# A platform for collaboration analysis in CSCL. An ontological approach

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## Introduction

A reflection on CSCL systems is a first step to understand how they are built. We are looking for a generic representation of the knowledge used to describe collaboration as well as the mechanisms to fit it in working systems. Mizoguchi & Bourdeau [3] pointed out the advantages of having a common vocabulary and a theoretical framework for understanding and interpreting how real groups work. Therefore, we approach that goal by using ontologies. That would allow us to reuse declarative knowledge about collaboration gathered from different sources.

Some work has been done for developing CSCL ontologies [2] but we think it had to be extended and validated. In a real collaborative learning environment, several configuration elements fit together and most of them have some relationship or dependency with others. Also, the act of combining them allows generating different modes of collaborative learning and guiding the students in their activity. We propose a first version of flexible, generic and portable ontology that considers and relates most of the elements involved in a collaborative learning scenario.

We identified and defined the necessary elements for configuring a CSCL environment (based upon our experience of designing them), thus providing a common vocabulary and reflecting on what categories are necessary in order to be able to observe the results of an experience. Then, we explicitly related and integrated them in a system. In that step, we validated this general CSCL ontology within the DEGREE system [1] and studied the usability of the proposal.

## Towards an integrated ontology for CSCL

We propose an integrated ontology for defining collaborative learning experiences and for analysing their results. We integrate two levels in our ontology, a definition level (named in Figure 1 as BASIC CSCL ONTOLOGY) and a collaboration analysis level (ANALYSIS CSCL ONTOLOGY, in Figure 1) which establishes relationships between the concepts in the BASIC ONTOLOGY and the analysis terms.

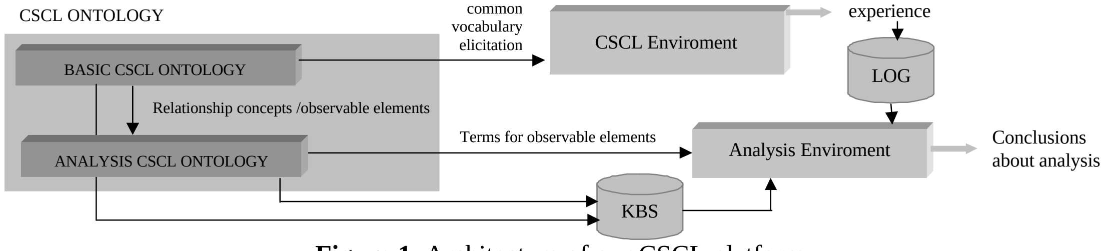


**Figure 1**. Architecture of our CSCL platform

### BASIC CSCL ONTOLOGY

We have designed a CSCL ontology starting from (Activity Theory (AT) [4]) and on collaborative system definition but extending and refining it in order to express computational aspects needed for building a system. This new ontology deals with all

```
-Activity
    p/o@n"Tools":Artefact
    p/o@n"Rules":Norms
    p/n"Division of Labour":Division of Labour
    p/o"Community":Group
    p/o"Subject":Individual
    p/o@n"Object":Motive
    p/o"Outcome":Result
 -Artefact
    p/o"Mediated-by":Mediating-tool
    p/o"Resources":Aplication
 -Mediational-tool
 -Aplication
      a/o"execuble":program
      a/o"link":String
      -DEGREE
        p/o"degree":link
     -Internet Resource
   -Conversational Structure
      a/o"Mediating-tool"
    -Text Oriented
        p/o@nodes"Nodes":Conversational Unit
    -Graphical Languague
   -Conversational Unit
     p/o@"Related to":Conversational Unit
     p/o" Attributes":Conversational attribute
     p/o"Category":Conversational Cathegory
  -Conversational attribute
     p/o"Attribute":String
     p/o"Value":Number
    -Creativity
    -Elaboration
    -Conformity
    -Initiative
 -Conversational Category
   -Argue
   -Agree
   -Propose
-Action
    p/o@n"Action":Activity
    p/o"Goal":Goal
-Operation
      p/o"Conditions":Constratints
-Norms
    p/o"Group Name":Group
    p/o"Agrement Method":Agreement method
........
```

**Figure 2**. Concepts about "conversational structure"

the concepts in AT (partially shown in figure 2) and gathers and relates some preceding ones [3]. In our approach, we interpret the "*Object*" slot in the AT twofold: as "a target thing" and as an "Objective". These two meanings are explicitly represented by introducing two relations as follows: *Outcome* is *made-by* "Activity" under the specified *Objectives* and is *made-from* Object. In the ontology, *Tools* are *Artefacts* composed of *Mediational Tools* and external elements or resources.

Mediational tools characterize actions and interactions bound to concepts. In figure 2, we partially list the ontology that we have used to describe the concepts for a "conversational structure" as a type of a mediational tool. We define interactions in terms of conversational structures, playing a relevant role both for coordinating the users and for interaction-based analysis. We exploit this knowledge in our analysis methods taking advantage of the categorization of the conversational structure as a list of conversational units (with attributes and categories). More information about the meaning of the attributes and categories of our conversational graphs can be found in [1]. An analysis focused on another issue would require the elicitation of a different set of elements to be included in the ontology.

**ANALYSIS CSCL ONTOLOGY**

We see the analysis of collaborative learning experiences as a data *abstraction* process and an *evaluation* process. Raw data are collected and logged from a collaborative experience. Then, through the qualitative abstraction process, they are turned onto observed data, which we call *processed data* in the ANALYSIS CSCL ONTOLOGY (see the concepts at the top of figure 3). In this process, the data are explicitly related with concepts in the BASIC CSCL ONTOLOGY. Given those data we might infer new values, which would fill the attributes of some concepts within the ANALYSIS ONTOLOGY. We call those values *interpreted/inferred data* (see the concepts in the middle of figure 3). The ontology express the type of data for each inferred value as well as the name of the method allowing to interpret them.

The *evaluation* can be performed by means of different *methods*, which could be declared in several ways: for KBS inference we would use an inference method with rules DB, for bayesian inference as a network and the method for expanding it, etc. An analysis method can be understood as a procedure that gets data out of an abstraction process. Then, it works with the data using an algorithm and generates the results. At the bottom of figure 3, the categorization for the methods and their attributes are shown, also based upon the interaction-based methods.

## Exploiting the new ontological analysis approach for new methods of analysis

We have implemented a generic algorithm which interprets and applies a method to the results of an experience. It collects data and generates *processed data*, supplies the generic code method with those data, interprets that code, evaluates the data and shows the method results in terms of the *inferred/interpreted data*. Thus, we have an explicit representation of the methods and their data in the ontology. This idea adds flexibility to the analysis process because it allows separating the data from their sources, the procedure for obtaining them, the definition of the methods to deal with them and the way of carrying out those methods. Hence, methods can be reused in a number of different manners (for example, by simply piping one into another through the sources of information). In this sense, we characterize the analysis methods as a *generic task*.

We have tested the approach with several analysis methods for validating it in the DEGREE system through a reengineering process. We also have defined new methods. For instance, a method for understanding and representing how the group advanced from one stage to the next one. We were interested in being able to infer critical states from the on-going process in terms of concepts such as *activeness*, *impasse* and *convergence/divergence* in order to be able to define stages in the collaboration process.

The new platform as well as the definition of the generic algorithm allowed us to reuse existent method code applying it to the intermediate *stages* of the process. It was done by simply adding some necessary new concepts because our architecture facilitates getting profit out of the ones already declared in the ontologies. In figure 3, the concepts about this method are marked in italics.

## Conclusions

In this paper we have presented a first step towards an integrated and portable CSCL ontology based upon the Activity Theory approach. We have taken advantage of an ontology-based platform and generic tasks for reengineering existing analysis methods and refining new ones. We have satisfactorily evaluated the resulting system with data from distance learning experiences.

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-Source of Information
-Raw Data p/o"List Fields":
-**Processed data refered_to "Scope": Scope Var**
-Statistical refered_to "Process":
-Number Contributions Average
-Size Contributions Average
-Depth Tree in the Discussion Process Average
-Relative Number Contributions answered by others
-Relative Number Contributions answered to others
-Relative Number Contributions continued to himself
-Proposing Average
-Arguing Average
-Agreeing Average
-Number Coordination Messages
-*Rate between Contributions*
-Number Proposals Average
-*Number of Parallel Discussions*
-Valued refered_to "Conversational Unit":
-Creativity
-Elaboration
-Interactivity
-Initiativity
-Complex refered_to "Process":
-*Path to Solution*
-*List Stages*
-*Relative Dispersion*
-*Impass*
-*Balance*

-**Interpreted/Infered**
-From Interaction p/o"scope":Scope Var
-Argumentation
from"Initiative":Valued
from"Interactivity":Valued
from"Depth Tree in the Discussion Process
method"Global Interaction":null
-Collaboration
from"Argumentation":Interpreted/Infered
from"Coordination":Interpreted/Infered
from"Cooperation":Interpreted/Infered
method"Global Interaction":null
-Cooperation
from"Argumentation":Interpreted/Infered
from"Conformity":Statistical
from"Creativity":Statistical
method"Global Interaction":null
-Coordination
from"Number Coordination Messages":Statistical
from"Inititative":Valued
from"Argumentation":Valued
method"Global Interaction":null
-Work
from"Number Coordination Messages":Statistical
from"Inititative":Valued
from"Argumentation":Valued
method"Global Interaction":null
method"Individual Interaction":null
-Attitude
from"Creativity":Valued
from"Inititative":Valued
from"Conformity":Valued
from"Promote Discussion":Valued
method"Individual Interaction":null
-Promote Discussion
from"Relative Number Contributions answered by others":Statistical
from"Number Contributions answered to others":Statistical
from"Number Contributions continued to himself":Statistical
from"Proposing Average":Statistical
method"Individual Interaction":null
-*Divergency*
*from"Number of Parallel Discussions":Statistical*
*from"Impass":Complex*
*method"Stages":null*
-*Fluency*
*from"Balance":Complex*
*from"Rate between contributions": Statistical*
*method"Stages":null*

**Analysis Method**
p/o"InputVars":List
p/o"OutputVars":List
p/o"Algorithm":String
-Interaction-based
-Quantitative
-States-based
-Graphical languages-based
-User accesses by date
-User accesss by hour
-Contributions by type
-Contributions by type/user/section
-Tree of discussion by type and user
-Qualitative p/o"KB":
-Global interaction
-Individual interaction
-Tasks division of work
-*Stages*
-Action-based
.......
-Interaction/Action/Stages-based
-Problem-Solving Related

**Figure 3.** Part of CSCL ontology centered on the interaction-based analysis concepts and methods