Emergence of GRID-enabled Collaborative Learning Spaces : a guided tour influenced by Maslow

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Abstract: In order to determine the impact of GRID-related technologies on Computer Supported Collaborative Learning (CSCL), we have adopted a pragmatic approach which consists in understanding the motivations of people who seek for collaborative learning inside Virtual Community (VC). Our analysis has been guided by Maslow's model of human motivations. Hence, we have followed the path from the needs of individuals towards the development of a VC. In parallel, we have made analogies between the Maslow model layers and the technological layers of the GRID model. One noticeable fact is that learning does not come first, but is an ultimate achievement guided by individual aspirations inside the VC.

Introduction

Context of CSCL

Computer Supported Collaborative Learning (CSCL) is the core motto of the European Learning GRID Infrastructure (ELeGI) , a project funded by the European Union under the IST 6th Framework Project (FP6).
For the next four years, EleGI aims to three main goals:

1. to define new models of human learning enabling ubiquitous and collaborative learning, merging experiential, personalised and contextualised approache.
2. to define and implement an advanced service-oriented Grid based software architecture for learning.
3. to validate and evaluate the software architecture and the didactical approaches through experiments among Learning Virtual Communities.

Collaborative learning differ from individual learning in the way that it enhances the social aspects involved in the learning process and brings positive results such as deeper understanding of content, increased overall achievement, improved self-esteem, and improves team work via group conflicts resoltion.

CSCL is a solution to boost group activities by eliminating the space and time constrains.
Groups are dispersed in various geographical areas thanks to new technologies (i.e. networks and computers). This also adds an exciting dimension to CSCL.

In addition, time is not a constrain anymore. Members may attend to learning activities at any time, hence dismissing the need of co-presence.

These anywhere- anytime characteristics enable a shift from real time group learning to asynchronous distributed learning activities, and introduce the notion of virtual group or *Virtual Community* (VC).

Motivations of VCs

VC has been introduced in 1993 [RH 1993]: *Virtual communities can be conceptualized as social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyber.*

However, we believe that creation and maintenance of loyalty between the VC members is primordial because they are held together by the feeling of togetherness and connectedness that confers a sense of belonging. An individual joins a particular community because he expects to find self-affirming and satisfying.
Thoughout this article we are tackling the human motivation aspect as a key factor for a successful development of a VC.
In order to guide us all along this approach, we adopted the Maslov's model [MAS], a very popular theory concerning motivation based on the necessity for human beings to satisfy their fundamental.

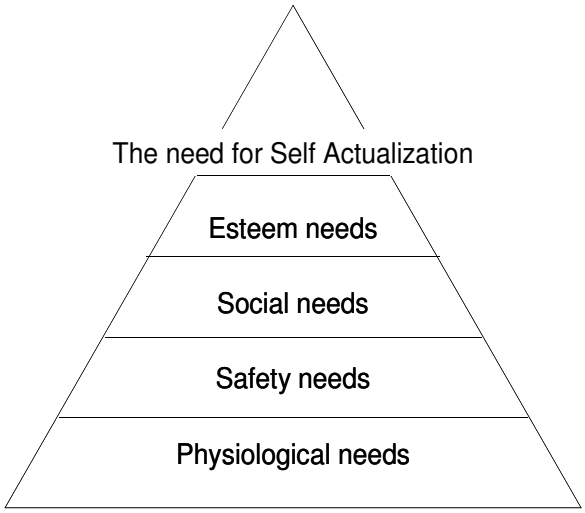


Figure 1: Abraham Maslow's hierarchical model of humans motivations

As presented in Figure 1, Abraham Maslow has developed a hierarchical model of the categories of such fundamental human needs. He organized those categories into a pyramid structure, and said that before a superior need was to be considered, all inferior needs had to be satisfied.

CLS in the Semantic GRID

In technical terms, trust and development of VC requires more than the simple connection to Internet.
For this reason, the infrastructure must include mechanisms of ressource virtualisation and security.
GRID has initially provided these features to enable massive distributed computing, but more recently the use of GRID has been extended to collaborative learning and is commonly reffered since 2002 as the Semantic GRID [ROU 2001].

Let us consider now a Collaborative Learning Space within the Semantic Grid.
Figure 2, present our conceptual framework in which we distinguish the three following components of a CLS and their relationship.

a) The *VC* itself
b) The *Agent(s)* that compose the *VC*
c) The *Service(s)* that are exchanged between these *Agents*

a) VC: In this context, a *VC* is a collection *Agents* playing a variety of roles.

b) Agent(s) that compose the *VC* can be humans or artificial *Agents* (ie. hosts, processes) [CER 2003]. A wider definition of *Agent* (referred as the Rational Agent) is given in [LEM] and can be sumarized by these three capabilities:

- able to interact through the mediation of interfaces (human senses or artificial captors);
- able to manipulate the description of the exchanged objects (the Syntax);
- able to understand, capitalize and classify experiences (the Semantic).

As it will be mentioned in section 2, the common denominator between human and artificial *Agents* is that they follow the same

authentication procedure within a given VC trust.

c) *Service(s)*: that belong to the VC and are used by the *Agents* to perform interactions
The notion of *Service* may adopt various meanings depending on the considered level within the Maslow model. For instance, in the lowest level of the Maslow model an *Agent* requires basic bootstraping services for discovering and join an appropriate VC, whereas in the highest level this *Agent* may interact with domain specific learning services.

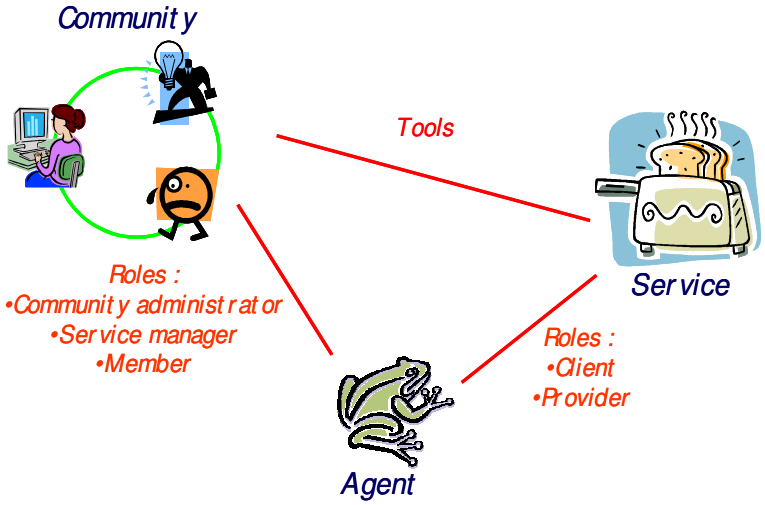


Figure 2: A CLS with its articulations between the VC, the Agent(s) and the Service(s)

Articulations in the CLS are symbolised in Figure 2 by the red links between the three components: VC, Agent and Service.

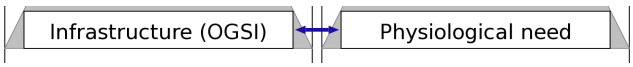
The Tools:
The VC requires services as tools to collaborate. Examples of basic tools are instant messaging or collaborative edition of documents. More sophistated novative training tools have been proposed within the EleGI project [D13]. But tools can also be basic bootstraping services that allow *Agent* to access to a VC.

The Client/Provider role:
An *Agent* may be in the role of service client or service provider at different instants. A definition of the cooperation link is given in[BRE 2004]: *Services are viewed as a special kind of cooperation in which the roles of the cooperating agents are no longer mutually exchangeable and equivalent [...]. Once the cooperation is planned, the execution of the task distribution - or, at least the part of the task distribution - is performed .*

The VC role:
Within a given VC , an *Agent* may occupy a role (eg. Service Manager) while this *Agent* will be on a different role in another VC (eg. Community administrator, simple member, etc.).

1. Existing as a member of a virtual community

The bottom layer of the Maslow model correspond to the vital ***Physiological Need*** to allow an *Agent* to find an interaction space where to feel confortable. In technical words, an *Agent* requires bootstraping services for discovering and choose to join a VC.
We have associated this layer with the ***Infrastructure*** provided by the Open Grid Service Infrastructure (OGSI) [OGSI].



1.1 Service requirements
At this layer, the service is a basic process which sets the VC interaction space and guide an agent to find its way and eventually suggest routes towards its personal learning aspirations.

For that, the main requirements are the *continuity* or the *availability* of the service. In fact, once the end to end connections have been established and the ressources properly allocated, any type of collaborative service will be provided by one or several service host. The availibility of these hosts has to be considered in the whole chain of service availibility. For this reason, hosts can be seen as agents of the VC since they infer in the whole trust chain.
A failure in a host may jeopardize the development of a VC.

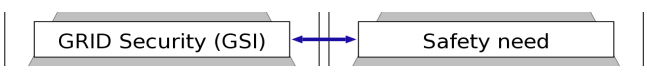
1.2 The Open Grid Service Infrastructure (OGSI)

Since GRID is a pervasive networked technology, this is a suitable candidate for providing the necessary service infrastructure for a VC.
The strenght of GRID services is the inheritance of the advantages of the Web Services (platform & language independant by using XML and use of HTTP protocol).
On top of that, the OGSI specifications have brought features such as service state management (transcient services, persistance), notification, group of services, dynamicity (time management) and handle/reference management (GSH, GSR).

The problem of host failure can be resolved with the capability of OGSI to manage services with distributed ressources. Therefore, VC can prevent host failure by deploying redundancy in the services.

2. Interacting with others in a safe and structured environment

The second layer of the Maslow model corresponds to the security needs to *give confidence* to an *Agent* in the services and VC is is willing to join.
We have associated this layer with the ***Security*** provided by the Grid Service Infrastructure (GSI).



2.1 Service requirements

At this layer, the service provides the necessary security means to offer authentication, privacy and integrity.

Since VC are beyond the boundaries of organisation domains, CLS must offer a secure environment.
This poses a number of challenges:

- how to be sure that every *Agent* is properly authenticated
- how can an *Agent* delegate tasks to other agents in a trusted manner
- how to ensure the integrity of shared data
- how to ensure the privacy of the conversation

2.2 Grid Service Infrastructure (GSI)

GSI allows to overcome these challenges by providing the four following features [GSI]:

- Mutual authentication: exchange of signed digital user certificates based on the X.509 standard.
- Delegation: signed proxy certificate valid for a short period of time
- Privacy: public key cryptography (also known as asymetric cryptography)
- Integrity: guaranteed by message digest algorithm using a hashing function

Mutual Authentication

Mutual authentication in GSI means that both part of a secure conversation must be authenticated. All type of agents (users and hosts) are concerned since communication may concern two people, one person and one host, or two hosts.
The process of authentication is an exchange of electronic certificates in X.509 format. A X.509 certificate is valid if it has been signed by a trusted Certification Authority (CA). The mechanism of delivering valid certificate applies for artificial agents in the same way than for human agents.
For mutual authentication, GSI uses the Transport Layer Security (TLS), a derivative of the Secure Sockets Layer (SSL). When an *Agent A1* initiate a connection with an *Agent A2*, *A1* first present its X.509 certificate. This certificate indicates to *A2* who *A1* is claiming to be, what *A1*'s public key is and who is the CA that has signed the *A1*'s certificate.
In practice, *A1* and *A2* have copies of the CA certificate, which contain the CA's public key. Thus, they know if the other agent's certificate has been really signed by a trusted CA.

Delegation
In order to allow features such as credential delegation and single sign- on, the GSI uses a solution based on GRID Proxy Certificate (GPC).
GPC is an extension to TLS that can be assimilated to a mandate in the way that it allows the holder to act on the behalf of another. The GPC is not signed by a CA, but it is signed by another agent.
Usually the lifetime of a GPC is very limited and can be restricted to a particular list of tasks.

Privacy
Privacy of information is ensured with key-based cryptographic algoritms. This process, known as assymetrical algorithm, consists to use two different keys to encrypt and to decrypt the information. The owner of the information encrypt the message with its private key and provide its public key to allow the receiving peer to decrypt the message.

Integrity
Integrity means that the recipient of data must be sure of that these data are conform to the original. The data could have been modified intentionnally or not. In order to ensure integrity, hash functions and algoritms such as the Message Digest (MD5) are used.
At both ends a communication channel, mecanisms of comparison ensure that the Message Digest are equals or determines whether there has been a transformation made on the object data.

3. Expressing and understanding each other's state of mind

The third layer of the Maslow's model correspond to the ***social need*** of the *Agent.*

Since the peer- group interactions is critical within a CLS, we propose for this layer a set of tools as services for *enhancing presence* [WRJB, 2000] among a VC. We have based our approach on the belief that sense of presence is more of a mental state that depends on knowing that the other peer is available.

Enhanced presence
Enhanced presence has been developped in the EleGI project through the deployment of an instant messaging tool called *BuddySpace* [EKD, 2003]based on the Jabber protocol. The particularity of this tools is its ability to provide a graphical visualization of people and their presence states into a geographical or logical map [RE 2002].

One of the technical challenge is to provide a Grid service based on this tool functionalities.

4. Providing services and assuming roles

The fouth layer of the Maslow's model correspond to the ***esteem need*** of the *Agent.*

4.1 Service requirements

At this layer, the service includes protocol elements for structuring conversations through speech or text messaging.

These protocols have been qualified in the EleGI project as *Conversational Processes*. There are several conventions in *Conversational Processes* that must be considered:

- Both part of a conversation must be recognised in their role.
- There are situations where roles in Collaborative Learning are symetrical or assymetrical.

4.2 Playing asymmetric roles in cooperation

Four roles can be distinguised inside the VC:

1. Community Administrator
2. Service manager (eg. tutor, system administrator)
3. Member
4. Simple visitor

Services are viewed as a special kind of cooperation in which the roles of the cooperating agents are no longer mutually exchangeable and equivalent.
In the first place, the initiative to request for a service -- i.e. to engage in a cooperation – is with one of the *Agents*, which also gets the role of client.
The other *Agent* becomes the service provider.
Once the cooperation is planned, the execution of the task distribution – or, at least the part of the task distribution that is selected as a service – is performed by the provider.

The behavioural norms are the result of some conventional distribution of actions (often based on attitudes, beliefs and common goals) that imply reciprocity. The latter is the reason that roles can also be viewed as complementary (social) relationships.

5. Learning through virtual interactions as a path towards self- accomplishment

The top layer of the Maslow's model correspond to the need for ***self acomplishment*** of the learning *Agent*.

5.1 Service requirements

At this layer, the service corresponds to a collaborative knowledge construction paradigm.
The interaction within the VC is not self centered around a knowledge gravity center (ie. a teacher) but rather based on collaborative constructivism. Agents construct their own understanding and knowledge of the real, through personal experiences, and reflect on those experiences.

5.2 A *socio- constructivism knowledge-building model*

Figure 4 , describes the phases that constitute a cycle of socio- constructivism knowledge-building [SB 2000] by considering learning as a social process.

The knowledge building process starts on the basis of tacit pre- understanding, which is related to learner culture, and it is enhanced via personal understanding cycle. When a learner has to resolve a new problem, he applies his experiences and knowledge; if the problem disappears, the new comprehension gradually settles in to become his tacit understanding and to provide the starting point for future understanding and further learning. But sometimes, the learner need to acquire the knowledge to resolve the problem through social interaction, communication, discussion and negotiation via social knowledge building cycle.

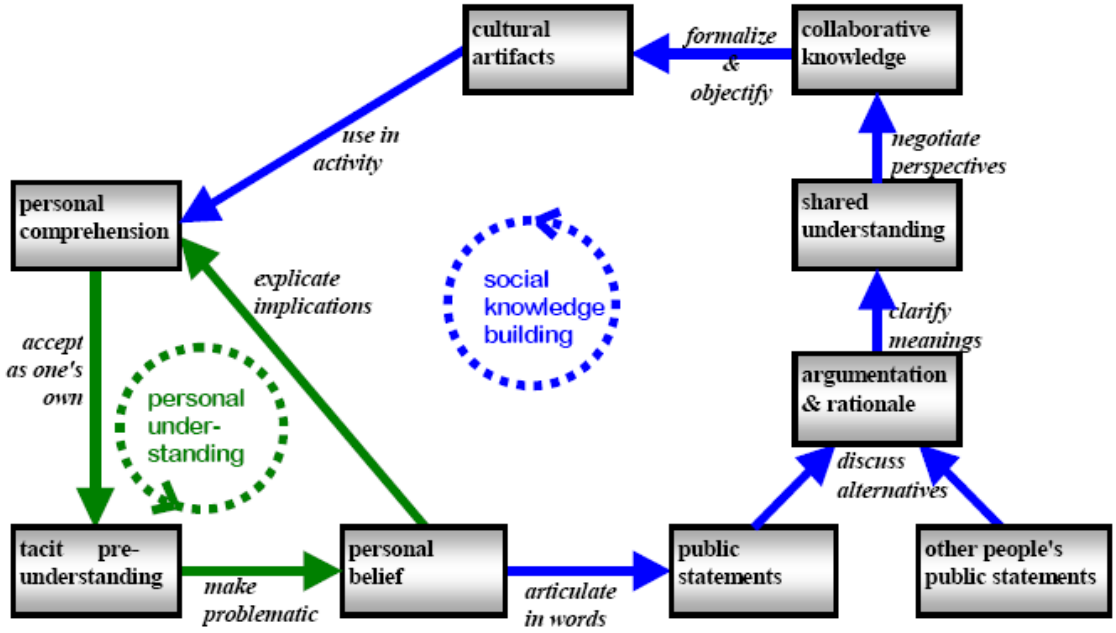


Figure 4 - Knowledge building process
(arrows represent transformative process and rectangles represent forms of knowledge)

This cycle starts when somebody's personal belief is articulated in words and this public statement is taken up in a social setting and discussed from the multiple perspectives of several participants. The original statements are thereby articulated into a more refined and extensive discussion on the topic, subject to conflicting interpretations. The opinion interchange may gradually converge on a shared understanding resulting from a clarification of differences in interpretation and terminology. If the negotiation of the different perspectives does result in acceptance of a common result, then such a result is accepted as knowledge.
So, constructivism promotes social and communication skills by creating an environment that emphasizes collaboration and exchange of ideas. Students must learn how to articulate their ideas clearly as well as to collaborate on tasks effectively by sharing in group projects. Students must therefore exchange ideas and so must learn to negotiate with others and to evaluate their contributions in a socially acceptable manner. This is essential to success in real world, since they will always be exposed to a variety of experiences in which they will have to cooperate and navigate among the ideas of others.

Conclusion

In this article, we have explored collaborative learning through the "motivational framewok" provided by Abraham Maslow and we have showed how GRID technology might prove enabling at each step of this path.

Our learner is not someone knowing exactly what s/he wants to learn and how s/he wants to learn it ; it is rather a person motivated by her/his own topics of interest and research and trying to improve her/his understanding. Neither is s/he motivated by technology : the less apparent, the best !

The following scenario underlines the key points of our exploration :

a. s/he first looks for a VC centred on his own topics of interset and research and becomes a member (GRID virtual communities are easy of access)

b. s/he then checks that s/he feels secure in such a VC (this is managed by the X509 certficates and the notion of GRID trust)

c. s/he progressively interacts with others using enhanced presence tools until I feel s/he can trust them (GRID enables enhanced presence tools)

d. s/he shares experiences and skills, becomes client for some services, provider for others, eventually s/he becomes a service manager, or even a community administrator (Semantic GRID is dedicated at knowledge collaborative construction)

e. s/he keeps on being an active member as long as s/he feels s/heis learning , which in our model is understood as her/his highest need.

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