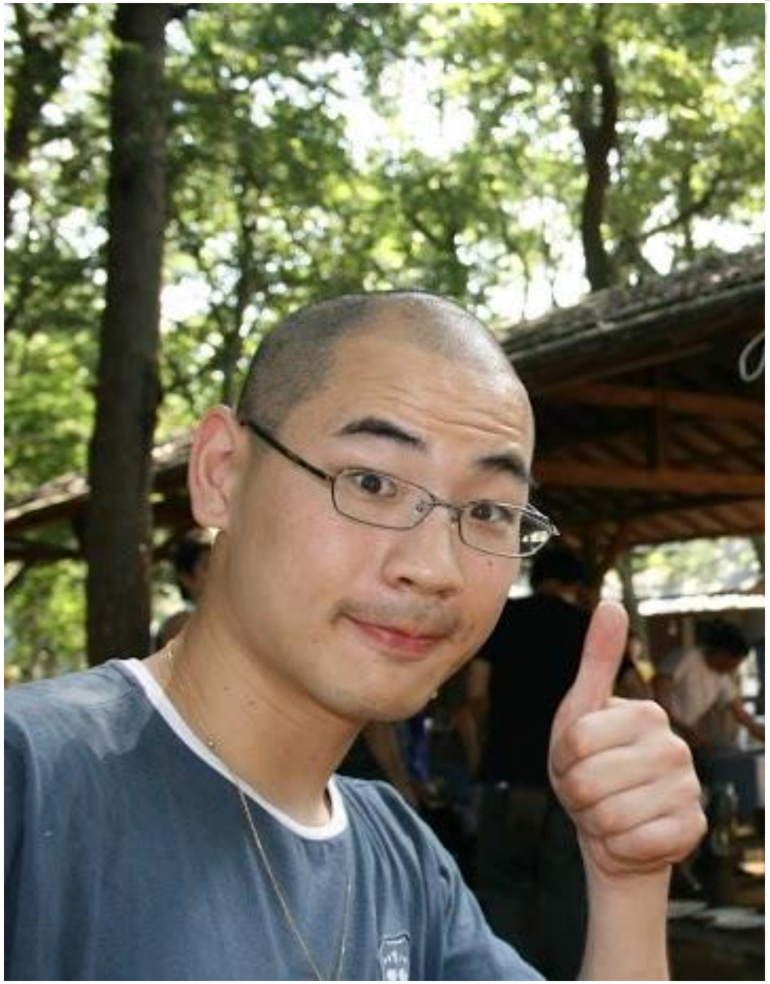
@BNU2018

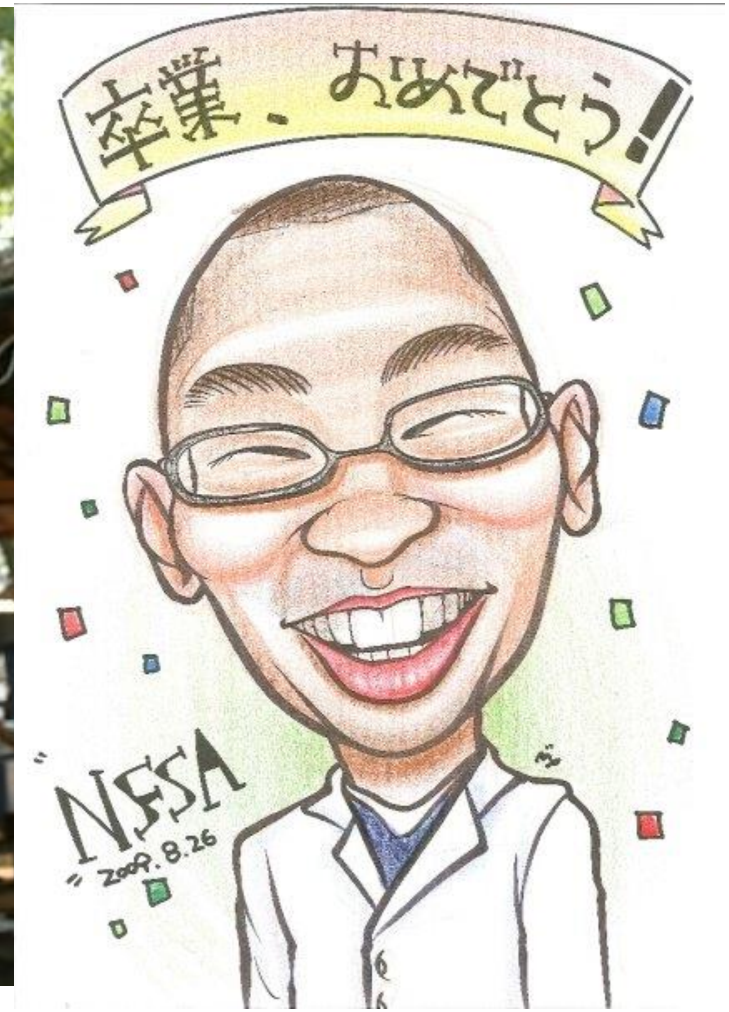
Advancements in Intelligent Support for Collaborative Learning

From Well-Thought-Out Group Formation to Effective Peer Interactions

Seiji Isotani
Professor
Computing in Education Laboratory
University of Sao Paulo
sisotani@icmc.usp.br

Who am I ?

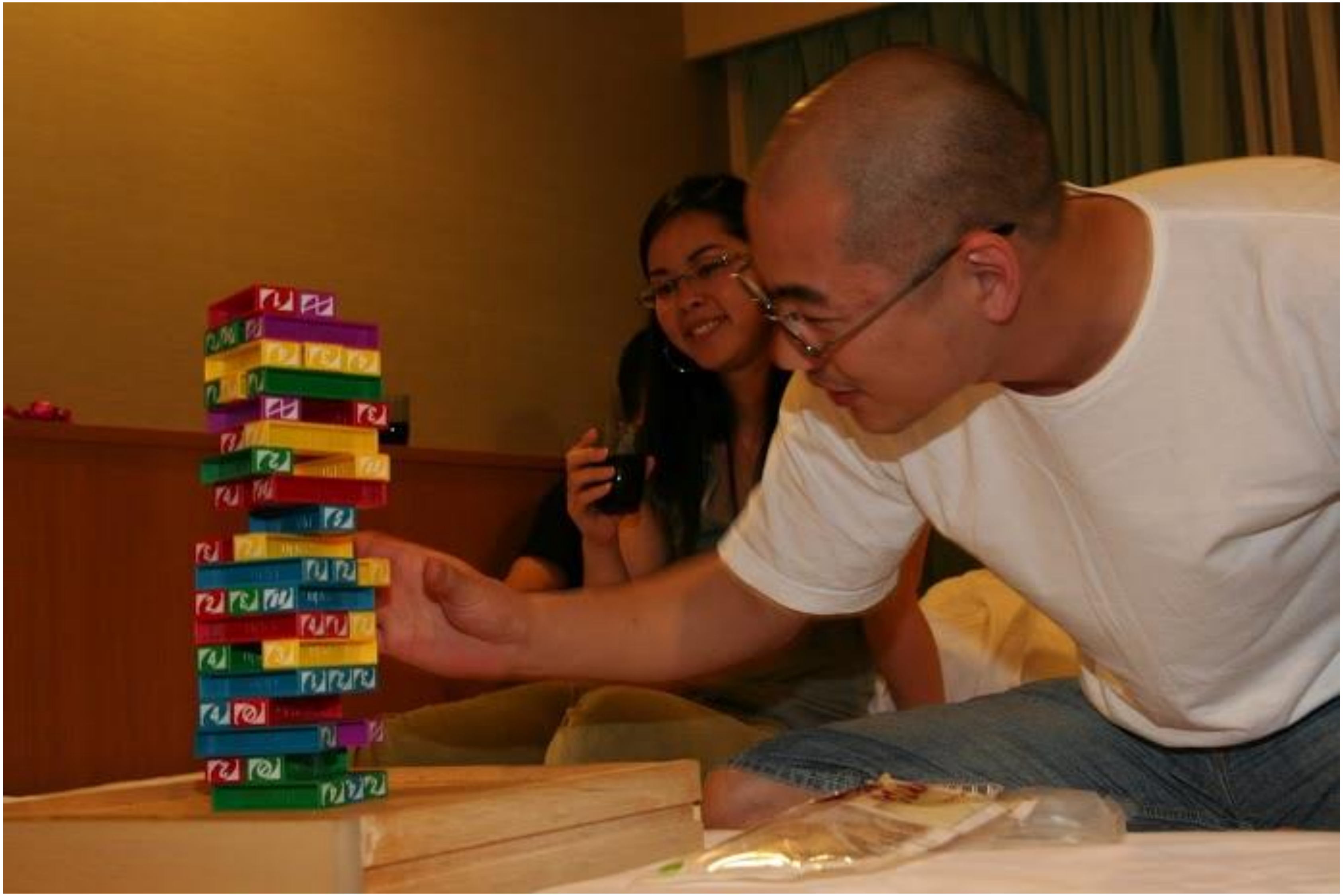




Hi I’m Seiji! I’m a Brazilian

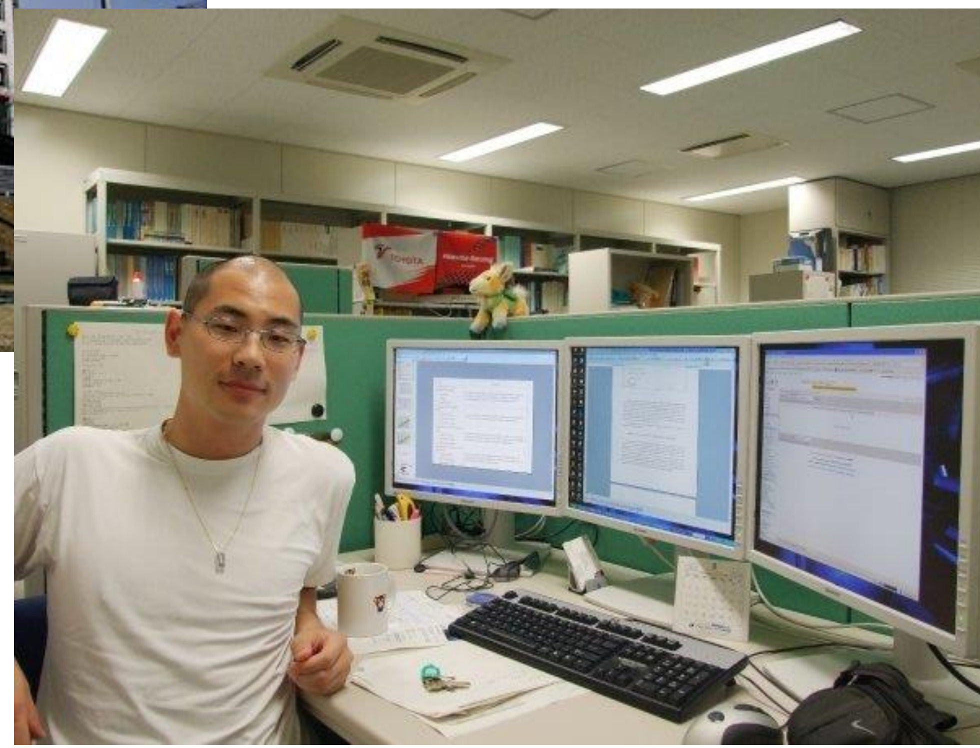
Love sports

Friendship...



Challenges ...

Undegrad in Computer Science at the University of Sao Paulo



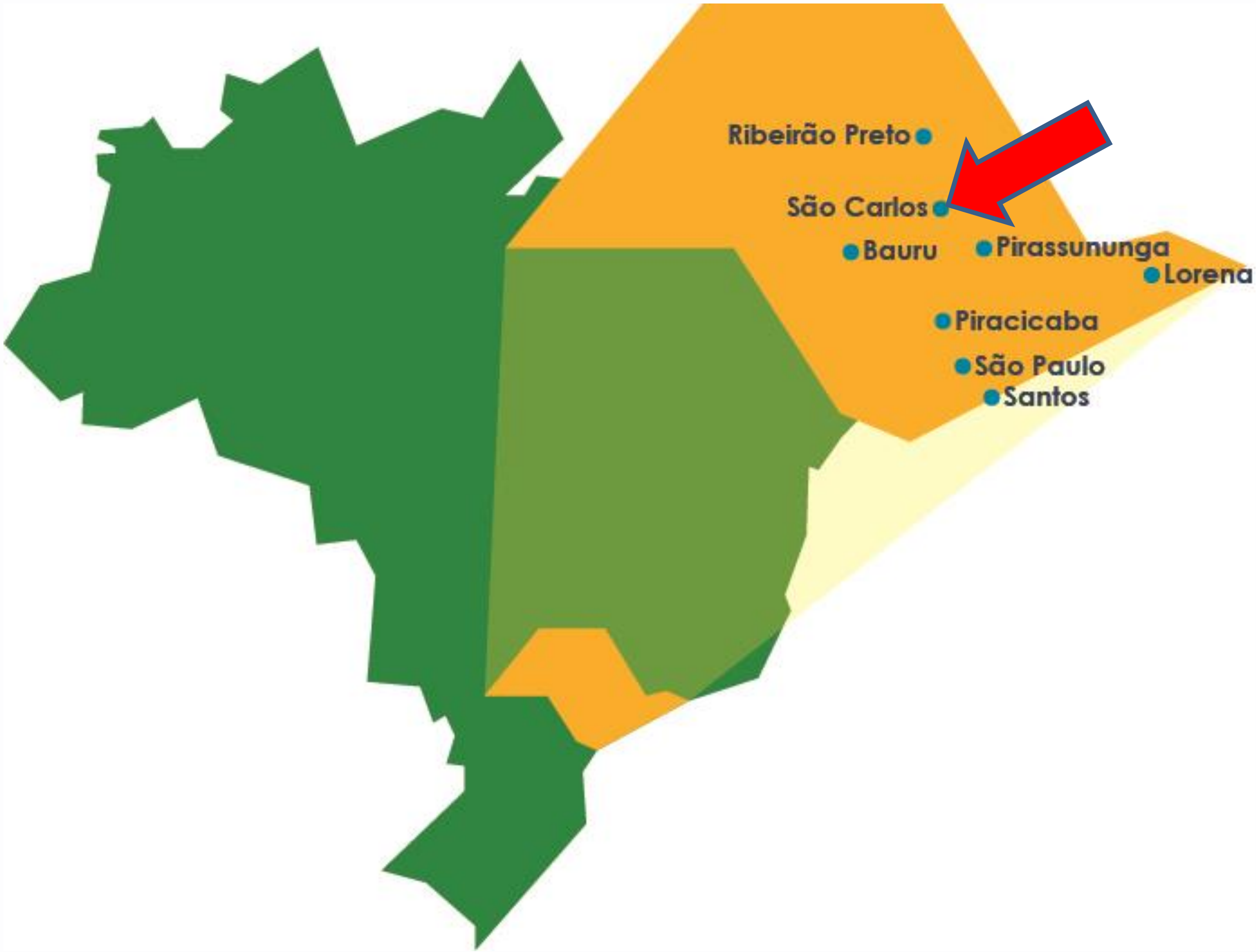
Ph.D. in Information Engineering

2 years as a Research Fellow at Carnegie Mellon University, USA

Back to Brazil at USP since 2011

UNIVERSITY OF SAO PAULO


Arctic Ocean
Arctic Ocean
Arctic Ocean
120°
60°
0°
60°
120°
180°
Ellesmere Island
Greenland (Den.)
Jan Mayen (Nor.)
Svalbard (Nor.)
Franz Josef Land
Severnaya Zemlya
New Siberian Islands
Wrangel Island
Novaya Zemlya
Banks Island
Victoria Island
Baffin Island
Faroe Is. (Den.)
Iceland
Norway
Finland
Sweden
Russia
U.S.A.
Canada
United Kingdom
Ireland
Den.
Estonia
Latvia
Lithuania
Belarus
Poland
Neth.
Bel.
Germany
Czech.
Slovak.
Ukraine
Aus.
Hung.
Moldova
Island of Newfoundland
France
Switz.
Slov.
Cro.
Bos.
Yugo.
Romania
Bulgaria
Mac.
Albania
Italy
Greece
Spain
Portugal
Georgia
Armenia
Azerbaijan
Kazakhstan
Uzbekistan
Turkmenistan
Mongolia
Kyrgyzstan
Tajikistan
N. Korea
S. Korea
Turkey
North Atlantic Ocean
United States of America
Tunisia
Cyp.
Leb.
Israel
Syria
Iraq
Iran
Afghanistan
China
Morocco
Canary Islands (Sp.)
Algeria
Libya
Egypt
Jordan
Kuwait
Qatar
Pakistan
Nepal
Bhu.
Saudi Arabia
U.A.E.
Oman
India
Bang.
Myanmar (Burma)
Taiwan
Mexico
Cuba
The Bahamas
Dominican Republic
Western Sahara (Mor.)
Mauritania
Mali
Niger
Chad
Sudan
Eritrea
Yemen
Jam.
Haiti
Puerto Rico (US)
Dominica
Barbados
Trinidad and Tobago
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
Panama
Senegal
The Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Nigeria
Djibouti
Ethiopia
Thailand
Vietnam
Cambodia
Philippines
Venezuela
Guyana
Suriname
French Guiana
Sierra Leone
Côte D'Ivoire
Liberia
Ghana
Togo
Eq. Guinea
Cameroon
C.A.R.
Somalia
Andaman Islands (India)
Maldives
Sri Lanka
Brunei
Malaysia
Singapore
Colombia
Ecuador
Galapagos Islands (Ecuador)
Uganda
Kenya
Sao Tome & Principe
Gabon
Rwanda
Burundi
Zaire
Congo
Tanzania
Seychelles
Indonesia
Brazil
Peru
Bolivia
Paraguay
Malawi
Angola
Zambia
Mozambique
Madagascar
Namibia
Zimbabwe
Botswana
Mauritius
Indian Ocean
Australia
Swaziland
South Africa
Lesotho
Uruguay
Chile
Argentina
South Pacific Ocean
South Atlantic Ocean
Tasmania
Falkland Islands (Islas Malvinas) (adm. by UK, claimed by Argentina)
South Georgia (adm. by UK, claimed by Argentina)
Îles Crozet (France)
Antarctica
150°
120°
90°
60°
30°
0°
30°
60°
90°
120°
150°
180°



USP international office

Undergraduate programs

58,204
students

*International
1,692

Graduate programs

29,547
students

*International
1,587

Master's
14,149

Doctorate
15,398

92,792
students

Visiting
5,041

USP international office

Faculty
6,008

Full time work dedication
5,230
(87.05%)

Academic Titles (PhD or higher)
5,964
(99.27%)

Technical-Administrative Staff
17,450

USP Ranking

1 Ibero American SCImago Institutions Rankings (SIR) 2018

118 QS World University Rankings 2019

77 CWUR World University Rankings 2018

14 The Times Higher Education BRICS & Emerging Economies 2018

148 U.S. News Best Global Universities 2019

SÃO CARLOS

Team

@BNU2018

Advancements in Intelligent Support for Collaborative Learning

From Well-Thought-Out Group Formation to Effective Peer Interactions

Seiji Isotani
Professor
Computing in Education Laboratory
University of Sao Paulo
sisotani@icmc.usp.br

Takeaway Message:

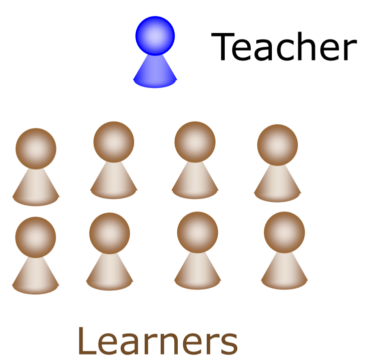
1. Take a **real world problem** that is hard to solve
2. **Organize the knowledge** from different sources
3. Build an **ontology**
4. **Hide the ontology** behind a model that people can understand
5. Apply the model and the ontology to **solve the problem**

Context

The field of Computer-Supported Collaborative Learning - **CSCL** dedicates to study about how **technology** can be used to **support collaborative learning** and its processes (Stahl et al., 2006)

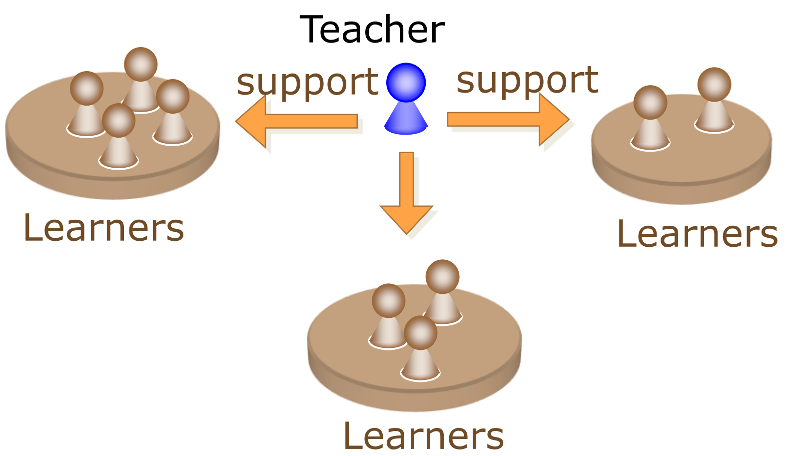
Context

Individual Learning



- students work individually toward an academic goal;
- more structured;
- Teacher plays an active role during the learning process;
- Individual assessment;
- …

collaborative Learning



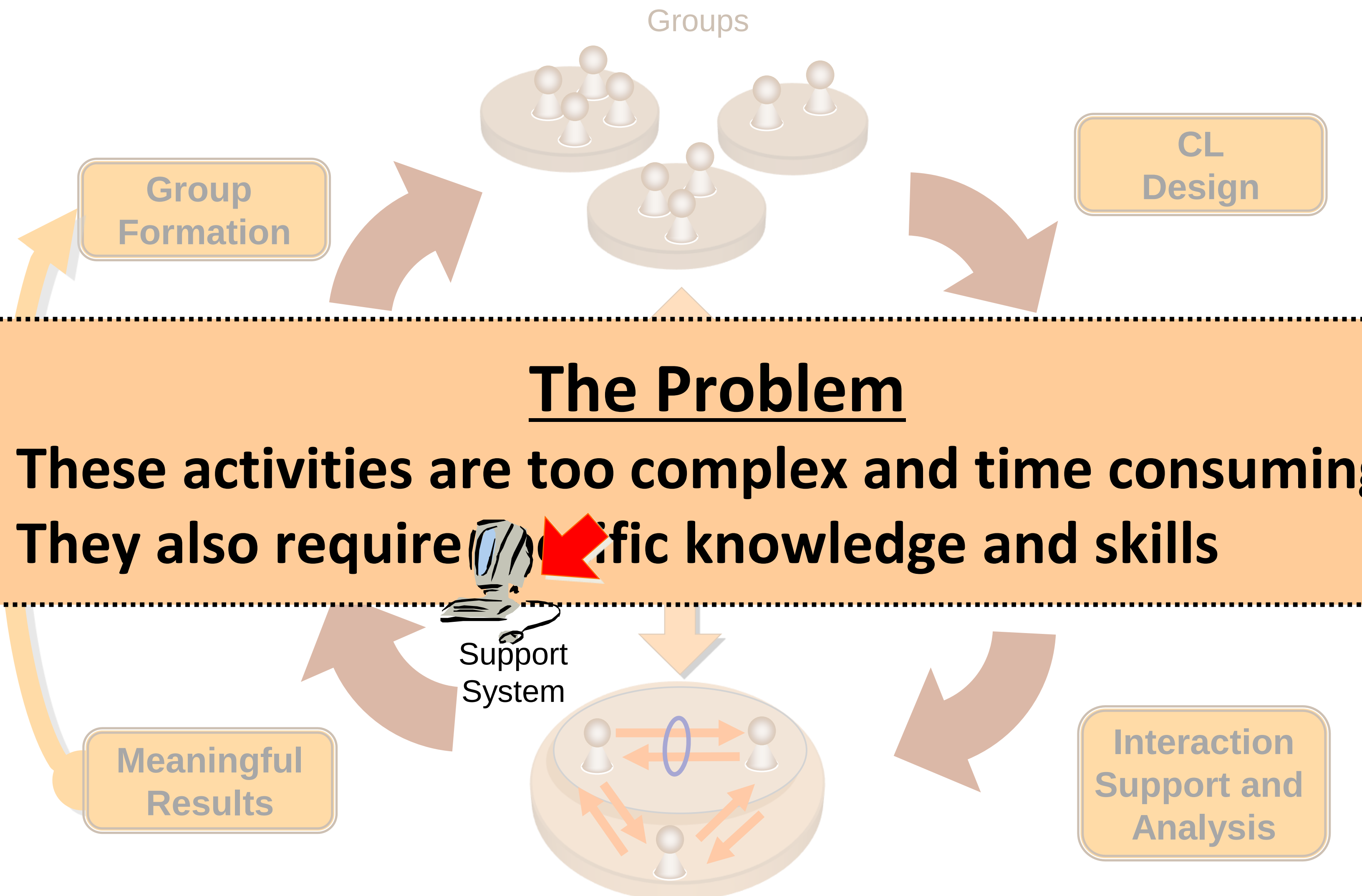
- students work in groups toward a common academic goal;
- less structured;
- Teacher plays a supportive role during the learning process;
- Individual and group assessment;
- …

Context

The field of Computer-Supported Collaborative Learning - **CSCL** dedicates to study about how **technology** can be used to **support collaborative learning** and its processes (Stahl et al., 2006)

Despite of the potential benefits of Collaborative Learning, **this approach is only beneficial when there is an adequate design and orchestration of its scenarios** (Hernández-Leo et al., 2011; Dillenbourg, 2013; Pietro et al., 2018)

Context



The Problem

- These activities are too complex and time consuming
- They also require specific knowledge and skills

How to increase the chances of successful collaborative learning (CL)?

How to provide intelligent support to design and carry out collaboration ?

Challenges !

Knowledge to design effective collaboration is distributed across several learning theories and best practices

Isotani, S; Mizoguchi, et al. (2009) An ontology engineering approach to the realization of theory-driven group formation. International Journal of Computer-Supported Collaborative Learning, v. 4, p. 445-478.

They do not share the same terminology, assumptions and expectations and can be even contradictory!

Hayashi et al (2011) An Ontological Model to Blend Didactic Instruction and Collaborative Learning. Lecture Notes in Computer Science, vol 6969. Springer, Berlin, Heidelberg, 1-13.

In fact, Only 35% of the the current CL technology rely on pedagogical knowledge

Borgest et al. (2018) Group Formation: The State of the art. Communications in Computer and Information Science. Springer, 174-191.

So, the question is ...

Can we organize this pedagogical knowledge and build an infrastructure to use it adequately?

Approaches to Represent Pedagogical Knowledge

- Script-based
- Pattern-based
- Ontology-based

Solutions

- Script-based Solution
  - Set of components to describe an collaborative learning activity
  - **Focus on components**
  - Way of communicating CL expertise
  - **Human-interpretable** notations
  - **Scripts are hard-coded** in computational tools

Table 2 Components of collaboration script examples

Name	MURDER Script	Universanté Script	ArgueGraph Script	Social Script
Participants	An even number of participants	Participants from at least two nations with at least as many participants per nation as there are case descriptions	An even number of at least four participants (works best with 20–30 participants) and a tutor	An amount of participants that must be divisible by three
Activities[a]	a) relaxing, focusing; b) reading, monitoring comprehension; c) summarizing, explaining; d) monitoring, giving feedback; e) elaborating; f) reviewing, reflecting	a) analyzing and elaborating the case; b) summarizing and explaining; c) analyzing, comparing and relating new information to personal prior knowledge; d) giving feedback and critiquing; e) problem solving	a) justifying opinions and constructing arguments; b) comparing, evaluating, and elaborating; c) negotiating and constructing arguments; d) explaining and justifying opinions; e) summarizing and making connections	a) applying theoretical concepts to cases and constructing arguments; b) critiquing (initially scaffolded with prompts for eliciting clarification, identifying conflicting views and constructing counter-arguments)
Roles	A summarizer and a listener	None	None	An analyst and two critics
Resources	Learning material with a small number of text passages	Case descriptions from at least two themes, with at least two case descriptions per theme.	One questionnaire for each participant and another copy for each small group. One argument sheet per questionnaire item.	Three case descriptions
Groups	Pairs	Theme groups, case groups and national groups	Class group and pairs	Case groups

Kobbe et al. (2007) Specifying computer-supported collaboration script. Int. Journal of Computer Supported Collaborative Learning (2007) 2(3), 211-224.

Problems with previous approach

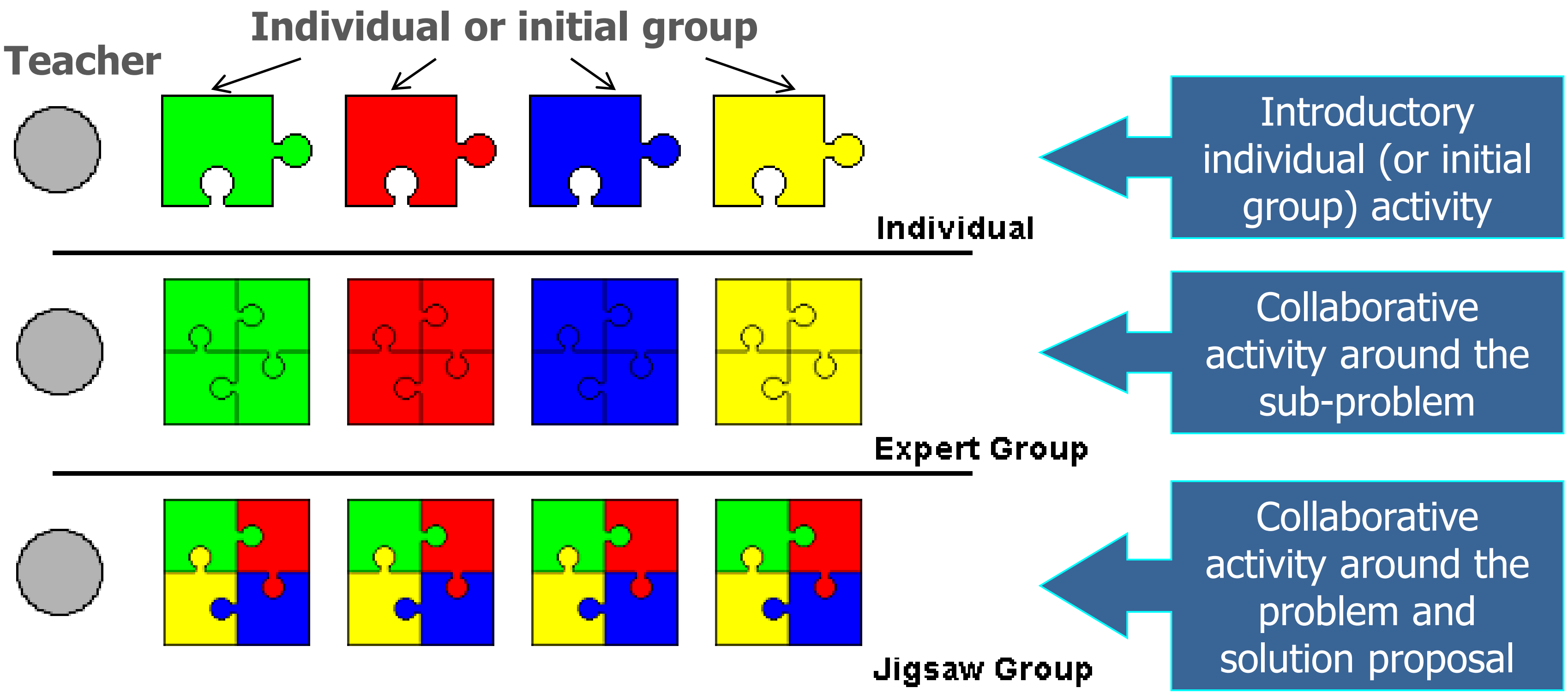
Problem

1. Human-interpretable notations
2. Too complex & ambiguous
3. There is not a common vocabulary to describe them
4. Different point of views, levels of aggregation, perspective and emphasis
5. Scripts are hard-coded in computational tools

Solutions

- Pattern-based Solution
  - Description of classroom best practices
  - **Focus on the flow** of the collaborative activities for promoting desired educational objectives
  - Way of communicating CL expertise
  - **Computer-interpretable** notations (IMS-LD)

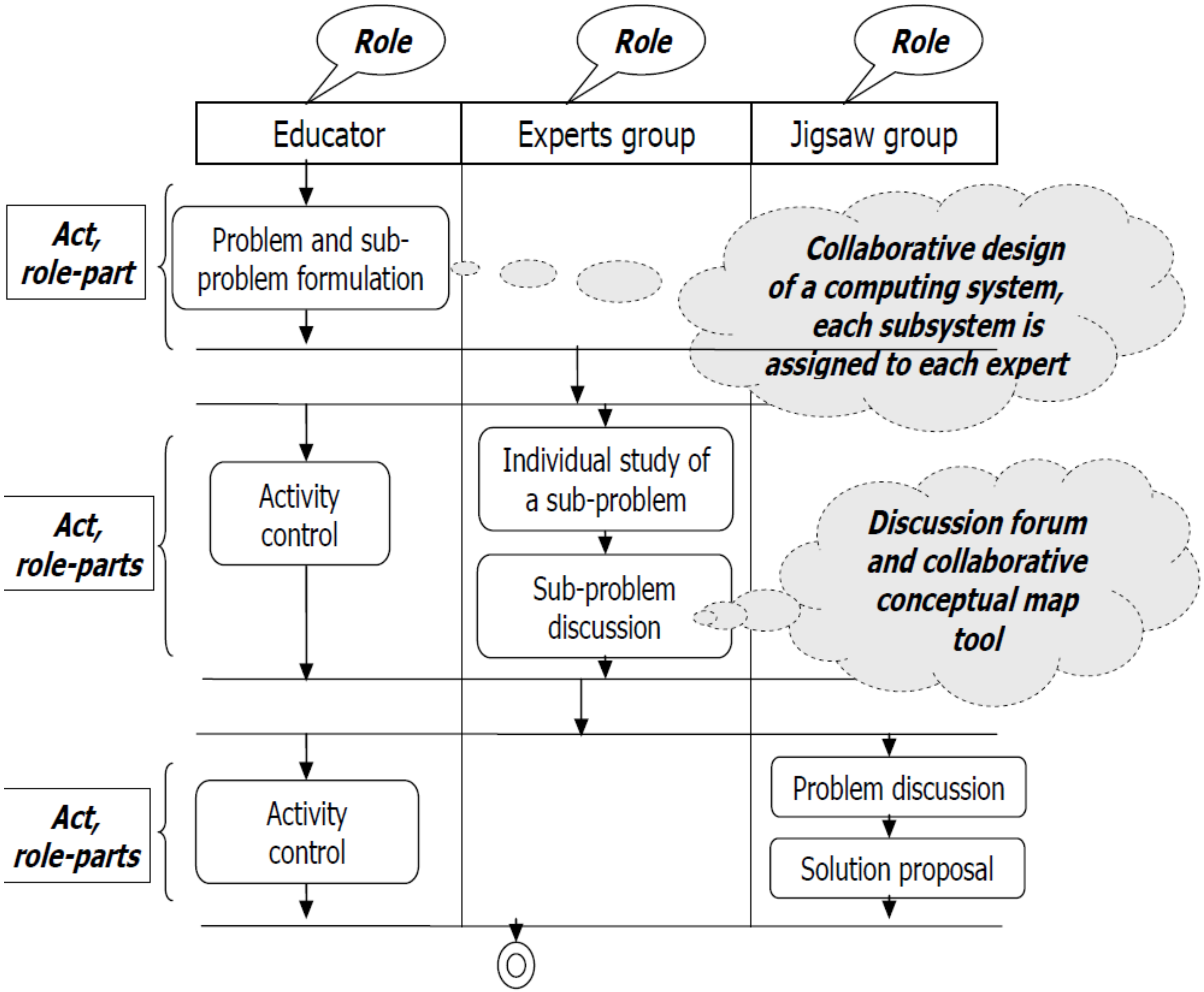
Example



Hernández-Leo, et al (2005). Reusing Ims-ld Formalized Best Practices in Collaborative Learning Structuring. Advanced Technology for Learning 2(4), 223-232

Manathunga K., Hernández-Leo D. (2016) A Multiple Constraints Framework for Collaborative Learning Flow Orchestration (2016) Lecture Notes in Computer Science, vol 10013. Springer, 225-235.

Jigsaw flow using IMS-LD



IMS-LD Description

```
...

<method>
 <play>
  ...
   <act>
     <role-part>
       <role-ref ref="R-student-A" />
       <learning-activity-ref ref="LA-solution-explanation" />
     </role-part>
     <role-part>
       <role-ref ref="R-student-B" />
       <learning-activity-ref ref="LA-solution-listening" />
     </role-part>
   </act>
   <act>
     <role-part>
       <role-ref ref="R-student-B" />
       <learning-activity-ref ref="LA-solution-explanation" />
     </role-part>
     <role-part>
       <role-ref ref="R-student-A" />
       <learning-activity-ref ref="LA-solution-listening" />
     </role-part>
   </act>
  ...
 </play>
</method>
</learning-design>
```

```
<roles>
  <learner identifier="R-class">
    <learner identifier="R-couple" create-new="allowed" min-persons="2" max-persons="2">
      <learner identifier="R-student-A" match-persons="exclusively-in-roles" />
      <learner identifier="R-student-B" match-persons="exclusively-in-roles" />
    </learner>
  </learner>
  <staff identifier="R-educator" />
</roles>
```

```
<activities>
  <learning-activity identifier="LA-solution-explanation">
    <environment-ref ref="E-communication-tool" />
  ...
  </learning-activity>
  <learning-activity identifier="LA-solution-listening">
    <environment-ref ref="E-communication-tool" />
  ...
  </learning-activity>
</activities>
```

```
<environments>
  <environment identifier="E-communication-tool">
    <service identifier="S-chat">
      <conference conference-type="synchronous">
        <participant role-ref="R-couple" />
      </conference>
    </service>
  </environment>
</environments>
```

Computer-based support to orchestrate collaboration

Hernández-Leo, et al (2005). Reusing Ims-ld Formalized Best Practices in Collaborative Learning Structuring. Advanced Technology for Learning 2(4), 223-232
Manathunga K., Hernández-Leo D. (2016) A Multiple Constraints Framework for Collaborative Learning Flow Orchestration (2016) Lecture Notes in Computer Science, vol 10013. Springer, 225-235.

Problems with previous approach

Problem

1. Limited framework to describe pedagogical approaches
2. IMS-LD is designed for individual learning
3. There is not a common vocabulary or formal way to describe collaboration flows
4. Computers cannot reasoning over IMS-LD
5. No support for intelligent authoring, group formation or interaction analysis

Solutions

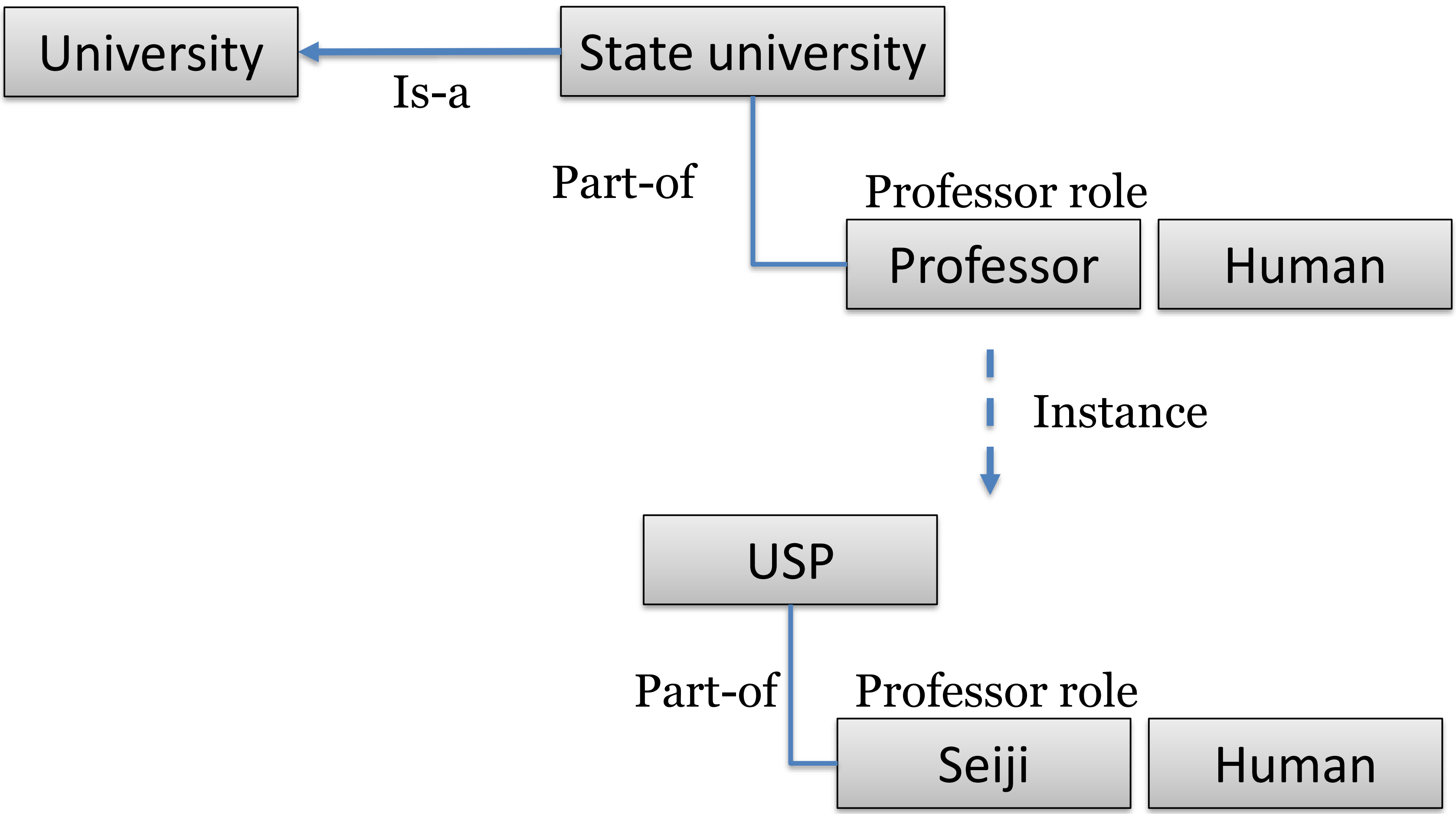
- Ontology-based Solution
  - Formal infrastructure to represent pedagogical knowledge
  - **Focus on representation and generalization**
  - Way of communicating CL expertise
  - **Computer-understandable** notations (OWL, RDF-S)
  - **Knowledge base is shareable** accross humans and machines

What is an Ontology?

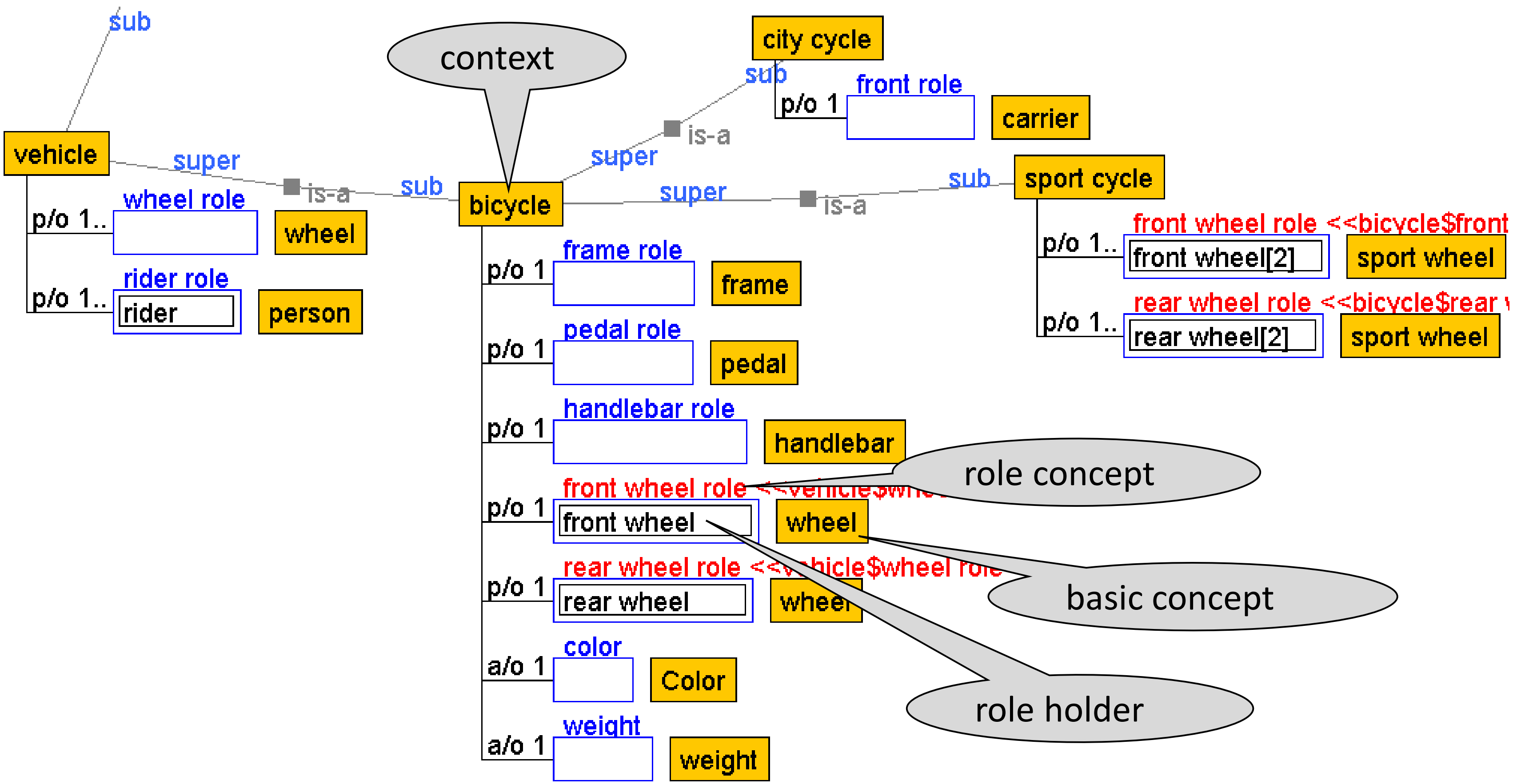
- A **formal explicit specification** of objects and relations in the target world used to share a common understanding within a community and to build models/frameworks about target objects (Mizoguchi, 2003;2004)

Mizoguchi, R. (2003; 2004) Tutorial on Ontological Engineering – Part 1, 2 and 3. Next Genration Computing.

Example of Ontology representation



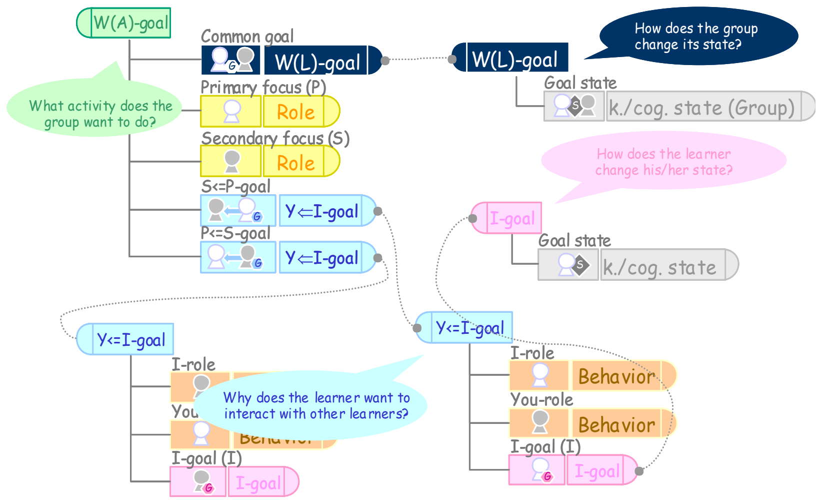
Example of Ontology representation: Ontology of Bicycle



Example of Ontology representation: Ontology of Bicycle in OWL

```
<owl:Class rdf:ID="Vehicle">
    <rdfs:label>Vehicle</rdfs:label>
    <rdfs:subClassOf rdf:resource="#Any" />
</owl:Class>
<owl:Class rdf:ID="sport_cycle">
    <rdfs:label>sport_cycle</rdfs:label>
    <rdfs:subClassOf rdf:resource="#bicycle" />
</owl:Class>
<owl:Class rdf:ID="city_cycle">
    <rdfs:label>city_cycle</rdfs:label>
    <rdfs:subClassOf rdf:resource="#bicycle" />
</owl:Class>
<owl:Class rdf:ID="bicycle">
    <rdfs:label>bicycle</rdfs:label>
    <rdfs:subClassOf rdf:resource="#Vehicle" />
    <rdfs:subClassOf>
        <owl:Restriction>
            <owl:cardinality rdf:datatype="http://www.w3.org/
            <owl:onProperty rdf:resource="#has_body_color" />
        </owl:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
        <owl:Restriction>
            <owl:onProperty rdf:resource="#has_body_color" />
            <owl:allValuesFrom rdf:resource="#Color" />
```

My Contribution



Ontological structure

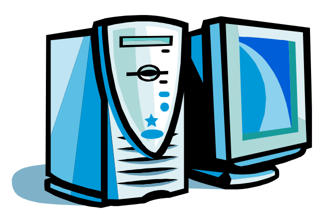
Use ontological engineering to describe formally meaningful information contained in theories

Pedagogical knowledge

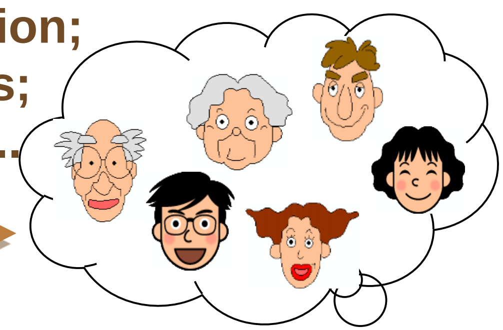
Use ontologies to support the development of ontology-aware systems

Run experimental studies to:

- ➢propose group formation;
- ➢design group activities;
- ➢ estimate benefits, etc..

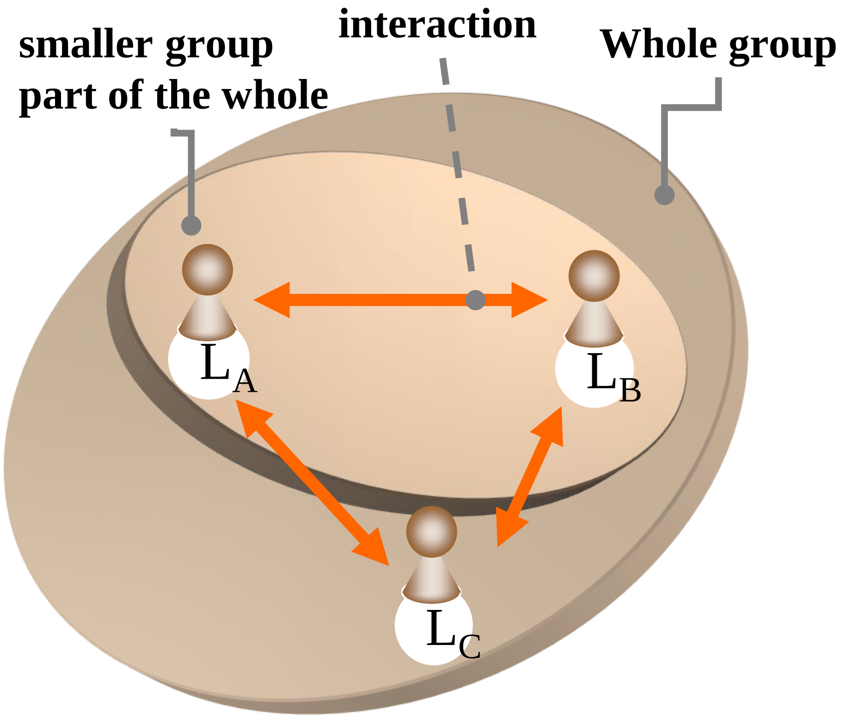


Theory aware intelligent systems

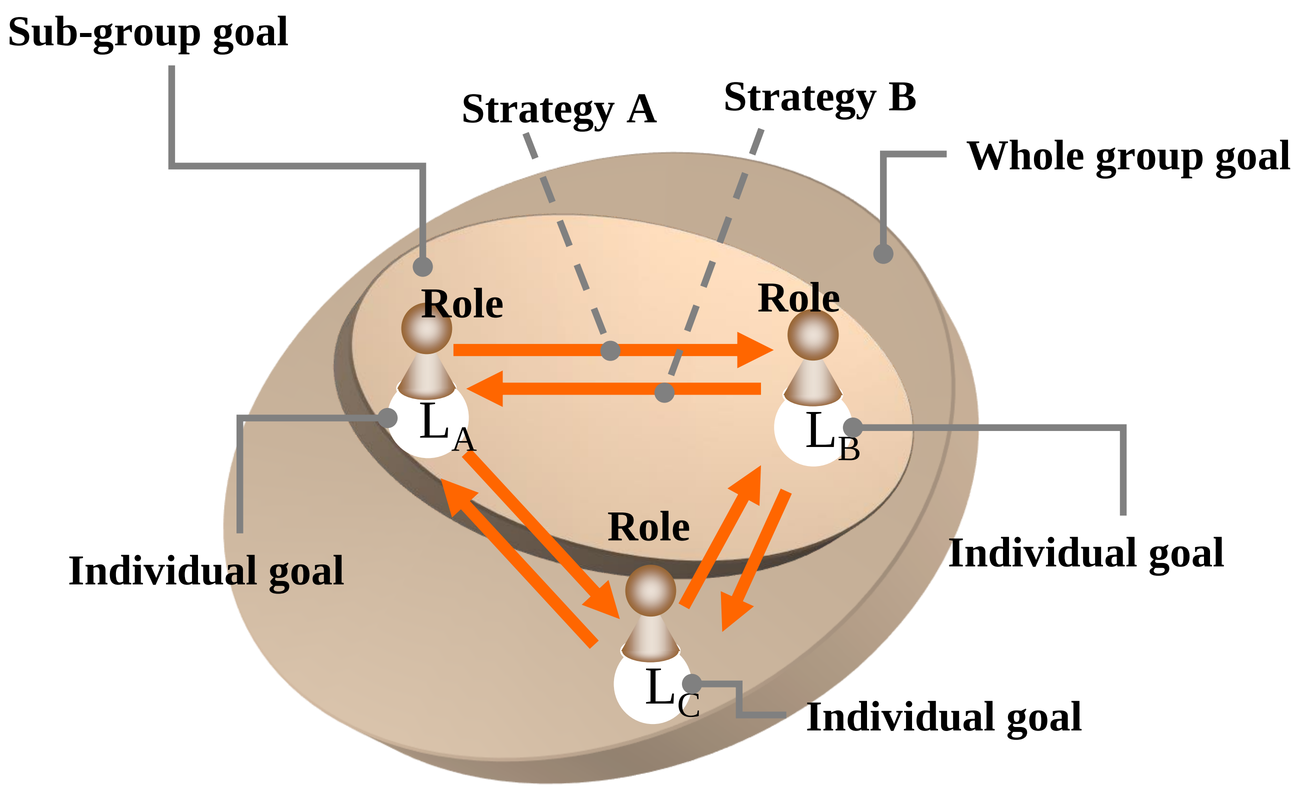


users

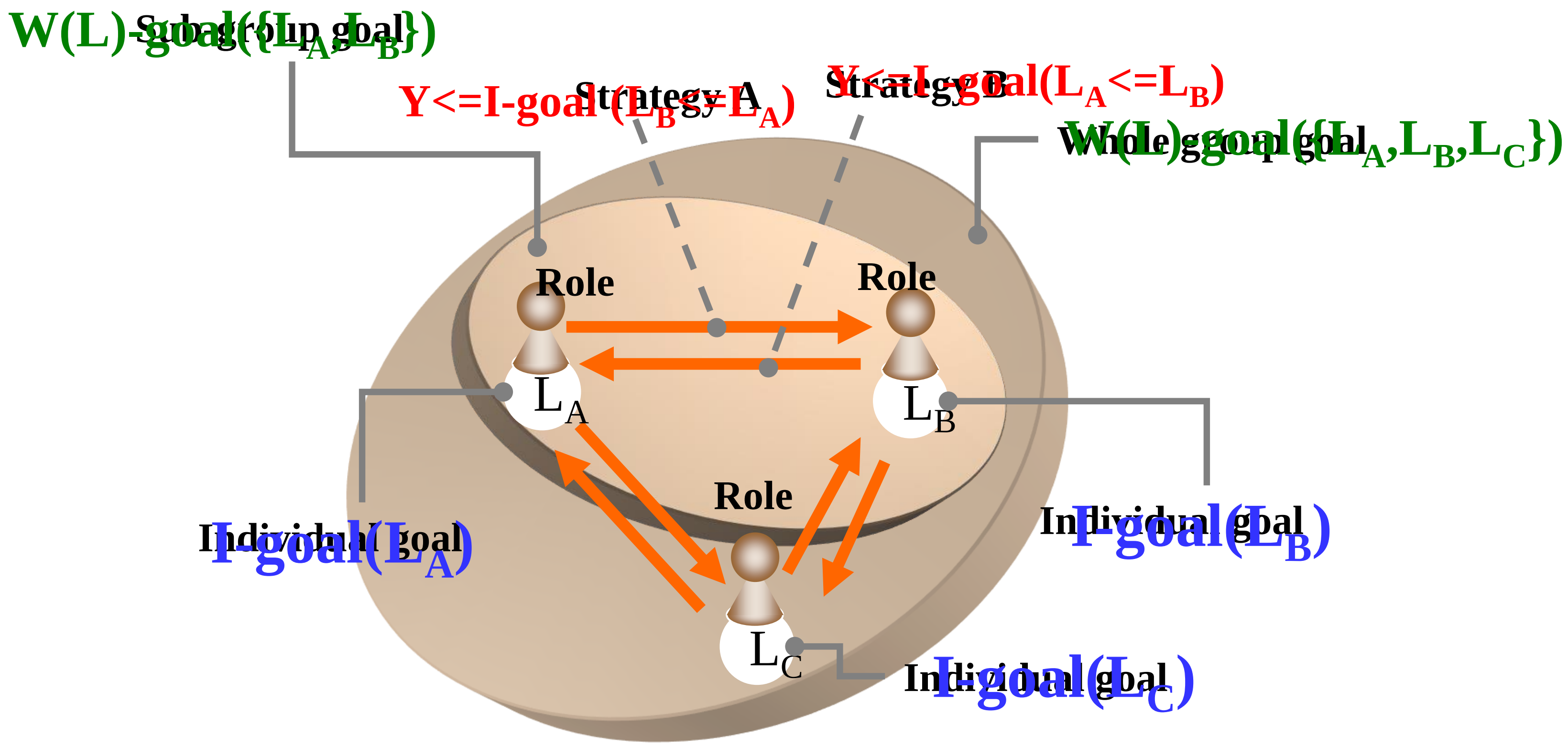
Teachers and students


smaller group
part of the whole
interaction
Whole group
L_A
L_B
L_C

Formalizing Collaborative Learning



Formalizing Collaborative Learning



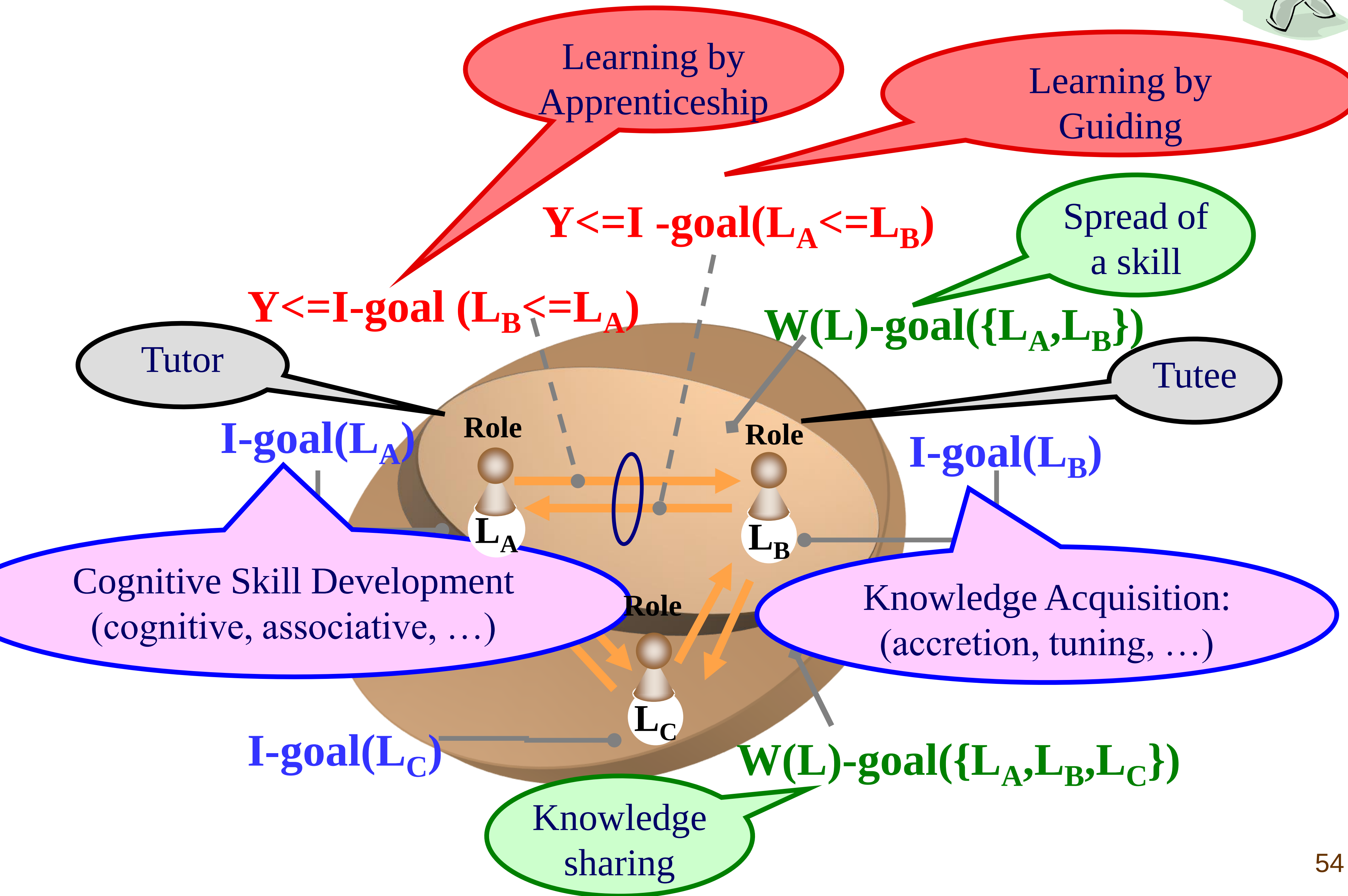
✓Learning Strategies

✓Learning Goals

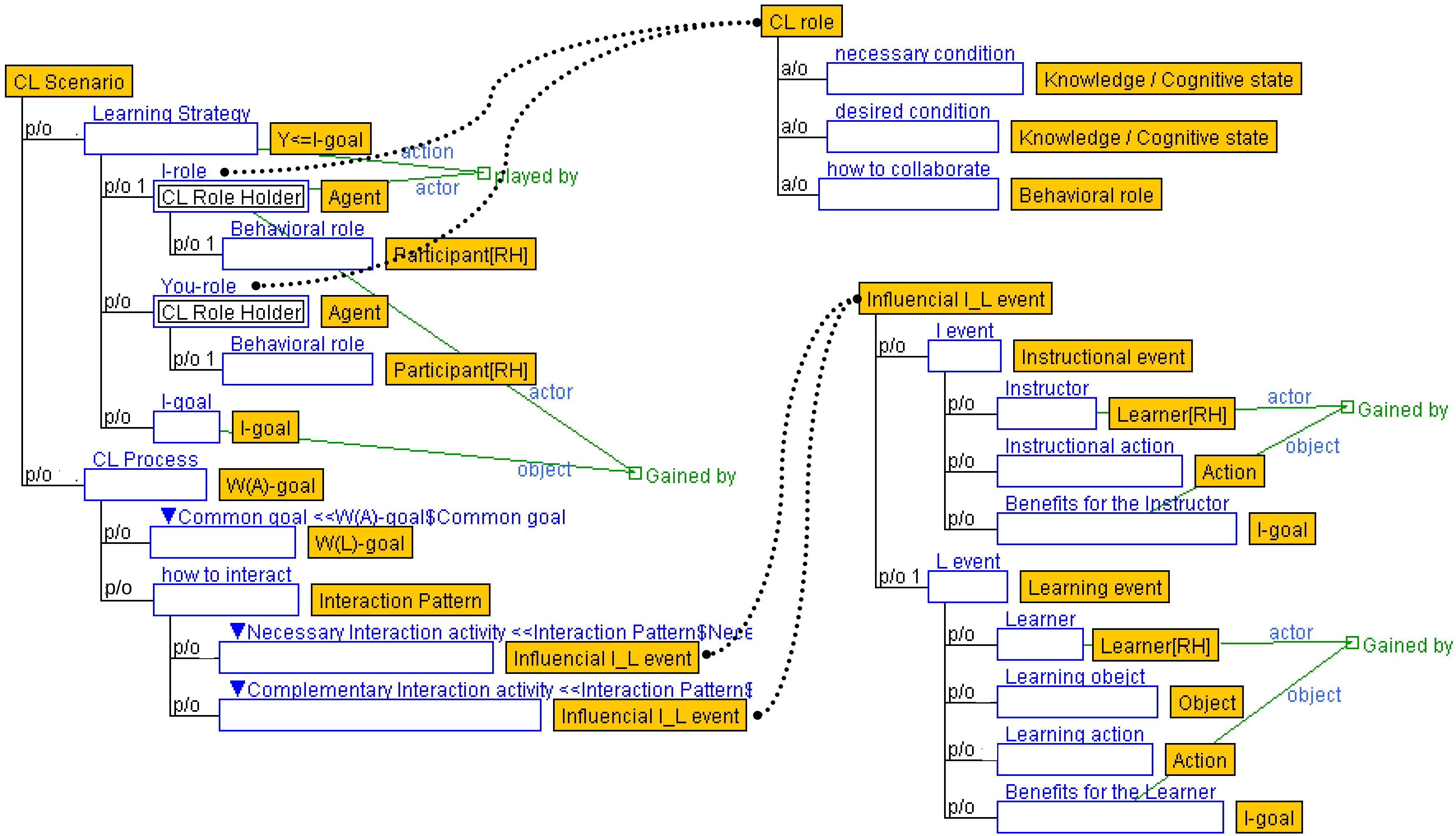
✓Group Goals

✓Roles

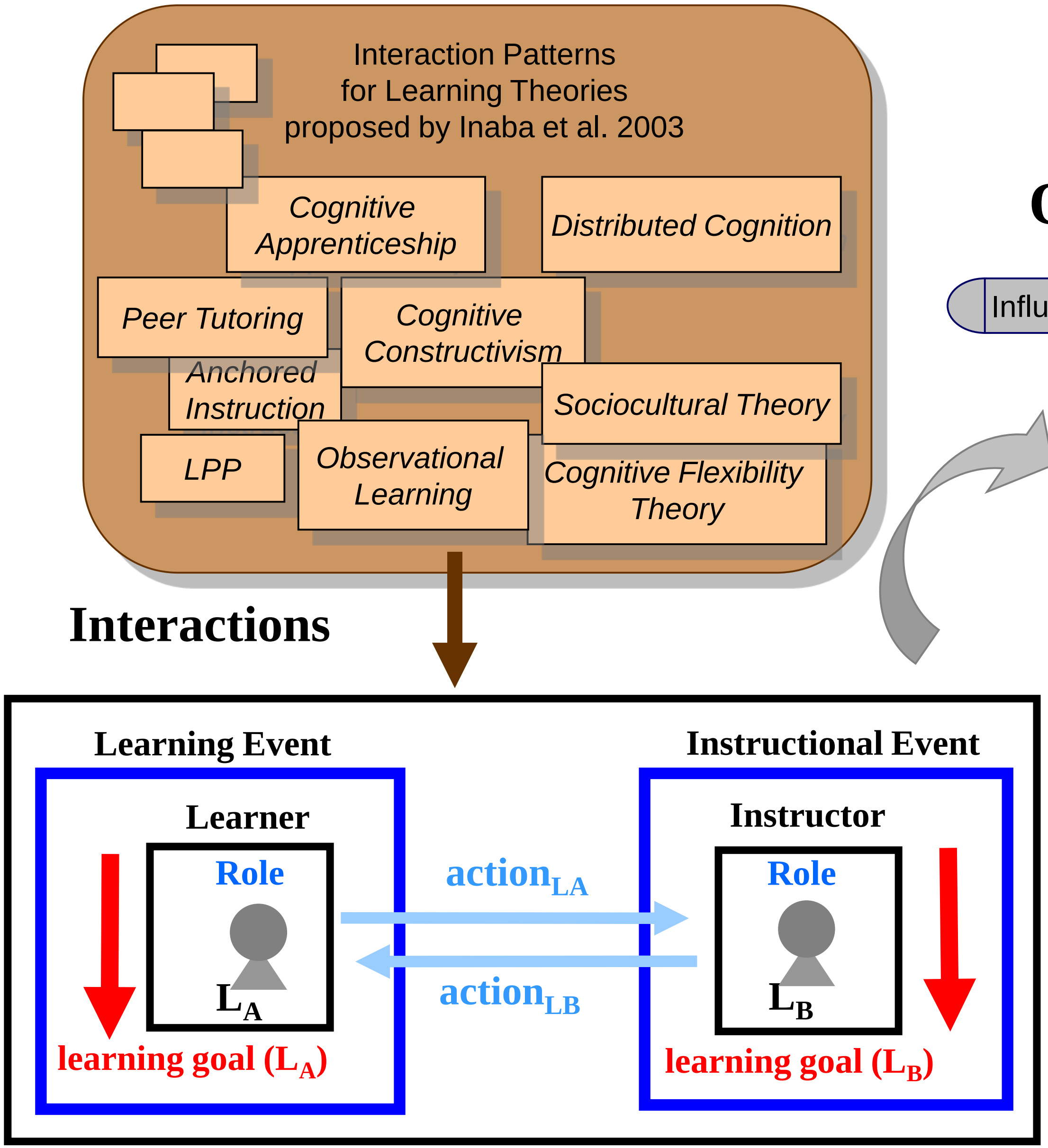
Formalizing Collaborative Learning



Formalizing Collaborative Learning: Ontology

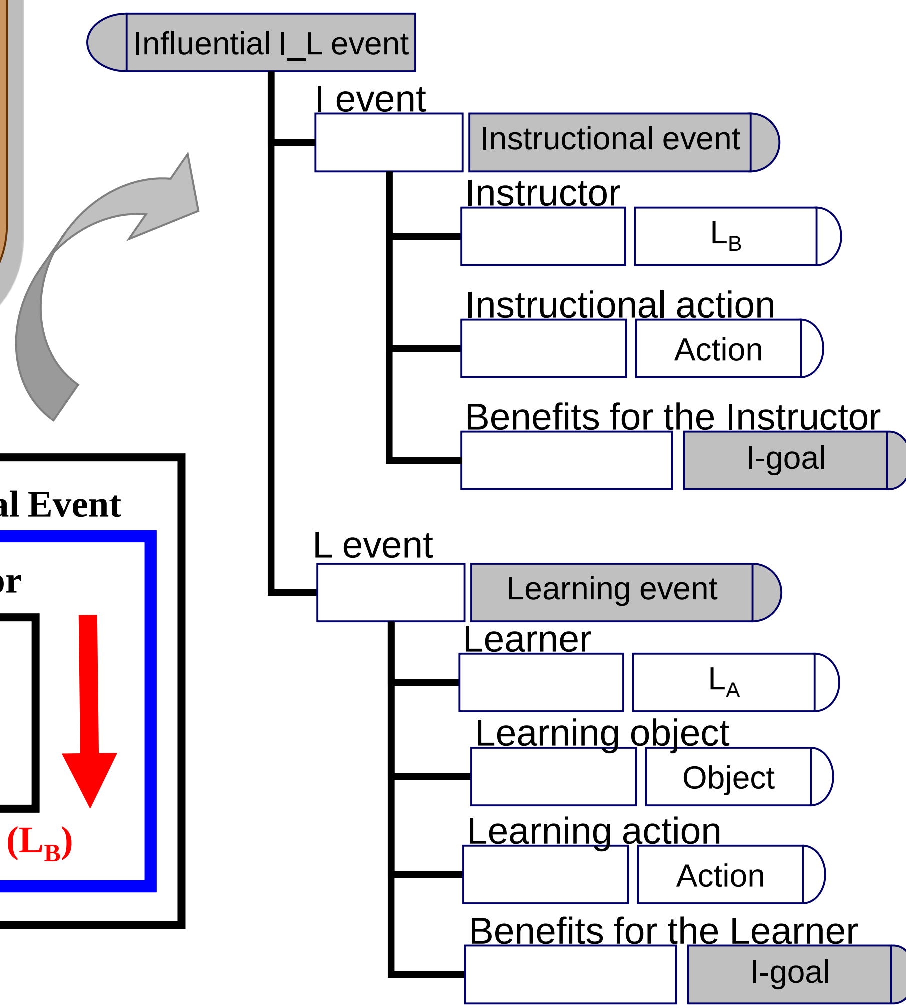


Formalizing Collaborative Learning: Instances



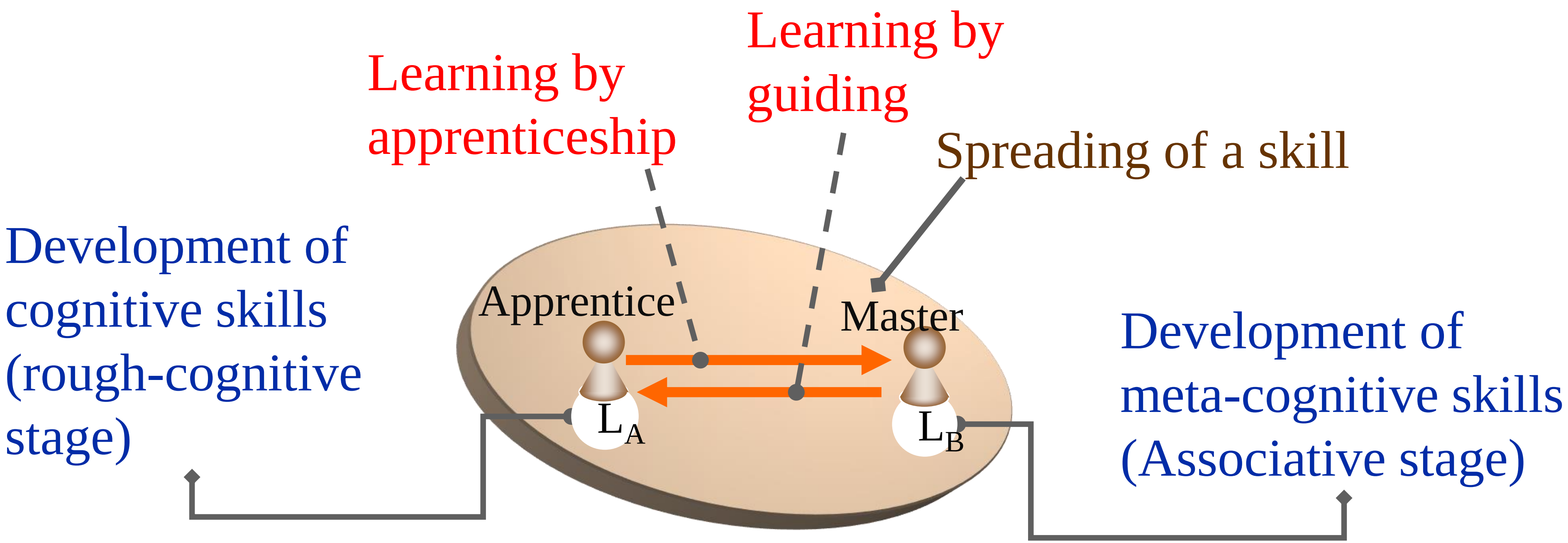
Influential I_L Events

Ontological framework

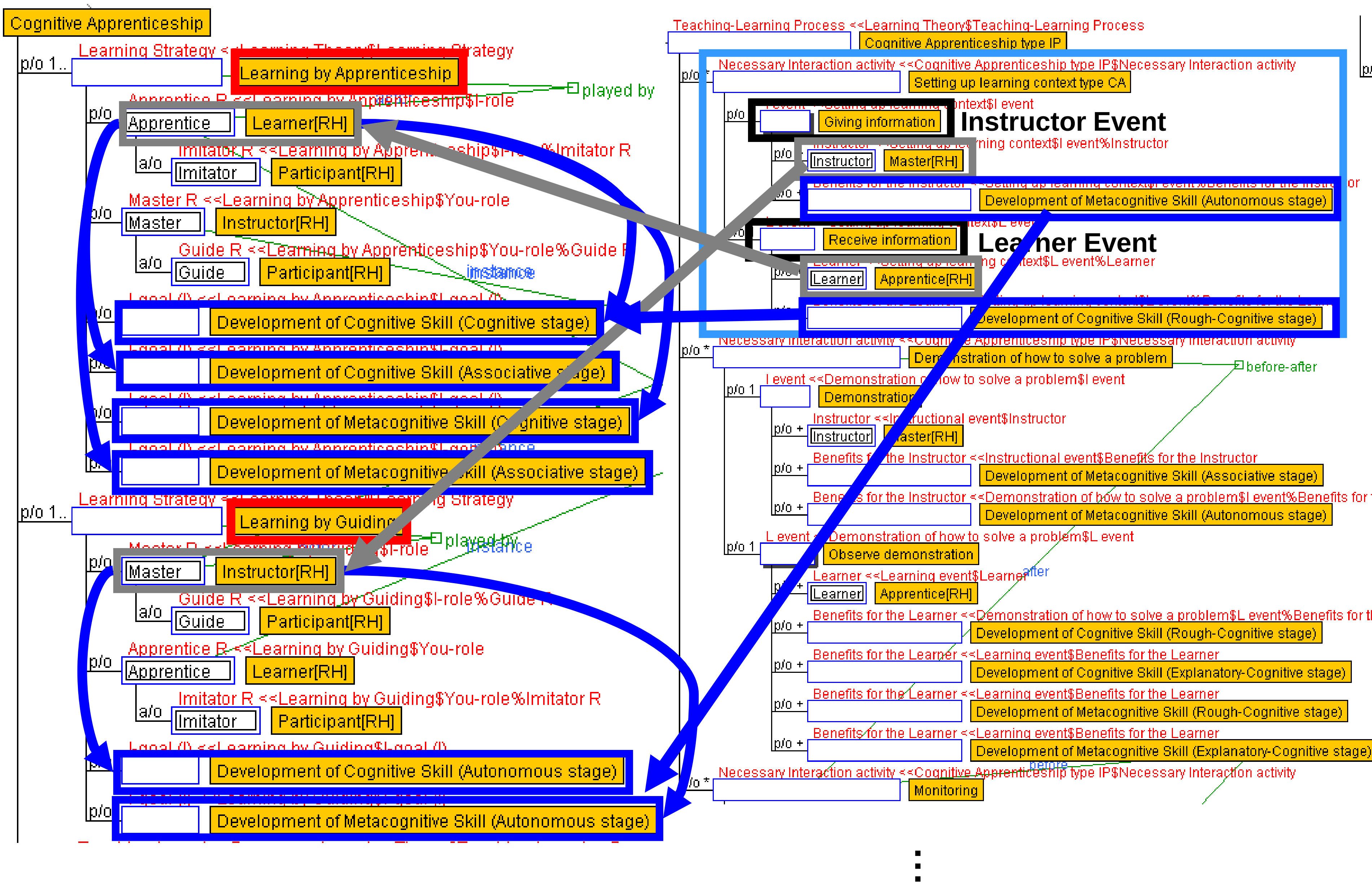


Formalizing Collaborative Learning: Example

Cognitive Apprenticeship Theory



Formalizing Collaborative Learning: Example



Collaborative Learning Ontology

This ontology-based approach solves several problems to formalize and apply pedagogical knowledge[1,2,3]

1. Challco et al. (2016) Gamification of Collaborative Learning Scenarios: Structuring Persuasive Strategies Using Game Elements and Ontologies. Communications in Computer and Information Science, vol 606. Springer, 12-28
2. Hayashi et al (2011) An Ontological Model to Blend Didactic Instruction and Collaborative Learning. Lecture Notes in Computer Science, vol 6969. Springer, Berlin, Heidelberg, 1-13.
3. Isotani et al (2009). An ontology engineering approach to the realization of theory-driven group formation. International Journal of Computer-Supported Collaborative Learning, v. 4, p. 445-478.

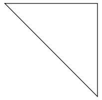
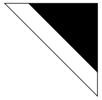
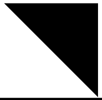
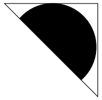
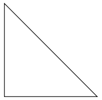
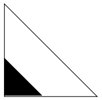
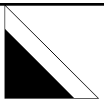
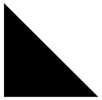
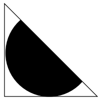
OK. But let's be realistic …

Almost nobody can understand this ontology

Takeaway Message:

1. Take a **real world problem** that is hard to solve
2. **Organize the knowledge** from different sources
3. Build an **ontology**
4. **Hide the ontology** behind a model that (some) people can understand
5. Apply the model and the ontology to **solve the problem**

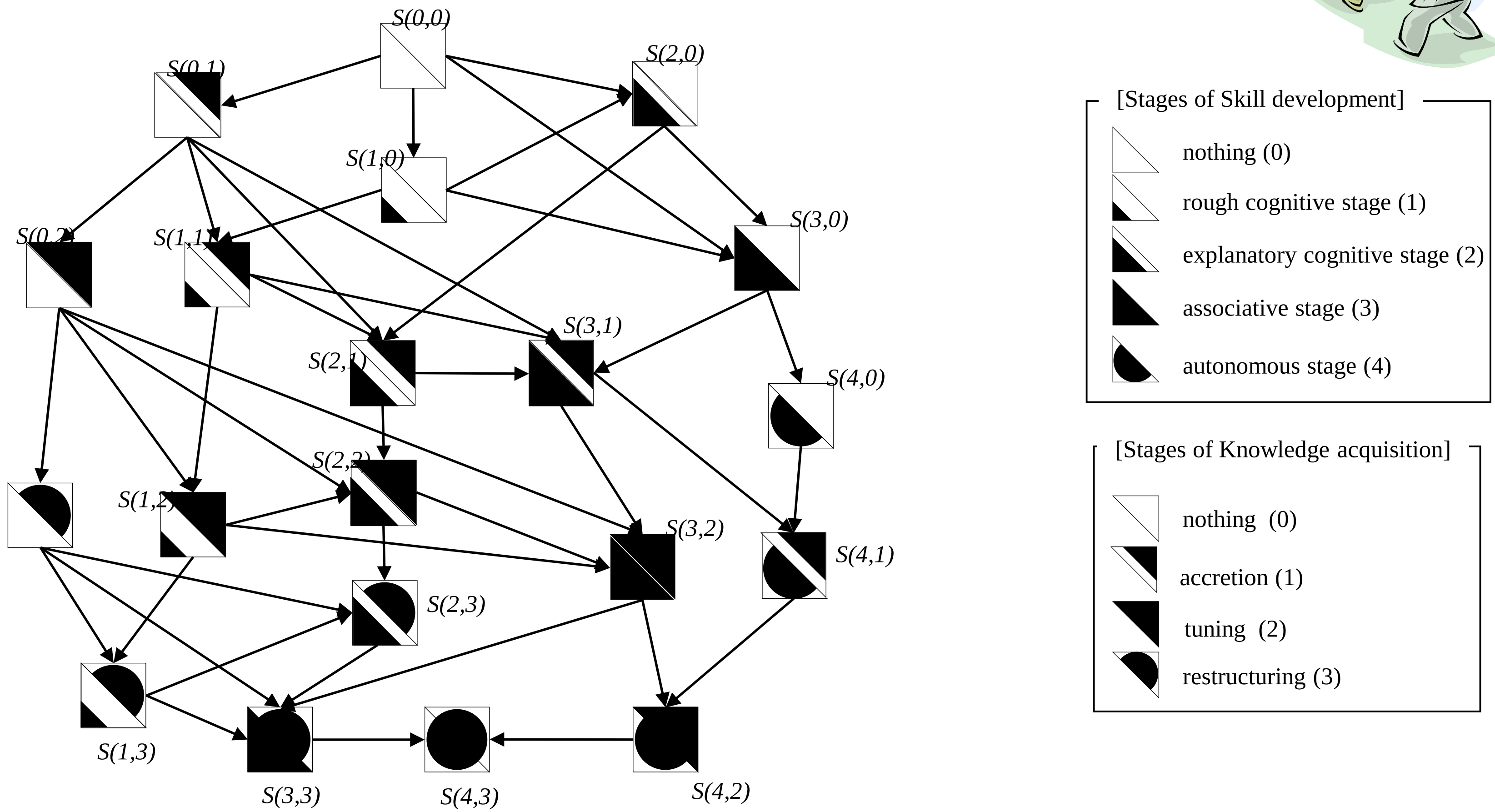
Learner's Growth Model

	I-goal	Graphical Representation
Acquisition of Content-Specific Knowledge		
stage	Nothing	
	Accretion	
	Tuning	
	Restructuring	
Development of Skills		
stage	Nothing	
	Rough-cognitive	
	Explanatory-Cognitive	
	Associative	
	Autonomous	

[Rumelhart D.E. and Norman, D.A., 1978]

[Anderson, J. 1982]

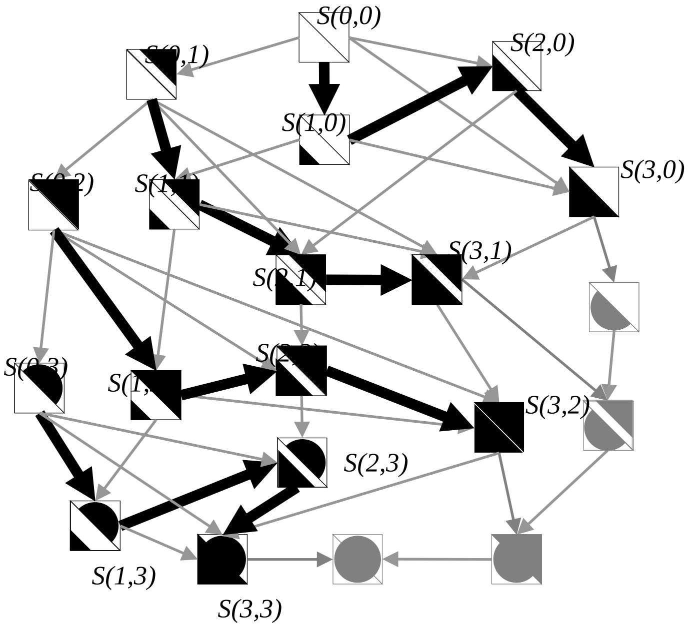
Learner's Growth Model (LGM)



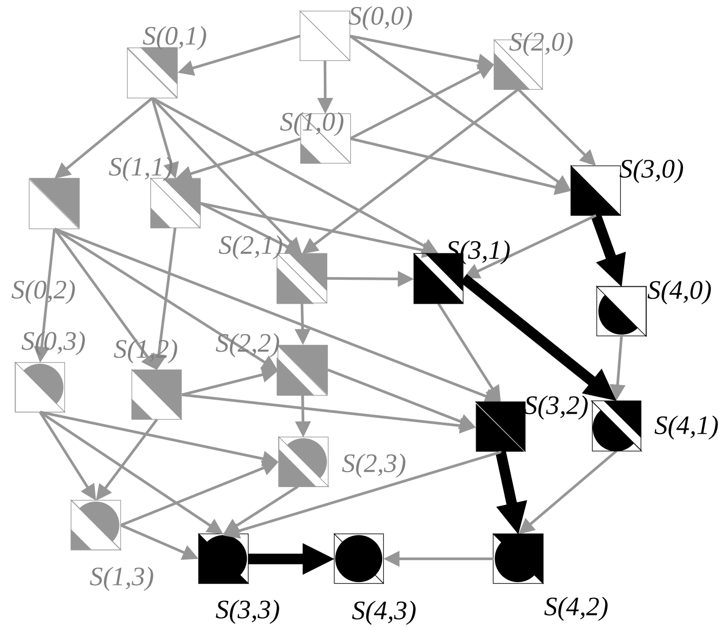
LGM is a graph that represents all possible transitions in learner's development

A learning theory shows some possible transitions in the LGM graph

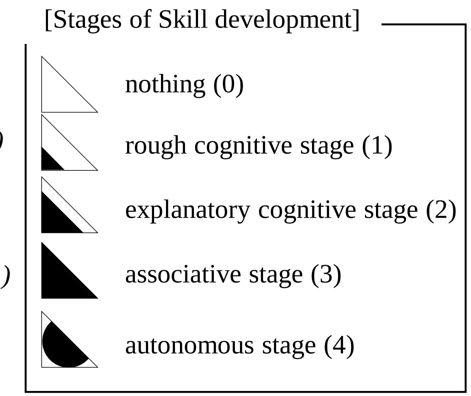
Facilitating Visualization with LGM

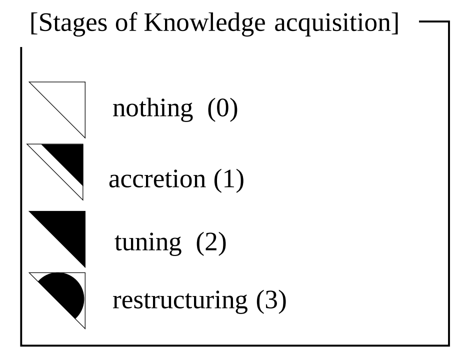


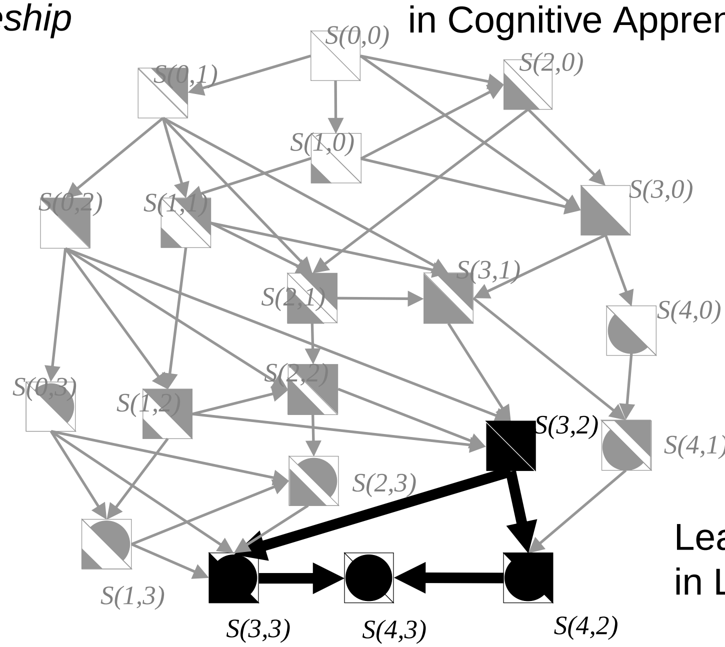
learning by apprenticeship
in *Cognitive Apprenticeship*



learning by guiding
in Cognitive Apprenticeship

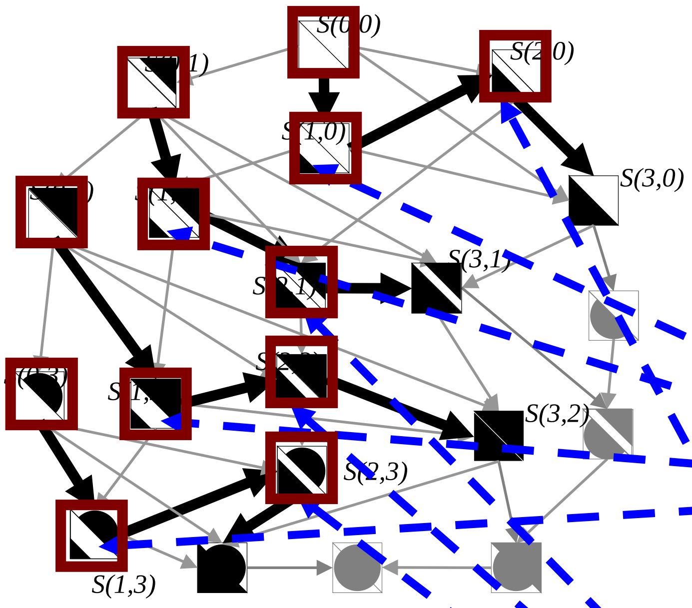


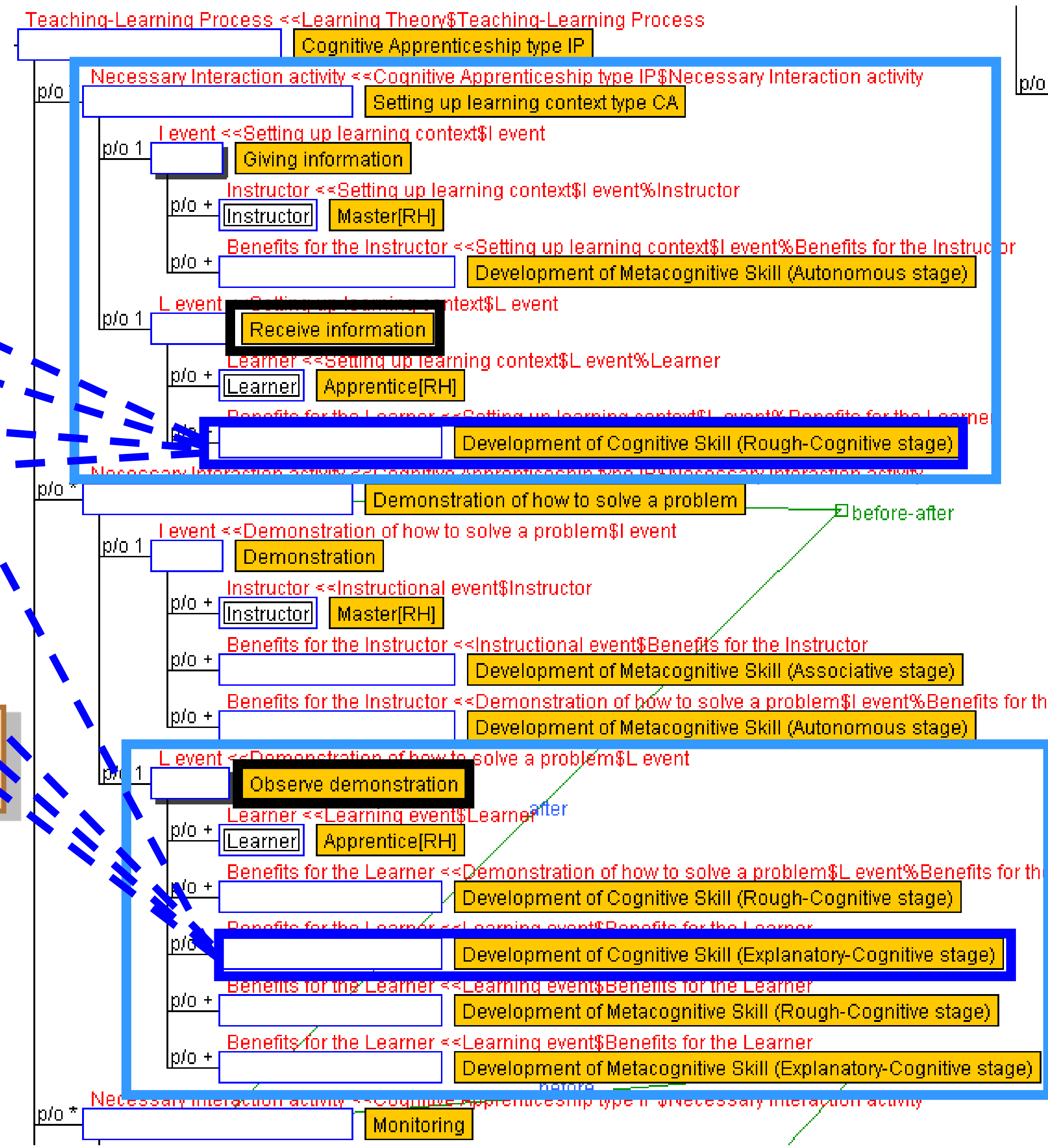




Learning by Discussion
in Legitimate Peripheral Participant (LPP)

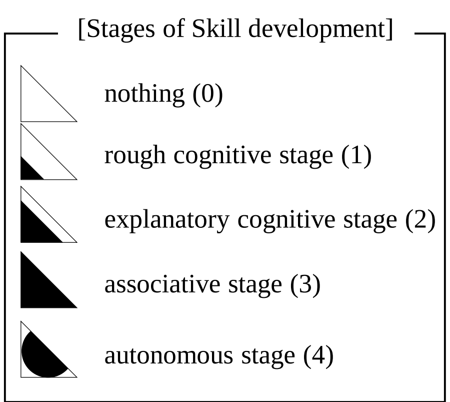
Facilitating Visualization with LGM





learning by apprenticeship
in *Cognitive Apprenticeship*

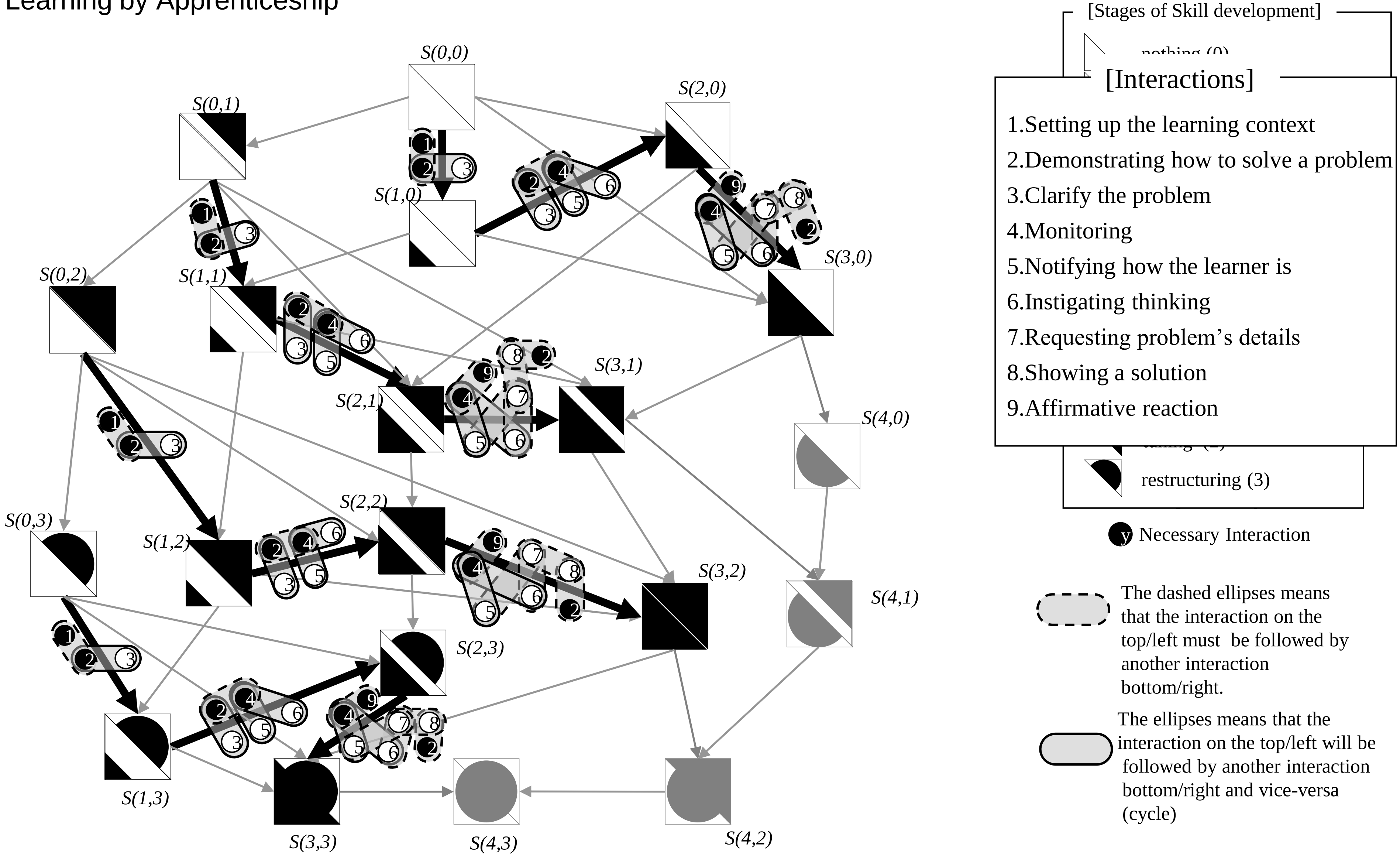
Learner plays an *apprentice role*
following the *learning events*



GMIP: Growth model improved by Interaction Patterns

Cognitive Apprenticeship

Learning by Apprenticeship

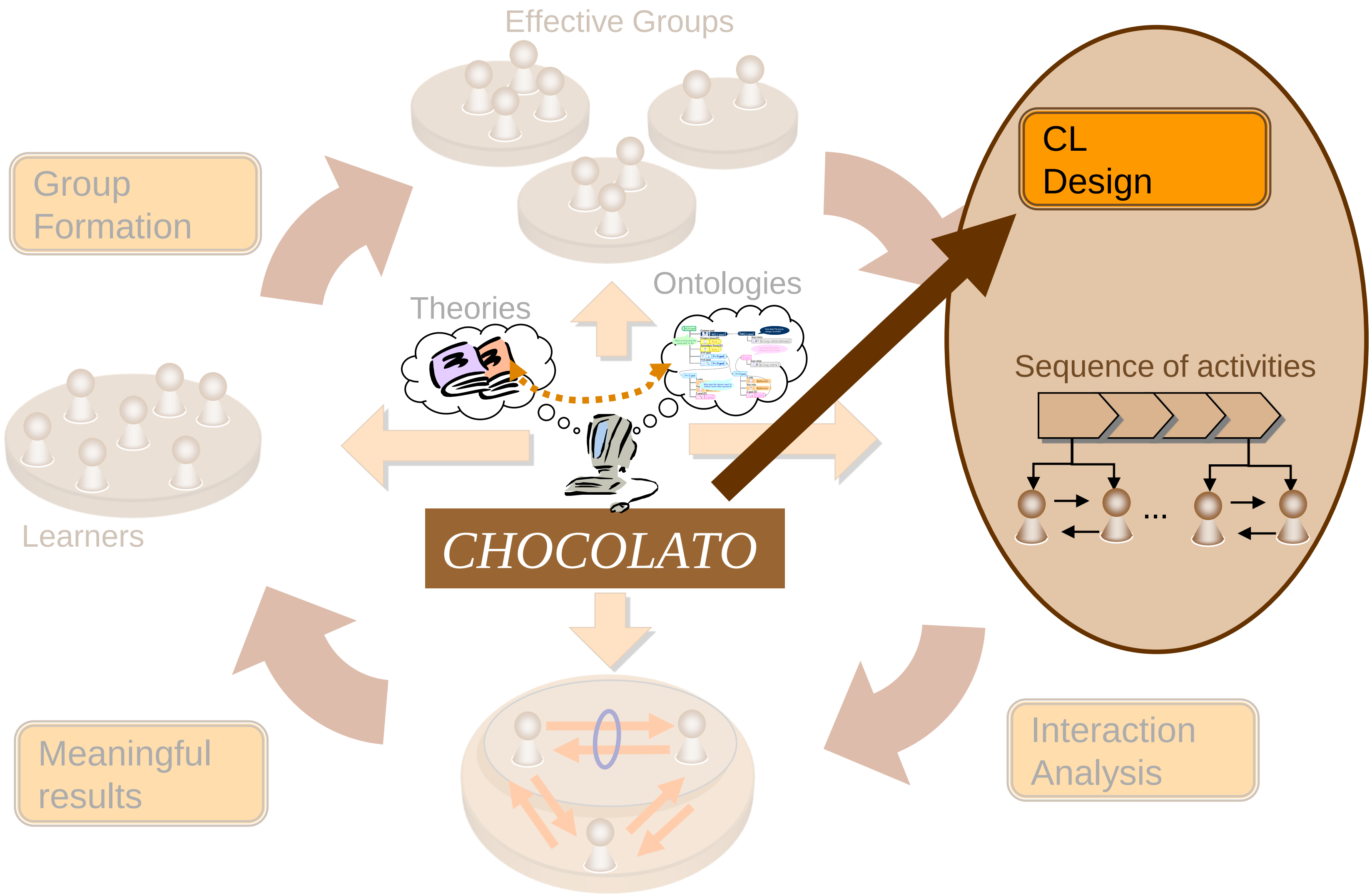


GMIP: Growth model improved by Interaction Patterns

The model offers a solution to create theory-aware tools that help to design CL activities[1,2]

1. Challco et al. (2016) Toward A Unified Modeling of Learner's Growth Process and Flow Theory. Educational Technology & Society 19(2): 215-227
2. Isotani et al. (2010)The foundations of a theory-aware authoring tool for CSCL design. Computers and Education, v. 54, p. 809-834.

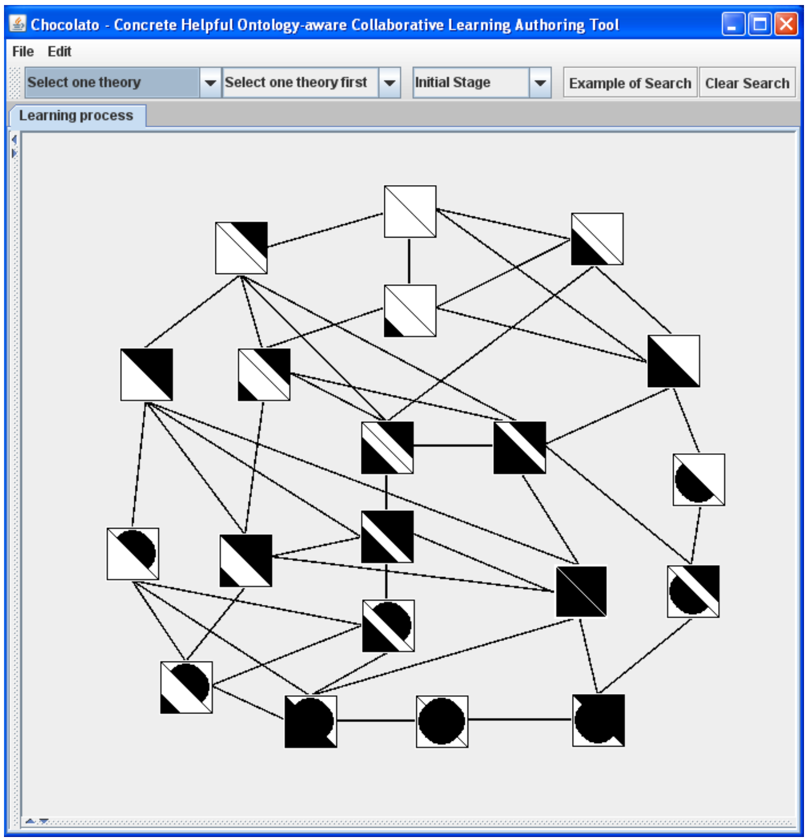
CHOCOLATO: Concrete and Helpful Ontology-aware Collaborative Learning Authoring Tool

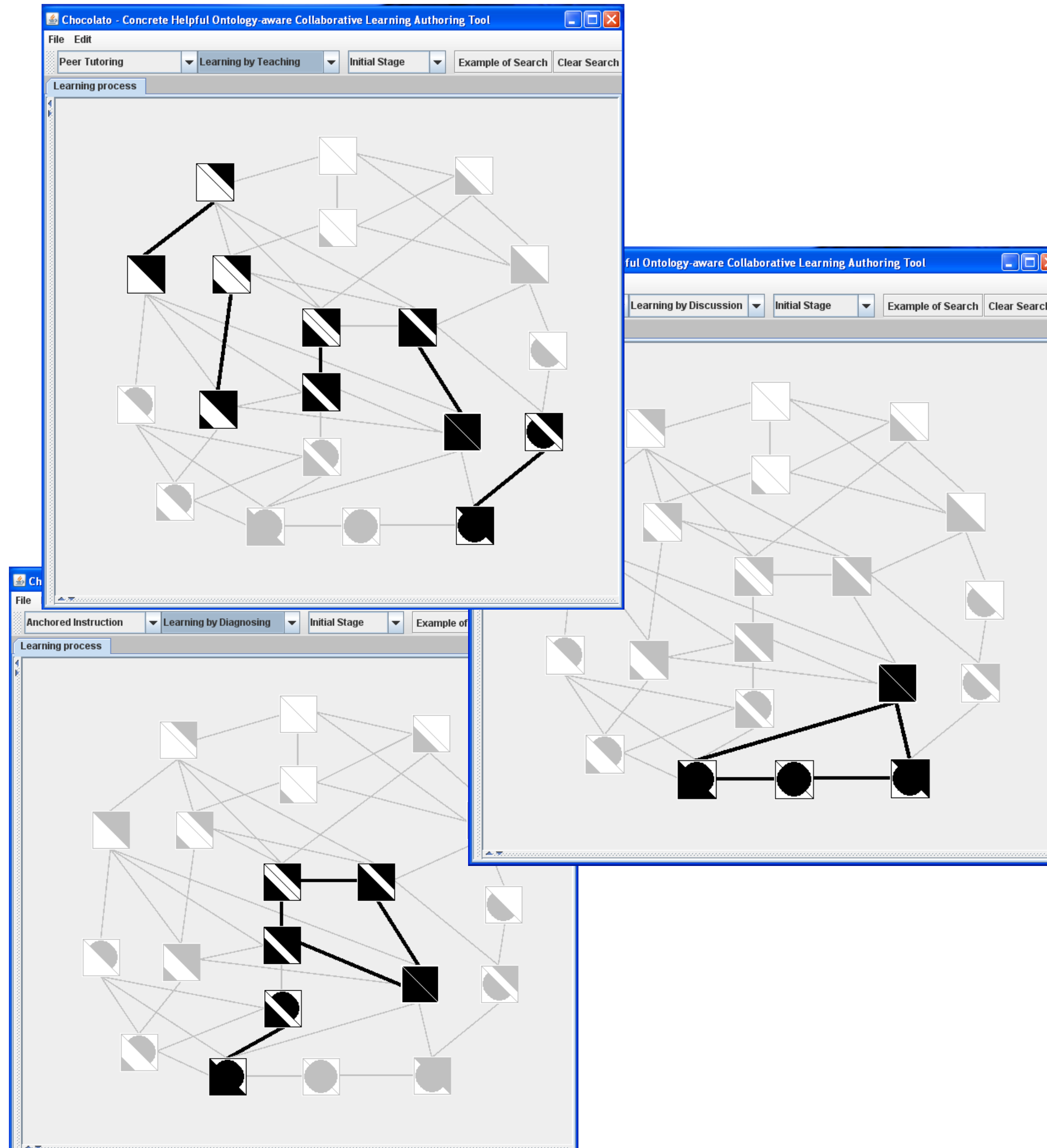


MARI – Main Adaptive Representation Interface

Path of different theories

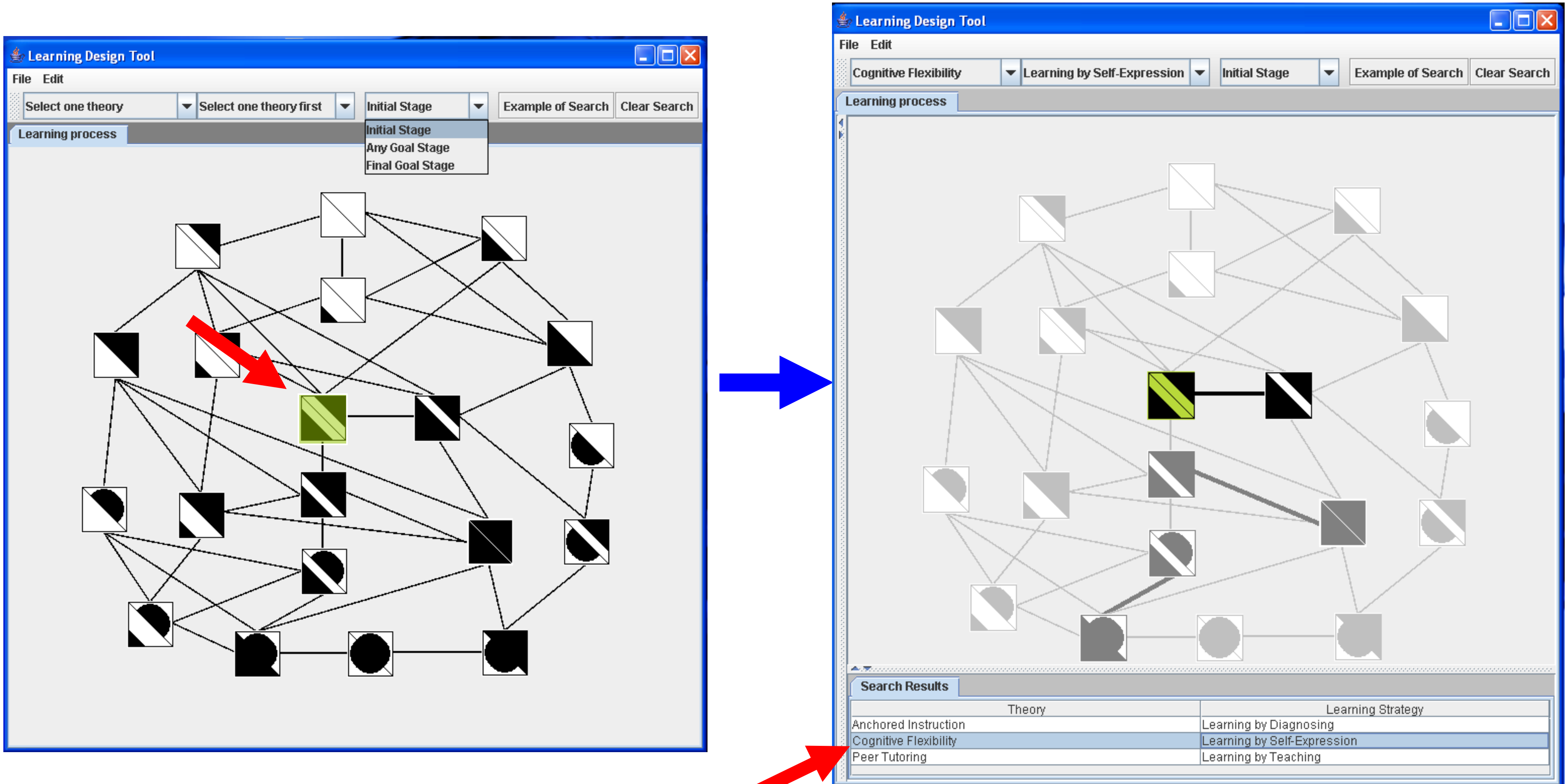
MARI
Main Adaptive Representation Interface





MARI – Main Adaptive Representation Interface

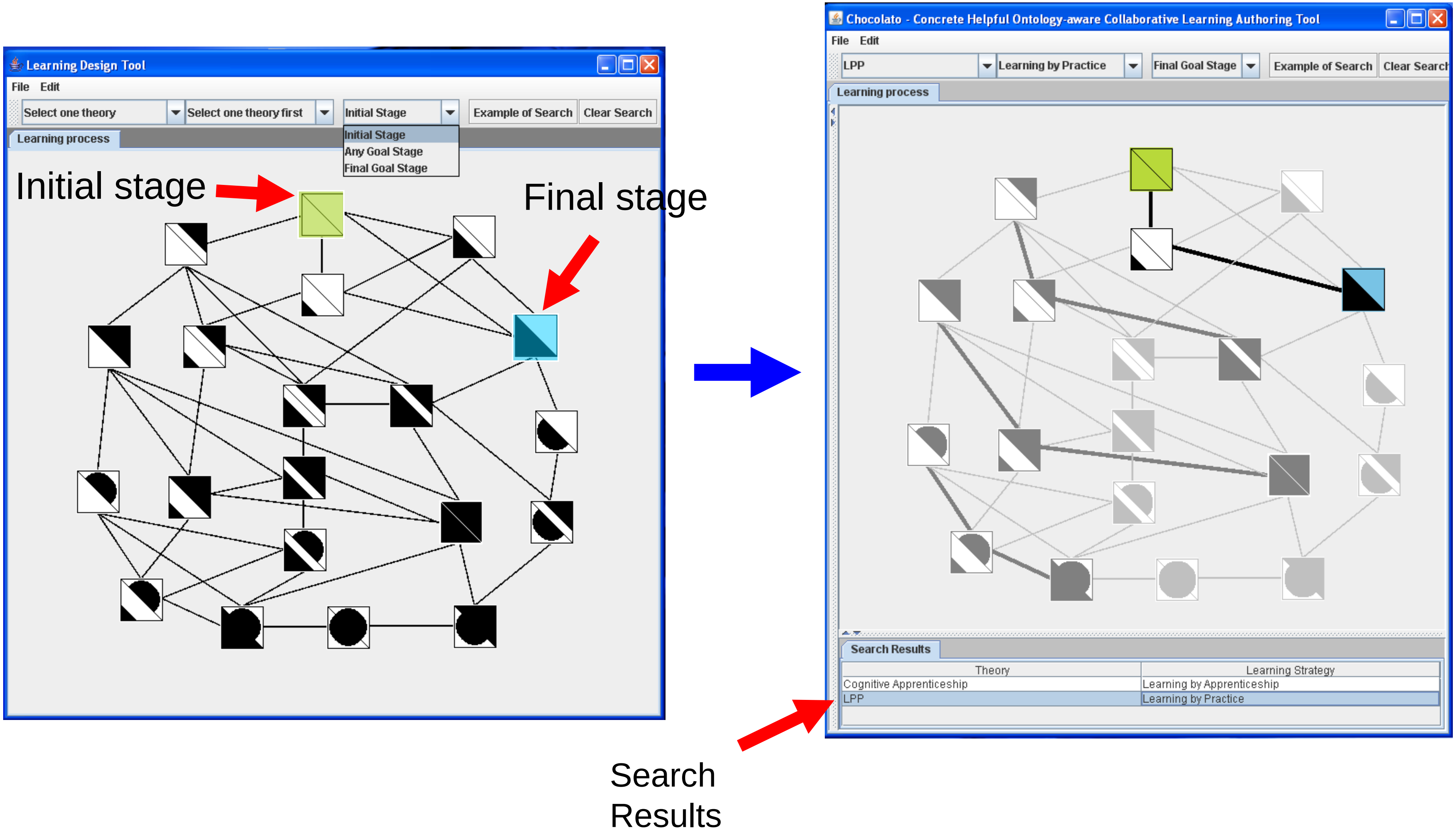
Search for theories



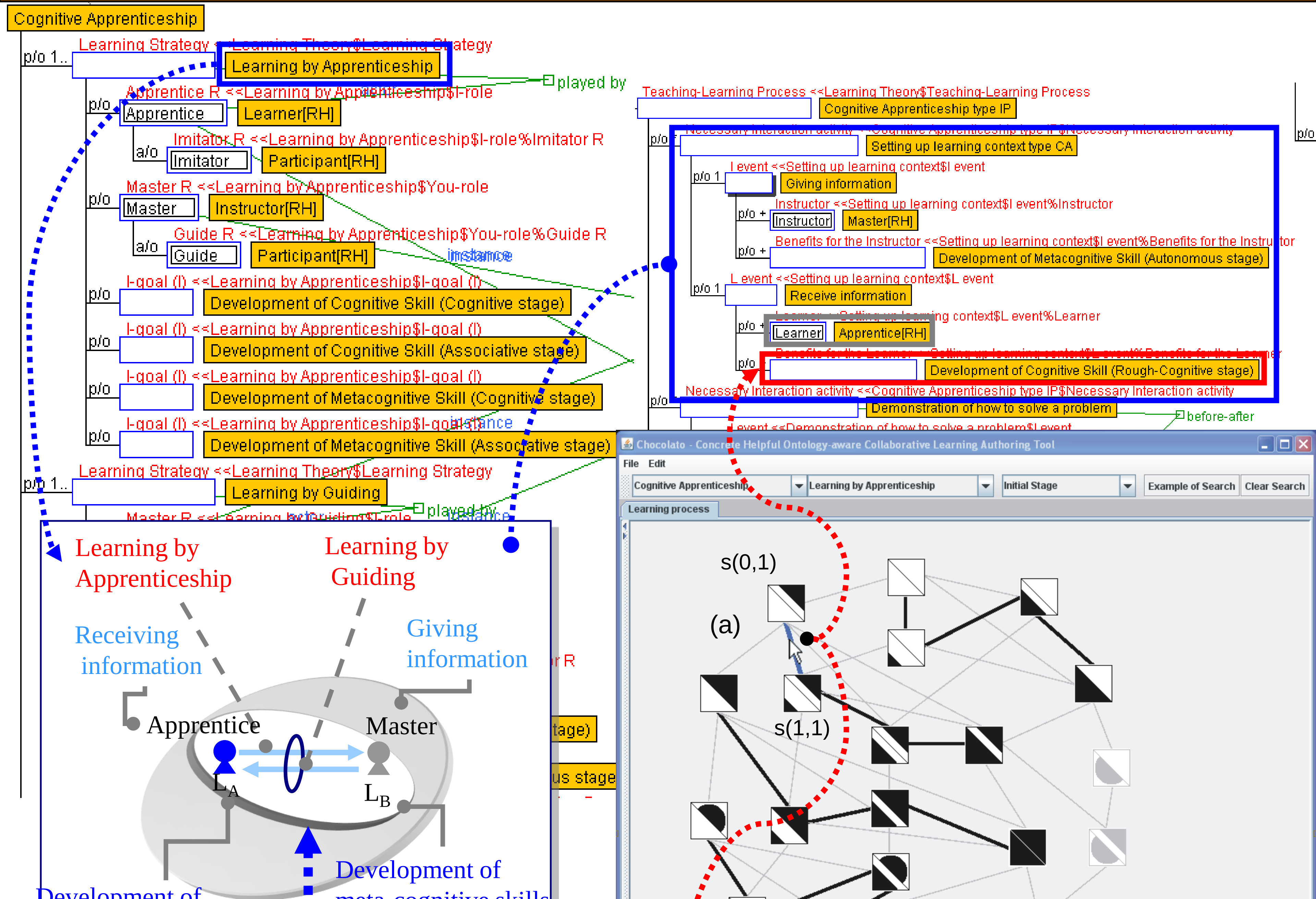
Search
Results

MARI – Main Adaptive Representation Interface

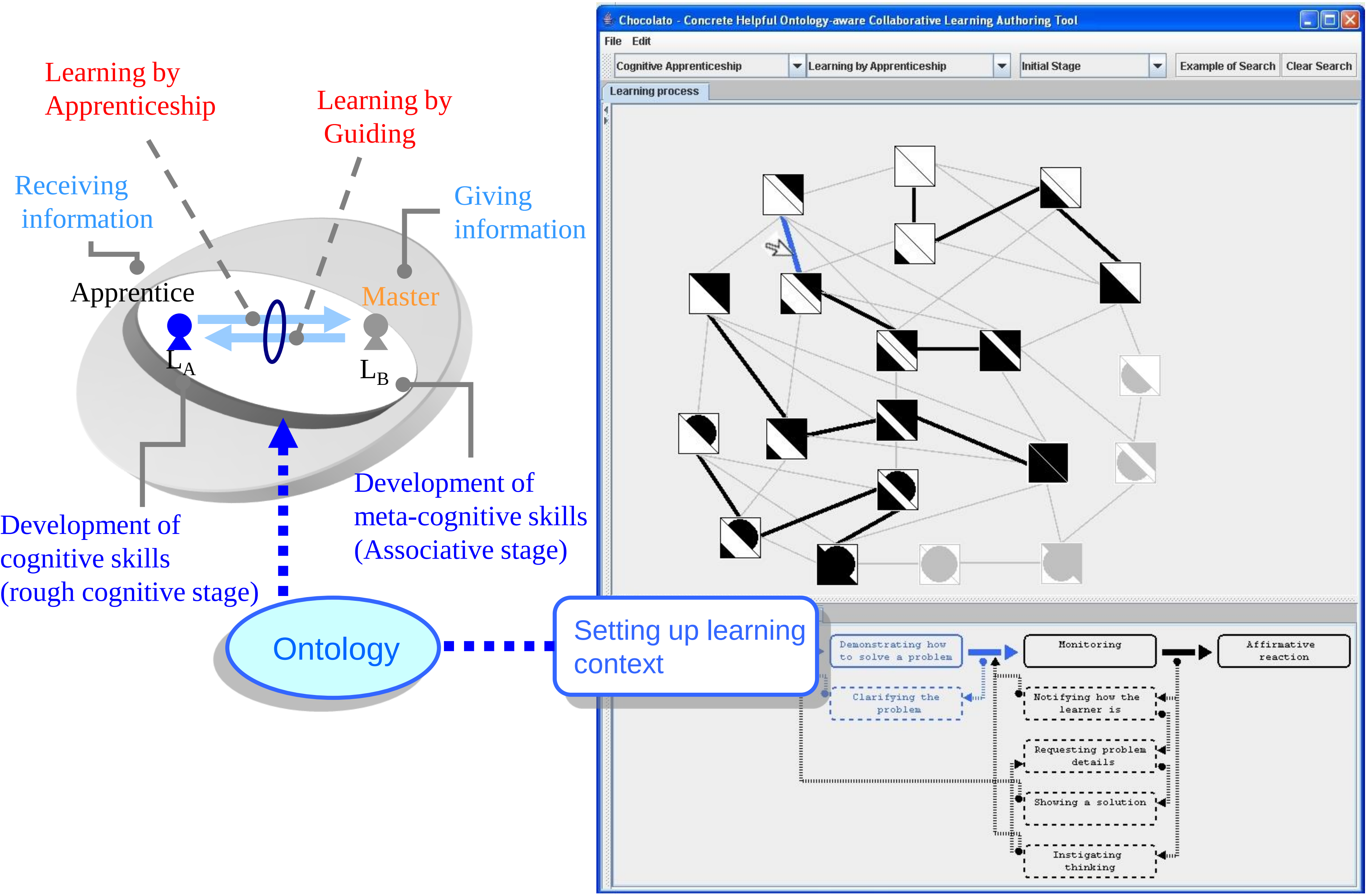
Search for theories



MARI – Main Adaptive Representation Interface



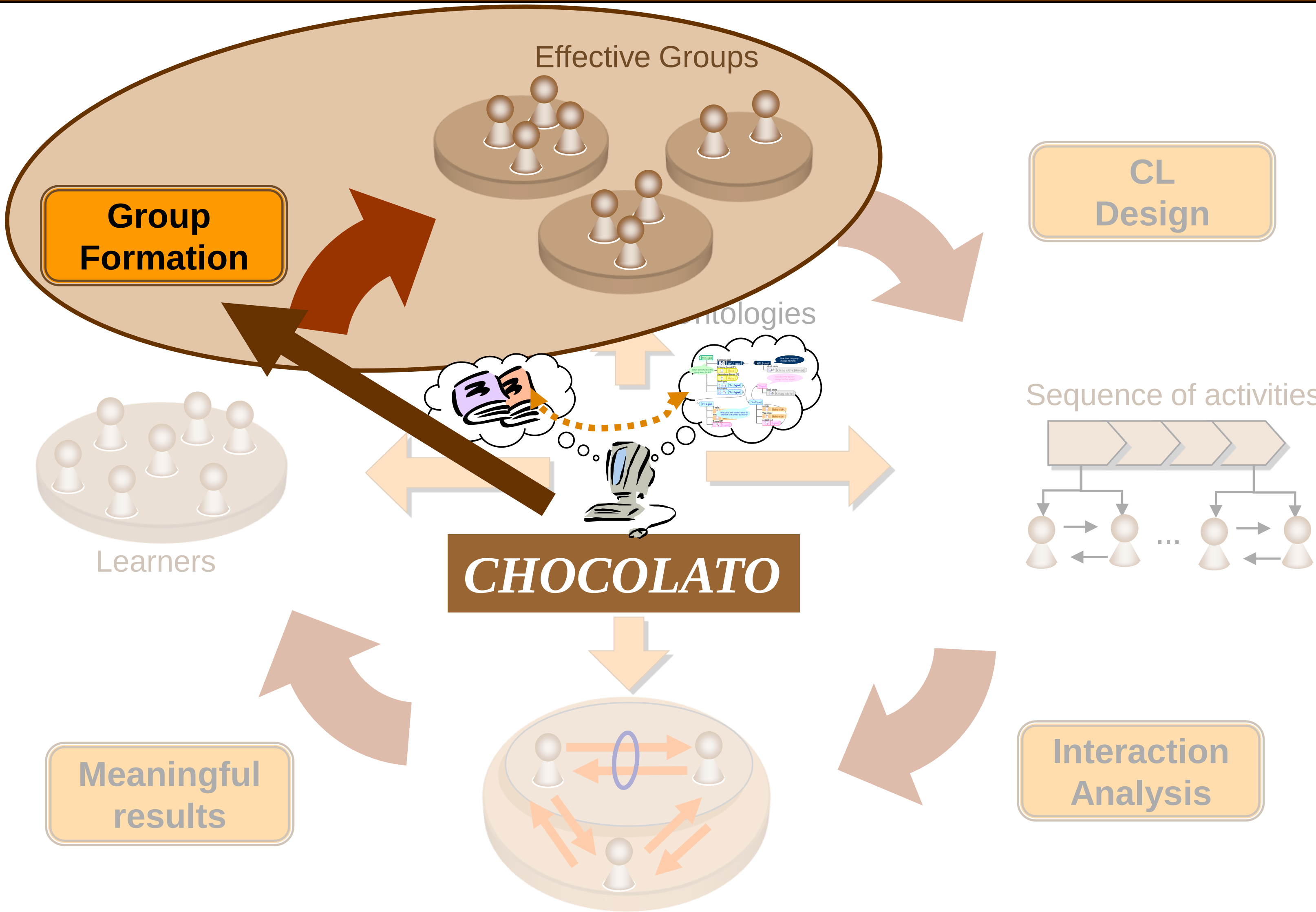
MARI – Main Adaptive Representation Interface



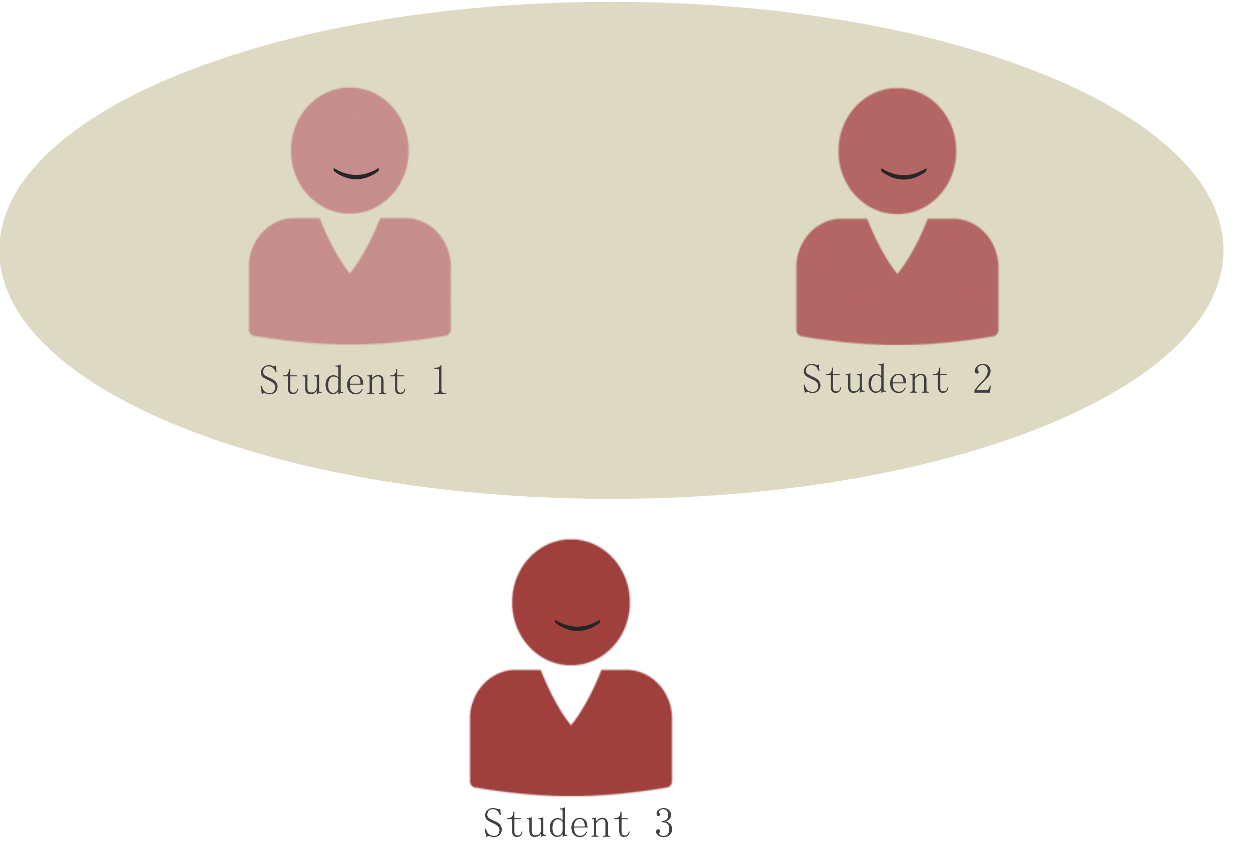
Takeaway Message:

1. Take a **real world problem** that is hard to solve
2. **Organize the knowledge** from different sources
3. Build an **ontology**
4. **Hide the ontology** behind a model that (some) people can understand
5. Apply the model and the ontology to **solve the problem**

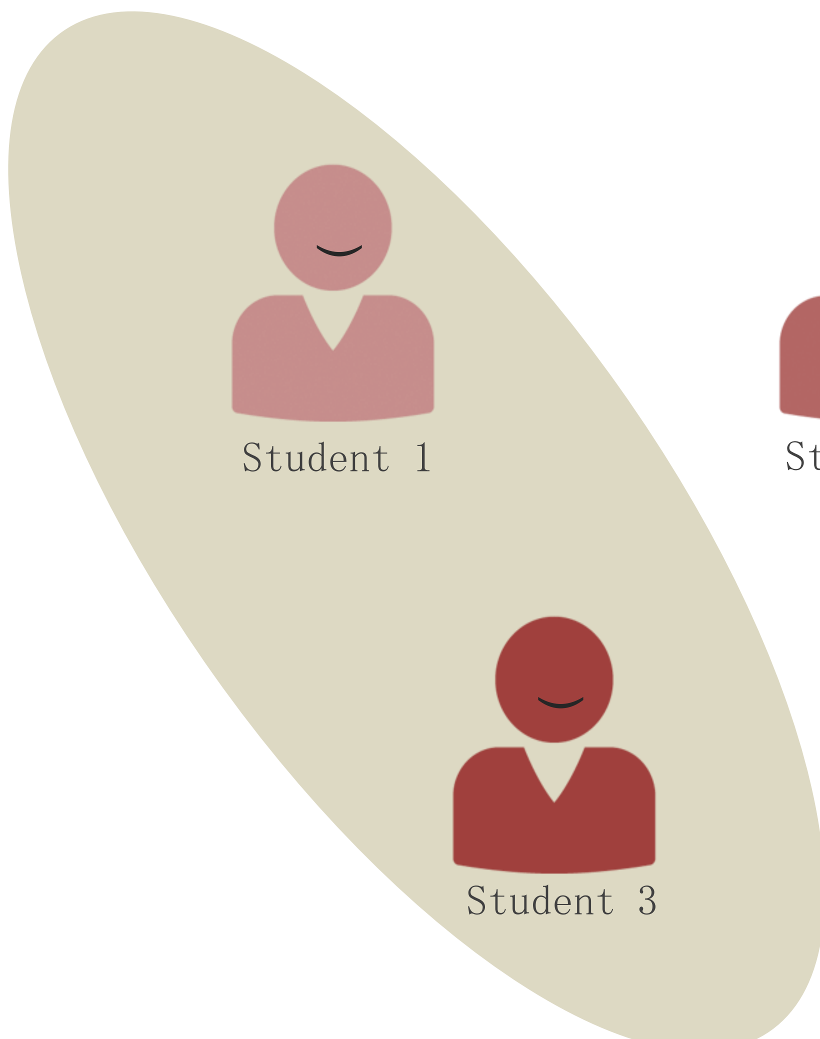
CHOCOLATO: Concrete and Helpful Ontology-aware Collaborative Learning Authoring Tool



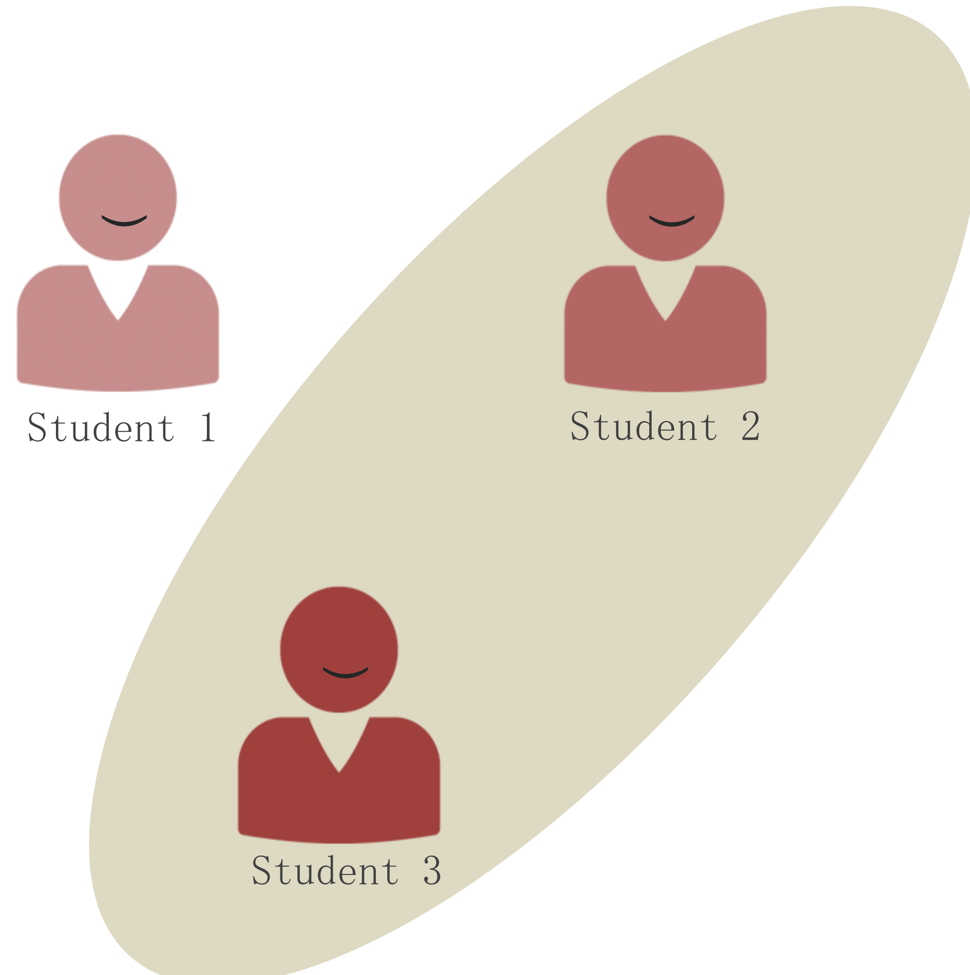
How to group students?



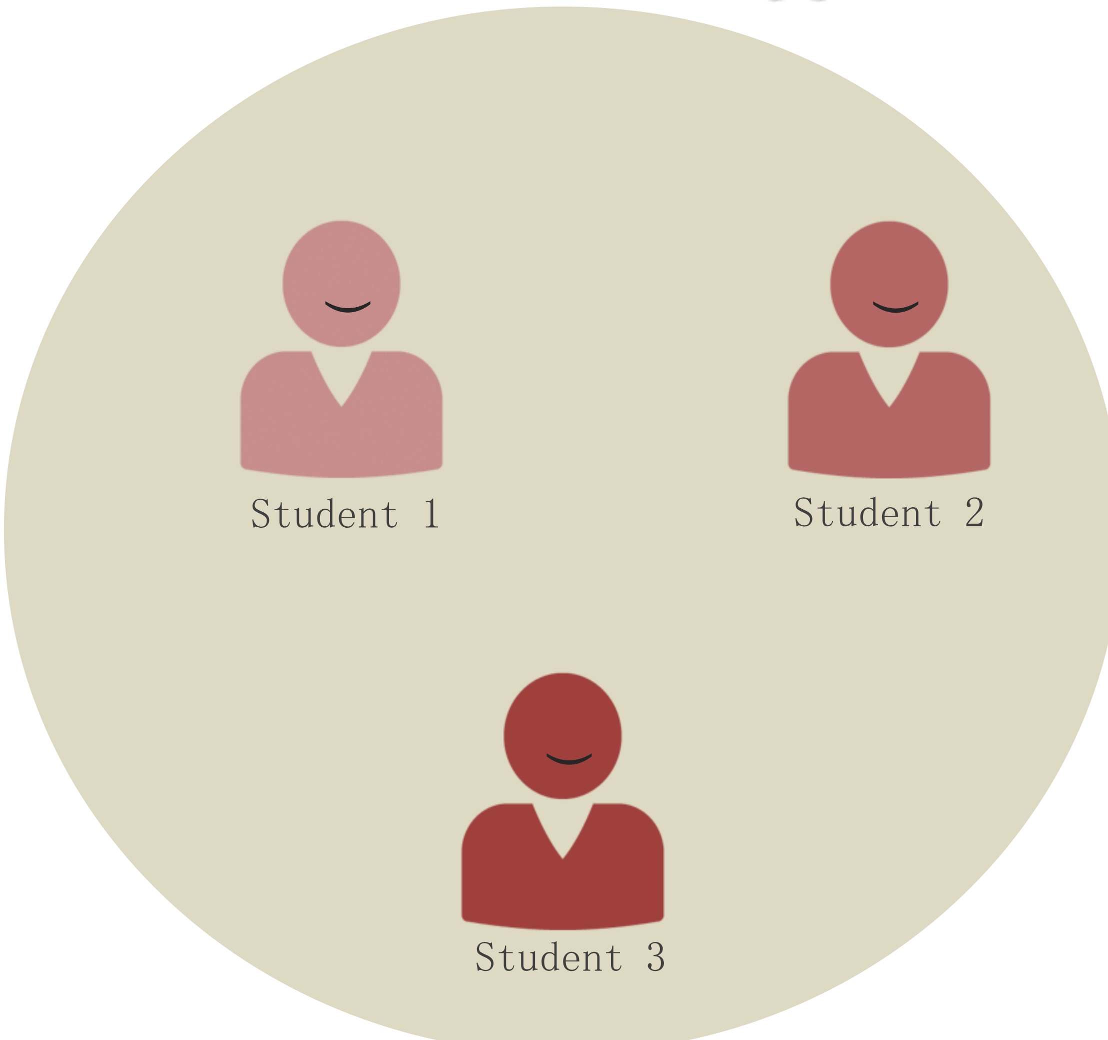
How to group students?



How to group students?

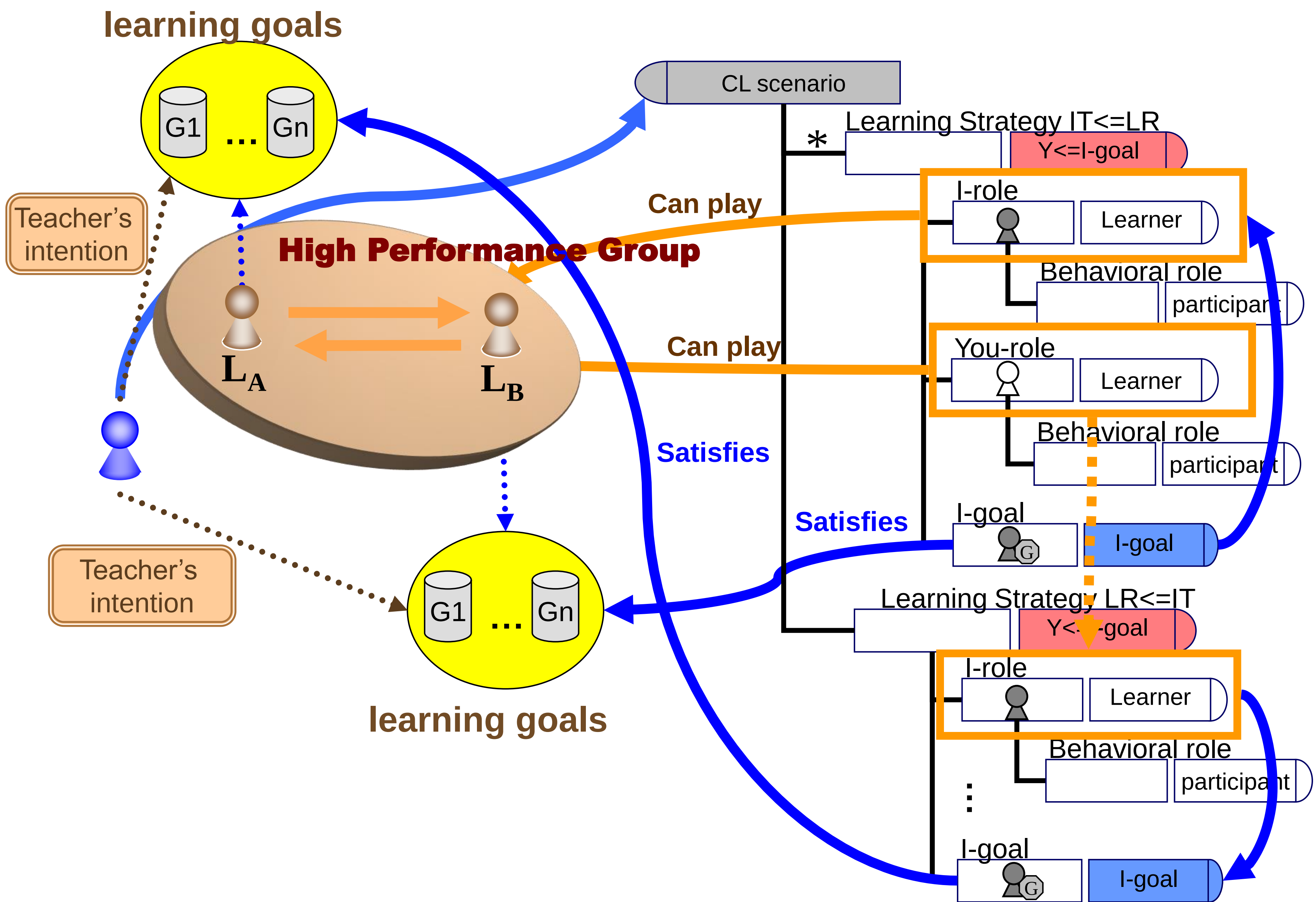


How to group students?

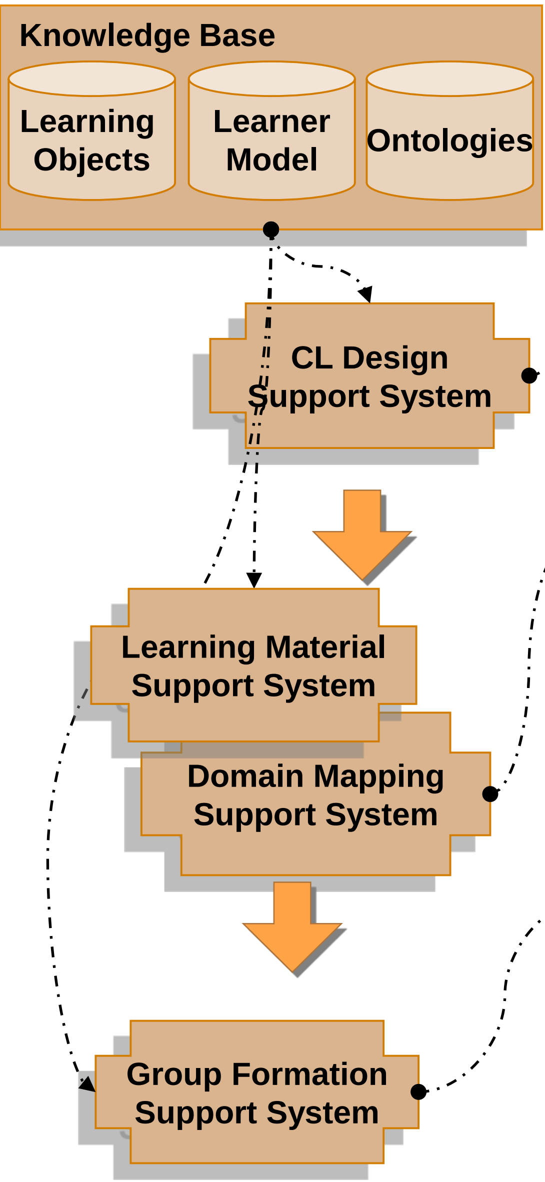


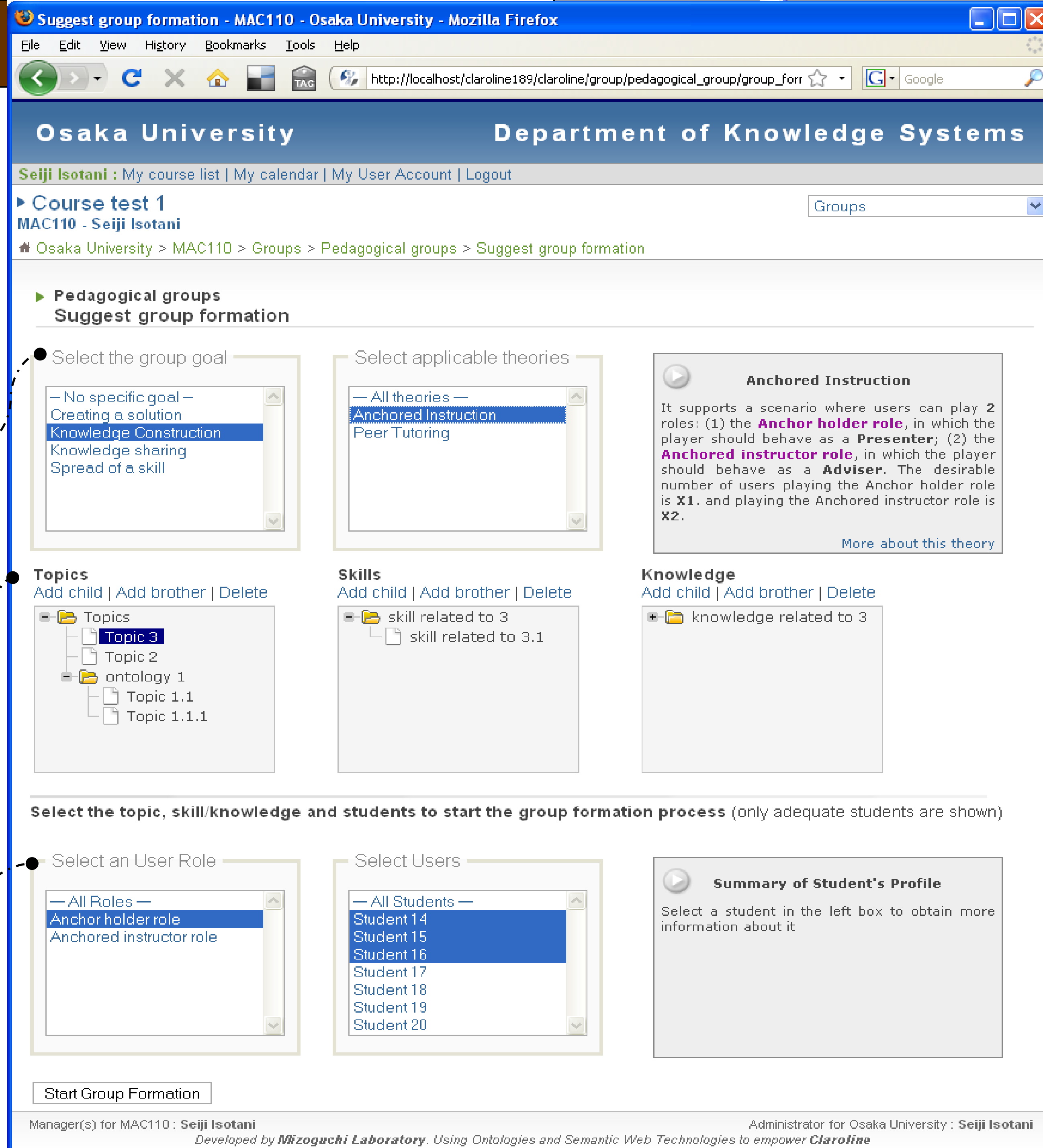
Theory-Driven Group Formation

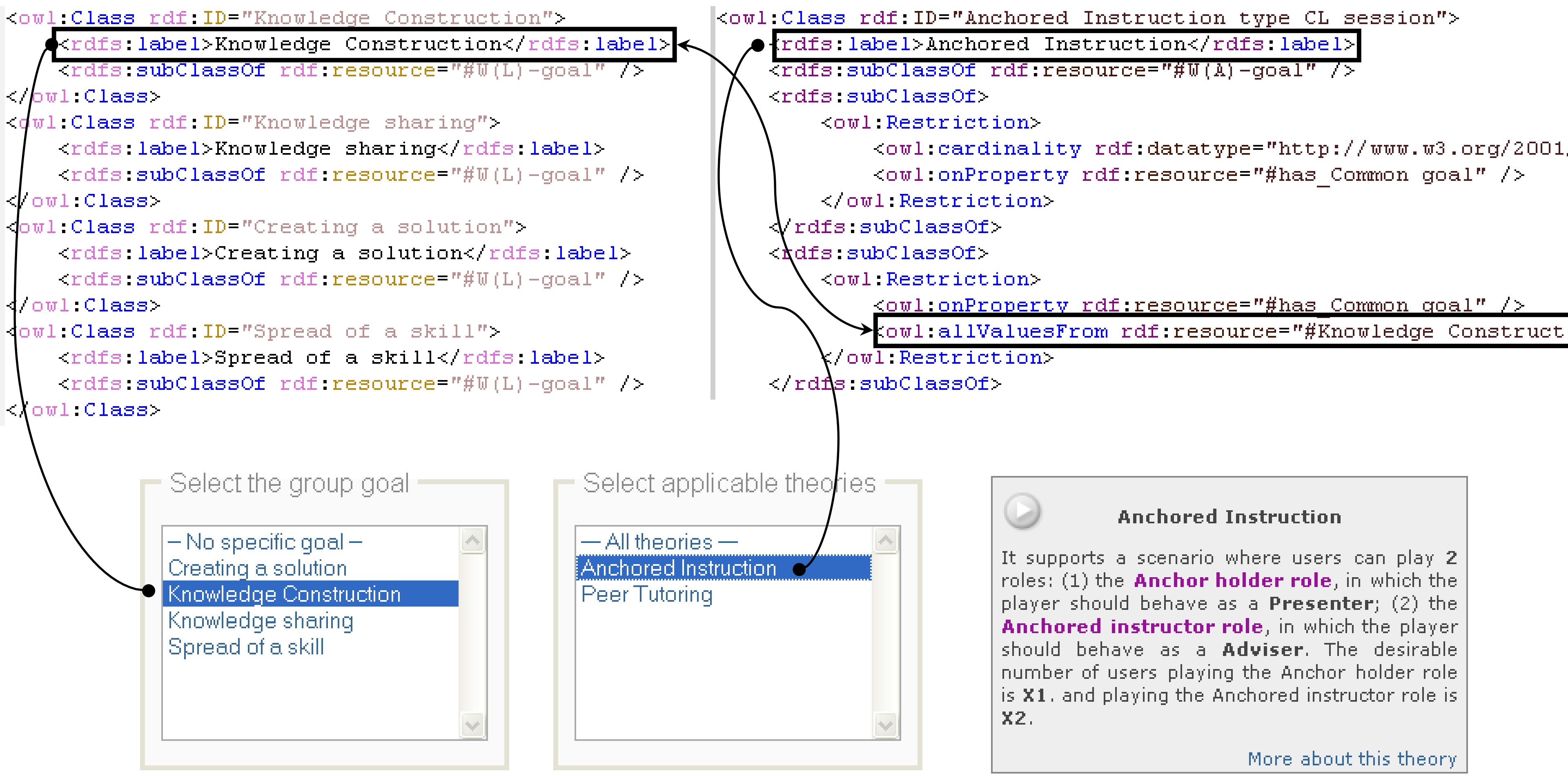
Identify which collaborative learning scenarios can help learners to achieve their goals



CHOCOLATO


Knowledge Base
Learning Objects
Learner Model
Ontologies
CL Design Support System
Learning Material Support System
Domain Mapping Support System
Group Formation Support System

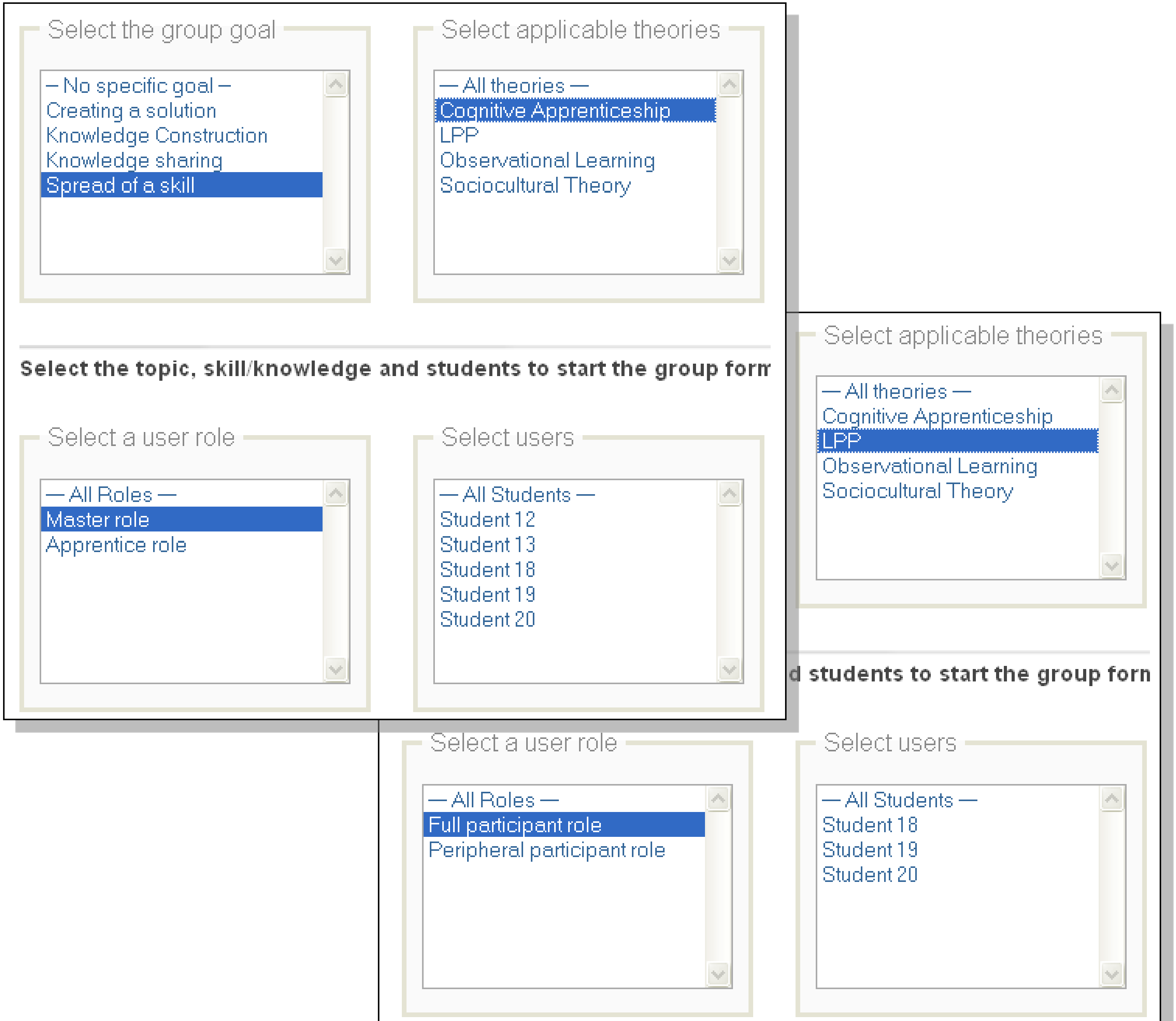

Suggest group formation - MAC110 - Osaka University - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/claroline189/claroline/group/pedagogical_group/group_forr
Osaka University
Department of Knowledge Systems
Seiji Isotani : My course list | My calendar | My User Account | Logout
Course test 1
MAC110 - Seiji Isotani
Groups
Osaka University > MAC110 > Groups > Pedagogical groups > Suggest group formation
Pedagogical groups
Suggest group formation
Select the group goal
— No specific goal —
Creating a solution
Knowledge Construction
Knowledge sharing
Spread of a skill
Select applicable theories
— All theories —
Anchored Instruction
Peer Tutoring
Anchored Instruction
It supports a scenario where users can play 2 roles: (1) the Anchor holder role, in which the player should behave as a Presenter; (2) the Anchored instructor role, in which the player should behave as a Adviser. The desirable number of users playing the Anchor holder role is X1, and playing the Anchored instructor role is X2.
More about this theory
Topics
Add child | Add brother | Delete
Topics
Topic 3
Topic 2
ontology 1
Topic 1.1
Topic 1.1.1
Skills
Add child | Add brother | Delete
skill related to 3
skill related to 3.1
Knowledge
Add child | Add brother | Delete
knowledge related to 3
Select the topic, skill/knowledge and students to start the group formation process (only adequate students are shown)
Select an User Role
— All Roles —
Anchor holder role
Anchored instructor role
Select Users
— All Students —
Student 14
Student 15
Student 16
Student 17
Student 18
Student 19
Student 20
Summary of Student's Profile
Select a student in the left box to obtain more information about it
Start Group Formation
Manager(s) for MAC110 : Seiji Isotani
Administrator for Osaka University : Seiji Isotani
Developed by Mizoguchi Laboratory. Using Ontologies and Semantic Web Technologies to empower Claroline



Development

- RDF/OWL Parser (ARC2), PHP, Claroline (LMS).

CHOCOLATO


Select the group goal
– No specific goal –
Creating a solution
Knowledge Construction
Knowledge sharing
Spread of a skill
Select applicable theories
— All theories —
Cognitive Apprenticeship
LPP
Observational Learning
Sociocultural Theory
Select the topic, skill/knowledge and students to start the group form
Select a user role
— All Roles —
Master role
Apprentice role
Select users
— All Students —
Student 12
Student 13
Student 18
Student 19
Student 20
Select applicable theories
— All theories —
Cognitive Apprenticeship
LPP
Observational Learning
Sociocultural Theory
d students to start the group form
Select a user role
— All Roles —
Full participant role
Peripheral participant role
Select users
— All Students —
Student 18
Student 19
Student 20

CHOCOLATO

(a) Created groups

Groups	Registered	Max.	Edit	Delete
Group 1 - Distributed Cognition	6	8		
Group 2 - Peer Tutoring	3	8		
Group 3 - Cognitive Apprenticeship	4	8		
Group 4 - LPP	4	8		

(b) Users' details

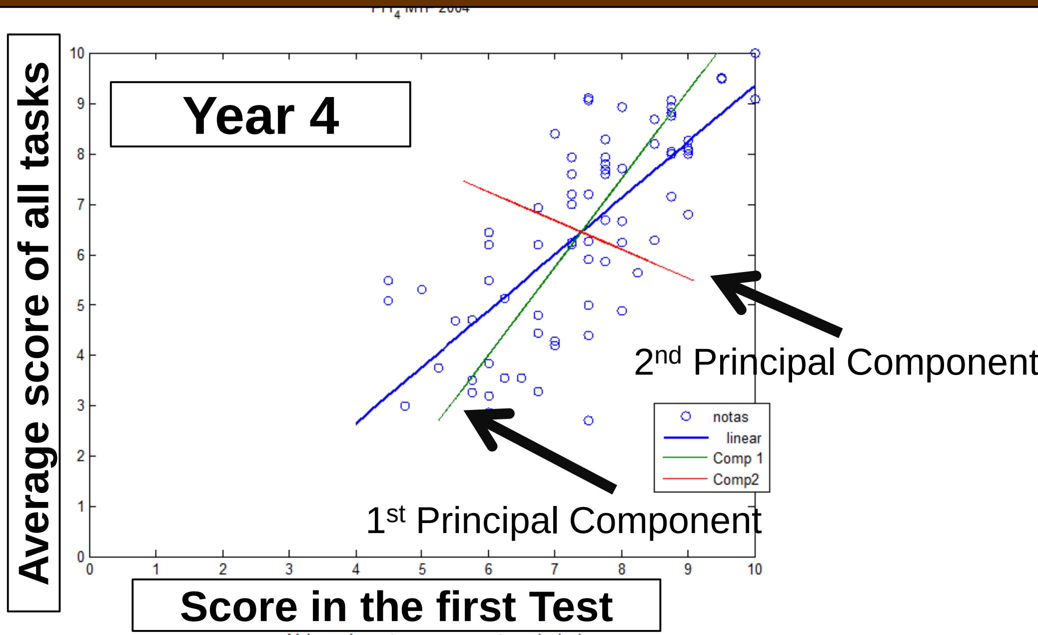
Last name	First name	Profile	Role	Group	Group Tutor	Course manager	Edit	Unregister
1 Isotani	Seiji	Manager	-	-	Group Tutor	Course manager		
2	Student 1	User	Peer Tutee	Group 2 - Peer Tutoring (35)	-	-		
3	Student 10	User	Full Participant	Group 1 - Distributed Cognition (34)	-	-		
4	Student 11	User	Full Participant	Group 1 - Distributed Cognition (34)	-	-		
5	Student 12	User	Peer Tutor	Group 2 - Peer Tutoring (35)	-	-		
6	Student 13	User	-	-	-	-		
7	Student 14	User	Full Participant	Group 1 - Distributed Cognition (34)	-	-		
8	Student 15	User	Full Participant	Group 1 - Distributed Cognition (34)	-	-		
9	Student 16	User	Full Participant	Group 1 - Distributed Cognition (34)	-	-		
10	Student 17	User	Full Participant	Group 1 - Distributed Cognition (34)	-	-		
11	Student 18	User	Master	Group 3 - Cognitive Apprenticeship (36)	-	-		
12	Student 19	User	Full Participant	Group 4 - LPP (37)	-	-		
13	Student 2	User	-	-	-	-		
14	Student 20	User	Full Participant	Group 4 - LPP (37)	-	-		
15	Student 3	User	Apprentice	Group 3 - Cognitive Apprenticeship (36)	-	-		
16	Student 4	User	Apprentice	Group 3 - Cognitive Apprenticeship (36)	-	-		
17	Student 5	User	Peripheral Participant	Group 4 - LPP (37)	-	-		
18	Student 6	User	Peripheral Participant	Group 4 - LPP (37)	-	-		
19	Student 7	User	-	-	-	-		

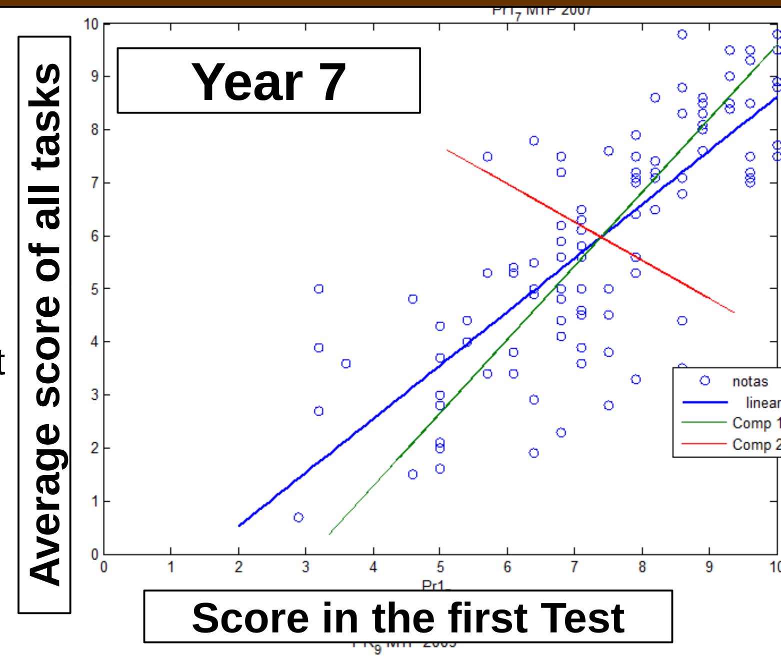
Collaborative Learning Ontology

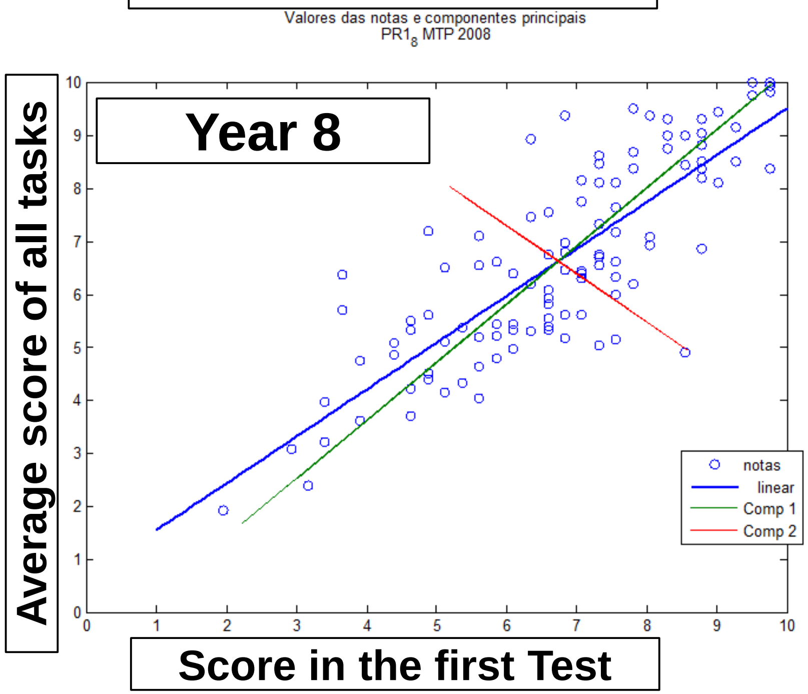
Does it really work in practice?

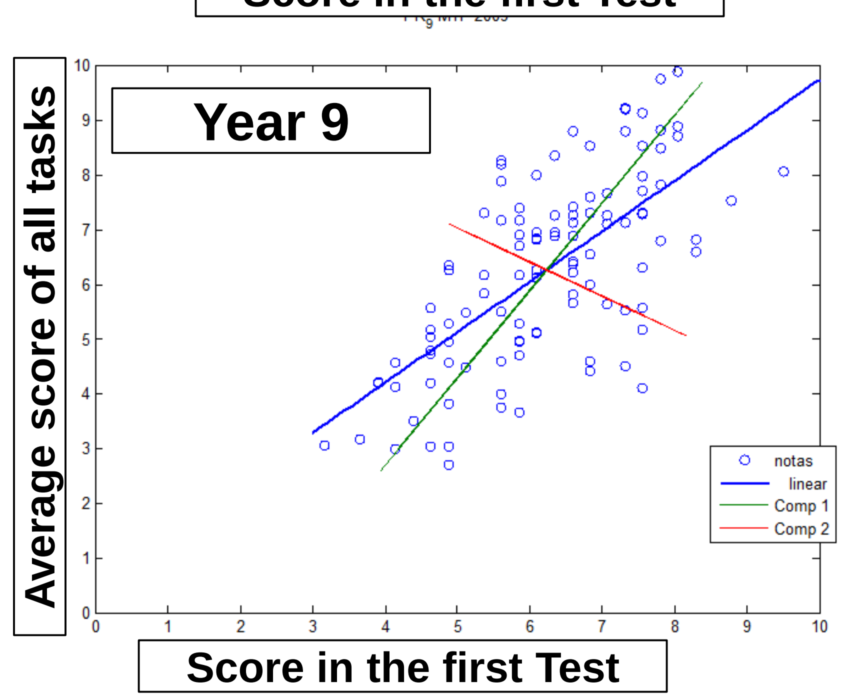
Isotani et al (2013) A Semantic Web-based authoring tool to facilitate the planning of collaborative learning scenarios compliant with learning theories. Computers and Education, v. 63, p. 267-284.

In vivo studies: PCA









Future Directions

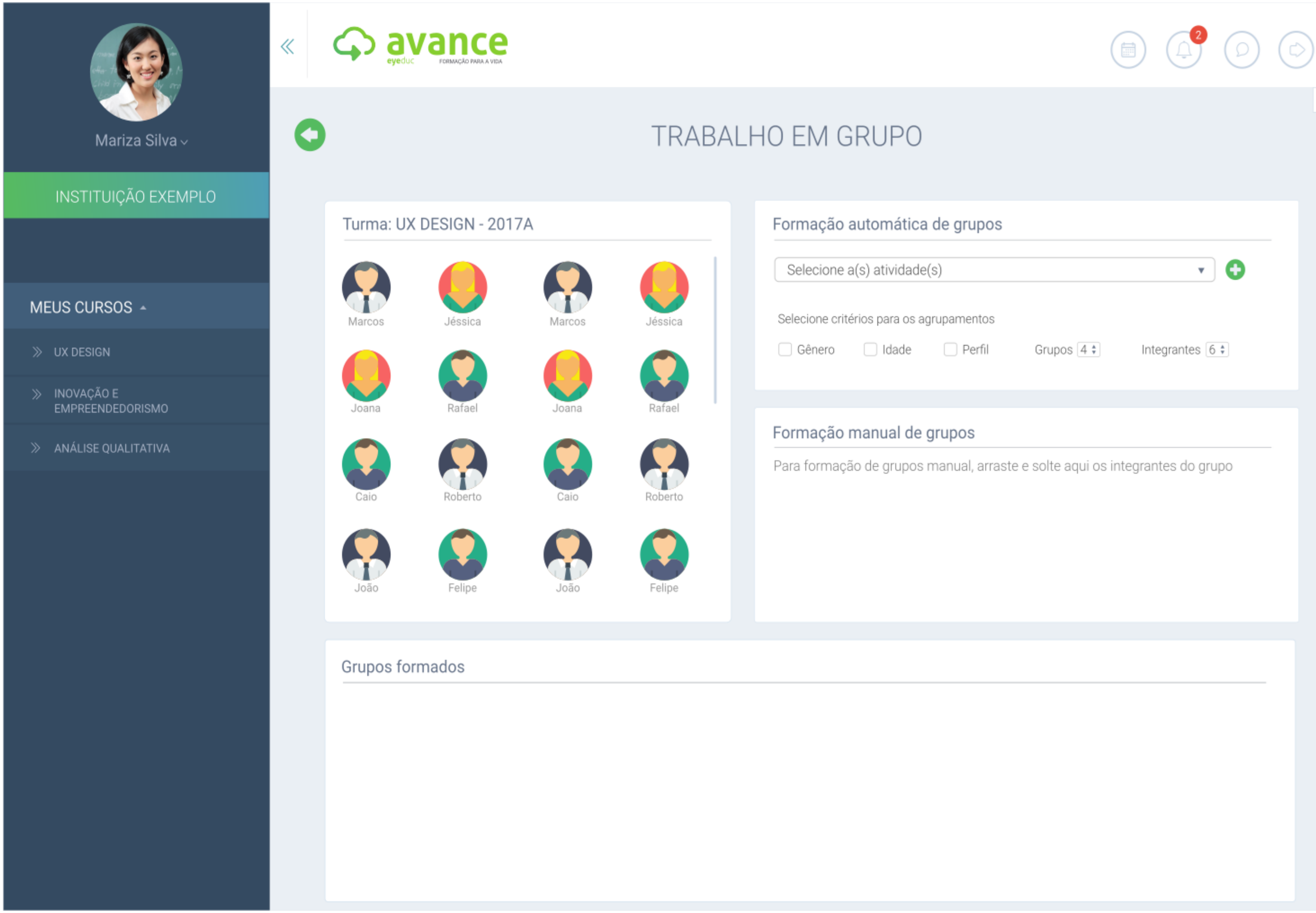
Does it really work at scale?

(self-controlled learning environment)

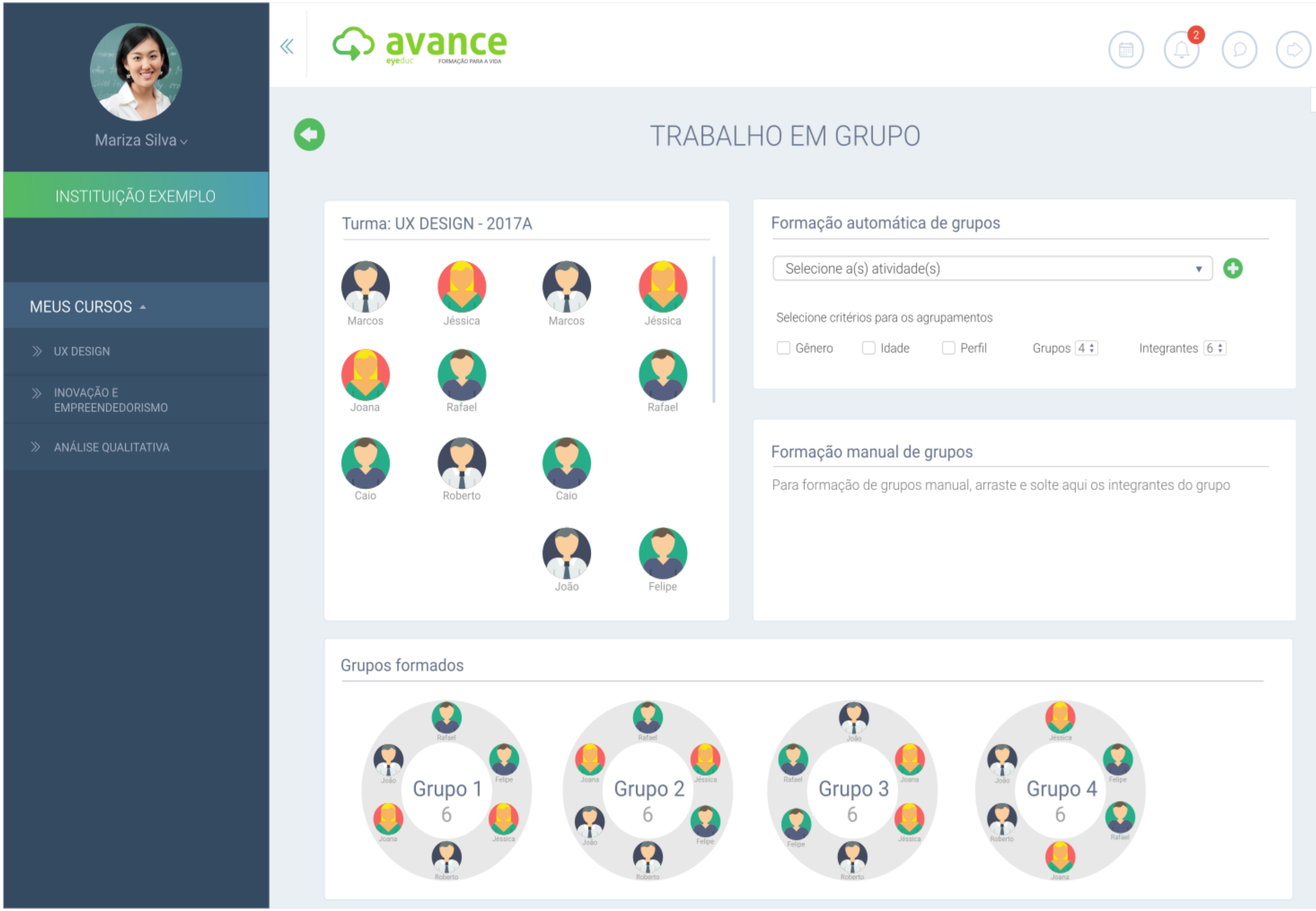
MEU tutor

Startup

High Performance Groups

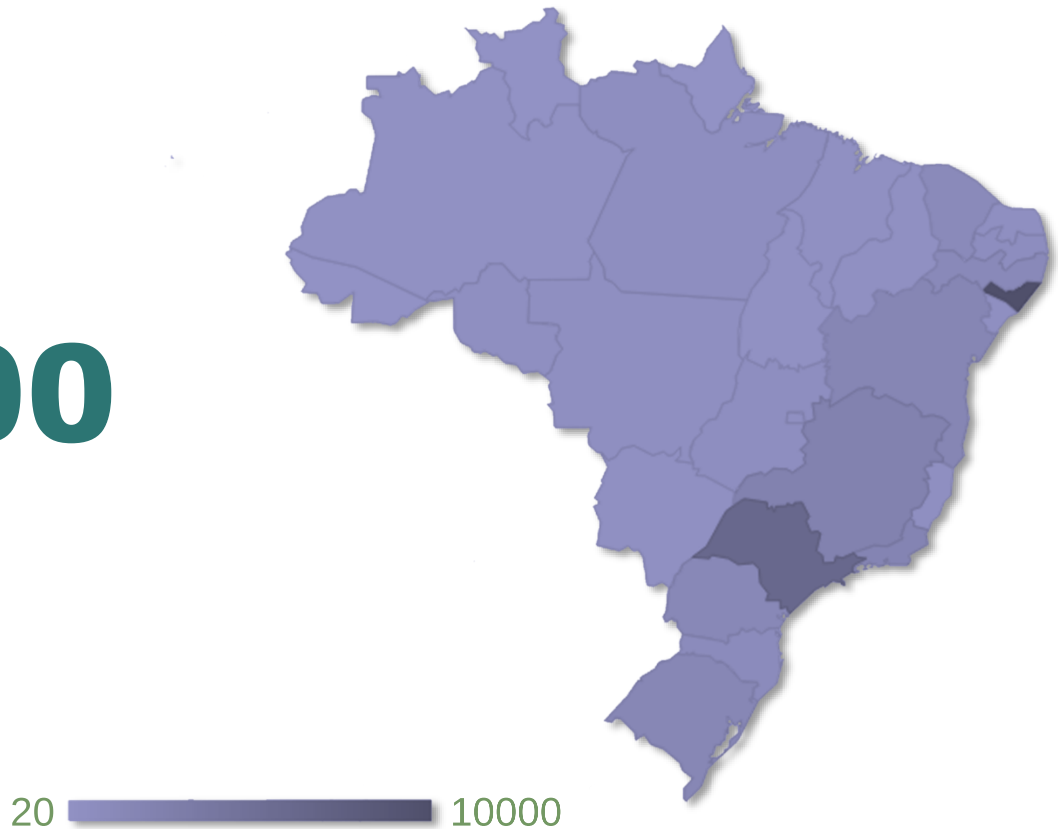


High Performance Groups



+10.000

STUDENTS



RESULTS

1. Tenorio et al. (2016) A gamified peer assessment model for on-line learning environments in a competitive context. Computers in Human Behavior, v. 64, p. 247-263, 2016.
2. Paiva, R. ; Bittencourt, I. I. ; Jaques, P. ; ISOTANI, S. . What do students do on-line? Modeling students' interactions to improve their learning experience. Computers in Human Behavior , v. 64, p. 769-781, 2016.

LEARNING EFFECTIVENESS

PARTICIPATION INCREASE

POTENTIAL

Opening educational data

http://learnsphere.org/

data infrastructure to support learning improvement online

Carnegie Mellon University

MIT

Stanford University

THE UNIVERSITY OF MEMPHIS

Understand the role of affective states in group formation (and collaborative learning processes)

Reis et al. (2018) Affective states in computer-supported collaborative learning: Studying the past to drive the future. Computers & Education 120: 29-50

Dealing with the **demotivation problem** when using computer-supported collaboration

Challco et al. (2018) Using Ontology and Gamification to Improve Students' Participation and Motivation in CSCL. Communications in Computer and Information Science, vol 832. Springer, 174-191

Takeaway Message:

1. Take a **real world problem** that is hard to solve
2. **Organize the knowledge** from different sources
3. Build an **ontology**
4. **Hide the ontology** behind a model that people can understand
5. Apply the model and the ontology to **solve the problem**

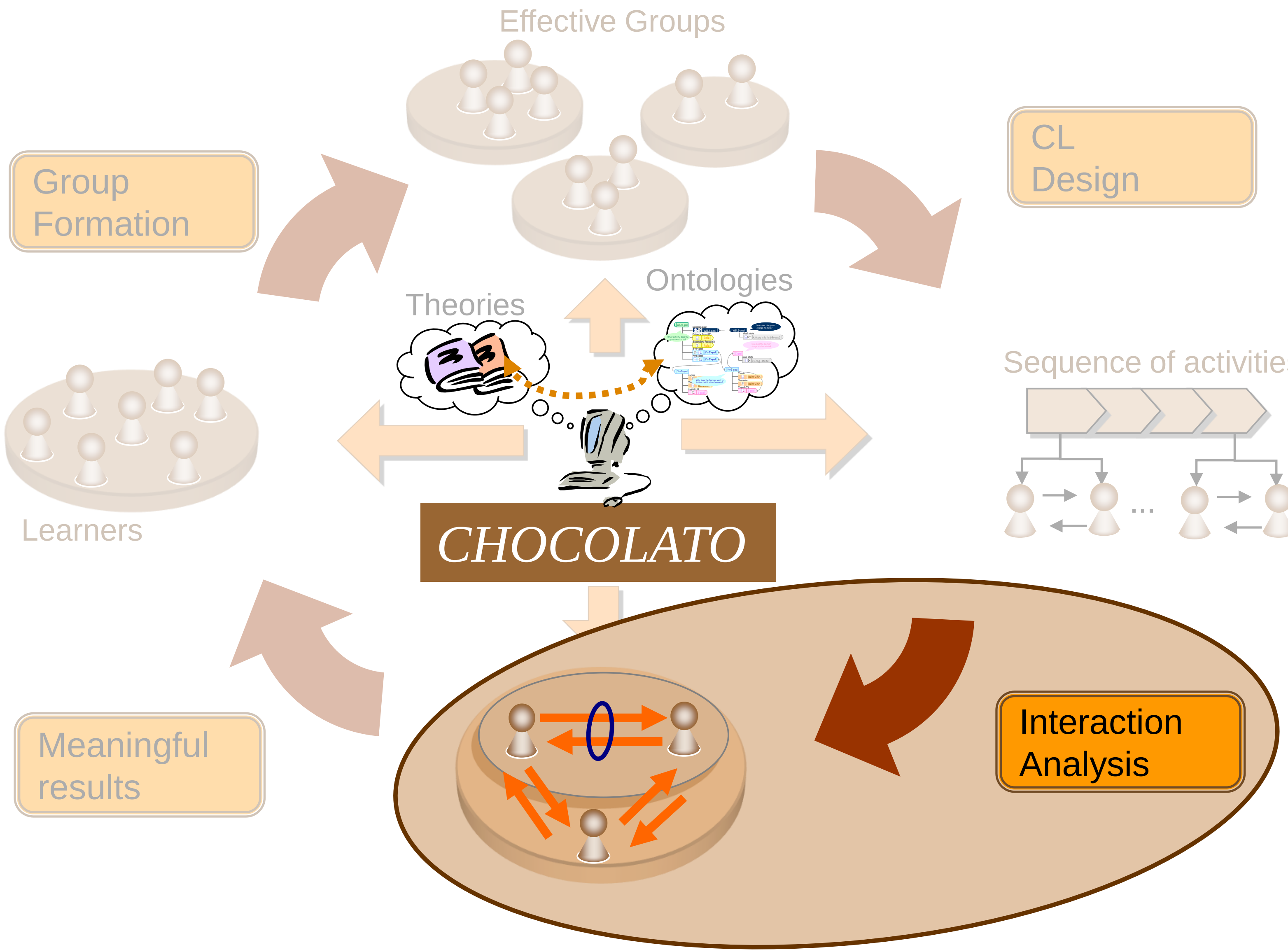
@BNU2018

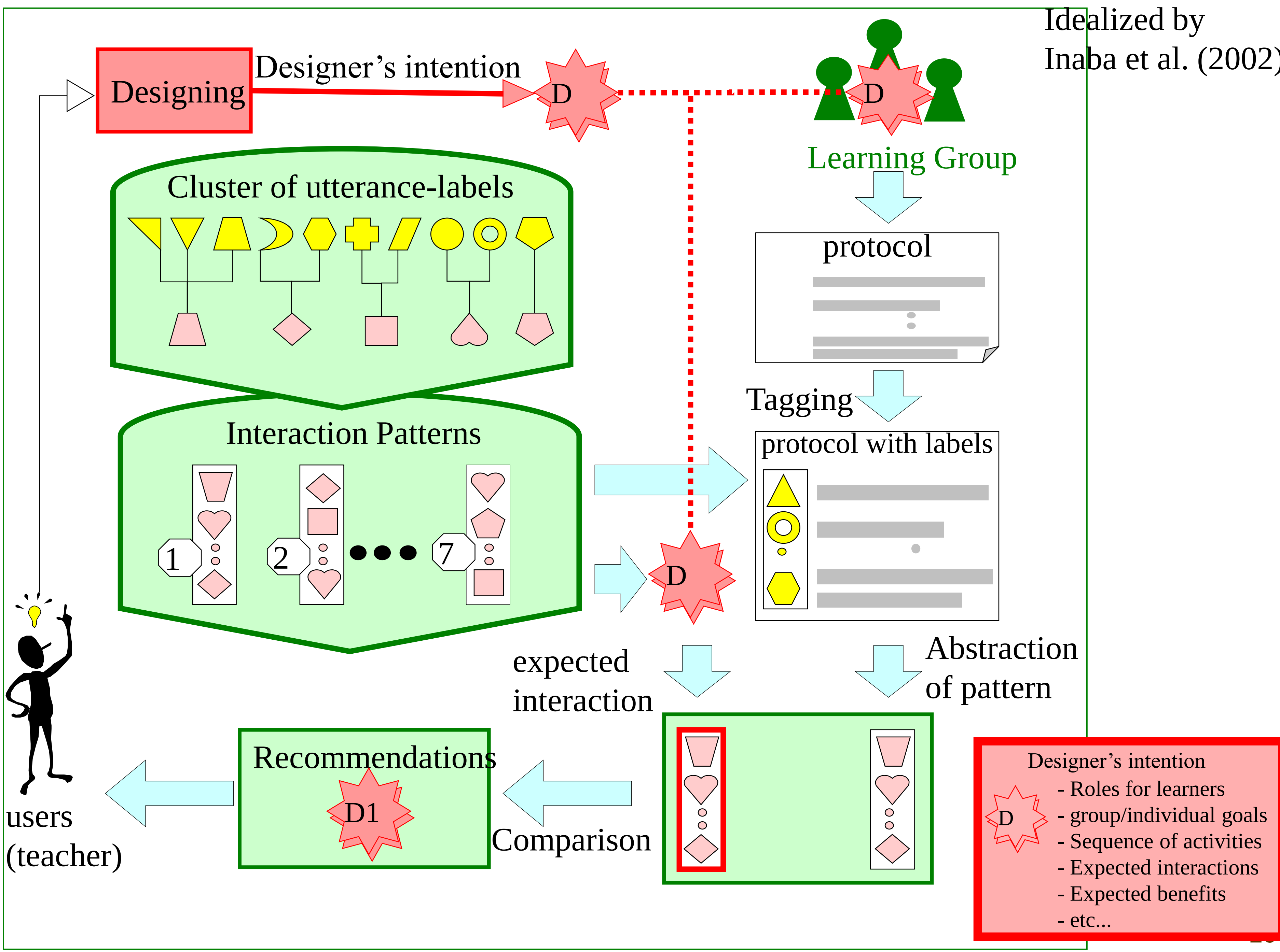
Advancements in Intelligent Support for Collaborative Learning

From Well-Thought-Out Group Formation to Effective Peer Interactions

Seiji Isotani
Professor
Computing in Education Laboratory
University of Sao Paulo
sisotani@icmc.usp.br

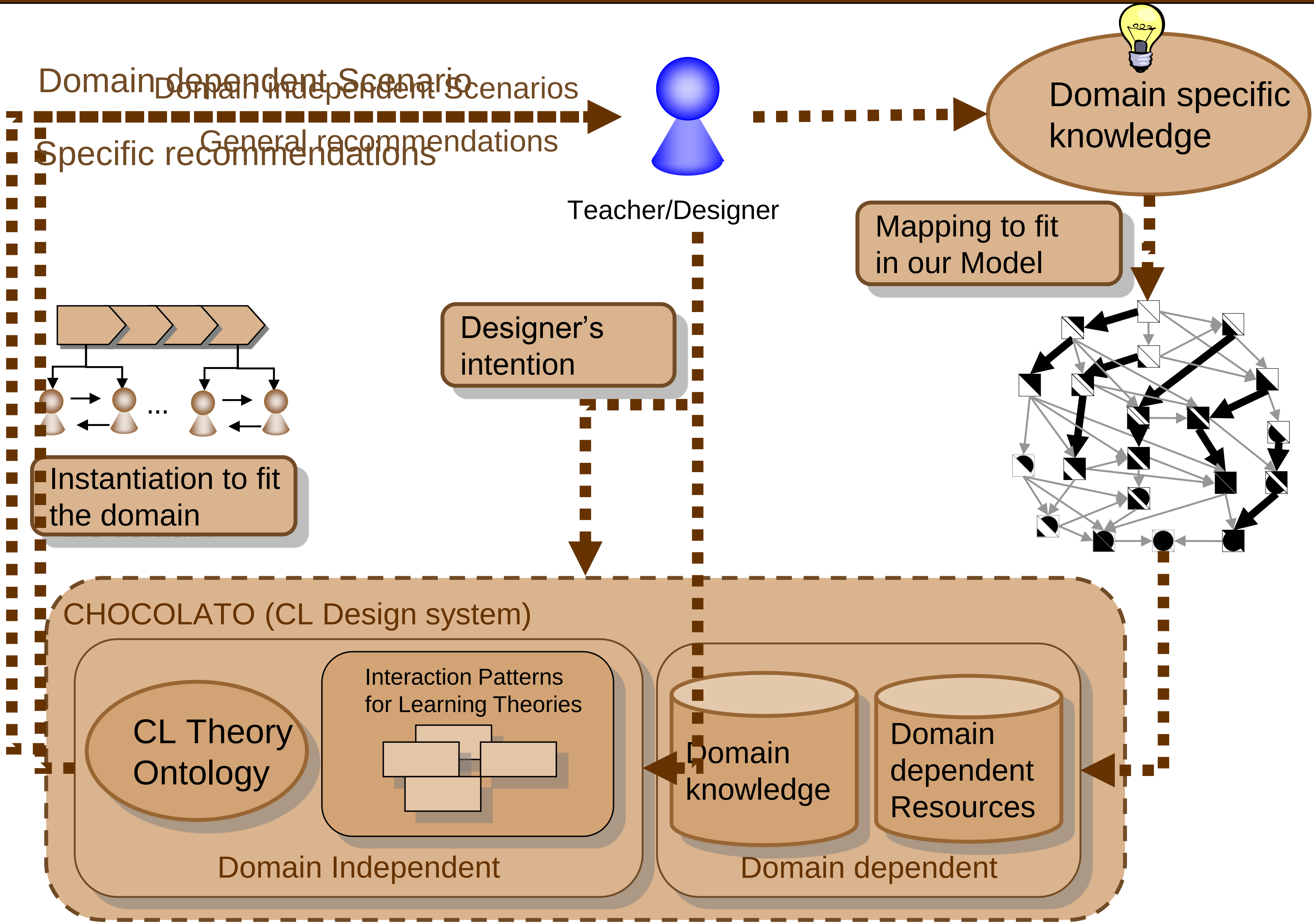
CHOCOLATO: Concrete and Helpful Ontology-aware Collaborative Learning Authoring Tool



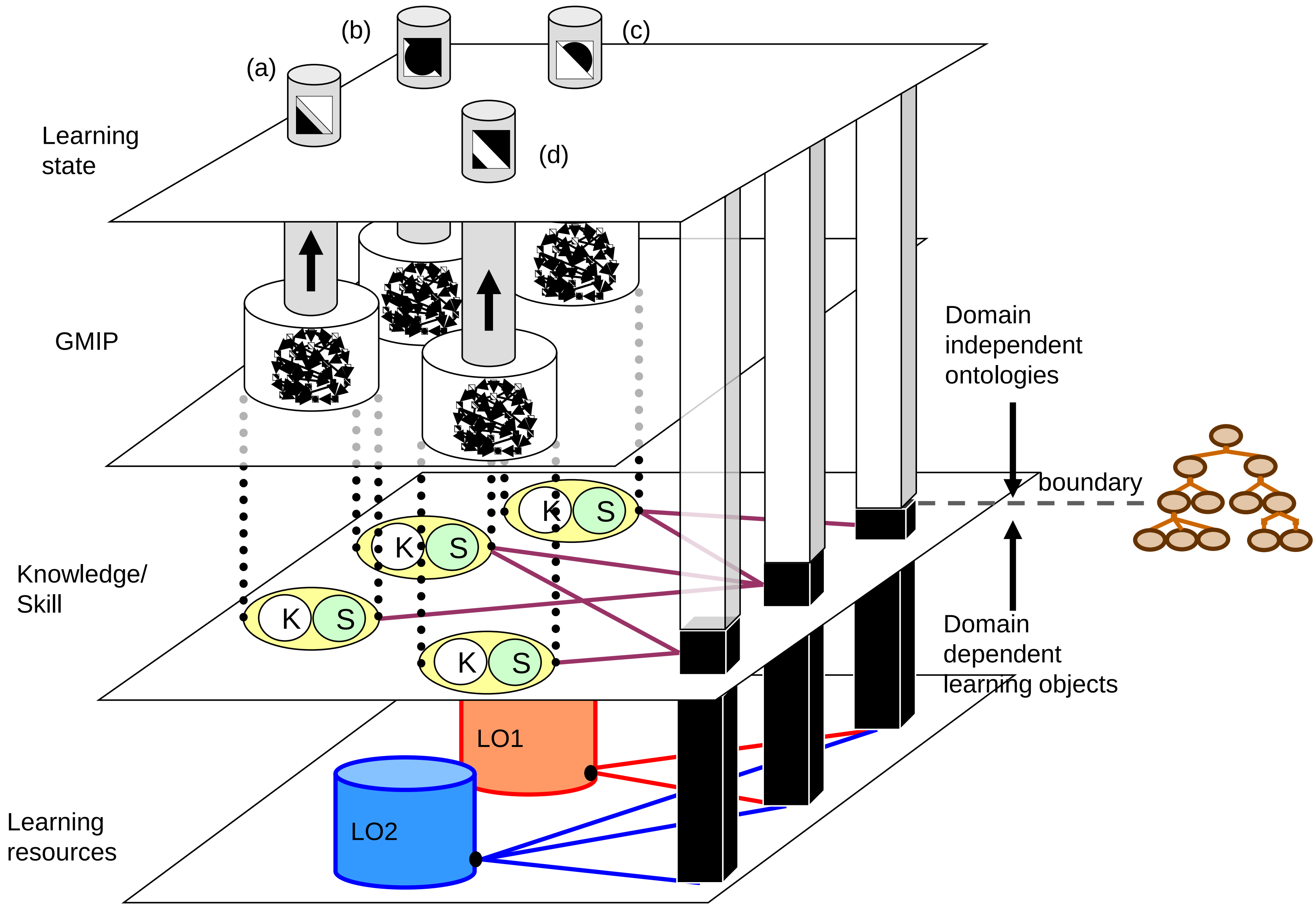


Idealized by
Inaba et al. (2002)
Designing
Designer's intention
D
D
Learning Group
Cluster of utterance-labels
protocol
Tagging
Interaction Patterns
1
2
7
protocol with labels
D
expected
interaction
Abstraction
of pattern
Recommendations
D1
Comparison
users
(teacher)
Designer's intention
D
- Roles for learners
- group/individual goals
- Sequence of activities
- Expected interactions
- Expected benefits
- etc...

Application



Framework to design domain-dependent CL scenarios

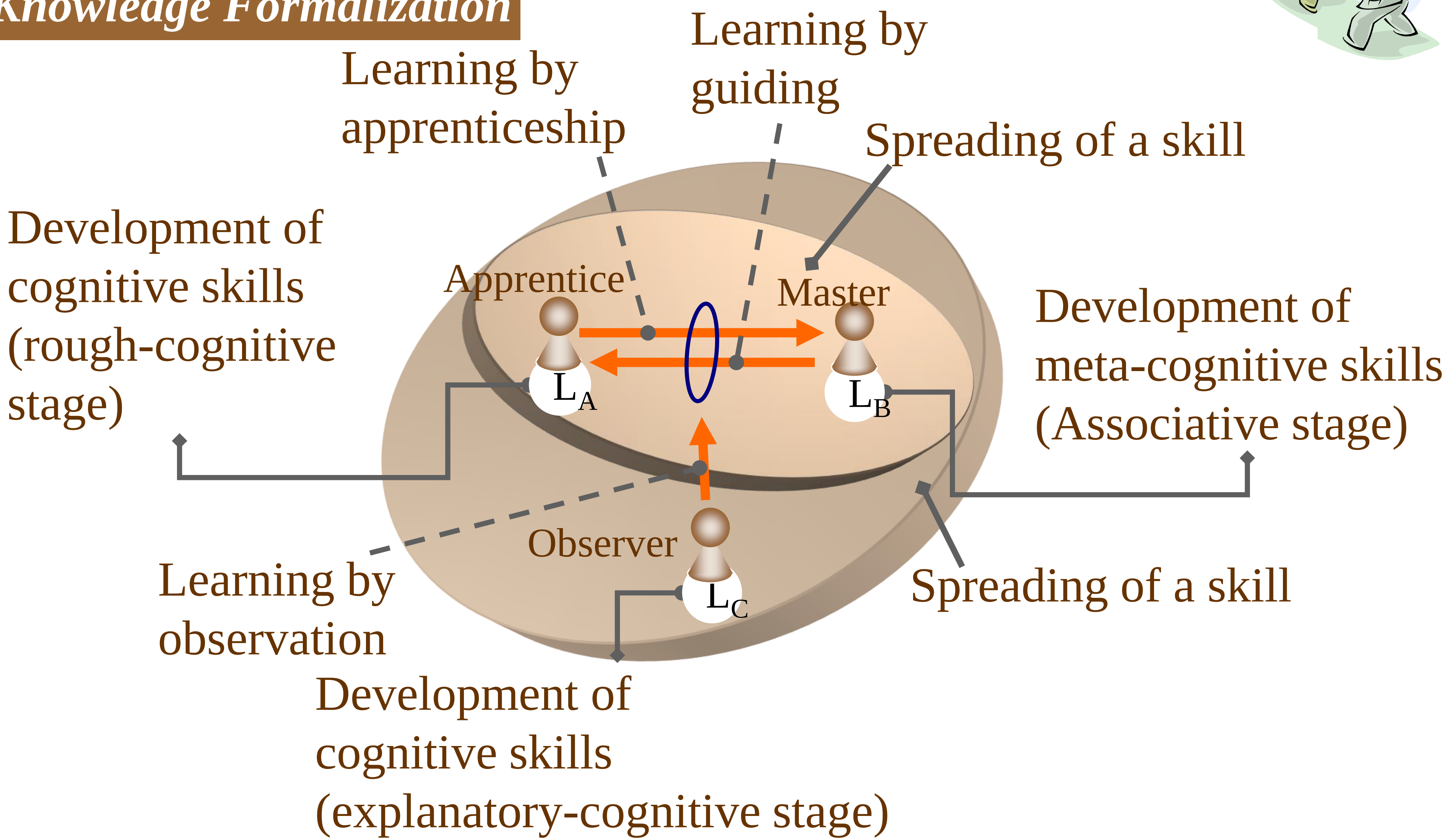


References

L. P. Prieto, K. Sharma, Ł. Kidzinski and P. Dillenbourg, "Orchestration Load Indicators and Patterns: In-the-Wild Studies Using Mobile Eye-Tracking," in IEEE Transactions on Learning Technologies, vol. 11, no. 2, pp. 216-229, 1 April-June 2018.

Formalizing CL

Knowledge Formalization



Knowledge Organization: Learning goal

I-goal		Definition	Sources
Acquisition of Content-Specific Knowledge		To add new knowledge concerning the target domain to existing schemata, to understand it, and then to consider relationship among knowledge, and (re) construct knowledge structure.	[2, 3, 4, 6, 15, 16]
	Accretion		
	Tuning		
	Restructuring		
Development of Cognitive Skill		To get knowledge concerning cognitive skills such as diagnosing and monitoring, to practice them, and then to refine them.	[16, 18, 23]
	Cognitive stage		
	Associative stage		
	Autonomous stage		
Development of Metacognitive Skill		To get knowledge concerning metacognitive skills for observing self-thinking process, diagnosing it and regulating or controlling of self-activity, to practice them, and then to refine them.	[16, 19, 23]
	Cognitive stage		
	Associative stage		
	Autonomous stage		
Development of Skill for Self-Expression		To get knowledge concerning the skills for externalizing self-thinking process and presenting the learner's self-perspectives, to practice them, and then to refine them.	[3, 21]
	Cognitive stage		
	Associative stage		
	Autonomous stage		

Formalizing CL

Knowledge Organization: learning strategy

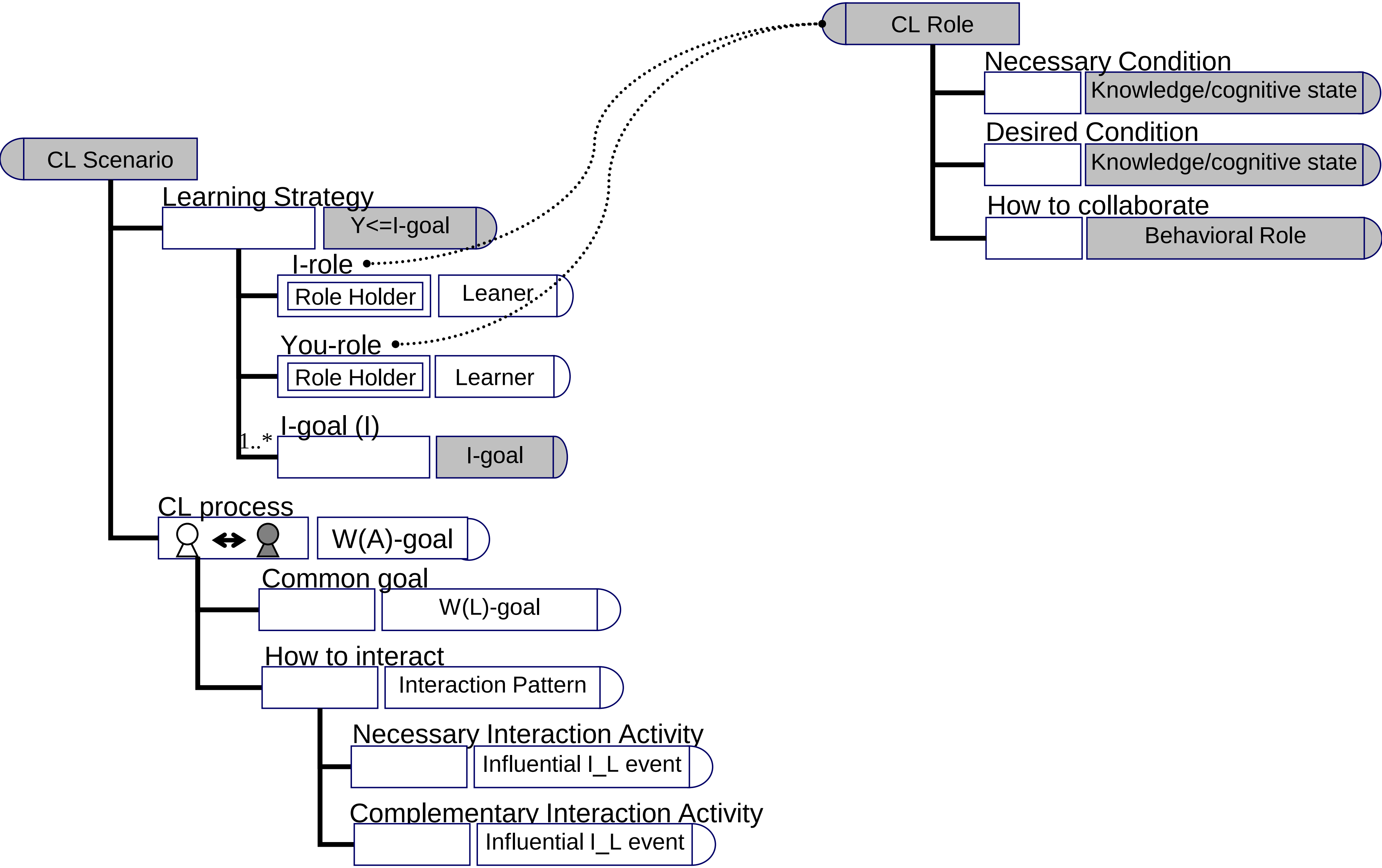
Y<=I-goal	Definition	Sources
Learning by Observation	Learning indirectly by observing other learners' learning processes	[2]
Learning by Self-Expression	Learning by externalizing self-thinking process, such as self-explanation and presentation.	[5]
Learning by Teaching	Learning by teaching something he/she already knows to other learners	[5,17]
Learning by being Taught	Learning directly by being taught by other learners	[17]
Learning by Apprenticeship	Learning by observing other learners' behavior and then imitating it.	[7]
Learning by Practice	Learning by applying knowledge or skill to a specific problem	[23,24]
Learning by Diagnosing	Learning by diagnosing other learners' learning or thinking processes	[6,18]
Learning by Guiding	Learning by demonstrating knowledge or skill to other learners and guiding the learners	[7]
Learning by Reflection	Learning by rethinking and observing the learner's self-thinking process.	[33,34]
Learning by Discussion	Learning by discussion with other learners	[10,27,30]

Formalizing CL

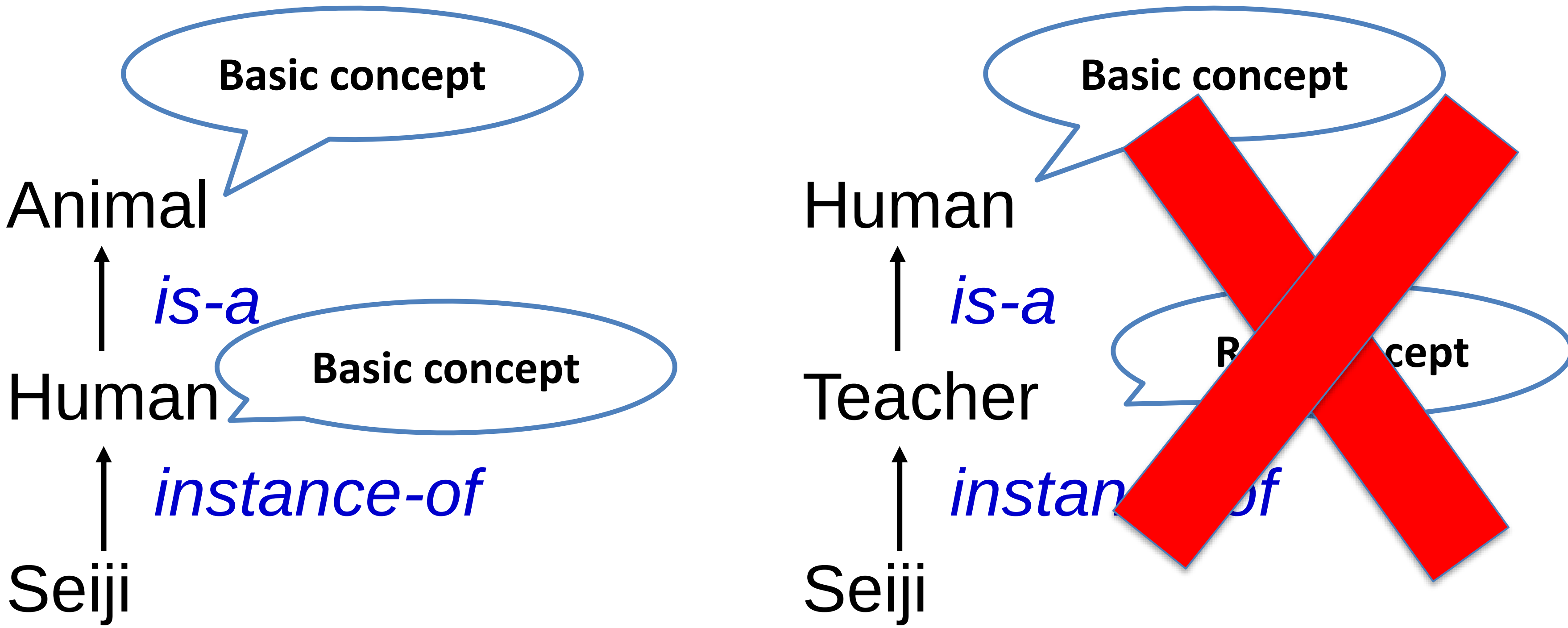
Knowledge Organization: Role for learners

Role	Condition	Predictable benefit (I-goal)	Sources
Apprentice	• *nothing*	• Development of cognitive and/or • metacognitive skill (cognitive stage & associative stage)	[6]
Master	• knowing how to use cognitive skill • having experience in using the cognitive skill • having how to use meta- cognitive skill • having experience in using the metacognitive skill	• Development of cognitive and/or • metacognitive skill (autonomous stage)	[6]
Peripheral participant	• knowing how to use cognitive skill • knowing how to use metacognitive skill • not having experience in using the cognitive skill • not having experience in using the metacognitive skill	• Development of cognitive skill (associative stage) • Development of metacognitive skill (associative stage)	[21]
Full participant	• having the knowledge • having experience in using the knowledge • having related knowledge in the domain • knowing how to use cognitive skill • having experience in using the cognitive skill • having how to use meta- cognitive skill • having experience in using the metacognitive skill	• Acquisition of content specific knowledge (restructuring) • Development of cognitive skill (autonomous stage) • Development of metacognitive skill (autonomous stage)	[21, 25, 28]
Peer tutee	• not having the knowledge	• Acquisition of Content Specific Knowledge (accretion)	[7]
Peer tutor	• having the target knowledge • not having experience in using the knowledge • misunderstanding the knowledge	• Acquisition of Content Specific Knowledge (tuning)	[7]

An Theory-based Ontology for CL



Example of Ontology representation



It is incorrect to have the *is-a* relation between “Human” and “Teacher” given that *teacher* is a role played by a *human* in a context (where is the context???).