Facilitating Perception on Virtual Learningware based Environments

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ABSTRACT

Questions related to perception in groupware systems have received a lot of attention in recent Computer Supported Cooperative Work (CSCW) studies. This paper presents a model of support of perception for a groupware approach based upon communication, coordination and cooperation. The suggested model is applied through learningware technology. The AulaNet learning environment was used as a source of experiences for development of the proposed model. The conception of a new service, implemented on AulaNet to illustrate the utilization of perception information, also is presented. Some of the problems that have been encountered, questions of implementation and difficulties derived from the addition of new functionalities, are highlighted throughout the paper.

I Introduction

The facility with which information is distributed via the Internet and the growing need for knowledge we are currently seeing increasingly have been motivating the use of groupware basics and the World Wide Web for the creation of virtual training space and/or collaborative learning. The potential of the Internet has been well received by schools, universities, governmental organisms and commercial organizations that are interested in promoting and creating learning environments [Lucena & Fuks et al. 1999b].

The research area that deals with topics that are related to collaborative learning through computers is cited in the literature, such as Computer Supported Collaborative Learning (CSCL) and is considered a subdivision of CSCW [Heeren 1996] dedicated to educational applications. On the Internet2 [Internet2 2000], learningware is the expression used to denominate groupware that is dedicated to collaborative learning.

In this scenario, the elements of communication and coordination invariably have been related and are studied with the idea being to facilitate the work [Easterbrook 1995, Fussell et al. 1998] and the collaborative learning [Lucena & Fuks et al. 1999].

The use of resources distributed on the Internet may hide information that would easily be available in a face-to-face scenario. As a consequence, work carried out together through groupware, that is based on digital technology and distributed, apparently may seem inefficient and wearing compared to face-to-face work [Gutwin & Greenberg 1999]. The act of perceiving is important for coordination with other individuals in collaborative tasks on distributed systems, where the mechanisms of interaction are different than the usual ones [Fussell et al. 1998]. Perceiving other individuals is an significant factor in the flow and naturalness of collaborative work. To make perception possible can be seen as a way to reduce the characteristic feeling of coldness engendered by remote collaboration.

Research related to groupware offers data for the introduction of new concepts into the study of work and collaborative learning. However, there is very little in the way of contributions on this when the theme is learning. The collaborative support tools may also support interaction between the participants of a distributed learning environment. A study about perception within this context is an attempt to fill in the current gap of research into collaborative computing related to Web–based learning.

The studies that have been conducted have resulted in the addition of new functionalities to the AulaNet environment. The AulaNet project began in 1997 at the Software Engineering Laboratory
LES) of the Computer Science Department at the Catholic University of Rio de Janeiro. The AulaNet furnishes an environment to facilitate the generation and maintenance of courses based on the Web [AulaNet 2000]. The tool was built based on the notions of communication, coordination and cooperation mechanisms. Some of these mechanisms were selected and contextualized as part of the learning. The environment has been structured in such a way that the teacher, the student and the administrator are players involved in the teaching/learning process.

The conception of a new mechanism, developed on the AulaNet in order to illustrate the use of perception information, also is presented. Some of the problems that were encountered, questions of implementation and difficulties stemming from the addition of new functionalities, are pointed out in the paper.

II Perception and Groupware

This study considers perception to be the knowledge created by the interaction of individuals and the environment to which they are related. In this sense, the concept of perception can be defined as “knowledge of what is happening” [Endsley 1995] and of what to do. This conception of perception involves states of knowledge, such as the dynamic process of perception and of action as a result of what has been perceived.

This article proposes a relationship between groupware concepts—communication, coordination and cooperation—and integrates them with another concept that is related to groupware, perception [Assis 2000]. The intersection points between perception and each one of the mechanisms are highlighted in order to analyze where there is a need for some perception information, and if some perception information can be generated. The analyses are used for the creation of a diagram of the relationships of the fundamental groupware concepts.

II.1 Perception and Communication

Communication is understood to mean the sharing of information. That is, to cooperate in one form or another with an individual or group of persons. However, communication can take place on a number of different levels and in different manners. The relevance of the information that has been communicated can only be acquired through an understanding between the communicator and the receiving party. It means that the information must be perceivable within the context in which it has been inserted [Delvin & Rosenberg 1996] and the rules inherent to the establishment of communication, appropriate means and relevant information, among other factors.

II.2 Perception and Coordination

Besides an understanding of the information that has been exchanged, the members of a work group need to be committed to the work. This means that the action must be coordinated so that there is no loss in the communication effort that would make cooperation more difficult. Shared knowledge [Easterbrook 1995] of a given situation will occur if the work group has the equivalent expectations regarding the action that will be taken.

The expectations are interpretations of the perception information that is needed to understand the situation and for a prognosis of how to develop the goals that have been established for the action to be taken.

The “situation” that has been mentioned possesses a contextualization role. Except for a private situation, the information loses relevance, no longer ensuring that the shared understanding is maintained and, thus, there is no way to guarantee the group’s participants will have the same expectations in different situations [Delvin & Rosenberg 1996]. The perception of the situation is the understanding of an interaction episode associated with the environment in which it occurs.

II.3 Perception and Cooperation

The interaction between individuals, or between an individual and the artifacts of a work environment does not consist of a collection of unrelated acts. As a result of interaction, there is a series of new happenings that implies an information set that, in turn, generates a cognitive structure in which individuals seek knowledge in order to plan and coordinate subsequent interaction [Neisser 1976].
Shared interaction space, not necessarily the same physical space, is needed for shared understanding. This space is supplied through the tools and artifacts that permit the movement of information and facilitate contact between humans.

Perception from the point of view of collaboration has functions on various levels [Dourish & Belloti 1992]. On the most abstract level, perception of the characteristics of the content of the actions of other participants makes it possible for individuals to structure their activities, thus avoiding duplication of work. On the most concrete level, there is perception about the content of each participant’s actions, which makes it possible for more perfect distributed and shared work as well as a group effort towards work, factors that need to be present in collaborative applications [Sohlenkamp & Chwelos 1994].

II.4 Modeling Group Work

When decisions and success depend upon the integration of the efforts of different members of a group, it is important that each member knows the work of his or her companions—what remains to be done, preliminary results, etc [Fussell et al. 1998]. For this reason, a groupware environment must provide information to its participants regarding what to do and what their colleagues are doing.

The term information of perception (or awareness information) is used to describe this follow-up of the progress of the group’s activities or production. Essentially, this information forms a context for individual work, with a comparison being the activities of the rest of the group. The context is used to ensure that contributions that have been established are appropriate to the group’s activities and to the process of collaborative work. Without such a context, the individuals are unable to measure their own work with respect to the group’s objectives and progress.

Another situation in which information of perceptions must be presented occurs when an individual needs to know what to do in order to continue working. This type of information is not always associated to the rest of the group’s knowledge of the work. In this case, there is a need for the use of some type of communication mechanism, or the availability of some repository of such information within the environment that indicates what steps to take. Based on this fact, we propose and introduce a model of groupware concepts. This model is shown in Figure 1.

![Figure 1 – Coordination Diagram.](image)

What can be observed in Figure 1 is the occurrence of a cycle indicating that the persons should communicate in order to coordinate their work efforts and cooperate on an objective. For cooperation, there is a need for communication, whether or not it is direct or through information obtained within the environment where the work takes place. In each relationship there is a stimulus supplied by information of perception that permits the occurrence of shared knowledge about a task or with the entire group. Being aware of all of the activities of their colleagues and of the impacts to the knowledge that is generated by the collaboration, the participants will have information that helps them synchronize the work, coordinating themselves around their individual contexts (see section II.2).

Once the process has been initiated so that communication takes place, there is a necessity for perception about the communication domain. Once these elements are available, as mentioned the communication—whether through direct or cognitive information—will generate information of
perceptions for the coordination of individuals around their own work context. This is the notion of group work progress and the paths to be followed for the work effort. In the event there is neither a communication problem nor any incomplete information, the shared understanding mentioned in section II.2 will occur. The understanding will permit that the shared space for the establishment of collaboration be available to the team's individual members. In the event these conditions have been characterized, as of the moment of the coordination of the group, then group work will be taking place.

It should be mentioned that each stimulus of the groupware mechanisms would once again generate information of perception within the work environment in view of the fact that new occurrences are taking place in terms of the progress of the work.

The representation of how to place perception in relation to the communication, coordination and cooperation mechanisms shown in Figure 1 presents various input stimuli and an output stimulus. This means that various events of the participants of the group, whether voluntary or not, must have a perception element that generates feedback for the coordination of the members of the work group. Thus the design of the relationship could be defined as the coordination diagram, where each mechanism generates new elements that must become perceivable in order to increase the group’s shared knowledge, thus facilitating cooperation.

Another problem that should be emphasized is that a non-manageable quantity of feedback can be undesirable. This information overload can place difficulties in the way of the organization of a group’s participants in terms of the work that is being carried out. The overload contributes to the poor management of information, causing misunderstandings and a lack of communication [Easterbrook 1995].

In this scenario, what is seen is that the generation of feedback requires a certain control in order that there is no overload. A new concept that helps in the modeling of perception must be introduced: the information “flow control.”

III Modeling Perception

In order to implement support for perception within a groupware system, the developers need to know what perception information a groupware system should capture regarding the interaction of other individuals in the environment and to consider how this information should be presented to the other players.

The proposed solution for these considerations unites a number of different experiences and points of view that are present in the CSCW literature [Brinck & McDaniel 1997, Gross 1997, Vertegaal, Velichkovsky & Van der Veer 1997 and Gutwin & Greenberg 1999]. The next sections present aspects that have been chosen to characterize the perception information.

III.1 Perception Mechanisms

By knowing about the communication, coordination and cooperation mechanisms, and especially how they should be used to maintain different elements of perception, the project developer of a shared virtual environment will be able to create the techniques and tools that will provide users with the proper information about goals, tasks and the other members of the environment. A primary distinction between the mechanisms is if the perception information should be explicitly generated, directed and separated from the subject of the shared work, or passively collected, distributed and presented within the same shared environment as an object of cooperation [Dourish & Belloti 1992].

The purpose of this section is to emphasize the mechanism that facilitates the flow of information in shared environments and that captures the complexity of the situation, having sufficient specifications to be of use to the project developer. It is necessary to say that a perception mechanism does not exist by itself in groupware and will be implicit in the mechanisms of communication, coordination and/or cooperation as seen in subsection II.4.

A number of definitions about perception mechanisms can be found in [Gutwin, Greenberg & Roseman 1996] mentioned as awareness mechanisms, although in this paper only the environment control mechanism and feedback was explicitly implemented.
### III.1.1 Environment Control and Feedback

The work group participants affected by some of the changes to the state of the situation of the data present in the environment or in the tasks that are being carried out must be notified through the appropriate communication mechanisms. The choice of the correct means of communication helps avoid information overload and the poor interpretation of data. Not all alterations must be presented to the group. Sometimes, they should remain available in an appropriate file for subsequent access, or not even exist at all, depending upon the situation (defined in subsection II.2). Moreover, the information can be related to other information. The control characteristic of this mechanism is responsible for managing the information.

### III.1.2 Analyzing Perception Mechanisms

The purpose of these mechanisms is the same as for any other groupware technology. Thus, as communication mechanisms offer their own ways of letting individuals communicate with each other, coordination mechanisms offer ways for organizing and understanding work and cooperation mechanisms exist to facilitate collaboration between individuals in a group, the purpose of perception mechanisms is to provide shared understanding. It should once again be emphasized that the difference of these mechanisms from the communication – coordination – cooperation mechanisms is that perception mechanisms do not possess their own functionality if they are not associated with one of the other mechanisms.

The name mechanism was selected in order to characterize its definition. However, what is important is what meaning is given to it. Similar functionalities already have been presented in the literature, as previously mentioned [Dourish & Belloti 1992 and Gutwin, Greenberg & Roseman 1996].

The environment control and feedback mechanism presents an idea of an environment controller that carries out operations that are invisible to the group. The information that is dealt with in the groupware can be managed by the environment control and feedback mechanism through shared access to the information residing in a repository. It is necessary to understand that the mechanism also is responsible for the control of information that is under its “responsibility.” The concept of generation of information and control were not separated into different modules because such a division only makes sense upon implementation and, thus, there is no need for differentiation at this stage.

The use of perception mechanisms to favor shared understanding facilitates the search for information and simplified communication, as well as making it possible to anticipate actions and provide assistance for the group’s work. In this way one may conclude that the perception mechanisms aid in the coordination of individuals with respect to cooperation.

### III.2 What to perceive?

An exhaustive study could be conducted in order to help discover these elements although, for this paper, the data from the outside literature is considered seeing how there is much about the subject that already has been catalogued (see [Dourish & Belloti 1992, Sohlenkamp & Chwelos 1994, Easterbrook 1995, Gutwin, Greenberg & Roseman 1996, Brinck & McDaniel 1997, Vertegaal, Velichkovsky & Van der Veer 1997, Fussell et al. 1998 and Gutwin & Greenberg 1999]).

The basic set of elements answers the questions “who, what, where, when and how” [Gross 1997]. This means where they are working and how the events happen. The individuals seek to be aware of this information in all types of cooperative work. It is the type of information that must be taken into account by project developers after defining what will be the context of the work.

The elements provide a basic vocabulary for the analysis of perception aspects with regard to groupware support. With this information, the virtual systems project developer can analyze, for example, how face–to–face situations would be translated to a groupware environment. Some of the elements mentioned in this section can be found in detailed form in [Vertegaal, Velichkovsky & Van der Veer 1997] as awareness elements.

In this article, the element in focus is knowledge that has been acquired and generated during the course of the work and that can be made concrete, generating a product that can be analyzed. It can be concluded that the presence of perception elements that characterize group production in a
way that permits that concepts established as pre-objectives be taken advantage of *a posteriori* is useful to the solving of other problems (Table 1 and Table 2).

<table>
<thead>
<tr>
<th>Category</th>
<th>Element</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>What</td>
<td>Production</td>
<td>What are the preliminary results of the work</td>
</tr>
</tbody>
</table>

**Table 1 – Production element relative to the present.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Element</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>What? (past)</td>
<td>Production History</td>
<td>What experiences have been made concrete in the work</td>
</tr>
</tbody>
</table>

**Table 2 – Production element relative to the past.**

Other types of information that are specific to an objective will occur. However, this basic set of elements provides a high-level organization in order to facilitate perception in shared environments. The elements related to the present characterize the information that should be dealt with and generally distributed as feedback.

The interest of this study in production will be better explained later in this paper.

## IV Application of the Model

The purpose of this article is not merely to deal with generic environments and work groups without characterizing how these environments function and what will be the possible roles of their players.

There is still no way to prove the usefulness of the model that is being presented except through comparisons to work carried out by the previously referenced research.

The players in question are defined by the technology that is being employed and by the environment itself that is being modeled. The next steps to be taken are to characterize an environment for the use of these concepts and to define the restrictions imposed on the coordination diagram by the technology that is intended to be used. This means that the model that has been presented needs to be associated with other environment models.

Many authors consider the perception concept to be a critical factor for the development of groupware on the Web [Dix 1996] and for the planning and conception of cooperative learning [Dushastel 1997].

The use of the Internet as a location for the publication of the content of a course, presentation of tutorials, conducting of tests and communication with learners, besides using the Web for presenting multimedia conferences in either synchronous or asynchronous form, is known in the literature as Web–based Instruction, or WBI [Khan 1997].

This study considers that learningware, which deals with cooperative learning, is an instance of groupware and, for this reason, is proper for using perception within a communication – coordination – cooperation model. The application of the perception model also can help perfect coordination in cooperative learning environments.

The experience of the AulaNet cooperative learning environment is taken advantage of for use of the concepts that have been presented. The insertion of perception models in the AulaNet environment architecture also is presented. The implementations that have been carried out to verify the concepts in practice also are illustrated and discussed in order to define more concretely some solutions to the problems related to perception.

### IV.1 Perception and Development of Learning

The learning period consists of an action based on acquired knowledge followed by an opportunity for reflection about the action and its results and consequences [Johnson & Bragar 1997]. The active learning process of the constructivist theory of Vygotsky [Vygotsky 1989] may begin with the action or the reflection:

- The process can begin with an action that is worked and matured until it is established as knowledge. The new knowledge provides reflection opportunities regarding new ways to resolve problems;
- The active learning process also can be initiated with a reflection. The ideas are used as a guide to future action.
Figure 2 presents the influence of the productions that derive from the action-reflection process of the participants on the objectives of the learning process in productions that stem from the contexts of other learners. Each box represents an individual's learning process. Each node represents a part of the knowledge that has been generated. The arrows related to the nodes indicate the preliminary influence of part of the knowledge in the conclusion about the learning process, represented by the last node. Note that the knowledge established by a learner during a task can influence the knowledge established by another learner (action–reflection 1 influences action–reflection 2). It is interesting to point out that the perception about an individual’s knowledge node can influence the establishment of somebody else’s knowledge (action–reflection node 2 influences action–reflection 3). Something else that can occur is that one of the knowledge nodes established by a learner can influence another node of the learning process of another learner (a node in action-reflection 2 influences a node in action–reflection 3).

The purpose of the action-reflection process is to supply learners with the opportunity of being potentially perceivable to habitual interpretations and forms of behavior besides planning and practicing new ways of interaction based upon reflections about previous actions.

The accompaniment of the interactions and the generation of knowledge helps in the elimination of the sense of loss stemming from the WBI and facilitates the connectivity process, avoiding the loss of relevance that occurs with tasks that are carried out over a period of time [Hill 1997]. The consequence is that the learners can consciously examine and compare their own contributions to the course and generate new knowledge to guide future contributions.

Regarding the teacher, the interactions make it possible to accompany the participation of the learners, thus facilitating evaluation. The experimental process that stems from the activities destined for perception [Langenbach & Bodendorf 1997], with interactive processes based on action and reflection, generates course experience that allows it to be refined in future versions.

Accompanying the learning processes is fundamental for establishment of shared understanding between learners and teachers, seeing how the learners can be engaged in activities without losing notion of space and time. The teachers can verify how the learner is doing, constantly checking up on what is desired and interfering when necessary.

The evaluation of the participation, when applicable, can be accomplished through the verification of the quality of the contributions. The experiences that have been obtained in a course are always important in order to correct learning mistakes, providing means of detecting errors during the instruction preparation stage or even in the tool that generates the distance-teaching environment.

It is convenient for this study to take advantage of the experience acquired through the Information Technology Applied to Education course (ITAE) [Lucena, Fuks & Assis 2000] offered by the Computer Science Department at the Catholic University of Rio de Janeiro, and that is being delivered using the AulaNet tool.

IV.2 Facilitating Perception within the AulaNet Environment
The AulaNet separates authorship of content and the programming effort necessary to implement navigation. In this way, the AulaNet supports interaction but does not interfere in the authoring of didactic content, which is conducted offline and, thus, outside of the environment. The teacher can act as project developer, content provider and instructor on the AulaNet. His or her interface with the environment lets him (or her) design (coordinator), organize didactic content (co-author teacher) and conduct the course (instructor). In the authoring phase of a course, the coordinator acts as project
developer, defining what the virtual environment where the activities will take place will be like. Then, the mechanisms used by the environment are presented.

**IV.2.1 Communication Mechanisms**

**Message to the Teachers** allows learners, through the environment's internal e-mail system, to contact their instructors, possible co-authors and the course coordinator.

**Discussion Group** permits the creation of a discussion forum between the participants of a course via the environment's e-mail system. Each message that is posted is sent to the mailbox of all of the participants of the course, besides being stored within the environment for future consultation.

**Interest Group** allows the creation of asynchronous textual conferences in the form of discussions oriented toward a topic. The teacher creates and names these conferences. In this mechanism, the message that is posted is not sent to the mailbox of all of the course participants, and only is stored within the environment for future consultation.

**Debate** permits the creation of synchronous textual sessions through a chat tool.

**Participant Contact** allows a participant to communicate synchronously in text format with whoever is connected to the environment. Learners can find a course and exchange messages while they look at content, navigate through the environment and carry out tasks.

The AulaNet is mainly designed for asynchronous communication favoring consumption on demand. This factor offers students the liberty of choice in order to assign their learning tasks according to their possibilities.

**IV.2.2 Coordination Mechanisms**

**Notices** makes it possible to create announcements regarding the course or to schedule events through releases.

**Lesson Plan** makes it possible to create a basic structure to accompany the course's didactic content. The lesson sequence is not predetermined, allowing students to take classes without a defined order.

**Tasks** permits the creation of work and exercises to be carried out by the students. The others can call up each student's work in the event this is the teacher's work method.

**Evaluation** is designed to create exams for the (self-) evaluation of a course's learners. The AulaNet makes it possible for a teacher to create online tests to evaluate the learning process. The environment's objectives are: help the author create tests for a large audience, give out grades and receive feedback from the learners.

**IV.2.3 Cooperation Mechanisms**

**Bibliography** makes it possible to create bibliographic references for the course.

**Webliography** permits adding external references (URLs) to the course Web site.

**Documentation** makes generic content linked to the course available, different than the lesson plan. The co-author teacher can set up a book containing his or her articles, for example.

**Download** makes it possible for a student to see a list of all of the files that make up the course content and transfer them to his or her machine’s or the local network’s hard disk. This makes it possible for a teacher to invite other teachers as well as learners to share his or her work area so that, together, they can build knowledge.

**Teacher Co-Authoring** allows other teachers to participate as co-authors of the course. This mechanism should be used to define the course’s content creators. Co-authoring teachers also can select mechanisms.

**Learner Co-Authoring** allows the indication of students for the creation of course content. This content should be certified by the teacher before its use in the course.
IV.2.4 Environment Architecture

In order to implement the feedback theory and the flow control (section II.4) as a perception mechanism, two new modules were added to the AulaNet architecture. The AulaNet environment’s central module activates the control flow and feedback management modules, also through APIs. The Flow Manager module is responsible for dealing with perception information as well as taking care of questions of persistence, storage, updating, removal and recovery as requested by the central module.

The Feedback Manager module makes it possible to access the data by supplying information about the use of services to the participants, or other modules take part in this action. So that feedback effectively is furnished, access to other components of the architecture is necessary. This module is responsible for supplying information and bases itself on the parameters that have been designed for the perception of the participants of the learning environment. Examples of feedback are the definition of the keying up between video cameras, the management of a chat broadcast service access based upon use restrictions or the sending of messages by electronic mail.

The implementation of the behavior of the feedback module depends upon the functionality of the service that is in use. This is what really occurred with the addition of the new AulaNet functionalities. In fact, only the communication between the feedback manager and the electronic mail module were implemented. This connection was the only one that was necessary in order to implement the new characteristics proposed for the AulaNet. The implementations that were carried out are presented in the next sections after this chapter. In the next section, the perception modules are isolated so that their components can be better explained.

IV.2.5 Incrementing the AulaNet

The change in versions of the AulaNet environment provided a major opportunity for insertion of new functionalities into the environment in order to satisfy certain demands encountered while using the tool in the initial versions.

The lack of mechanisms that permit the follow-up of participation in the tool was the reason for the introduction of the concept of perception information management in its implementation. In the environment there are a number of services that allow learners to control the learning dynamics and they stress the importance of the learner’s participation. It would be interesting that the information about participation be available in some fashion to allow for analysis of the productions and knowledge that have been generated by the course.

A theoretical question for the planning of Web-based courses involves the control of the learner’s activities. Following the constructivist theory, the learners themselves select and sequence the educational activities and create their own learning opportunities in order to satisfy their needs. The AulaNet seeks to make this type of theory possible by designating a tutorial level for the instructors in a way that facilitates the learning process.

Statistics related to the participation by learners help in the evaluation of the process and are taken into consideration for the generation of reports. The objective of generating participation reports is to help accompany the learners through the various events of the course and the appreciation of the quality of the product that has been generated for this participation from the teacher’s point of view.

The teacher will be able to require the participation of the learners who continue to behave as if they were in a traditional educational model. For their part, the learners will increase their perception about the environment. In practice, during the course this perception will help them form a context about their work, having the activities of the rest of the group for comparison (section IV.1). The context is used to ensure that the contributions that have been established are appropriate to the group’s activities and the cooperative work process. The perception also will aid in the identification of leaders and in the search for the more competent colleagues in order to resolve the tasks required of work as a group.

The mechanism that is associated with obtaining the productions was denominated “Participation Follow-up.” This mechanism helps fill in the gap that existed on the AulaNet with regard to some of the requirements of the learning development process, which are: the review and follow up of the progress of the learners and management of any necessary intervention; and the provision of reports on the results of the learning process [Internet2 2000].
The first step in the conception of the mechanism is to define what environment services should be considered as generators of “participation + participation product”, characterizing the effective participation of the learner. It makes no sense to catalogue all of the environment’s services in view of the fact that the mechanism is not designed to generate administrative statistics but, rather, to help teachers and learners in the development of the learning process. The next sections will analyze the services that have been taken into consideration. Immediately afterwards, the new mechanism is presented.

**IV.2.6 Services and Contributions**

The AulaNet services that denote the realization of “participation + participation product” are: Message to the Teachers; Group Discussion; Interest Group; Debate; Tasks; Evaluation; and Learner Co-authoring.

The other services were not considered because they generate no content that is available to be run. Without access, there is no way to verify the relevance of the contribution and to define if use of the service was a simple access or not.

**IV.2.7 Defining the Perception Elements**

The perception elements that were considered for the implementation were Production, as previously mentioned, and Reach [Gutwin & Greenberg 1999]. The Reach element was needed because a simple access by a participant to a service does not always signify production. On the AulaNet, Debate and Learner Co-authoring require registration by the instructor in order for access to be considered. The product properly speaking is perception information. In the AulaNet concept, this product was denominated contribution. The contribution characteristics also can be altered. It is up to the instructor to carry out these readjustments. The next section presents the implementations that were realized on AulaNet services in order for them to operate in a way that supplies perception information.

**IV.2.8 Participation Follow-up**

Based upon the implementation of perception support regarding the contributions of the participants of a course, a new coordination mechanism was developed: Participation Follow-up. The development of this mechanism seeks to answer some of the questions discussed in section II. The main motivation was the proposal of a coordination diagram in which the groupware mechanisms generate perception information that, in turn, supplies coordination elements for an environment’s participants. The basic functionality of the coordination elements is to take advantage of the perception elements, which are also denominated awareness tools [Fussell et al. 1998]. The main idea of the new mechanism is to get information from the use of some AulaNet services and put them together so as to provide information of perception to the users of the environment (as stated in Figure 1).

The Participation Follow-up mechanism’s objective is to supply information about the progress of the activities being carried out by a group’s participants that can be viewed in the participation reports mentioned at the beginning of this section. This is one of the pre-selected AulaNet environment mechanisms. When a course is created, the follow-up will be a part of it, unless the teacher removes it. In this case, the learners will no longer have access to the reports. However, the instructors still can access them. This occurs because, based upon the different analyses carried out in this work, it was considered that the participation follow-up is a fundamental part of the development of the learning process.

The report service is made available to the follow-up mechanism through the AulaNet consumption interface. The page containing the report options can be seen in Figure 3.
Many different types of reports can be generated. On the AulaNet, the reports were separated by Course Event, Participant and Service. Figure 4 shows one of the reports that classifies the contribution of participants in course events.

Each report has a specific purpose. However, in general the report service seeks to position instructors and learners in relation to course happenings. For example, the reports present the attendance numbers in order to provide information about how to quantify class behavior. They also provide an analysis of how each participant in particular behaved in relation to the group in general. The reports about the use of services help to discover any deficiencies that learners may have with regard to their participation. Other reports could be added to those that have been implemented, but these were considered to be sufficient for the initial composition of the mechanism.

The furnishing of reports is an alternative designed to minimize learners’ sensation of being “disconnected” [Hill 1997]. In one of the non-enrollment classes of the ITAE course during the first semester of 1999, of 20 initial participants only seven really were active. A frequent complaint of those in the active group was that the dropouts made the course monotonous. In reality, some 230 contributions were generated for the course between seminars (posted by the discussion group), debates or on topics from the interest group. It is a considerable quantity when compared to the 350 contributions from a class of 15 students effectively enrolled during the same semester. It is evident that the generalized lack of a notion about how the course is going can frustrate the learners. In the case of the reports, the information about contributions wound up positioning the participants in the course events, thus diminishing frustrations.

IV.2.9 Evaluation of the Contributions

Being able to properly evaluate the learners is a fundamental part of the effectiveness of a distance learning course. The AulaNet has an evaluation mechanism that is based upon the manipulation of questions for the construction of an exam designed to test knowledge that has been acquired during the course.

Testing the understanding of a class of learners is only one part of the evaluation process. Analyzing the amount of participation also helps to check how well interaction in the learning process is going. Judging the quality of the contributions that have been made completes the cycle. Grade information was added to the Perception Information in order to satisfy this new aspect.

Only the instructor, based on the Reach element, has permission to judge the contributions. After they are completed, the contributions related to each service are stored for future access. The grades remain visible to all participants in the class through the reports, or together with the contribution itself, depending upon the functionality of the service. The attribution of grades for a contribution from the interest group can be seen in Figure 5.
Not all service content can be available to be accessed. That is why the cardinality of a grade can be 0 or 1. That is, the contribution may or may not be graded. The debate content also is not stored. Nevertheless, the instructor records the debate soon after a chat session. That is why on the visual interface of the debate the instructor can grade the participants. The interface can be seen in Figure 6.

The AulaNet allows teachers to define a course’s grading intervals. The mechanism works as follows (Figure 7): first, the teacher lists the maximum grade level to be given. Then the number of grade intervals is set up. The next step is to confirm the operation. A new screen will appear for names to be attributed to the intervals and then the operation is fully confirmed (Figure 8).

As an example, suppose that the maximum grade is 10 with five intervals. On the name attribution screen, the interval from 10.0 to 8.0 would be called Excellent; from 8.0 to 6.0 – Good; from 6.0 to 4.0 – Regular; from 4.0 to 2.0 – Poor; and from 2.0 to 0 – Very Poor. In the case that intervals are not defined the default (shown in the example in Portuguese) will be used.

With the grades, the participation reports can show class averages, thus facilitating the evaluation of the learners by the instructor (Figure 9). The learners also can use the grades to orient their learning process, based upon the instructor’s evaluation of them, which according to constructivist theory is an example of the most competent pair; or the learner can seek more competent partners to set up sub-work groups.
The service was implemented so that the teacher could list the weight of course events (Figure 10), thus facilitating reflection about the most important activities.

**IV.2.10 Problems Found**

With relation to the validity and relevance of the grade system, the main concern in adopting this type of resource for evaluation of contributions is to remit the AulaNet to the traditional teaching model. The question is: who is capable of judging a contribution? In the case of the AulaNet, it was decided that the instructor would supply the grades. But are instructors capable of assessing whether a learner’s contribution has helped another learner favorably or unfavorably? The responsibilities for approving or failing learners may not be the main objective of the course.

The contribution “quantity + quality” approach was used by the instructor of students enrolled in the ITAE course for the 2nd semester of 1999. The fact is that the ITAE course for regularly-enrolled students mostly follows the traditional teaching model in which students must “pass” in order to receive credits. Until the conception of this paper the grading system had not yet been tried out in other situations and in other courses.

Another additional question is that the function of the giving out of grades to all contributions to a course could overload an instructor. The class of enrolled students of the ITAE 2nd semester 1999 course received some 350 productions during the period. The load on the instructor to give out grades is very heavy. Only by experimenting with other courses and during a number of successive semesters will it be able to determine the best way to use the grading system and if its implementation is valid.

**V Conclusions**

This article presented a study about dealing with information designed for perception. The first step was to delineate parameters between perception and the fundamental concepts of groupware—communication, coordination and cooperation. It is argued that, for group work, it is necessary that individuals communicate and coordinate among themselves. The coordination provides the means for the work to be carried out effectively so that it meets its objectives.

The problem of overload can be evidenced with the implementation of feedback. On the AulaNet one observes that part of the functionalities implemented implies new responsibilities for the instructor. The generation or not of a lot of information must be managed through experiments for its use. The new implementations are based upon observations that have been made with regard to the AulaNet environment, using the ITAE course as the main source of experience.

One of the objectives of the new mechanism that has been implemented is to facilitate the coordination of learners. The mechanism has been used in the accompaniment of the ITAE course, demonstrating that knowing about the progress of the learners of a course can lead to taking greater
advantage of the course’s subject matter as well as spurring healthy competition among the participants, thus increasing group production.

In the traditional teaching model, the teacher enters the classroom, looks around the environment and quickly identifies whether there is a presence of the majority of students. Because of the predominantly asynchronous nature of the AulaNet and the distributed scheme of the interaction, “quickly looking around” this new environment means to deal with a new teaching approach. The development of the mechanism for “Participation Follow-up” seeks to provide a new format for viewing participation in the course in a manner that orients both learners and teachers during the learning process.

Using the flow manager to take care of information was what made it possible to conceive of the “Participation Follow-up” mechanism. Other more complex mechanisms may be conceived as of the support offered by the manager. For example, the services can be based upon the information that is manipulated by the flow manager to change the strategy for sending feedback and to minimize problems such as overload, or even poor interpretation, of information.

In view of the fact that instead of supplying the group with coordination elements some of the AulaNet mechanisms permitted for the development of a new coordination mechanism, it was seen that the coordination diagram proposal was valid.

The purpose of the study that has been presented in this work is to contribute with research into collaborative computing for Web–based learning systems. Modeling the management of perception information in a shared information environment seeks to contribute to the implementation of Web–based systems. The aspects related to perception can be used to generate new groupware theories besides providing the generation of new functionalities or incrementing old ones in learning environments like the AulaNet.

VI Future Work

Although the references that were analyzed make the usefulness of this study clear, a lot of work still can be done to better evaluate the use of the perception concept in cooperative work. There are a series of paths to take for subsequent work, including:

- Analysis of the new mechanisms that can be implemented, conducting comparisons between already existing services and assessing their usefulness. Carrying out analyses about the mechanisms that have been implemented to support perception reveal the importance of this concept in the development of groupware. Regarding the functionalities that have been implemented, experiments with versions of courses could be proposed, using the participation follow-up mechanism and other versions that have not been used, so that the coefficient of the improvement in coordination can be known. The experiments help to refine the mechanism, for example by checking if the “quantity” and the manner in which feedback information is sent are appropriate for a learner’s development, if they overload learners/instructors or if they cause disturbances in the interpretation of action instead of collaborating;

- In general, the implementations realized can be extended in a manner that makes it possible, besides a system that grades the contributions, to allow both instructors and even learners to submit comments about the contributions of other members of the group. In this way one avoids simple grade giving, helping refine a contribution until it is good enough for the needs of the group. In this case, the learners would be developing a creative process through debate. An additional possibility would be to permit learners to also give out grades and “correct” their colleagues’ contributions, permitting the occurrence of a debate by exhibiting “opinions of opinions” related to the course’s subject matter.

- Even outside of the scope of the study, some details related to perception through the visual interface were implemented. Figure 1 distinguishes the ITAE course students who did not contribute in the “seminar contributions” category of the discussion group from those who did. When there is a need to view such behavior in other categories, all one needs to do is select it in the report guide.
The visual highlighting provides immediate information of a context that can be interpreted and used to define the preferences, or to anticipate the instructors’ or learners’ needs. Viewing the visual highlighting in Figure 11 helps to define which participants are not contributing to the course or who simply are having trouble in contributing within a given service.

As for future work, it would be interesting to conduct research into the field of interfaces, checking to see which perception information formats best express what the developers of groupware or learningware seek to present.

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VIII Bibliographic References


