An architecture of cooperative learning in a distance education context

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***Abstract**: This paper describes a virtual class which is based on the principles of CSCW (Computer Supported Cooperative Work) and ICAL (Intelligent Computer Aided Learning) systems. The virtual class proposed allows to a group of learners to participate in training sessions of an adapted tele-teaching system or adapted virtual class, this system takes into account progression rhythm differents inside a community of remote learners. The virtual class allows adapting the teaching system in a flexible, individual, and collective way. This system allows also the implementation of a pedagogical method: the cooperative learning. This implementation is being developed in a distance education context using the Internet and Java. The object modeling methodology is being used to specify an architecture of the adaptable virtual class.*

I Introduction

The principle of the architecture proposed for an adapted training service is to allow the adaptation of knowledge transmission from a teaching function managing a virtual group of learners by a communication system (figure 1). Teaching functions are distributed taking into account the participation of teachers, system, resources and learners in some cases (when a learner has the knowledge or experience necessary for playing the teacher's role).

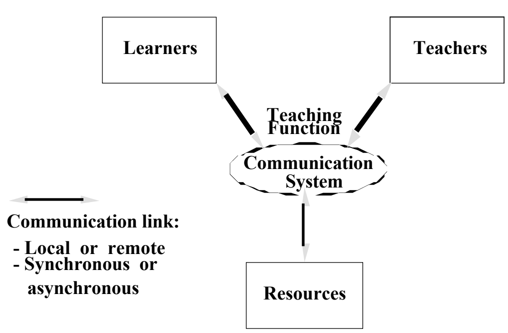


Figure 1: General architecture for each adapted training service.

The majority of learning telematic systems developed does not or rarely enable the system to control the teaching module. In general the teachers control this function, in the same way as traditional classrooms. In this paper, we propose for each adapted training service that the system allows distributing the teaching functionality with the participation of teachers, learners and resources in a virtual class system. We take into account two kind of sites in a multi-site environment for distance education.

a) The central site which provides a set of reusable SITB from a server.

b) The decentralized sites, which allow to learners to participate in an adapted training class.

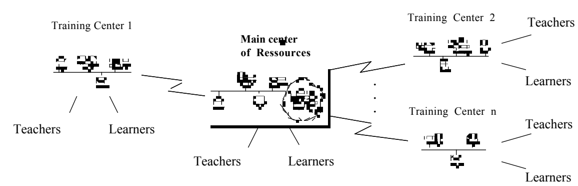
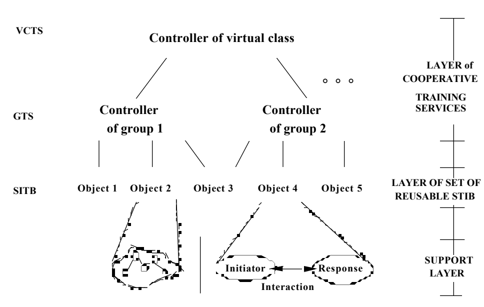


Figure 2: A multi-site environment for distance education.

II General architecture

In the multi-site environment of tele-teaching, we propose that any training site must be represented according to the ARESFED (In french: "Architecture pour la Reutilisation et l'Exploitation des Services de Formation dans le contexte de l'Education à Distance") [Hernández 95d]. This architecture is composed of three layers: support layer, layer of a set of reusable SITB (Service Independent Training Building Block) and a cooperative services layer [Hernández 95c], [Hernández 95d] (figure 3).



SITB: Service Independent Training Building Block
GTS: Group Training Service
VCTS: Virtual Class Training Service

Figure 3: Training architecture of a virtual class.

In this way, the representation of each training site is simplified and standardized. Thus, we must specify only one architecture: the ARESFED (in portuguese it is called ACVA: "**A**rquitetura de uma **C**lasse **V**irtual **A**daptativa").

II.1 Support Layer

It represents a set of frameworks from which the training architecture is built:
Information Space, provides information management services relevant to the courseware developed (for example: an object-oriented database management system stocks all the reusable objects).
Communication Space, supplies services supporting a distributed system and network service.

II.2 Layer of a set of Reusable SITB

This layer is represented by a set of functional, independent, and reusable components. These components will be shared and reused for creating a new service. We have identified with a participation of educationalists two kinds of resources: didactic (teaching activities) and information resources ("bricks of domain")[Canut 94], [Vincent 94]. From reusing of these types of resources a training service can be specified as a dynamic training service. The criteria of reusing of didactic and information resources are determined by learner's educational needs. The dynamic training service must diagnose an adequate resource that responds to learner's educational needs. In this way a dynamic training service is considered as an adaptable service.

II.3 Cooperative Service Layer

This abstraction level represents the two kind of cooperative training services provided by this architecture. We consider two kind of adaptable services [Hernández 95c]:

a) global level represents a virtual class composed of a set of remote learner groups and
b) local level represents a particular learner group; each remote learner group is classified by a knowledge level.

These two classes of cooperative services must be adaptables to learner's behavior in a training session.
The composition criterion of virtual class takes into account a pedagogical context; this pedagogical context is based on the cooperative learning [Doyon 91]. A virtual class will be composed of a set of heterogeneous groups, each group allows to a set of remote learners to participate to a training session. In a traditional class the homogeneity of knowledge level is not always assured. Some cases, this homogeneity of knowledge level becomes very superficial. For solving this problem, we consider a first level of adaptation to learner's educational needs; this first level corresponds to take into account a composition of a virtual class from heterogeneous groups. These groups have a variable composition [Hernández 95d]. Each heterogeneous group corresponds to a different level of knowledge allowing characterizing a group of learners with the same level of knowledge about a particular domain. However, inside a group of learners is possible to find different behaviors of learners according to progression rhythm of each learner. The second level of adaptation is taken into account into a group of learners. A particular knowledge level associated to a group of learners may also become superficial and not adapted. For preventing this problem, we propose to consider the behavior zones into a group of learners. In this case, it is necessary to allow and manage the change of behavior zone of a learner inside a group (*inter-group change*) for assuring an adapted knowledge level of learners inside a particular group (local view). For assuring an adapted virtual class (global view) is also necessary to allow and manage the change of group (*intra-group change*).

II.3.1 The Adapted Training Service of a Virtual Class Architecture

The adapted training service of a virtual class has as principal functions:

a) the managing of progression of a set of remote learners,
b) the controller of the VCTS (Virtual Class Training Service) takes into account a pedagogical, structural and adaptable control of a virtual class.

An initial composition allows creating a set of heterogeneous groups; this initial composition is based on a learner evaluation. However, for preventing that the initial distribution becomes static and not adapted during a training session, we must consider a *logical mobility of learners*. This logical mobility must respond to learner's educational needs according to behaviors detected of a group of learners during a training session. So, two levels of distribution of learners have been considered: *variable groups* corresponding to level of class and inside a group of learners, that is a set of *behavior zones* have been established (figure 4) [Hernández 95c].

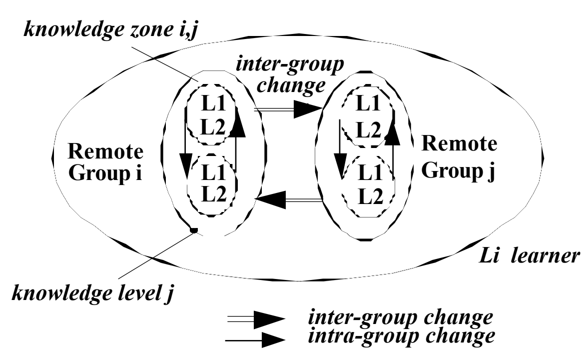


Figure 4: The distribution of learners in the virtual class.

II.3.2 Group Training Service (GTS)

A controller of a Group Training Service (GTS) must adapt a training session to learner's educational needs. The actors considered in a virtual class are remote learners, teacher and shared didactic resources (didactic and domain entities).

Activating didactic interaction represents a local didactic strategy. The controller of a GTS manages these didactic interactions.

The controller of a GTS must establish a dialogue with the controller of the virtual class. This dialogue allows indicating either a learner may change of group or a learner has a problem or a learner send a request (when he wants to express a problem or point of view).

We established with educationalist team three behavior zones inside a group, these behavior zones represent three types of possible progressions: normal, intermediate and critical zones [Hernández 95c]. The control of these behavior zones represents a *fine adaptation to knowledge level* and to learner's educational needs.

The architecture for each controller of a group training service (GTS) was specified in [Hernández 95d].

III Specification Object-Oriented of the Adaptable Virtual Class

The first step of the OMT (Object Modeling Technique) methodology [Rumbaugh, 91], is concerned with devising a precise, concise, understandable, and correct model of the real-world. We are going to show two models of Analysis process: Object and Dynamic models.

III.1 Object Model

III.1.1 Global view of the ACVA ("Arquitetura de uma Classe Virtual Adaptativa")

In the case of ACVA we represent each layer of architecture as a subsystem (figure 5). In this way, the global view of ACVA is represented by an object model, which takes into account the three subsystems of the ACVA. The object model notation used is the notation UML (Unified Modeling Language) which is equivalent to OMT notation.

III.1.2 Server of reusable SITB (Service Independent Training Building Block)

This server represents the layer of reusable SITB (figure 6). The coordinator of SITB must control the interactions with GTS (Group Training Service) and VCTS (Virtual Class Training Service) coordinators, and the recovery interaction with a learner or teacher.

III.1.3 Group Training Service (GTS)

A Group Training Service belongs to cooperative service layer (figure 7). The coordinator of Group Training Service has to manage: - the communication with the VCTS (Virtual Class Training Service), - the reusing interaction with the server of SITB and - the didactic control taking into account a didactic strategy. One coordinator of GTS allows to consider the behavior of group by behavior zones (which were specified in [Hernandez, 95d] and two kind of profiles: learner's profile and profile of group [Hernandez, 95d]).

III.1.4 Virtual Class Training Service (VCTS)

The VCTS also belongs to cooperative service layer (figure 8). The coordinator of VCTS has to manage: - the communication with each group, - the reusing interaction with the server of SITB and - the pedagogical control taking into account a pedagogical strategy. The coordinator of VCTS takes into account the behavior of each group and virtual class by two kind of profiles (profile of group and profile of virtual class).

III.2 Dynamic Model

The dynamic model shows three-dependent behavior of the system and the objects in it. Begin dynamic analysis by looking for events (externally-visible stimuli and responses). Then summarize event sequences for each object with a state diagram [Rumbaugh, 91].

III.2.1 Scenarios

A scenario is a sequence of events. We take into account some scenarios for "normal" cases. Each scenario is represented as an event trace (an ordered list of events between different objects) [Rumbaugh, 91].

Initial Composition

This scenario represents an evaluating class by a SITB, which is reused from server of SITB. The results of class evaluating allow establishing knowledge level for each learner, after that a set of groups necessary will be created.

Dynamic composition

During a training session is possible to establish (by one coordinator of a GTS) intra-group change (progression or regression). This change must be validated by the VCTS.

Human intervention in the teaching function

A teacher or learner can participate in a function teaching during a training session when a learner (or group of learners) establishes that a human contact is necessary. This participation may be taking into account one role to play (speak, ask, answer, inform, evaluate and tutor). A teacher or learner playing the tutor role may provide pedagogical aiding. A learner or teacher playing the ask role can ask one question to a learner (s).

III.2.2 State Diagrams

Each scenario or event trace corresponds to a path through the state diagram. We take into account one state diagram associated to each coordinator (coordinator of SITB, coordinator of GTS and coordinator of VCTS).

IV Conclusion

The architecture of the virtual class proposed is a response to traditional virtual classes, which are not adapted.
Works are in progress for implementing a server of reusable SITB in the object-oriented programming methodology domain. This server will be implemented using of Internet and Java; the access to server will be analogous to a learning environment. The same server will be also used for reusing a set of reusable SITBs and adapting them in a virtual class by Internet. A tutoring system also is being developed (using Java) to reuse a set of reusable SITBs from the server Internet.

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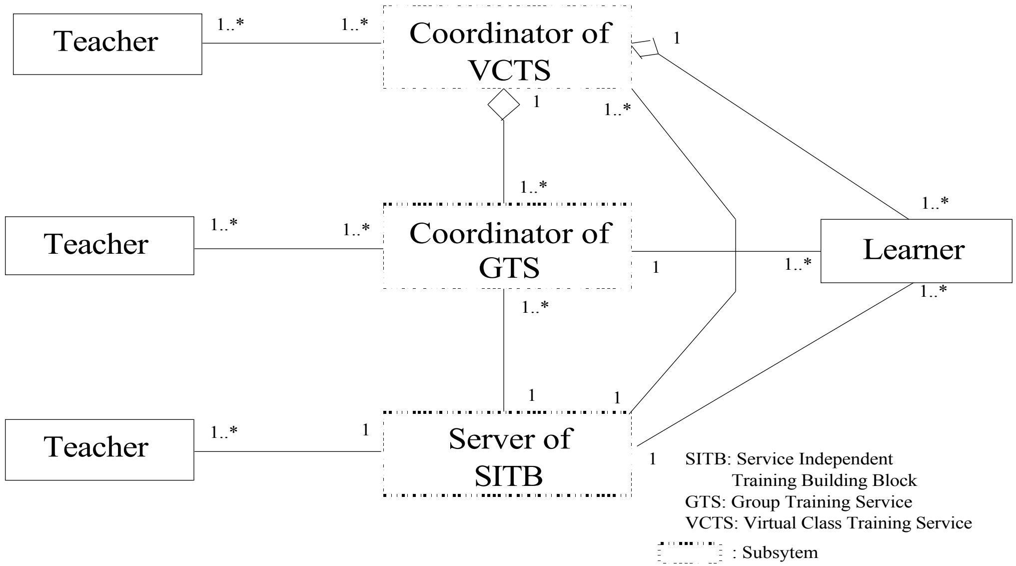

Figure 5: Subsystems of the ACVA (Unified notation).

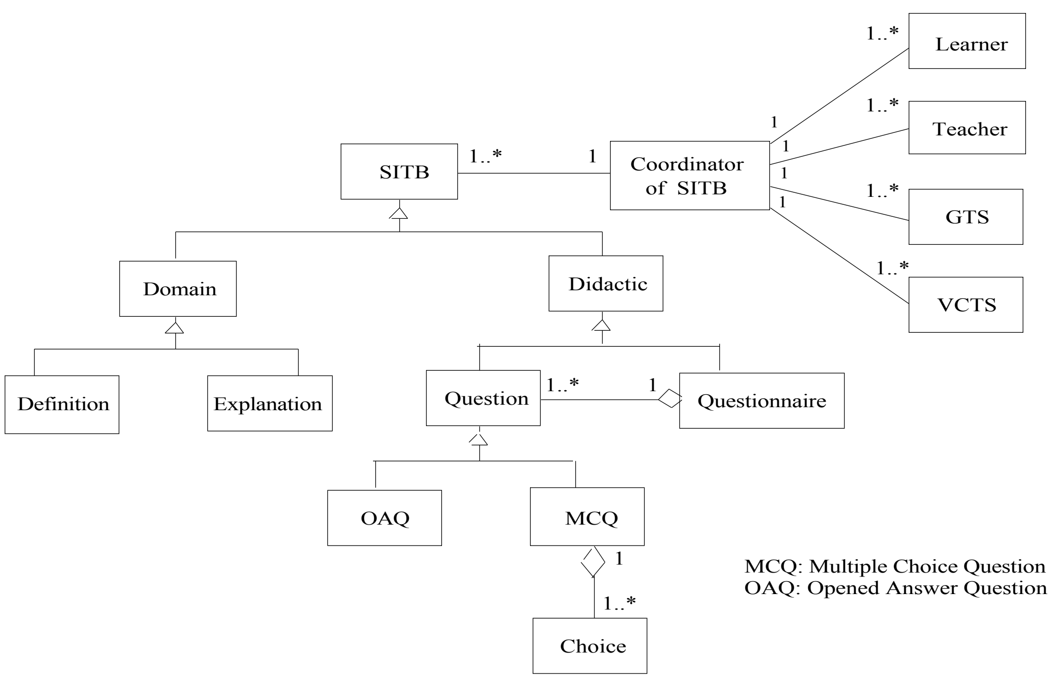

Figure 6: The server of reusable SITBs (Unified notation).

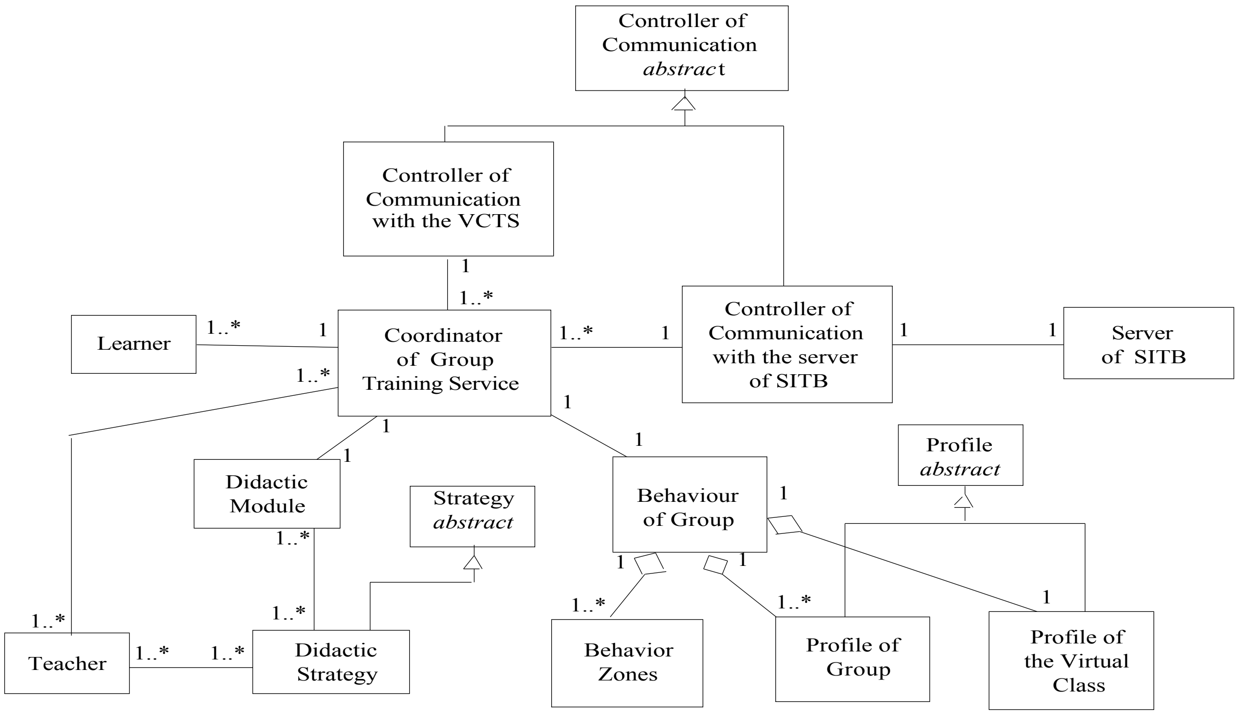

Figure 7: Group Training Service (Unified notation).

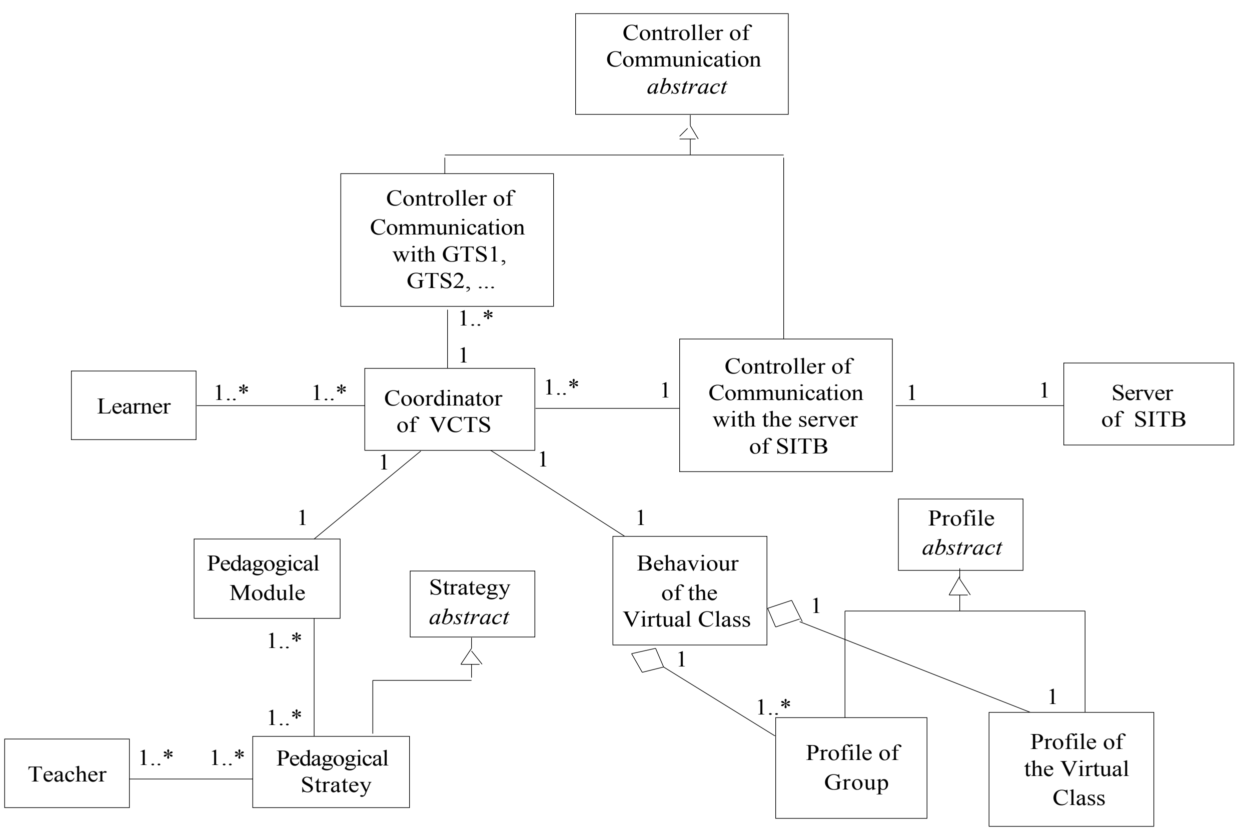

Figure 8: Virtual Class Training Service (Unified notation).