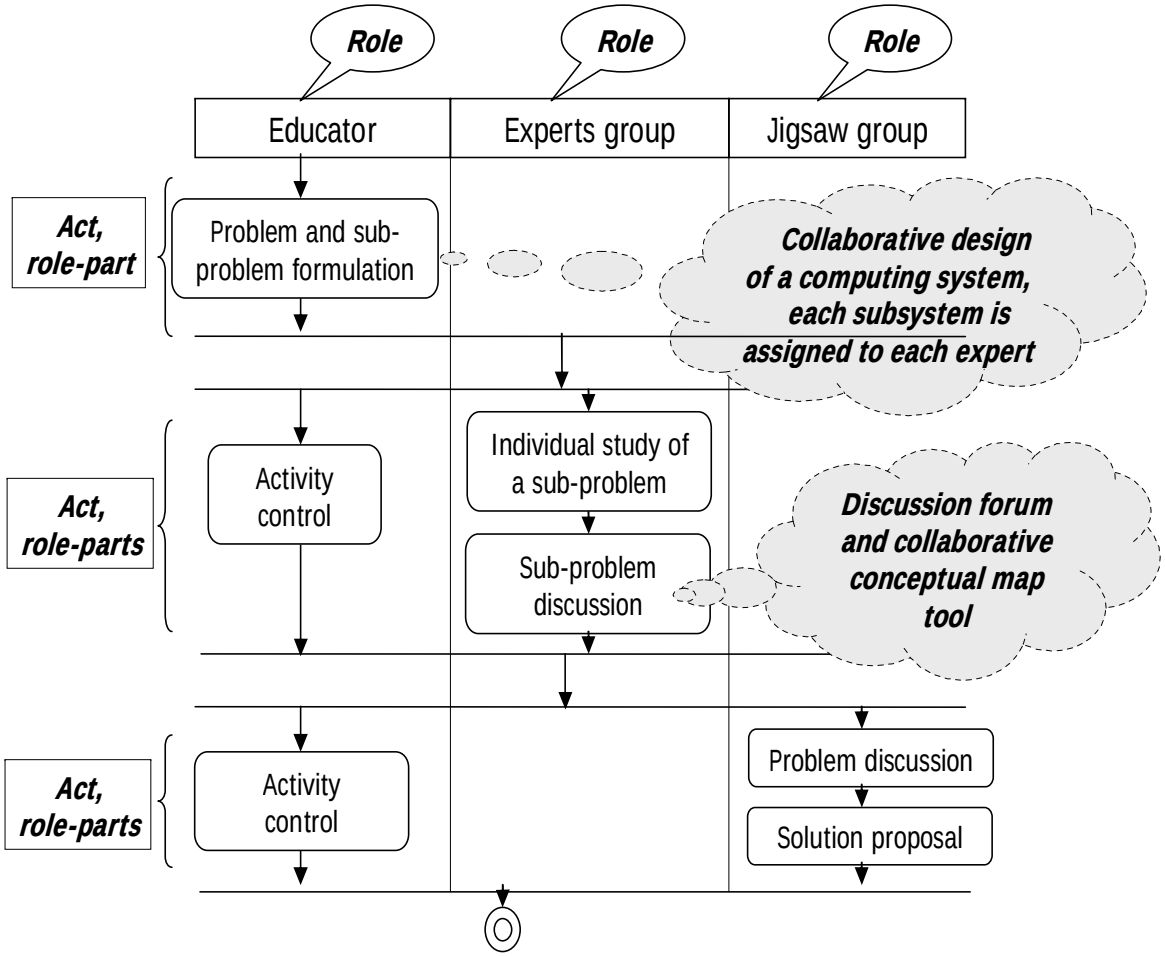


Figure 5. IMS-LD description and customization of the Jigsaw CLFP

Hernández-Leo, D., Asensio-Pérez, J.I., Dimitriadis, Y., Bote-Lorenzo, M.L., Jorrín-Abellán, I.M., Villasclaras-Fernández, E.D. Reusing IMS-LD Formalized Best Practices in Collaborative Learning Structuring *Advanced Technology for Learning*. 2(3): pp. 223-232, October 2005.

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 parctices

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

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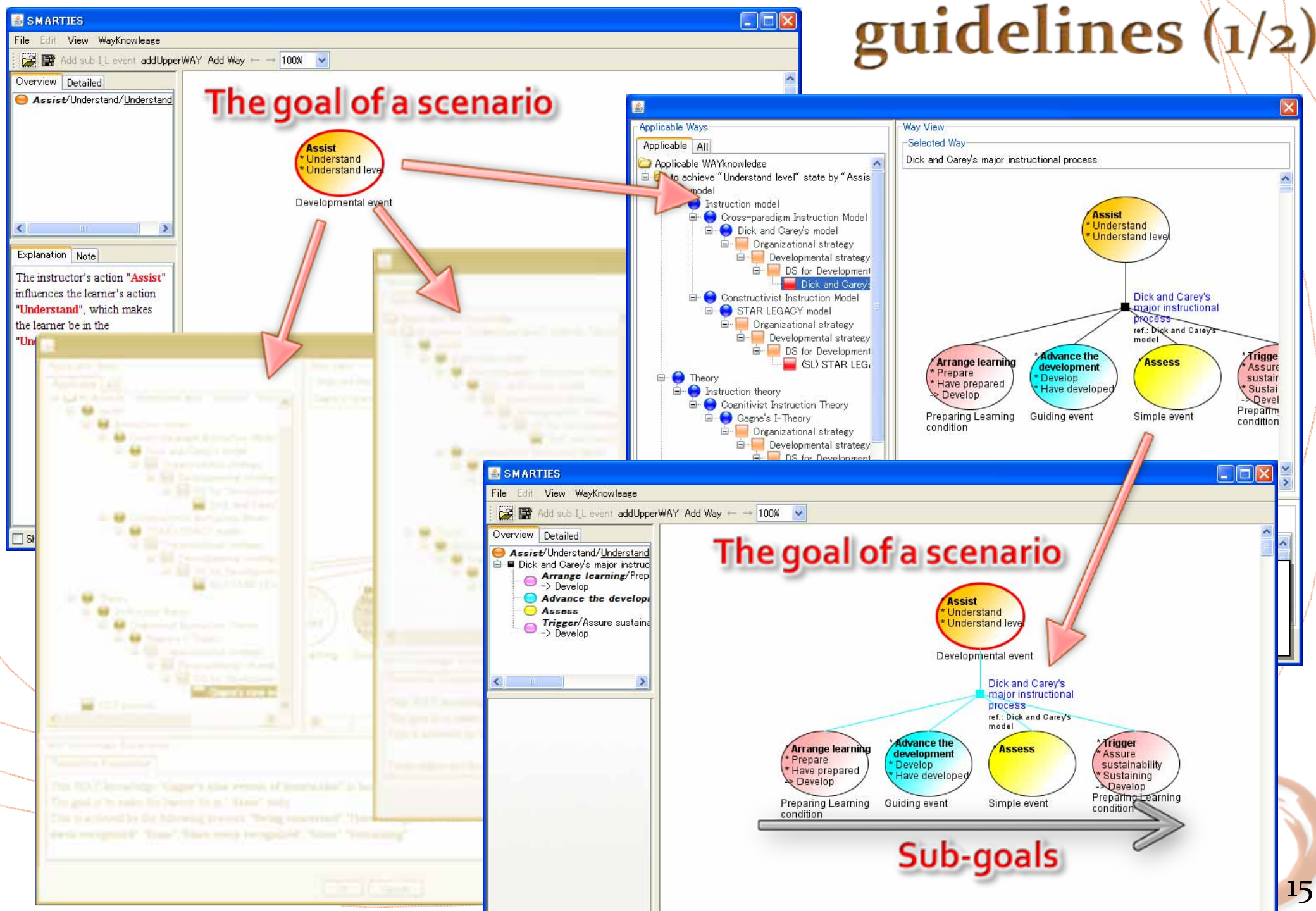
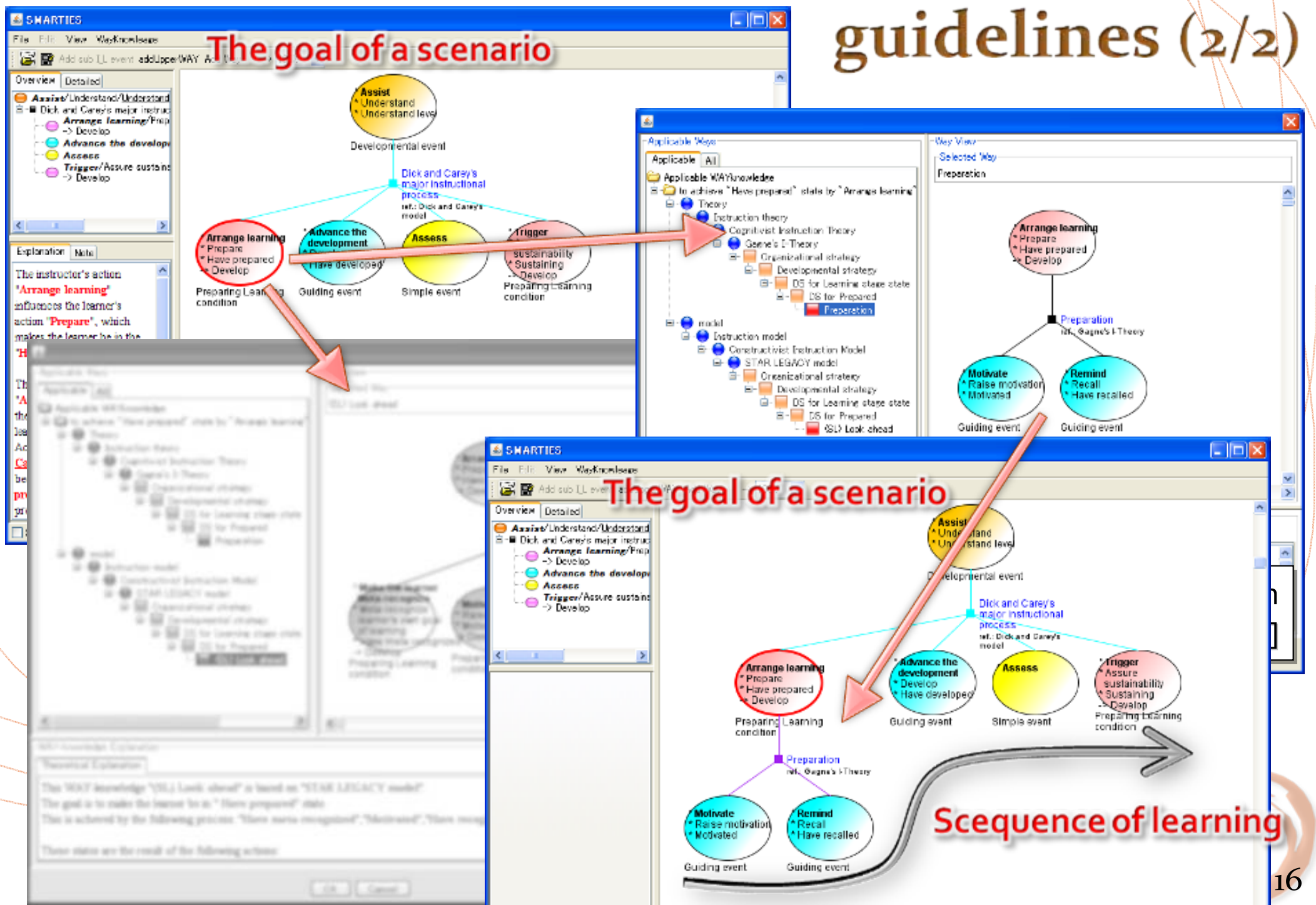
SMARTIES provides theory-based guidelines (1/2)

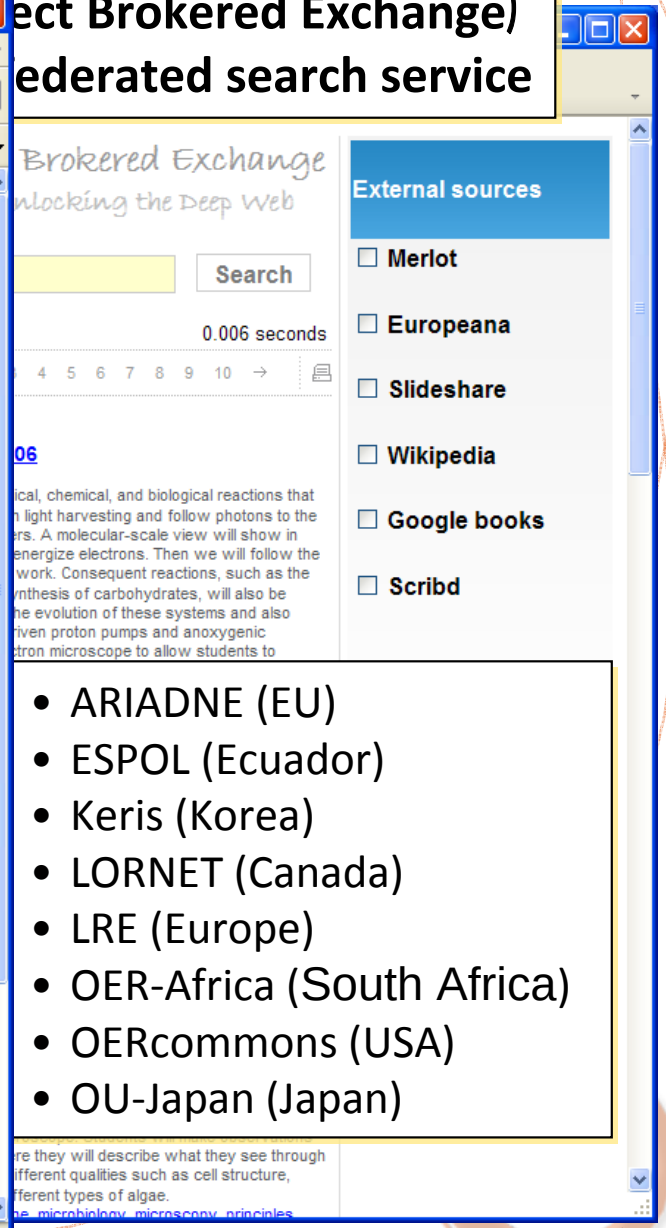


SMARTIES provides theory-based guidelines (2/2)



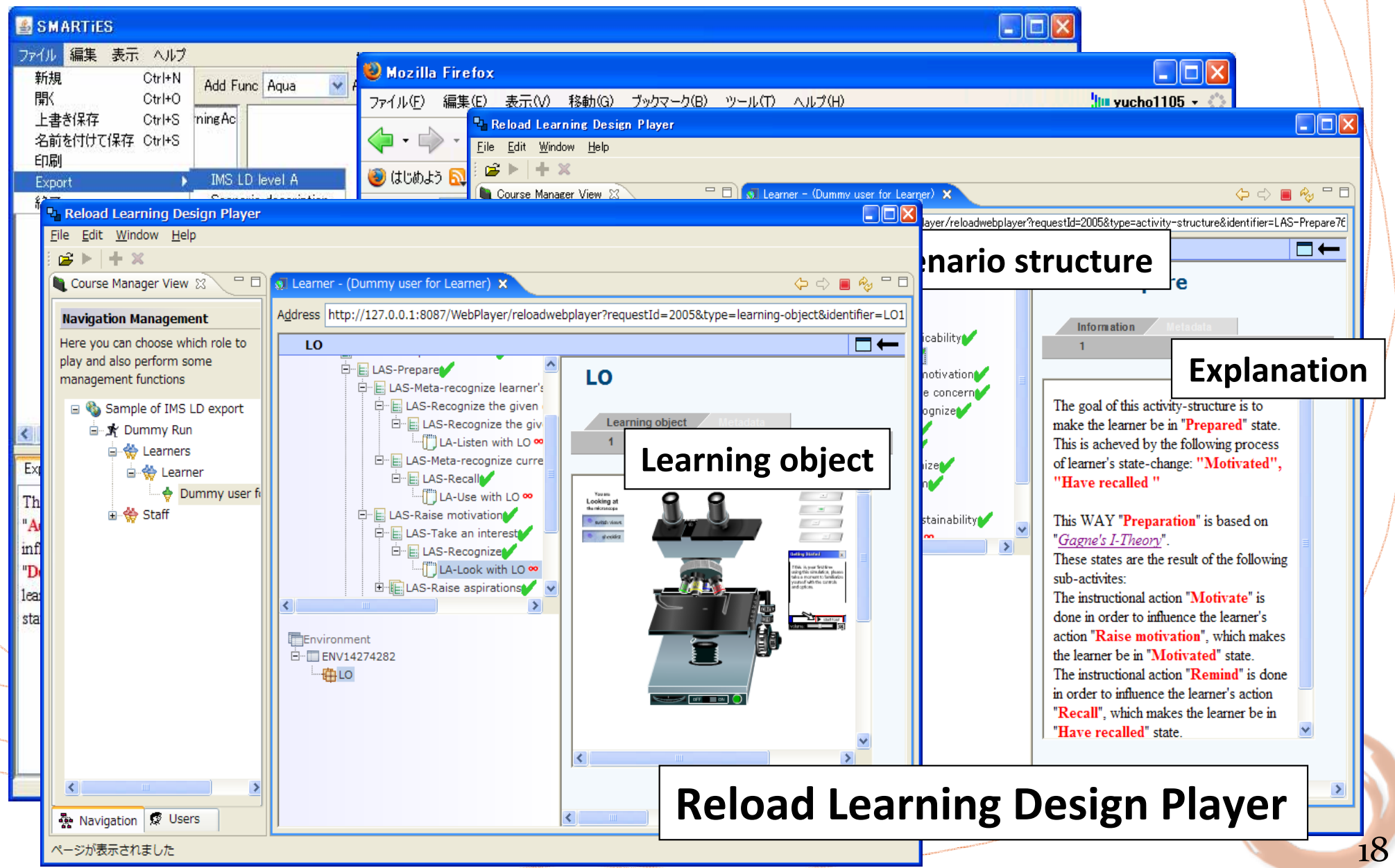
Learning Object (LO) linked with learning activities

ect Brokered Exchange)
ederated search service



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

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
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SMARTIES: a theory-aware and standards compliant authoring system

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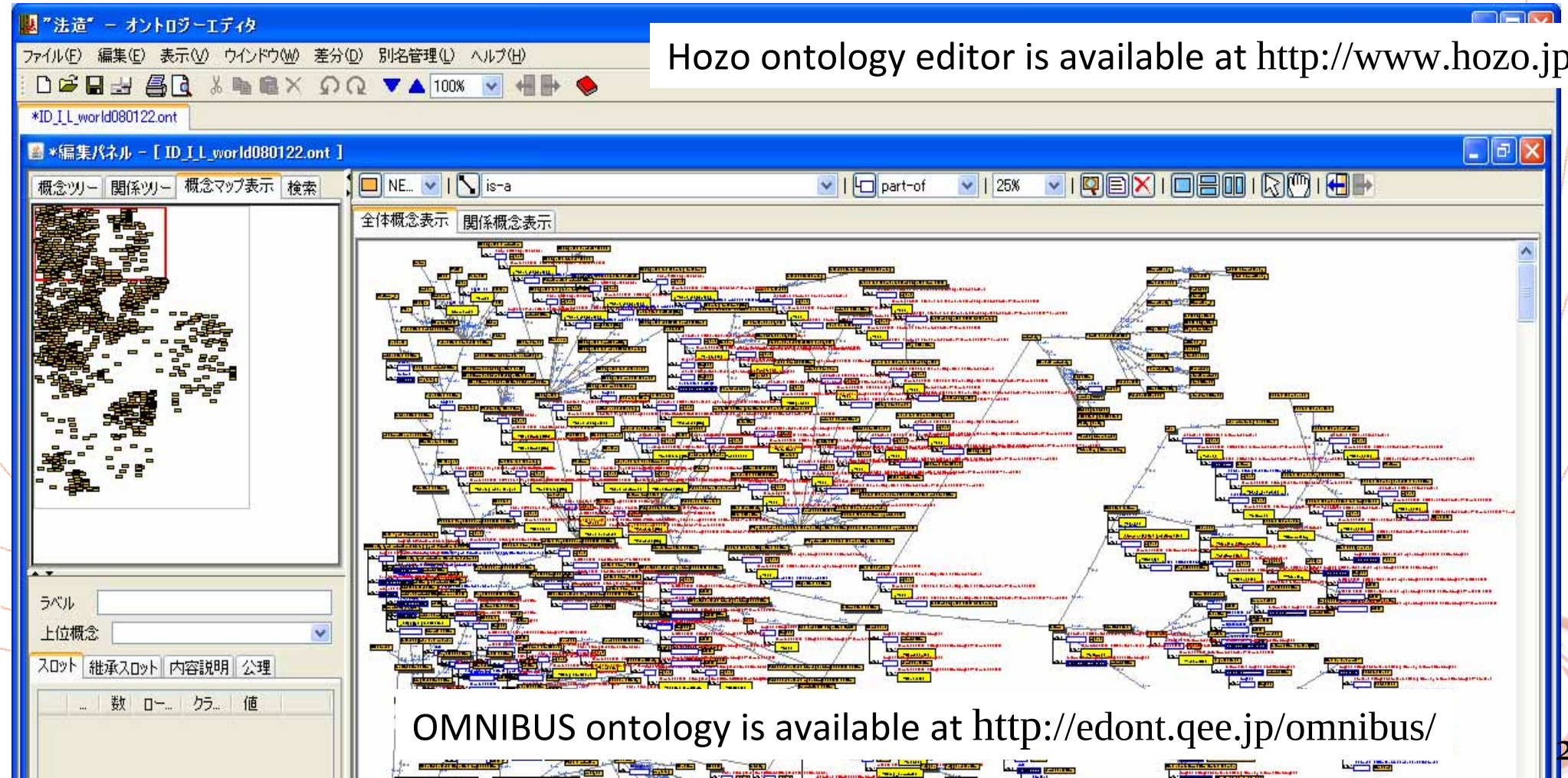
OMNIBUS ontology

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)



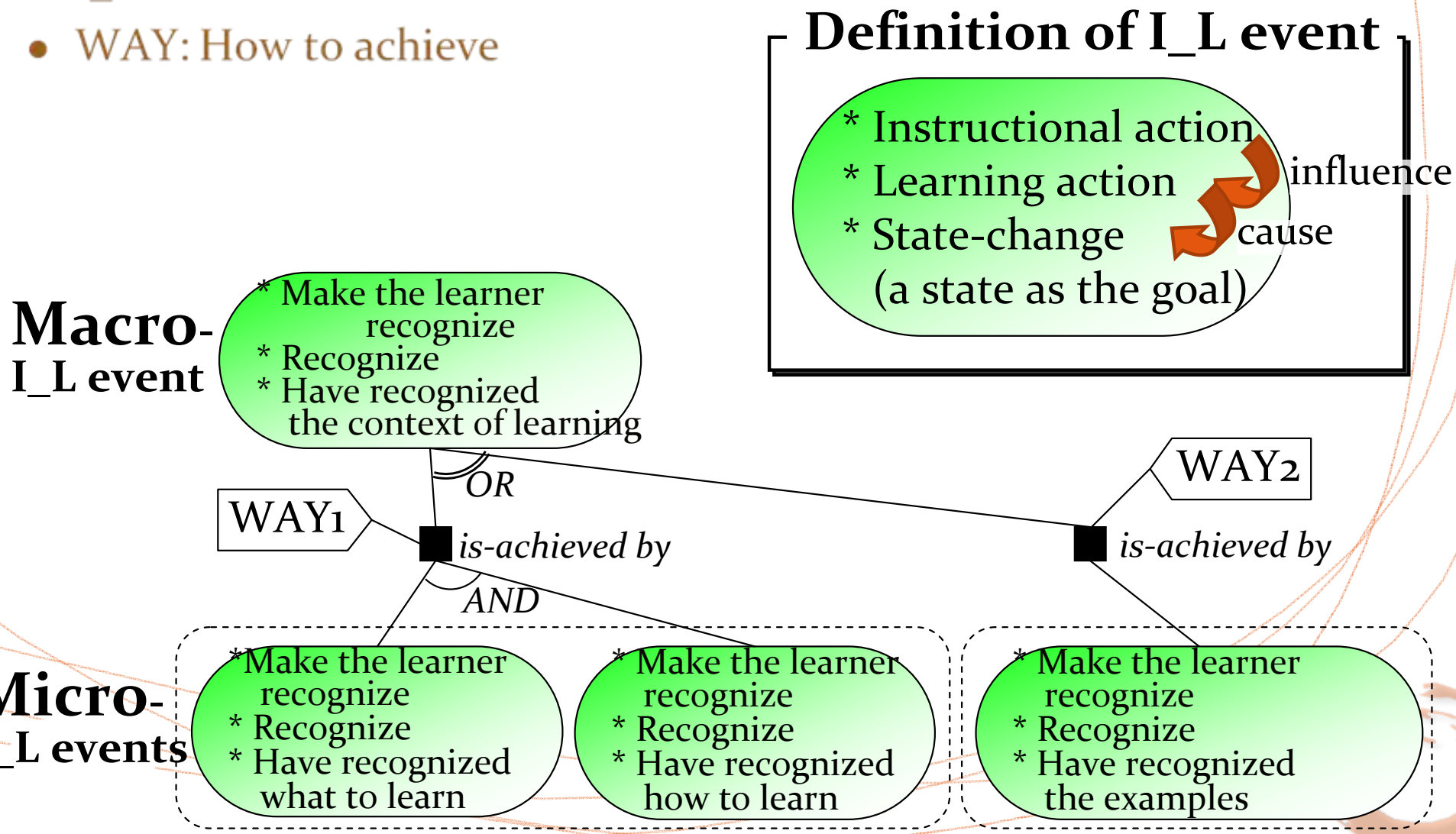
Hozo ontology editor is available at http://www.hozo.jp/

OMNIBUS ontology is available at http://edont.qee.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

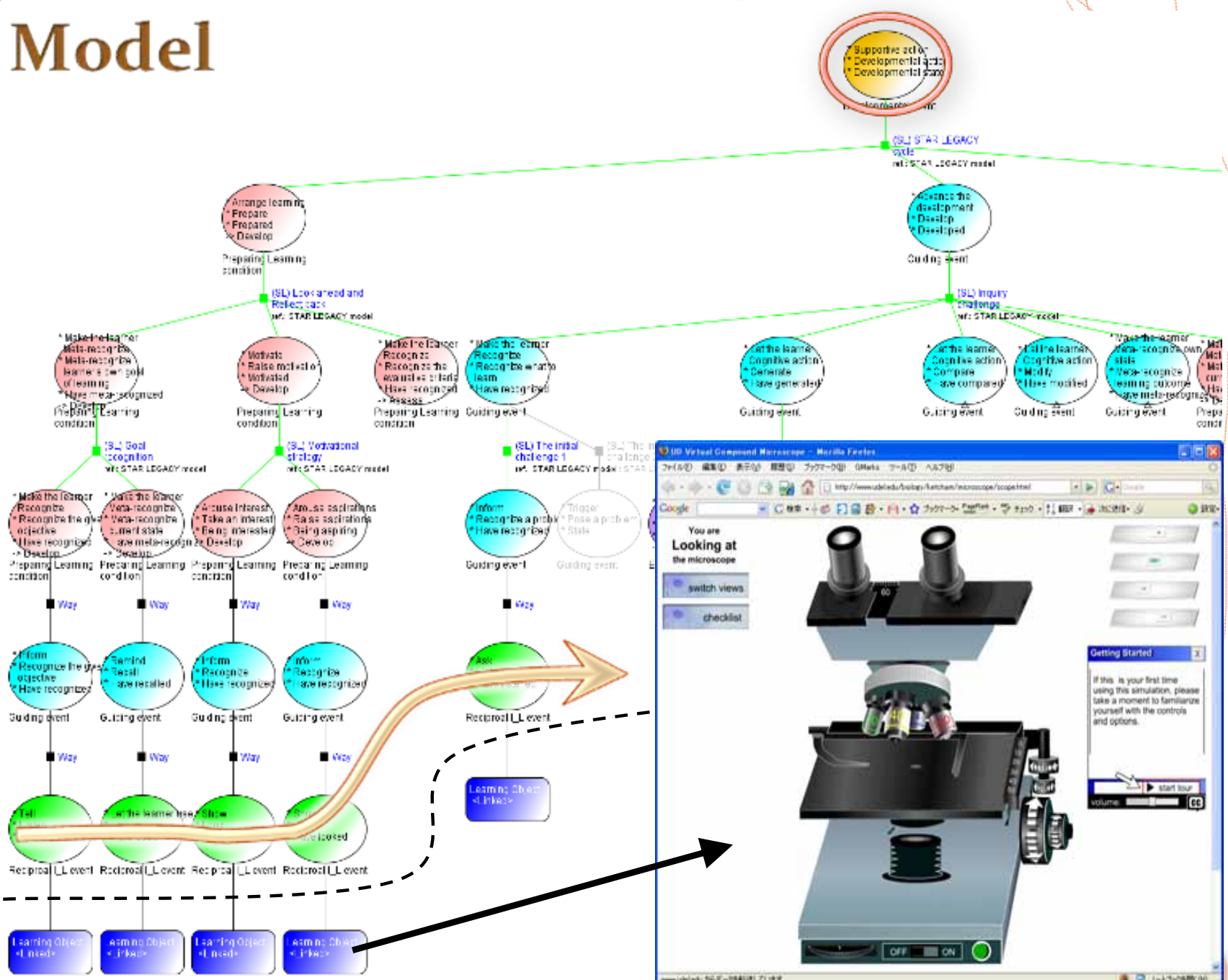


Learning and Instructional Scenario Model

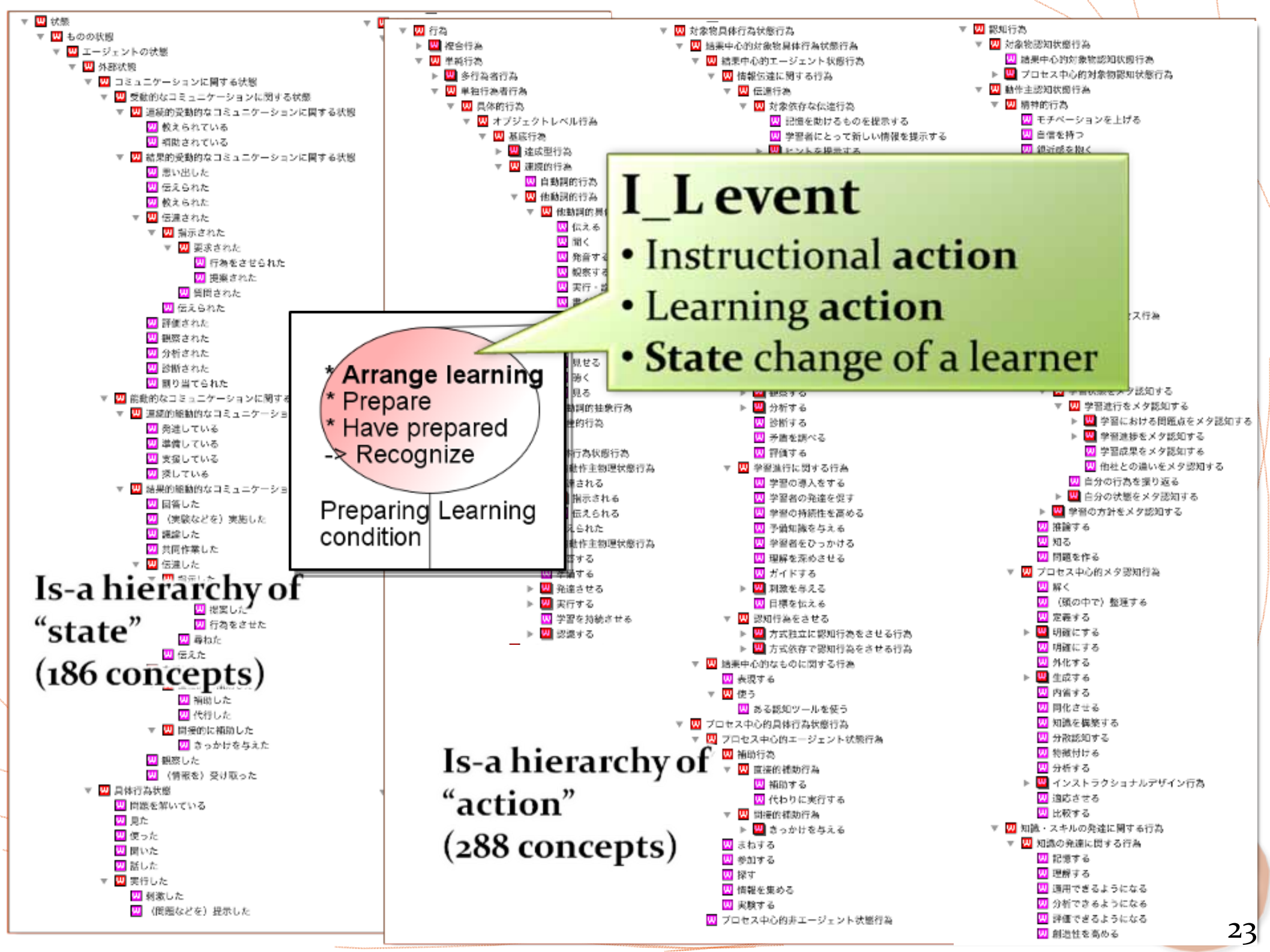
The goal of the whole course

Design rationale

Flow of actual learning and instructional activities



Learning objects


I_L event
• Instructional action
• Learning action
• State change of a learner
* Arrange learning
* Prepare
* Have prepared
-> Recognize
Preparing condition
Learning
Is-a hierarchy of "state" (186 concepts)
Is-a hierarchy of "action" (288 concepts)

Another point of WAY

Learning is modeled as state-change of a learner.

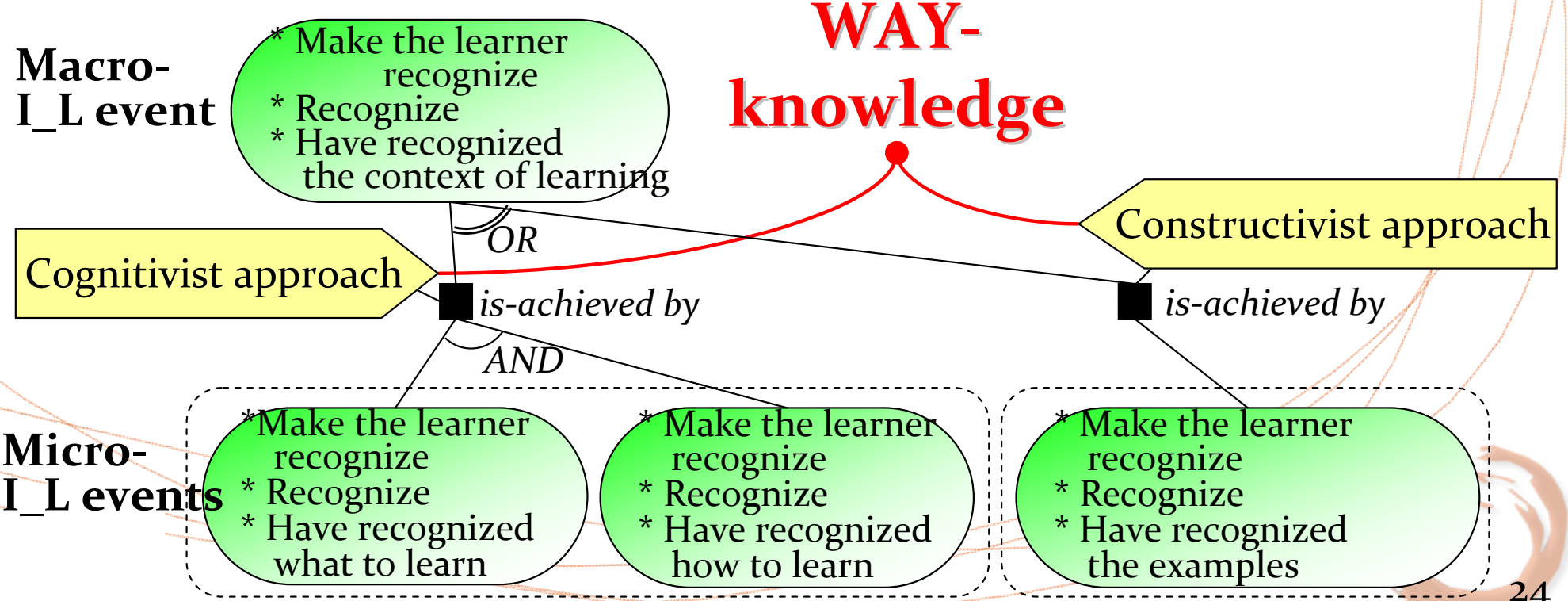
- I_L event: what to achieve
- WAY: How to achieve
- **Principle: theoretical and empirical knowledge**

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
Num. of theories	**1**	**3**	**6**	**1**
Num. of WAY-knowledge	**2**	**30**	**51**	**16**
Num. of WAY-knowledge of each theories	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

Hayashi, Y., Bourdeau, J. and Mizoguchi, R.: "Using Ontological Engineering to Organize Learning/Instructional Theories and Build a Theory-Aware Authoring System", *International Journal of Artificial Intelligence in Education*, Vol. 19, No. 2, pp. 211-252, 2009.

The inside of SMARTIES

OMNIBUS: an ontology for organizing learning and instructional knowledge

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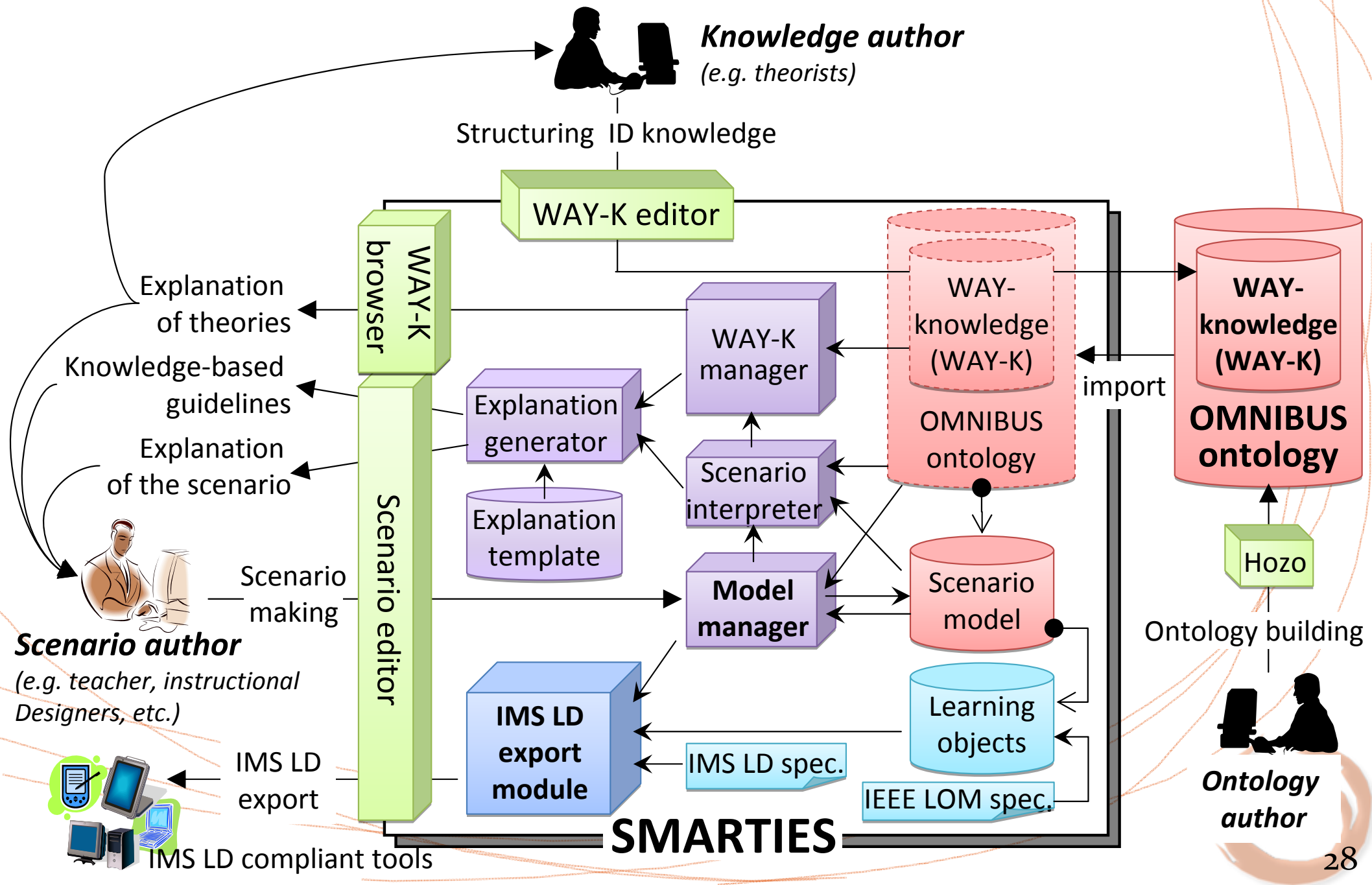
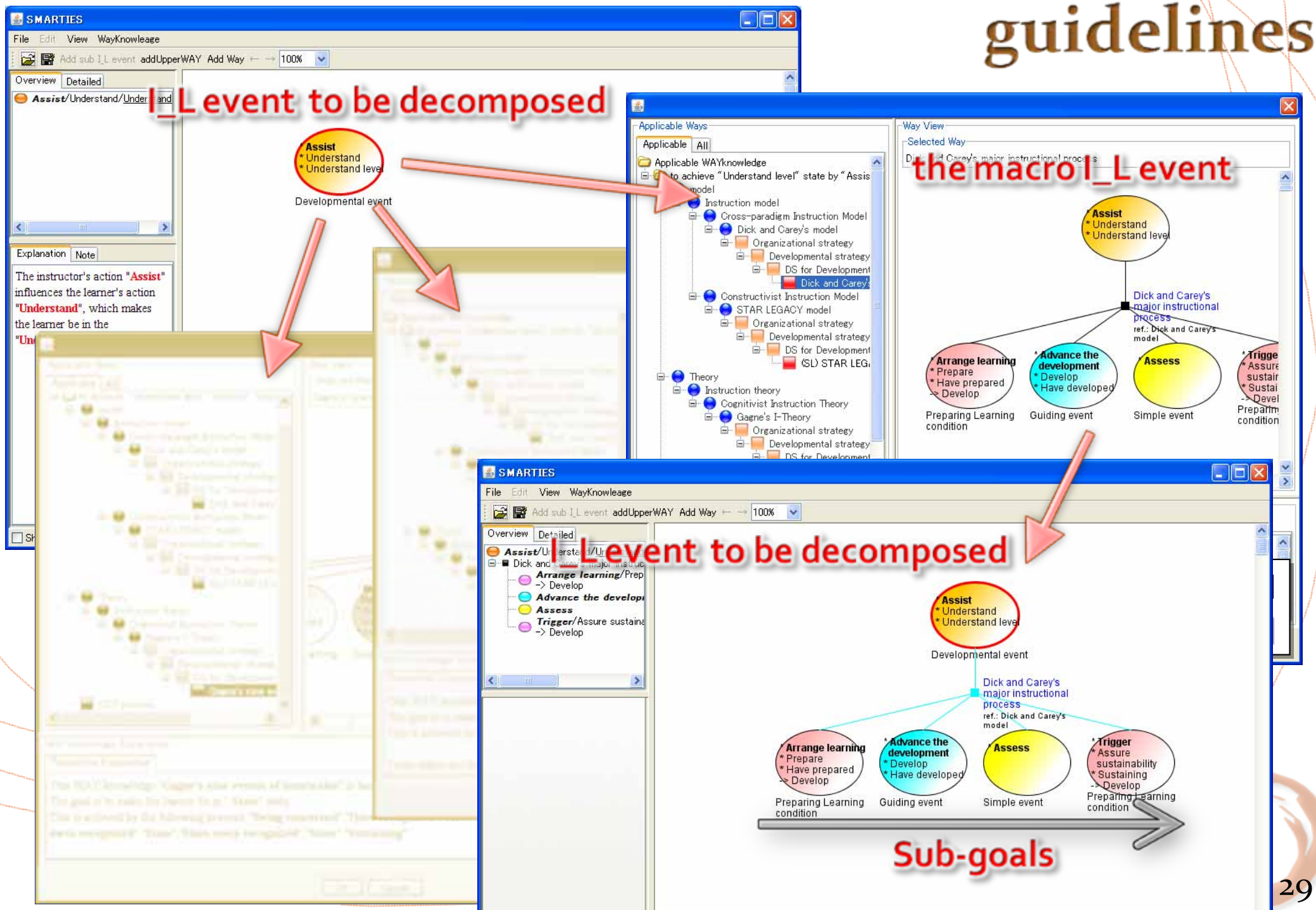
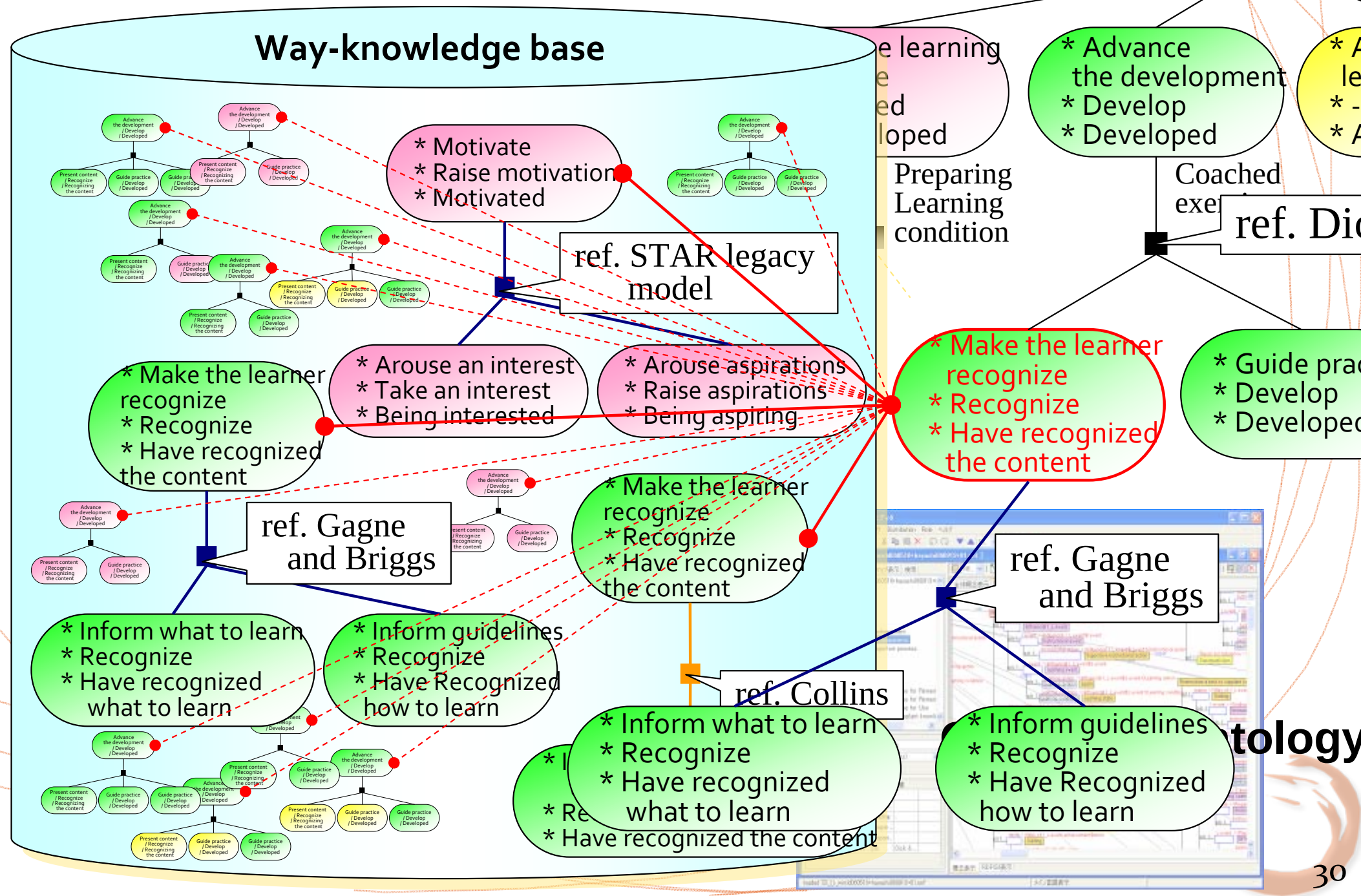
The system architecture of SMARTIES



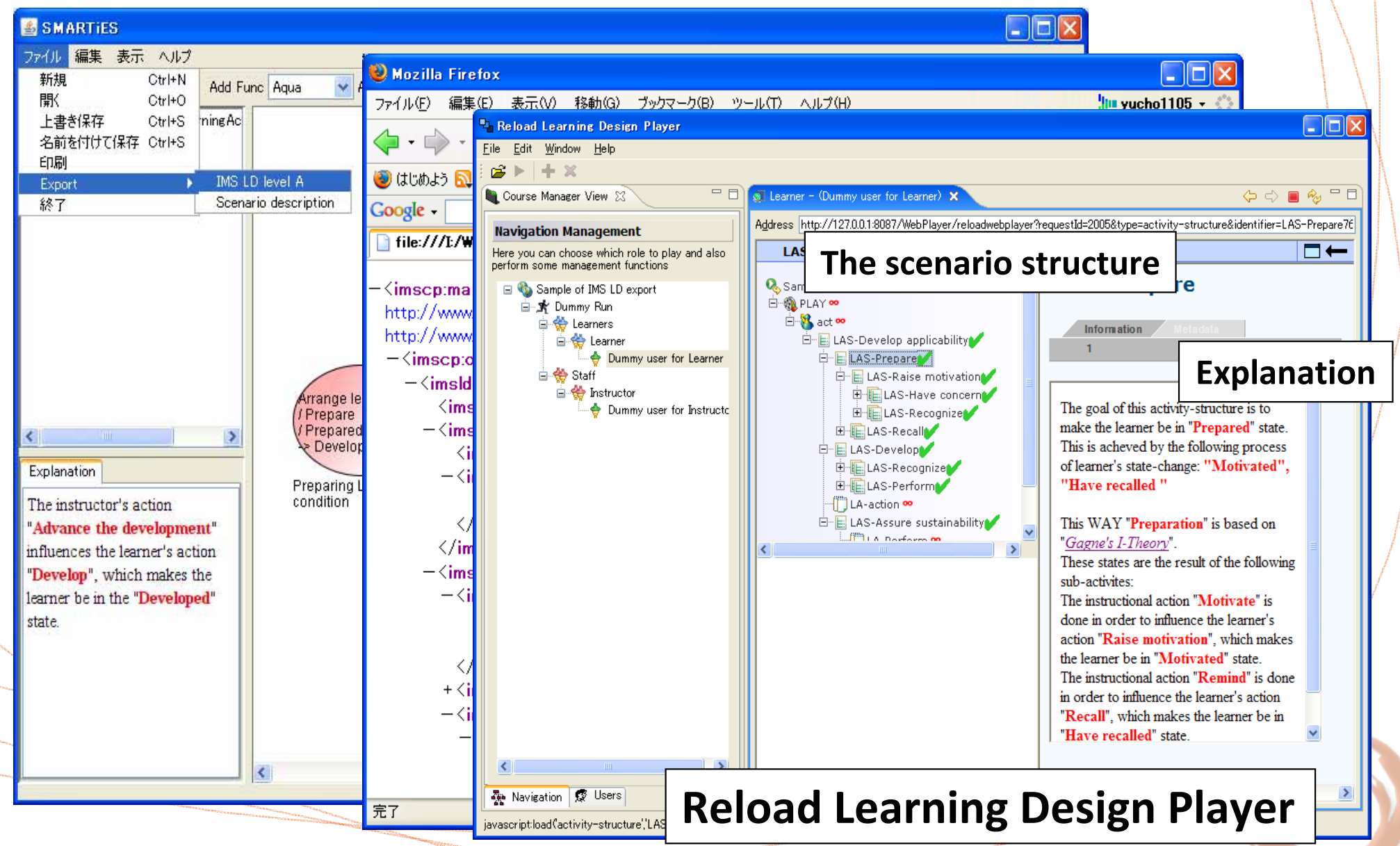
SMARTIES provides knowledgeable guidelines



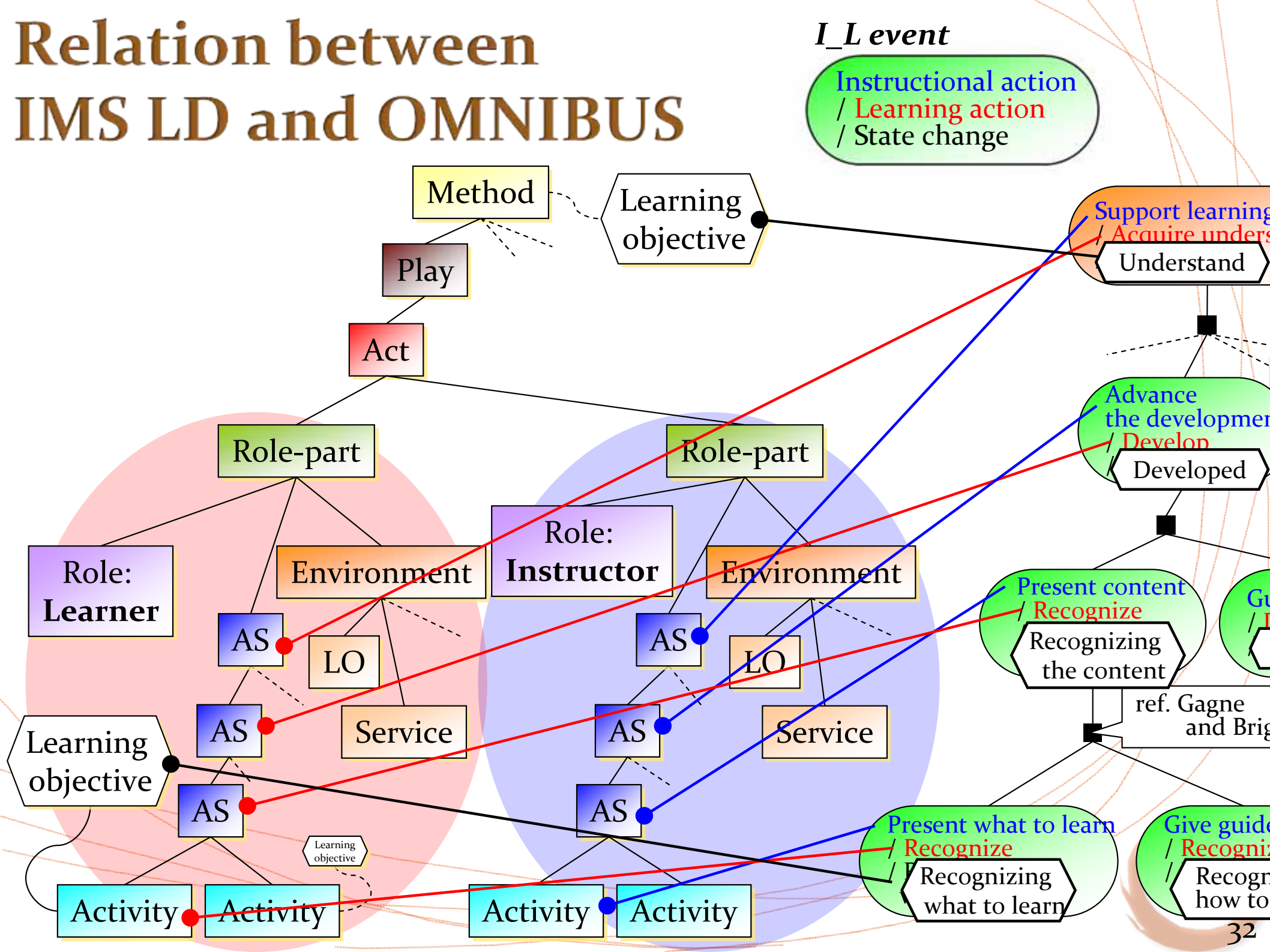
Utilization of WAY-knowledge



Output in the form of IMS LD



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>
```

Role

```
   <imsld:roles>
    <imsld:learner identifier="R-learner"/>
    ...(Snip)...
```

Activities

Activity-structure for *Instructor*

```
   <imsld: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
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     <imsld:activity-structure-ref
       ref="LAS-Give guidelines85806694"/>
    </imsld:activity-structure>
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      <imsld:activity-structure-ref
       ...(Snip)...
      </imsld:activity-structure>
```
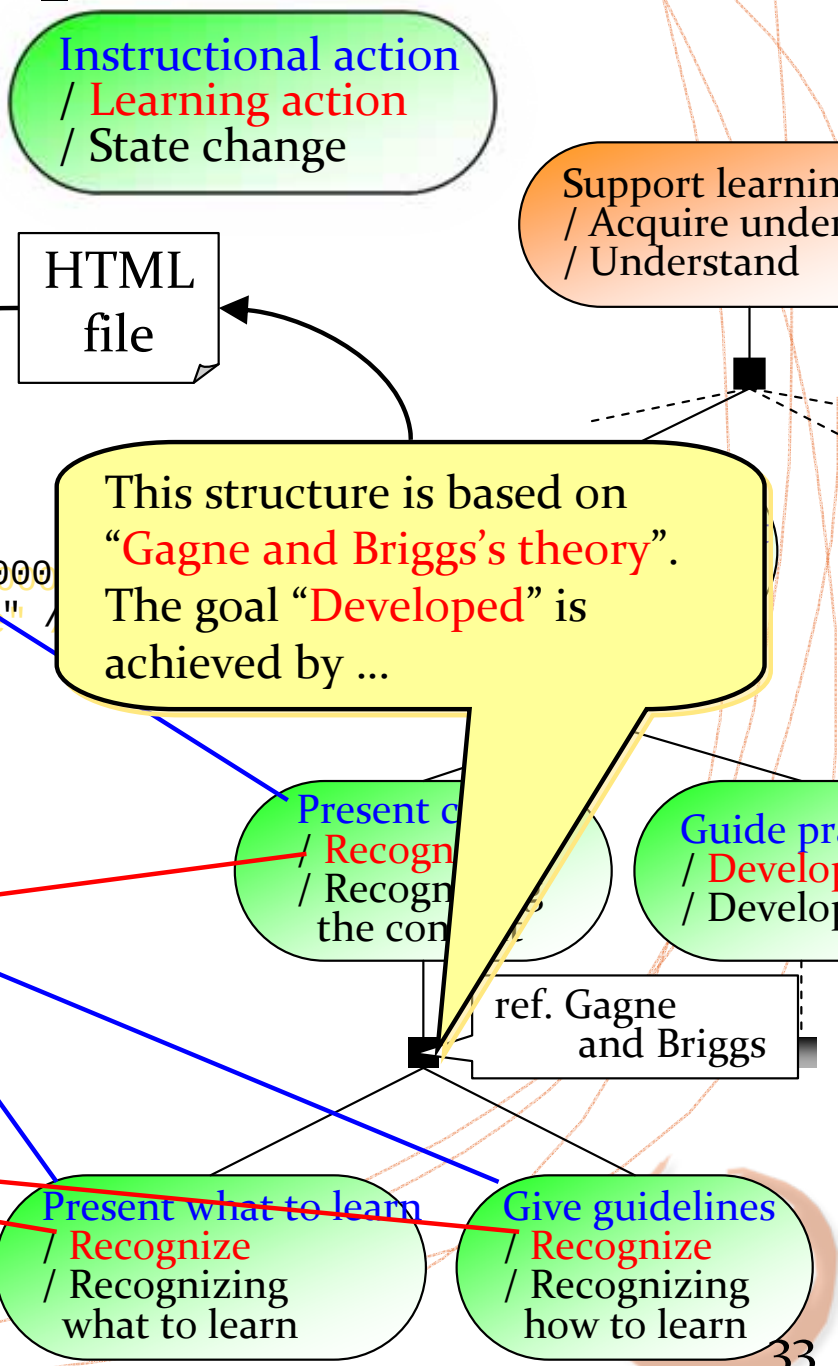

Activity-structure for *Learner*

Environment

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

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 theorecical 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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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